User Guide for SAGA (Version 5.0)

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Reference:

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Acknowledgment

Most of the System for Automated Geo-Scientific Analysis or SAGA was created and developed by the working-group Geosystem Analysis (formerly associated with Göttingen University and currently with Hamburg University), headed by Prof. Dr. Jürgen Böhner. The current versions of SAGA are mainly due to the creativeness and participation of the core set of developers; namely Rüdiger Köthe, Andre Ringeler, Victor Olaya, Dr. Christian Caro, Dr. Volker Wichmann, Prof. Dr. Jürgen Böhner and, in particular Dr. Olaf Conrad, who shouldered the main programming work. However, SAGA would not have reached this level of sophistication without that multitude of methodical innovations cooperatively worked out by the working-group Geosystem Analysis as a whole in context with national and international environment related research projects.

Not being a member of the SAGA development team makes the creation of a SAGA User Guide particularly challenging. I am indebted, as is the SAGA user community, to Dr. Volker Wichmann, for the time and effort he invests in providing users technical answers to SAGA questions via the forums. This User Guide, and its earlier versions, would be impossible without Volker's input. As I put the Version 5.0 Guide together, I am continually reminded by my various notes and e-mails over the years, how much Volker's explanations have made it easier for all of us to apply SAGA.

I hope you will enjoy using this User Guide as much as I have enjoyed producing it. I continually am encountering subtle and powerful features in SAGA. Please feel free to e-mail me if you have any questions or suggestions for improvement. My e-mail address is:

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This User Guide for SAGA is contributed to the SAGA user community to, hopefully, assist the user in successfully applying the SAGA functions, tools, commands, and procedures in addressing applications specific to spatial analysis.

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Chapter 1 – Introduction to SAGA Version 5.0

Introduction

This User Guide is for version 5.0 of the software **S**ystem for **A**utomated **G**eoscientific **A**nalyses or SAGA, released on June 30, 2017. SAGA is a Geographic Information System (GIS) originally developed at Goettingen University in Germany. Several years ago the core development and software maintenance team moved to the University of Hamburg.

The development objectives for the SAGA program are:

- To give geo-scientists an effective but easy to learn tool for the implementation of geoscientific methods; and
- To make these methods accessible in a user-friendly manner.

The programming language for SAGA is C++. Program code relies on the GNU Lesser General Public License (SAGA API) and GNU General Public License (SAGA GUI, CMD and most of the tool libraries).

SAGA is Free Open Source Software (FOSS). The source code is readily available. The intention is for the software to be protected and remain open for modifications. The program can be distributed freely.

Complementing the functions and commands that are available in the core SAGA program are additional capabilities provided by tools. Earlier versions of SAGA referred to tools as modules.

The SAGA API is used to develop tools under the Lesser General Public License (LGPL). These tools are published optionally as part of the open source project. Authors of tools may choose that their tools be unpublished or distributed as proprietary software.

Two development paths have characterized the evolution of GIS software. These were grid (or raster) and vector. Eventually, as technological advances in hardware improved computer performance and expanded storage capability, hybrid GIS programs integrating grid and vector functions into the same program became feasible and available.

SAGA is a hybrid GIS with emphasis on grid functions. The vector capability of SAGA has gradually increased since early releases. For example, the "Shapes" tools library (a library of vector tools) in SAGA Version 2.0 had about 40 tools. The same library in Version 5.0 has 95 tools. These numbers do not reflect vector tools in other libraries. Although the emphasis is more on the grid functions as related to analysis, the vector side of SAGA has become quite powerful and capable.

There have been many definitions for GIS. What differentiates a GIS from other information systems is in the spatial or geographic component of the data. The data in a GIS is georeferenced. This means the definitions of data objects include their location on the surface of the earth. The power of a GIS is the capability to integrate any physical and socio-economic data objects linked to locations on the earth's surface for a geographic area and analyzing this data spatially to address a wide range of thematic issues of a geographic nature.

The U.S. Federal Interagency Coordinating Committee on Digital Cartography (1988) defined GIS as:

"A system of computer hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems." (U.S. Geological Survey Open-File Report 88-105, "A Process for Evaluating Geographic Information Systems", Technology Exchange Working Group, Technical Report 1. 1988.)

Traditionally, "Public Domain", relative to software, has meant software developed with public funds. Since public funds were used for its' development, it seems fair and just to have the product be available gratis to the public.

However, for many of us that have been users of public domain software products, we have come to realize, there is always a price. The price may be in extra time spent learning exactly how to use the program. The design and user interface may not be the most "user-friendly". Or, the price may be related to time learning how to work around software bugs that either were never discovered prior to release or were discovered and never fixed due to a shortage of funds and necessary support. And, quite often, the downside was, the developers did not have time to produce a user guide or software manual. This latter downside can be costly relative to the software being actually used by a user community or detrimental to the expansion of a user community.

Experienced users of a category of software wanting to use a public domain program often ignore the absence of a user guide or software manual. However, for others the lack of documentation can be a major obstacle that can eventually result with the program becoming too costly or frustrating to use except by the most highly motivated and challenged potential user.

This user guide is an upgrade from the Version 2.0.5 User Guide released in 2010. This guide, like its' predecessor, is intended to provide useful information for the various functions, capabilities, tools that are incorporated in SAGA 5.0 for spatial analysis. Much of the guide format is oriented around the organization of various menus in SAGA. The menus provide the general outline and the menu options and sub-options provide the details within the outline. Sometimes a menu option is encountered that will be briefly introduced and discussed in a later section or chapter in more detail. Every effort has been made to include all options on Menu Bar menus (the 3 standard plus the seven optional menus), features and commands available in the three tab areas of the Manager: Tools, Data, and Maps, and the many parameters supporting grid, shapes, and point cloud layers and tables.

A second volume to this User Guide is anticipated, time permitting, later in 2018 or early 2019. It will expand and update the ‘How To Do’ theme of volume 2 of the Version 2.0.5 User Guide. The topics covered include SAGA basics, deriving grid layers from DEM’s, a recreation suitability analysis, using SAGA tools with digital satellite data, delineating view sheds for visual impact assessment, on-screen digitizing for shapes layers, using the four SAGA buffer tools, and more. The emphasis in these chapters is not so much on the content and applications described but on the application of SAGA features and tools.

Organization of this User Guide

This volume is focused primarily on the user interface and what I characterize as core GIS features. You will find that functions, tools, and commands in SAGA are found in these general areas: in the tool libraries, Menu Bar menus, on the toolbar, and in the Manager window. This volume extensively explores the Menu Bar and toolbar supported tools, functions and commands and a few of the tool libraries providing more generic GIS capability.

Chapter 2 explores what I refer to as the standard Menu Bar menus: File, Geoprocessing, and Window. The options available in the menu dropdowns are presented. In addition to the standard Menu Bar menus are seven action-dependent menus.

The Manager window has three primary tabs: Tools, Data, and Maps. The Manager Tools tab options and parameters are the subject of Chapter 3. Chapter 4 covers the options and parameters related to the Data tab and Chapter 5 describes options and parameters available in the Maps tab area of the Manager.

The Menu Bar Map menu dropdown options are described in Chapter 6. The interim or action-dependent menus 3D View, Layout, Histogram, Scatterplot, and Diagram are discussed in Chapter 7. Chapter 8 explores the interim Table menu and several related table options.

Each of the three layer types is supported by its' own set of parameters or settings. The parameters for grid layers are described in Chapters 9, for shapes layers in Chapter 10, and for point clouds in Chapter 11.

About the Examples

Most of the examples in this guide involve layers from a database I developed for the area of Mason County, Washington, USA. The state of Washington is located in the northwest U.S. on the Pacific Ocean (Figure 1-1).

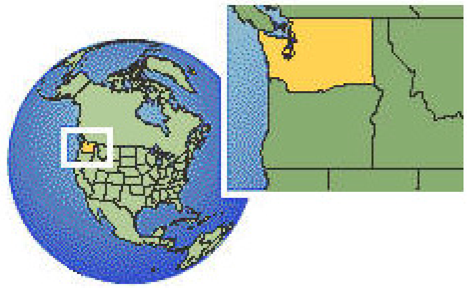


Figure 1-1. Location of Washington State, USA.

Mason County is in the western part of the state, west of the Cascade Mountains bordering south Puget Sound (Figure 1-2).

Figure 1-1 Mason County, Washington State.

The county is 1051 square miles (2722 square kilometers) in total size. About 8.56% of the total area is water. The population for the county in the 2015 census was estimated to be 61,023. Population density is fifty-nine people per square mile (twenty-two people per square kilometer).

The single incorporated city and center for county government is Shelton. Unincorporated communities include Allyn, Belfair, Grapeview, and Skokomish.

A rectangle bounding the county, has approximate corner geographic coordinates (latitude and longitude and UTM Zone 10 meters) as follows:

	Latitude	*Longitude*	*Easting*	*Northing*
NW	47º 36’ 43.8”	123º 30’ 39.8”	460553	5274230
NE	47º 36’ 43.8”	122º 47’ 42.3”	516696	5274230
SW	47º 04’ 31.9”	123º 30’ 39.8”	460553	5213287
SE	47º 04’ 31.9”	122º 47’ 42.3”	516696	5213287

The primary grid system used in this Guide is a rectangular window of rows and columns defining Mason County, Washington consisting of 585 rows and 539 columns of grid cells. The total number of grid cells is 315,315; each grid cell is 104.37 meters by 104.37 meters in size. I have included some examples of grid systems using smaller cell sizes.

I have supplemented this dataset with many layers developed in the ArcGIS environment by the Mason County GIS Group. The layers available from the County use the Washington State Plane Coordinate System South zone. All layers referenced in this Guide use the Universal Transverse Mercator Zone 10 North coordinate reference system.

The grid and shapes layers used in the examples are typical layer themes one encounters in a GIS environment. I have chosen to provide details in how to use the SAGA commands, tools, and functions with these layers as well as providing a sample dataset. These datasets are available for downloading from the SourceForge website at the same location the updated SAGA User Guide is available.

The best way to learn SAGA using this guide is to follow the examples using either the sample dataset or your own layers. Once you get started you will find that SAGA is easy to use. I would encourage you to use your own layers as much as possible.

Standards and Conventions
Several steps are involved with selecting something using the mouse. The process for making a layer active is described below.

What is an active layer? I make a layer or map view window active by clicking with the mouse on the layer name as it is displayed in the Data tab area of the Manager or on the map view window name as it is displayed in the Maps tab area of the Manager.

I move the mouse pointer over the Data tab in the Manager window and press the left mouse button. The list of layers in the Data tab area displays. I move the mouse pointer over the name of the layer I want to make the active layer and press the left mouse button. The layer name in the list becomes highlighted. If I go to the Settings tab area of the Object Properties window I will see that the parameter settings are for the active layer. This same process is used to make a map view window active. In the text I will often refer to the active layer or make a layer the active layer and not explain in detail how to do that.

The above description serves two purposes. First, it explains how to make a layer or map view window the active layer or active map. Secondly, it describes the sequence of steps using the mouse to accomplish this task. SAGA operates in a windows environment. There are many tasks requiring an action with the mouse. Rather than describe the sequence of steps in every example, I often will shortcut the description with the words "click on it with the mouse" or "right-click on it with the mouse" (in this latter case press the right mouse button while clicking on it with the mouse).

Three categories of layers are supported in SAGA: grid, shapes, and point cloud. Grid layers are sometimes referred to as rasters, primarily because of their structure. In SAGA, satellite images or satellite rasters become grid layers. Shapes layers support 4 primary object types: point, multipoint, line, and polygon. Shapes is another term for referring to vectors layers. Unlike grid layers that have a row/column or matrix like structure, vector objects are defined by points or vertices, defined by X and Y coordinate locations. Lines and polygons include further instructions defining the logical link (either as a line edge or polygon edge) between points. Usually I am consistent in referring to grid layers and shape layers.

Many parameters are what I call "toggle check box" parameters. That is, the value field to their right contains a check box used to toggle between on and off status. Move your mouse pointer into the check box and press the left mouse button and it toggles the status of the box between on and off. A check mark in the box indicates, normally, that the parameter is toggled on while the lack of a check mark indicates the parameter is toggled off. Rather than repeat this explanation every time a check box parameter is encountered, I sometimes indicate that it is a check box type parameter and assume the reader understands how they operate.

Many of the examples involve one or more grid layers. Grid layers are members of a specific grid system defined by a spatial extent and cell size. When a grid layer is loaded into a SAGA work session, if the grid system it is a member did not already exist for the session, it becomes listed along with any other loaded grid systems. Grid tools generally have a grid system parameter that must be chosen first before a member grid layer can be selected for a grid input parameter.

Execution of many tools is done using an Okay button that is part of the parameter window. I move the mouse pointer over the button and press the left mouse button. The tool then executes using the current parameter settings. Rather than repeat this explanation for every tool description, I am going to assume that referring to clicking on the Okay button to execute the tool is understood and the reader will know the procedure. This same convention is true for Yes and No buttons.

Changes to parameters in the Settings tab area of the Object Properties window are often enabled using a two-step process. Some parameters require the pressing of the keyboard Enter key following the change. Clicking with the mouse on the Apply key at the bottom of the window is often the final step for enabling a parameter change.

All of the shapes, grid, and point cloud layers used in this volume are using the coordinate reference system Universal Transverse Mercator, Zone 10 North.

A lot of technical terminology is part of GIS and SAGA. I distinguish between parameters and options. I enclose a specific parameter name with apostrophes. There may be times when a parameter is referred to as a setting. Menus have options. A menu option is enclosed by quotations. Also, quotations surround attribute names and data field references in dialogs or dialog windows. Often attribute names are in capital letters.

I do not use quotations or apostrophes around references to sub-headings, titles in tab areas of the Manager, or button names. Nor are they used around view window references, e.g., I use map view window or 3-D view window and not 'Map View' window or '3-D View' window.

There is one option that is a challenge. This is the "Action" option. Due to its' extensive role in interacting with layers, map view windows, etc., in the Manager I tend to consider it a tool rather than an option. However, technically what used to be called modules are now called tools so there is an inconsistency. But I am going to refer to the Action tool, no quotes.

Chapter 2 – The Menu Bar Menus File, Geoprocessing, and Window

Overview
The Graphic User Interface (GUI) in SAGA is the interface between SAGA functions, commands, tools, geographic data and the user. The GUI in SAGA is a Windows-like implementation.

Introduction to the SAGA project and spatial environment
SAGA tools and capabilities support the creation, management, and manipulation of three general categories of spatial layers: grid, shapes, and point cloud.

In grid layers, numeric data values in grid cells describe a layer theme for the matrix of cells defining a grid layer. Data values in a grid layer are for a single attribute or theme; every grid cell in the study area characterized by the attribute has a value recorded for the attribute while other cells will be populated by zeroes or no data values. For example, if the layer theme is elevation, every cell in the study area will have an attribute value for the elevation in each grid cell. A road network grid layer will have data values for grid cells traversed by roads. Grid cells outside of the road cells will contain the data value 0 or a no data value.

The spatial definition of a grid system (in many cases a study area) consists of its' grid cell size and the matrix of rows and columns of grid cells covering the area. The grid cell size and shape is the same for each cell in the grid system. The cell size is often referred to as the data resolution for the grid system or study area. Once a cell size is defined, a matrix of rows and columns of grid cells spatially define the study area based on the map extent of the area.

A study area may have an irregular shape. For example, a study area boundary may be defined by a watershed boundary or a political administrative boundary (e.g., a County). The spatial extent of a study area is a rectangle that fully encloses the study area. Grid cells not within the study area but within the spatial extent contain a no data value.

A grid cell layer in SAGA can be made up of as many as five data files. The .sgrd file is an ASCII header file and the .sdat file format is a binary format for the grid cell data. A history file uses the .mgrd format. If there is information for the projection and coordinate reference system it is stored in a .prj file. There may be a .sdat.aux.xml file. This file contains geospatial metadata. All the files together make up the layer.

The shape format is a common, non-topological vector format developed by the Environmental Systems Research Institute (ESRI). ESRI permits shape files as an open format to be used in GIS software particularly for data transfer.

There are two main parts to a vector or shape layer. The spatial part defines the geometry and locations of the features or objects making up the layer. The second part is tabular. Unlike grid layers that are single dimensional related to attributes, shape layers are multi-dimensional related to attributes. One or more characteristics can be linked to each object occurring in a shape layer. These characteristics are stored in an attribute table file.

A shape layer will contain one of three types of geometric features or objects: points, lines, or polygons. A point object is a point defined by a single coordinate pair; an X and a Y coordinate. Examples of point shape layers are nesting sites, wells, fire hydrants, etc. There is a variation of points called multi-points. It is supported as an object but is encountered rarely.

A second category of shape layers is line or linear features. A line is defined as one or more connected line segments or edges. An edge has a beginning point (an X and Y coordinate) and an ending point (an X and Y coordinate) and logic connecting the two points with a straight line. In SAGA, these points are referred to as vertices. Examples of line object shape layers include roads, streams, power lines, etc.

The third category of shape layers is polygons. A polygon is three or more connected line edges enclosing an area. Examples of polygon shape layers include soil types, lakes, census tracts, counties, etc.

When the SAGA software stores a shape layer, the layer involves five separate files. Two of the files are in .shx and .shp binary formats. These files contain the feature geometry and a shape index. A history file is stored in the .mshp format. This file identifies the options used to create the layer. Projection format and coordinate system information is stored in a .prj file. Attribute data related to the layer objects is stored in a dBase .dbf file.

Point cloud layers have some similarity to point shape layers. The objects are points or vertices defined in a three-dimensional coordinate system, i.e., X, Y, and Z coordinates. Unlike grid and shape layers that involve up to five data files, a point cloud layer is stored as a .sg-pts-z zip file. There are two files. One is in the *.sg-pts format and is the point cloud data. The second one is a*.sg-info file and is a metadata file. A history file is part of the metadata file.

Many of the spatial analysis commands and tools in SAGA involve grid layers. Generally, in order for SAGA spatial analysis commands to involve two or more grid layers, the grid layers are from the same grid system. The grid layers within the same grid system have the same grid characteristics. They use the same grid cell size, have the same number of rows and columns, have the same map extent, and use the same coordinate reference system.

When I have an analysis requirement involving grid layers from different grid systems, the *Grid-Tools/Resampling* tool can transform or convert them to a common grid system. However, if the requirement is a viewing requirement as compared to a spatial analysis function, layers from different grid systems as well as shape layers can be part of the same map view window if they all use the same coordinate reference system.

Some SAGA spatial tools do accept input of grid layers that are members of different grid systems. These include, for example, *Grid - Calculus/Grid Calculator*, *Grid - Tools/Mosaicking*, *Grid - Tools/Patching*, and *Grid - Tools/Grid Masking*.

While grid layers are always part of a grid system, vector or shape layers have no comparable organization or spatial organizing structure. A grid system provides structure, map extent, a common coordinate reference system and cell size for its member grid layers. Shape layers, in comparison, strive for independence. In order to work with other layers, shape layers must have a common coordinate reference system. Their map extents can differ. They do not have to be the same shape type to view in the same map view window. There are many tools designed around different shape input types.

Introduction to the SAGA Graphical User Interface

The major parts of an opening SAGA window display or work area are labeled in Figure 2-1. This User Guide is about explaining all of these components and the tools, functions, and commands they support.

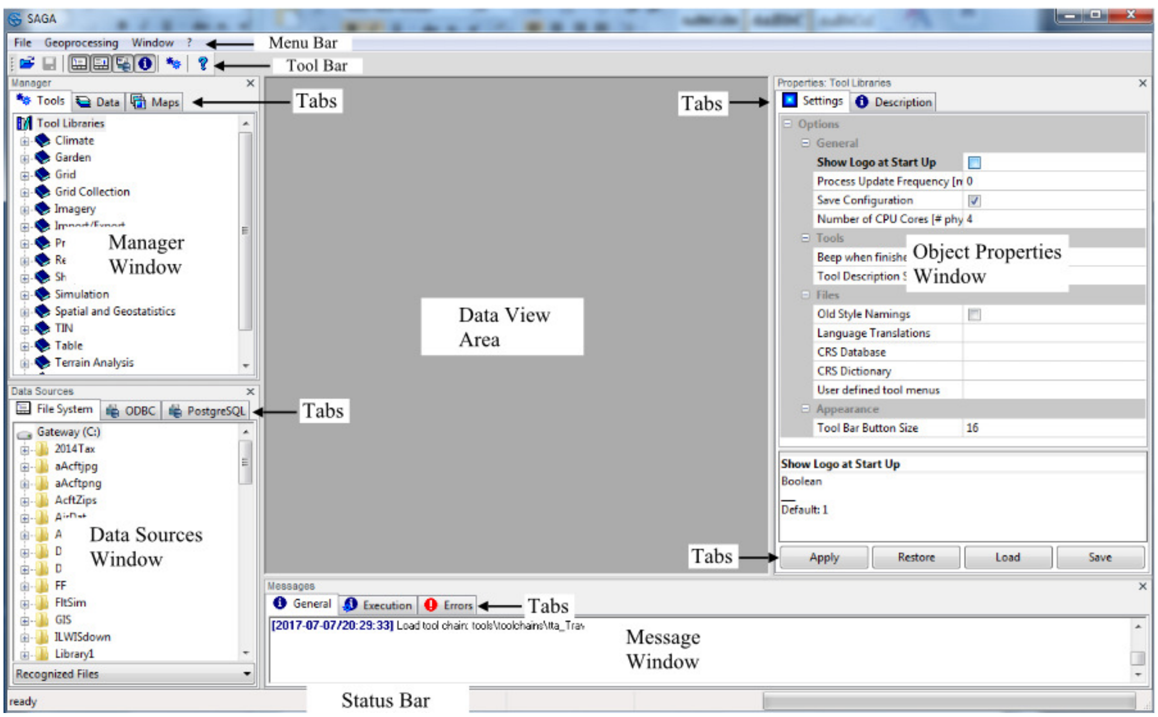


Figure 2-1. The parts of a SAGA work area window.

Immediately below the "SAGA" window title is the Menu Bar and toolbar.

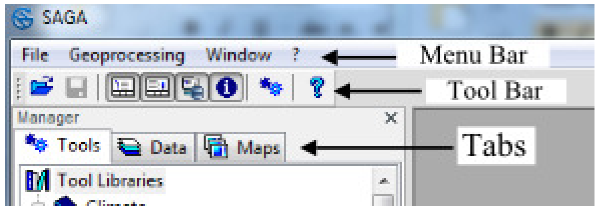


Figure 2-2. Zoomed in view of the Menu Bar area.

The Menu Bar standard menus are File, Geoprocessing, and Window (see Figure 2-2). Additional menus become available depending on specific options or actions chosen. For example, if a map view window is the active window in the data view area, a Map menu is added to the Menu Bar.

The toolbar icons are shortcuts for many of the options available on Menu Bar dropdown menus. What I refer to as topical toolbar sets are appended to the standard toolbar set. For example when a 3D view window is displayed in the data view window, a set of toolbar icons for the various commands associated with manipulating the 3D view, is added to the toolbar. Special toolbar sets disappear when the action they support is no longer in effect.

In Figure 2.1, I see four windows or panels. Each includes its own set of tabs.

The Manager and the Object Properties windows are the most used of the four window types. The Manager window has tabs for tools (used to be called modules), data, and maps. The Tools tab area is one of two approaches for choosing a tool. The other approach uses the Menu Bar Geoprocessing menu.

The Data tab area of the Manager provides a view of what layers and tables are available in the current work session. These can be layers and tables brought into the work session when the work session first opens. This will be the set of layers and tables in the work session at the time of the immediately prior exit from SAGA.

Layers and tables in the Data tab area list also result from using the load command, for loading a project, from an import tool, or output from a tool execution.

The layer list is structured by layer type. Grid systems and member layers are at the top of the list followed by a section for point clouds. Shape layers are organized by object type, i.e., line, points, and polygon. The last section in the list is for tables.

The third tab on the Manager window is Maps. When a layer displays in the work area it displays in a map view window. A text definition of the map is in the Maps tab area of the Manager. The map has a name. Below the map name is listed the one or more layers that make up the map. A map and map view window are the same.

Two other tabs serve the Manager window: Tree and Thumbnails. These tabs support two distinct views of the Data and Maps tab areas. The tree view is a text view of the content in a tree-like structure. The thumbnails view uses thumbnails rather than text names for the content.

The Object Properties window has five possible tabs: Settings, Description, History, Legend, Attributes that relate to layers. The Settings, Description, and Legend tabs are used with layers and maps, and the Settings, Description, and History tabs are available for tables.

Many of the parameters displayed in the Settings tab area support how a grid or shape layer displays in a map or map view window. The parameters supporting grid layer are different from parameters supporting shape layers although there is some overlap. In addition, the parameters supporting shape layers vary depending on the shape type or object, i.e., point, line, or polygon. Each layer type has a chapter in this user guide explaining the parameters and their settings (Chapters 9, 10, and 11).

The Description tab displays descriptive information for a layer, map, or table. I cannot edit this information from the Description tab. However, much of the information is dependent upon parameters in the Settings tab.

The History tab displays information on the options of how the layer or table was created. The Legend tab is a visual display of the layer or map legend.

A major role for the Action tool on the toolbar is to select a grid cell, a shape object, or a point cloud vertex. The data value stored in a selected grid cell or matrix of grid cells, the attribute values for a selected object, or the attribute values for a selected point cloud vertex, will update the content of the Attribute tab area of the Object Properties window.

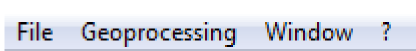
The Messages window has three tabs: General, Execution, Errors. Time stamps are entered when layers are loaded and tools executed. This information displays in the General tab area. More detailed information about tool execution displays in the Execution tab area. Error messages show up in the Error tab area.

I have not used the Data Sources window. It is related to SAGA implementations that take advantage of particular databases or other special processing environments.

I usually refer to the data view area as the work area. The space for displaying map view windows and tables is what remains in the overall Saga window once the several panels summarized above are displayed and located.

Everything summarized above is described in more detail in the chapters of this user guide.

Menu Bar

The Menu Bar: 

The Menu Bar has three default titles; each is a dropdown list of options. The File dropdown menu supports loading various SAGA objects such as grid, shape and point cloud layers, projects and tables. The Geoprocessing dropdown menu provides access to SAGA tool libraries. Managing the availability of the Manager, Object Properties, Data Source, and Message windows in the work space is controlled by the options available in the Window menu.

When I execute SAGA without loading layers into the work session, the Menu Bar appears as displayed in Figures 2-1 and 2-2. Additional menus display between the Geoprocessing and Window menu names depending on actions I choose in the work session. For example, I execute SAGA and choose the "[empty]" option on the opening 'Select Startup Project' dialog window. No layers are loaded for the opening of the work session. I use a "Load" command to load a layer. I double-click on the loaded layer name in the Data tab area of the Manager window. The layer displays in a map view window in the work area. As soon as the map view window displays, a new menu, named Map, displays on the Menu Bar (between the Geoprocessing and Window menu names) along with a topical set of icons for the toolbar. In this chapter, I will introduce the default Menu Bar menus: File, Geoprocessing, Window.

When the Menu Bar displays the three default menus, the menu options can also be chosen by the eight icons visible on the toolbar.

Figure 2-3. The default Toolbar set of 8 icons.

Here is a cross-reference between the eight toolbar icons and their corresponding Menu Bar options.

Toolbar Icon	Menu Bar Command
	Load
	Save Project
	Show Manager Window
	Show Object Properties Window
	Show Data Source Window
	Show Message Window
	Find and Run Tool
	Help

As I access the various commands and tools in SAGA, additional menus appear on the Menu Bar depending on a particular action. Each menu has a corresponding topical set of icons that are added to the toolbar. These additional Menu Bar menus are Map, 3D-View, Histogram, Layout, Diagram, Scatterplot, and Table. These additional menus are described in Chapters 6, 7 and 8.

Menu Bar: File
File is the left-most default menu on the Menu Bar.

When I click on File, the dropdown list of options in Figure 2-4 appears.

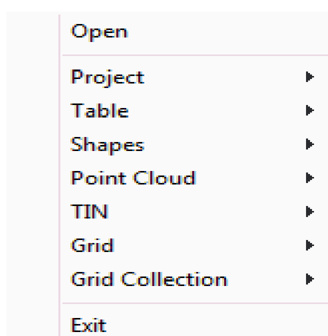


Figure 2-4. The Menu Bar File dropdown menu of options.

File: Open
Clicking with the mouse on the "Open" command displays the 'Load' window in Figure 2-5. This "Open" option is like a general-purpose open option as it can open any layer type or table.

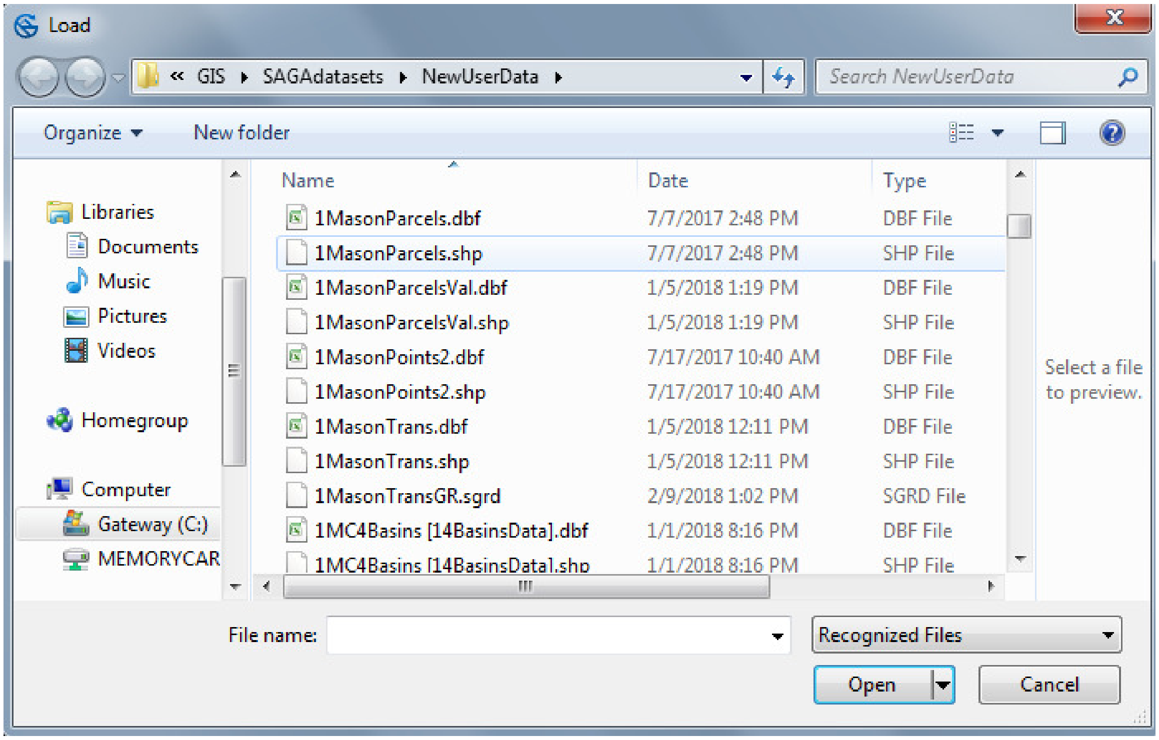


Figure 2-5. The 'Load' window.

The 'Load' window allows the user to open any number of different SAGA layers and tables. In Figure 2-5, I can see that the first file in the list is '1MasonParcels.dbf'. This is a dBase .dbf file. It is the attribute table linked to the file in the list named '1MasonParcels.shp'. This is a polygon shape layer. Near the bottom of the list is a grid map named MasonTrans.sgrd'. There are actually 4 or 5 files stored for a grid map layer, one of which is the .sgrd format file. The same is true for a shape layer; at least 4 files store a shape layer. The additional support files are not listed because the list in the 'Load' window is a list of tables and layers and is not a files list as displayed for a folder. This is also why I do not see all of the files associated with the '1MasonParcels' layer. The dBase file is unique as it is also treated as a table file independent of its role for a shape layer. I can select one or more map layers or table, of any type, to open.

Using this "Open" command is a generic variation of the File menu choices. I notice in the field to the right of the "File name:" information field a button used for narrowing down the list of displayed files in the window according to layer type or tables. There are nine options including "Recognized Files" (the display in Figure 2-5) and "All Files".

The "All Files" options displays the full contents of the folder. For example, all of the files making up a grid or shape layer display. The other seven options are more specific.

Each one narrows the display to one SAGA object type: tools (*.dll, *.so, *.xml), projects (*.sprj), grid layers (*.sgrd, *.sg-grd-z), grid collections (*.sg-gds), shapes layers (*.shp), point clouds (*.spc, *.sg-pt, *.sg-pts-z), or tables (*.txt, *.csv, *.dbf).

File: Project - Overview
I think of a project as a SAGA entity for logically associating one or more grid systems, grid layers, shape layers, tables and map view windows that I want associated or linked together for a particular purpose or theme. When I want to load a group of logically related layers into a SAGA work session, I can load a defined project rather than each individual layer or table. Zero or more projects can be loaded for a work session. I can add additional tables or layers as needed. Or, I may choose to not load a project but to load individual layers and tables.

I find that I define projects based on geographic area of coverage, theme, or issue. For example, I have a project defined for Mason County, Washington. Most of the grid and shape layers related to Mason County are included in the project. I also have a project defined for a viewshed analysis. The grid and shape layers all relate to defining the viewshed for a fire lookout tower on the Olympic Peninsula. Another project I have involves grid and shape layers for analyzing mass movement susceptibility. Projects can help organize large numbers of layers into logical groupings based on a spatial or topical theme. A layer, table or map can be a member of more than one project.

If I delete a layer from my desktop (or move it to a different storage location) that is included as part of a project, when I re-load the project the layer cannot be found and is not loaded into the work session.

The project file actually is a configuration file for a specific time and operating environment. The file contains storage paths to where data files related to work session layers, tables, and map view windows are stored. Many of the display parameter settings for layers listed in the Data tab area of the Manager, are saved in the project and configuration files along with map view window definitions. These parameters are described in detail for grid, shapes and point cloud layers in Chapters 9, 10, and 11 in this volume. In general, these parameters relate to defining the name that SAGA uses for a layer, how text is displayed, what colors are used for displaying data, grouping data values for color emphasis, memory handling, etc. As you can see a project file does not contain actual data values related to grid, shape, and point cloud layers. The project file contains storage paths to where data files related to layers and tables are stored and the display parameter settings for the features at the time the project file is created or saved. A project file is like a configuration file.

Users can modify the layer defaults. When I define a project, the current layer parameters (a “project” definition) are saved along with the layer name as belonging to the project. The project level layer parameters are independent of the layer data values. Each time I load the project, any modified layer parameters are also loaded. It is important to remember that parameters are not stored as data as part of the grid layer storage. They are stored as part of the project environment related to the SAGA GUI. Since they are not stored as part of the grid layer storage file, they are not available for use in command line arguments.

The SAGA project file format is .sprj. Project files can be saved in any folder. As a convenience, I have a folder named "Projects" and this is where I save all my project definitions. I save my layer files in different folders usually named for the study areas.

The project has a role when I start and exit a SAGA work session. There is a 'Startup Project' parameter that controls how SAGA saves a work session environment or does not save the environment. I can view the properties of this parameter using the Settings tab in the Object Properties window. If the Object Properties window is not visible, I can click on the 'Show Object Properties Window' command in the Menu Bar Window dropdown menu. When the Object Properties window appears on the screen, I click on the Settings tab.

I display the Object Properties window and click the mouse on the Data tab at the top of the Manager window. Next, I click on the "Data" title at the top of the layer list in the Data tab area. The Settings tab area of the Object Properties window is updated. An updated Settings tab area displays in Figure 2-6.

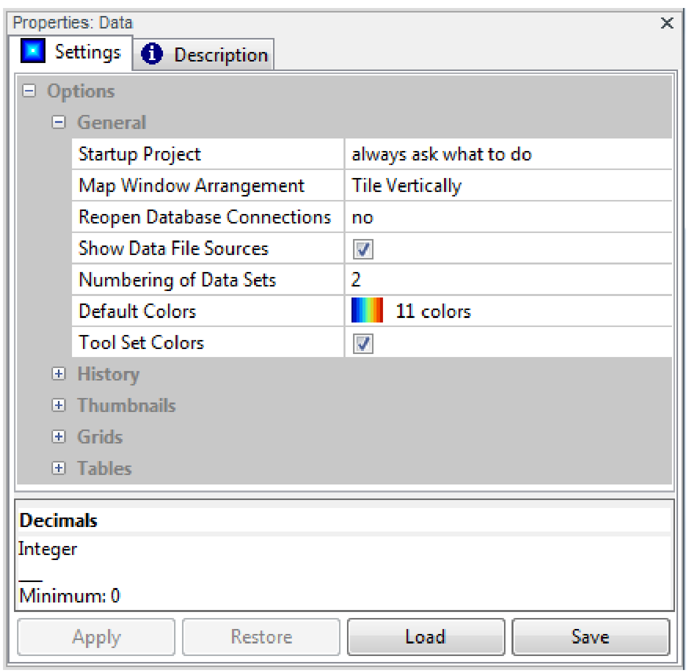


Figure 2-6. The 'Startup Project' parameter.

I can see that there are five sections in the 'Settings' area: General, History, Thumbnails, Grids and Tables. The + boxes on the left indicate that all except the "General" section is collapsed. The box to the left of the "General" title displays a minus symbol. This means it is expanded so I can view the parameter settings available.

The 'Startup Project' parameter (see Figure 2-6) at the top of the options has three choices. The default setting is "always ask what to do". The other two options are "empty" and "last state". The choice for the 'Startup Project' parameter is important to how a SAGA work session begins and how SAGA exits from a work session. When I make a change to the ‘Startup Project’ parameter, I must click on the Apply button near the bottom of the Object Properties window for the change to be applied.

Select Startup Project: "always ask what to do" option
When the default "always ask what to do" option is used for the 'Startup Project' parameter, when I start up SAGA a dialog window displays like the one in Figure 2-7.

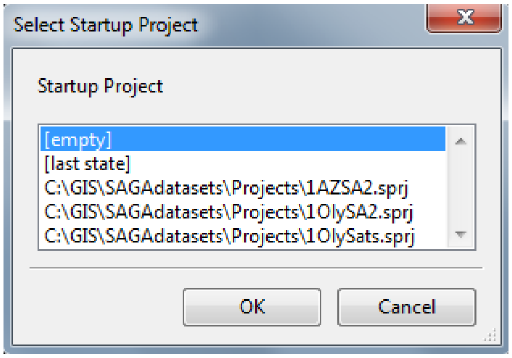


Figure 2-7. Opening dialog window.

The 'Startup Project' dialog is asking the user what next. If the "[empty]" option is chosen, the work session opens. No project is opened nor are any layers or tables loaded.

If the "[last state]" option is chosen, the configuration file created by the previous SAGA exit, is used to restore the layer and display environment of the previous exit. If the entry for the 'Startup Project' parameter at the time of the previous SAGA exit is "empty" the new work session will be "empty" as well. Even though a configuration file was created from the previous SAGA exit, the "empty" option means the 'Select Startup Project' dialog window does not display for the next startup.

Select Startup Project: "empty" option
Choosing this option results in an empty work session for the new SAGA startup. The 'Startup Project' dialog window does not display on startup. No project is opened nor are any layers or tables loaded for the new work session.

Select Startup Project: "last state" option
The 'Startup Project' dialog window does not display. The startup work session content is defined by the configuration file created at the time of the previous exit from SAGA. The layers, map view windows, display parameters for layers and maps, etc., are restored to replicate the work session previously exited.

The 'Startup Project' dialog window also supports the option of loading any one of up to 17 of the most recently loaded projects for a work session. I can see in Figure 2-7 the first 3 projects of the 17. The first three are 'AZSA2', '1OlySA2', and '1OlySats'. Choosing any project in the list loads the project into the work session.

The ‘Project’ menu in the Menu Bar File title dropdown menu has six choices that display when I click the mouse pointer on the File title.

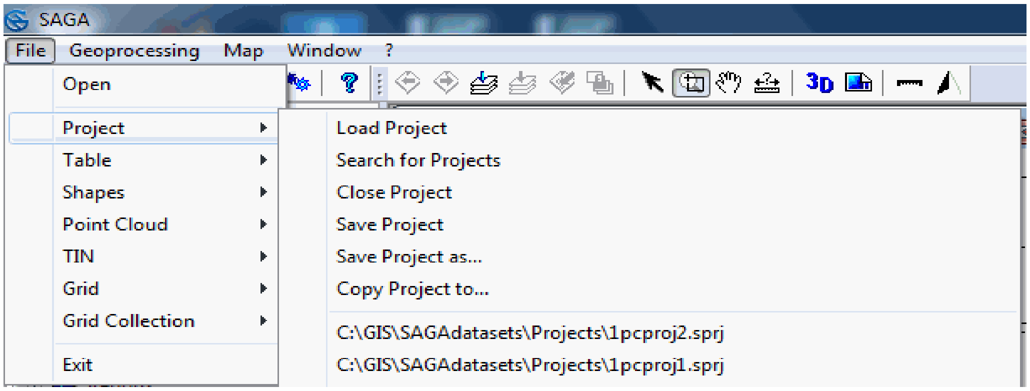


Figure 2-8. The Menu Bar File "Project" options.

The list of options in Figure 2-8 are available from the File menu option "Project".

File: Project: Load Project

If I choose the "Load Project" option, a 'Load Project' window similar to the one in Figure 2-9, displays.

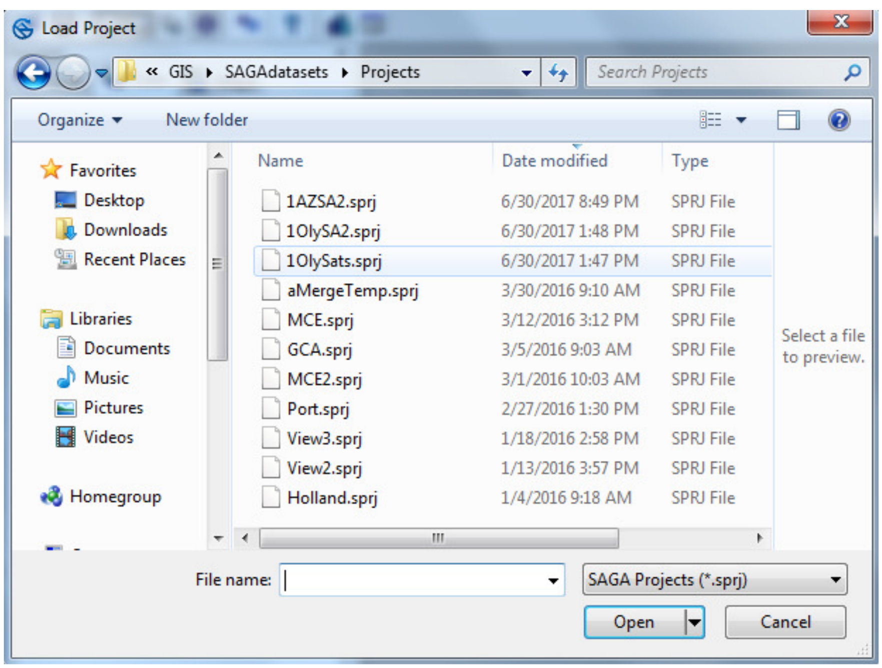


Figure 2-9. The ‘Load Project’ dialog window.

In this example, the dialog window displays the content of my projects folder. Project definition files can be stored in any folder; I store mine in a folder named "Projects". If my projects folder does not display, I can use the Windows navigation tools to browse to its' storage location.

I choose a project file by clicking on it with my mouse. Once the name is selected, it is automatically entered into the "File name:" data entry field near the bottom of the dialog. Alternatively, I could key the project name into the data entry field from the keyboard.

More than one project can be opened in a work session. If layers have already been loaded into the current work session, regardless if from loading a project or using a load command, when I click on the Open button on the ‘Load Project’ dialog, the 'Load Project: Close all data sets' dialog in Figure 2-10 displays. If no layers exist for the current work session, this dialog window is not displayed.

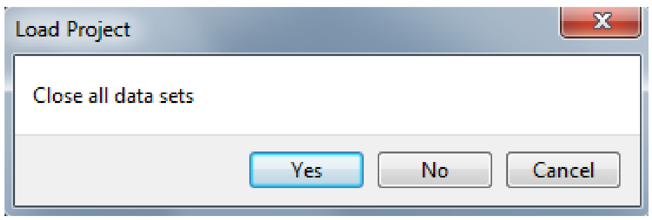


Figure 2-10. The "Close all data sets” message.

If I want the new project being loaded to replace any project or layers already active in the work session, I can click the Yes button in the ‘Load Project’ dialog window. All data sets in the current work session will close and new ones associated with the selected project loaded. I can click the No button, existing data sets remain, and additional ones from the loading project are added to the work session.

Once the loading is finished, when I click on the Data tab, a list of all the currently loaded layers displays, using the tree structure. I can change the display from the tree structure to thumbnails by clicking on the Thumbnails tab.

Clicking on the Cancel button on the ‘Load Project’ dialog window closes the ‘Load Project’ window and exits the option.

File: Project: Search for Projects
The first step in using this option is to identify a folder containing project files. The 'Search for Projects' window in Figure 2-11 displays when I choose the 'Search for Projects' option.

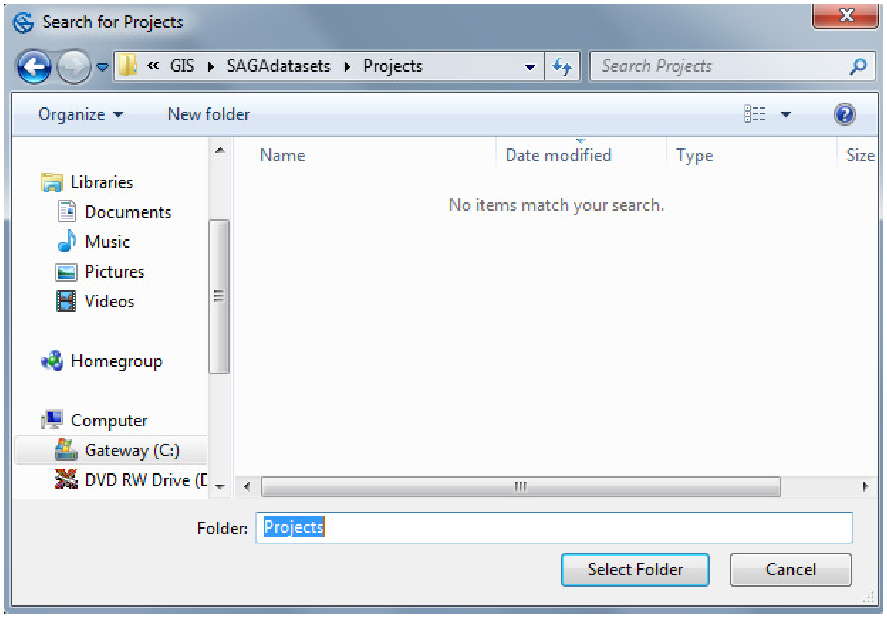


Figure 2-11. The 'Search for Projects' dialog window.

The purpose of the 'Search for Projects' window is to navigate to a folder containing project definitions. Once the folder name displays in the path field at the top of the window, I click on the folder name in the path. The folder name copies into the data input field to the right of the "Folder:" name near the bottom of the window. Then I click on the Select Folder button to continue.

As noted earlier, I store all of my project files in a folder named "Projects" even though a project file can be stored in any folder.

An 'Open Project' dialog window now displays. See Figure 2-12.

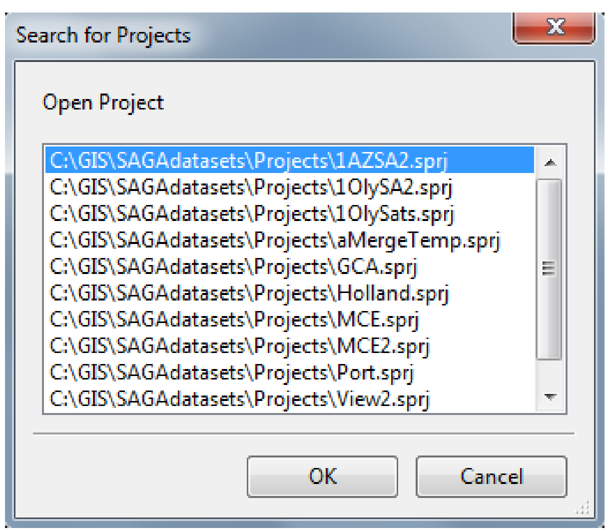


Figure 2-12. The 'Open Project' dialog window.

When I click on a project name and path in the dialog window, the process to load the project starts.

File: Project: Close Project
I use this option when I want to close an active project in the work session. If I have multiple projects loaded I do not have the option of closing only one; this is an all or nothing option. The 'Close' dialog window in Figure 2-13 displays.

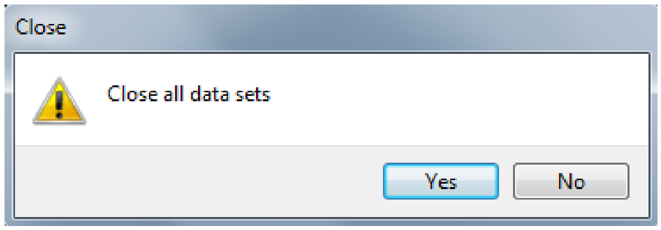


Figure 2-13. The 'Close' dialog window.

Clicking on the Yes button signals that I want any active project closed. By clicking with the mouse on the No button I can exit this window without closing projects.

File: Project: Save Project
When I have loaded a project into the current work session, if I update the project by creating new layers or tables, I can save the modified project using the "Save Project" option. SAGA automatically re-saves the modified project using the most recently used project name.

If I have not loaded a project as part of a work session, when I choose the "Save Project" option, the 'Save Project' dialog window in Figure 2-14 displays.

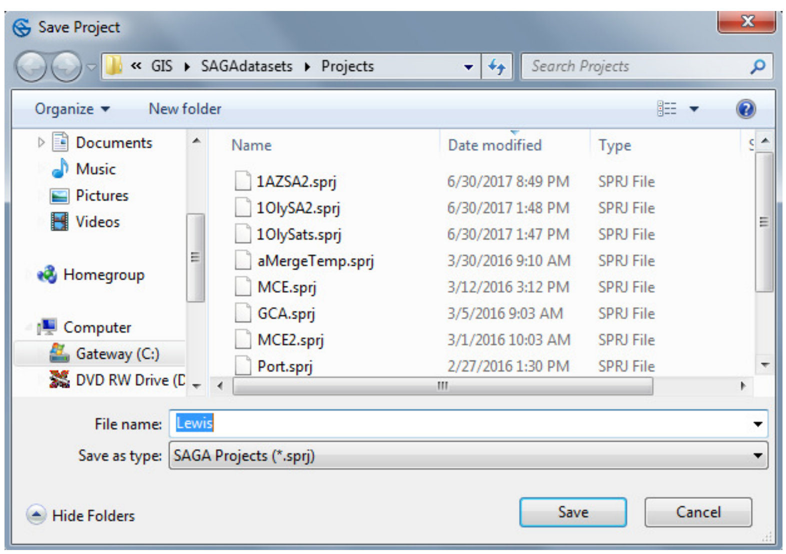


Figure 2-14. The 'Save Project' dialog window.

I am naming this project file "Lewis" so I key "Lewis" into the entry field for the file name.

I could use one of the existing project names in the list by clicking with the mouse on the existing name. This would enter the selected name into the "File name:" data field. Since the name already exists, the 'Confirm Save As' dialog window in Figure 2-15 displays. Clicking on the Yes button means the project parameters for the current work session environment replace the ones for the selected existing project name.

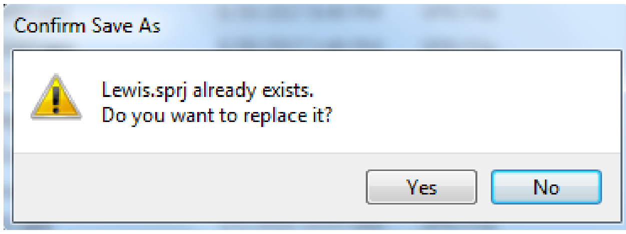


Figure 2-15. The 'Confirm Save As' dialog window.

In this example, I am going to use "Lewis" as the project name. I click on the Save button and the new project "Lewis" is defined and saved. Display parameters for all grid systems, grid layers, shape layers, point clouds, map view windows and tables loaded in the current work session are saved as the 'Lewis' project.

If I re-load the 'Lewis' project file, the same working environment as existed when I defined the project, is re-stored. This would include any grid systems, grid layers, shape layers, maps and tables that had been active in the work session.

It is not unusual to load more than one project into the same work session. When multiple projects exist in the work session, when I use the "Save Project" option, the current work session project environment is saved using the most recently used project name.

File: Project: Save Project As…
When the "Save Project" option is used, the current display parameters for layers, map view windows and tables loaded in the Data and Map tab areas of the Manager automatically save using the most recently used project name. If I do not want to use the most recent project name, I can use the "Save Project As…" option to assign a new project name.

In this example, I have two projects loaded. One is named ‘Mason’ and the other is ‘Grapeview’. I am going to save the two using a new project name “Mason-Grape” to reflect the combination of layers for all of Mason County (cell size of 104 meters by 104 meters) and layers for the Grapeview school district (part of Mason County) with layers using a cell size of 30 meters by 30 meters. I click on the "Save Project As…" option. The ‘Save Project’ dialog window in Figure 2-16 displays.

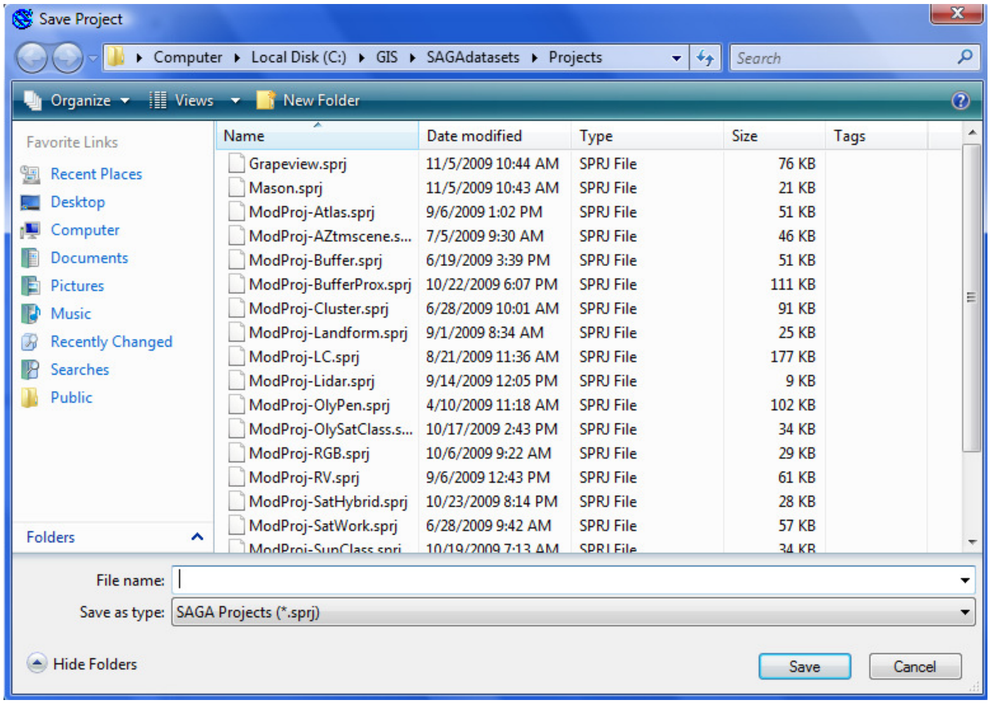


Figure 2-16. The 'Save Project' dialog window.

In the "File name:" data field I enter "Mason-Grape" and click on the Save button. The new project file saves. Now, if I want to load all of my layers for Mason County as well as ones for the Grapeview school district I can use the "Load Project" command and my "Mason-Grape" project name and the more than 60 grid layers and 15 shape layers are loaded.

File: Project: Copy Project To...

I use this option when I want to make a copy of all the files associated with layers and tables currently loaded in a work session. This includes all of the files that define a layer. There are up to five separate files that make up a grid or shape layer. A point cloud layer is a single file that also includes vertex attributes. A table may be defined by one or two files depending on the table format. In addition to layer and table files, a project definition file is created for the current work session.

The 'Save Project' dialog window displayed in Figure 2-16 opens. I can navigate to where I want to copy the project and its' files. A new folder is created at that location using the name I enter in the "File name:" data field. A copy of all the files associated with the layers and tables listed in the Data tab area of the Manager are copied into the new folder. Also, a project file (.sprj) is saved using the name entered in the "File name:" data field.

File: Project: recent loads

The lower portion of the "Project" popup list of options displays the names (up to seventeen) of recently loaded projects. The most recent are at the top of the list. I can load any of the project files in the list by clicking the project file name.

Many of the File: Project options are also available in the Data tab area of the Manager. Move the mouse pointer over the “Data” label and press the right mouse button. The popup list of options in Figure 2-17 will display.

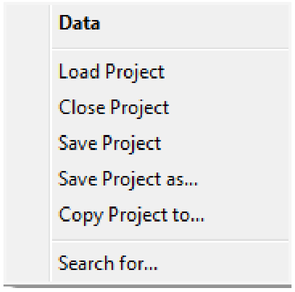


Figure 2-17. The "Data" section popup list of options.

The "Save Project" and "Search for..." options on the list in Figure 2-17 are only available on this popup list of options. The "Save Project" option works with the 'Save Project' dialog displayed in Figure 2-16.

The "Search for..." function searches for text in the 'Name' and 'Description' parameters for layers and tables listed in the Data tab area of the Manager window. The 'Locate...' dialog window in Figure 2-18 is used.

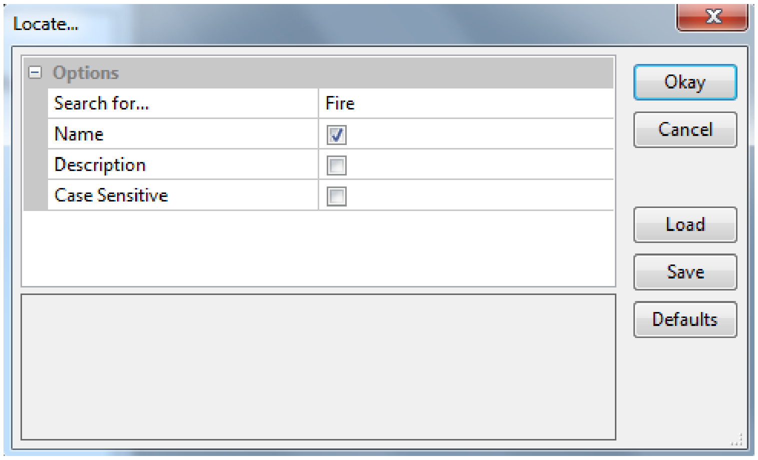


Figure 2-18. The 'Locate...' dialog window used with the "Search for..." option.

In this example, I am searching for any file or files listed in the Data tab area that have the word "Fire" in their name. The toggle check box in the value field to the right of the 'Name' parameter displays a check indicating the option is in on status. The 'Description' parameter for the layers can also be searched for text by clicking with the mouse on the empty toggle check box in the value field to its' right. The 'Case Sensitive' parameter is used when I want the search text to be matched including upper and lower case characters.

This next section of the Menu Bar File dropdown menu (see Figure 2-8) relates to loading of data files mostly by layer type. Of the six options, the first one, "Table" is the only one that is not explicitly spatial.

File: Table - Overview

SAGA uses tables in many areas. The attributes associated with shape objects are stored in dBase table files (.dbf) called attribute tables. Custom display colors for layers are stored in tables referred to as color lookup tables. These are usually text files (.txt). A second text format supported is .csv or comma separated values. There are other SAGA functions that use and support tables. Chapter 8 provides more information on the use of tables in SAGA.

File: Table: Load

In this example, I use the "Load" option in the "Table" popup list of options to load a dBase table, i.e., a table stored as a .dbf file format. The 'Load Table' dialog displayed in Figure 2-19 is used to locate and identify a table file for loading.

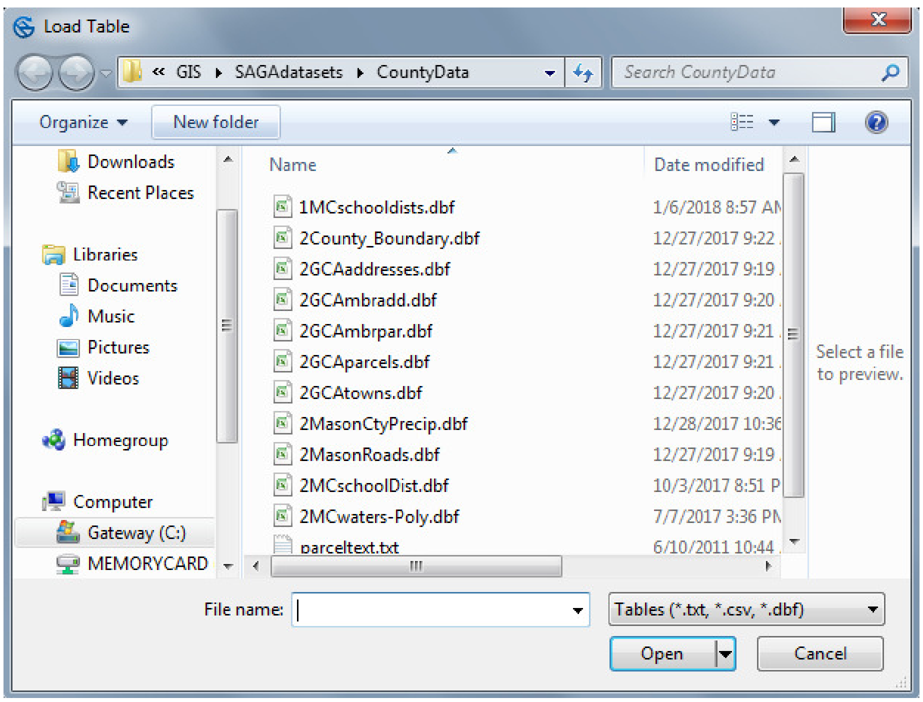


Figure 2-19. The 'Load Table' dialog window.

The dialog window in Figure 2-19 displays a list of files stored in my "CountyData" folder. I store some of my shape layer files for Mason County in this folder. I can see in the data field to the right of the "File name:" label that the default file types are "Tables (*.txt, *.csv, *.dbf)". The .txt file is the tabs delimited version. The .csv format is a variation of the .txt with comma separated values. The .dbf format is a dBase format. These are the default file types and the only file types supported for this specific command. The only file names displayed in the 'Load Table' dialog window are for file formats .txt, .csv, and .dbf.

If I click on the small black triangle in the right side of the data field displaying “Tables (*.txt, *.csv, .dbf)**”,** a second option can be chosen called “All Files”. This option displays a complete files list for the folder, including not only .txt, .csv, and .dbf, but other file formats as well. But the ‘Load Table’ window supports only the loading of tabs delimited text (*.txt), (*.csv) or dBase (*.dbf) file formats. If I select a different file format to load it will fail.

Most of the .dbf files are attribute table files linked to a shape layer. Even if I try loading a shape (.shp) file, this dialog window will only load the .dbf attribute table file linked to it and not the other files related to the shape layer.

I am going to load the dBase file for school districts named ‘1MCschooldists.dbf’. I can choose the .dbf file by clicking with my mouse on the file name and highlighting it. The name is entered automatically into the data entry field for file name. Or, I could key the name into the data entry field using the keyboard. Once the correct file name is displayed in the “File name:” field, it is loaded when I click with the mouse on the Open button.

Figure 2-20 shows the table. Each row in the table relates to a specific spatial feature or object in the shape layer. There are 21 polygon objects defining the nine school districts in the county. Some districts are defined by more than one polygon object. The columns are attributes describing the districts.

01. 1MCschooldists

	SCH_DIST	SD_Nam	DIR_DIST	DIRECTOR	Shape_Area
1	42	Southside	0	Southside	277247485.93
2	54	Grapeview	0	Grapeview	885760841.54
3	137	Elma	0	Elma	416647524.37
4	402	Pioneer	0	Pioneer	2510136911.6
5	65	McCleary	0	McCleary	20850232.116
6	403	North Mason	1	North Mason I	2537804573.9
7	311	Mary M Knigh	1	Mary M Knigh	541072079.31
8	311	Mary M Knigh	3	Mary M Knigh	961271251.02
9	309	Shelton	2	Shelton Schoo	2367249840.5
10	311	Mary M Knigh	2	Mary M Knigh	739.592733
11	311	Mary M Knigh	2	Mary M Knigh	1996592060.1
12	309	Shelton	1	Shelton Schoo	684200397.44
13	309	Shelton	3	Shelton Schoo	1509993912.7
14	403	North Mason	4	North Mason I	630858684.41
15	403	North Mason	3	North Mason I	610871857.39
16	403	North Mason	2	North Mason I	223112216.79
17	403	North Mason	5	North Mason I	228791463.81
18	404	Hood Canal	1	Hood Canal Di	353683258.75
19	404	Hood Canal	2	Hood Canal Di	863924410
20	404	Hood Canal	4	Hood Canal Di	5661765663.8
21	404	Hood Canal	3	Hood Canal Di	6021829115.9

Figure 2-20. The ‘1MCschooldists.dbf’ attribute table file.

File: Table: recent loads
The lower part of the "Table" popup list of options displays the names of up to seventeen of the most recently loaded table files. The most recent are at the top of the list. I can load any of the files in the list by clicking on the project file name.

File: Shapes – Overview
Shapes refers to vector data. A shape data file can contain one of three types of spatial objects: points, lines or polygons. As part of the overall shape format, there is a linked attribute table made up of rows (records) and columns (fields or attributes). Each feature or spatial object in a shape file has an attribute row in the table; one row per object. Each row is made up of columns where each column represents an attribute or characteristic. Figure 2-20 displays an example of a shape attribute table.

File: Shapes: Load
The "Load" option in the "Shapes" dropdown list of options is used to load a vector file of the shape (.shp) format and the associated ancillary file for attributes in the dBase format (.dbf). When I click on the "Load" option, a dialog window like the one in Figure 2-21, displays.

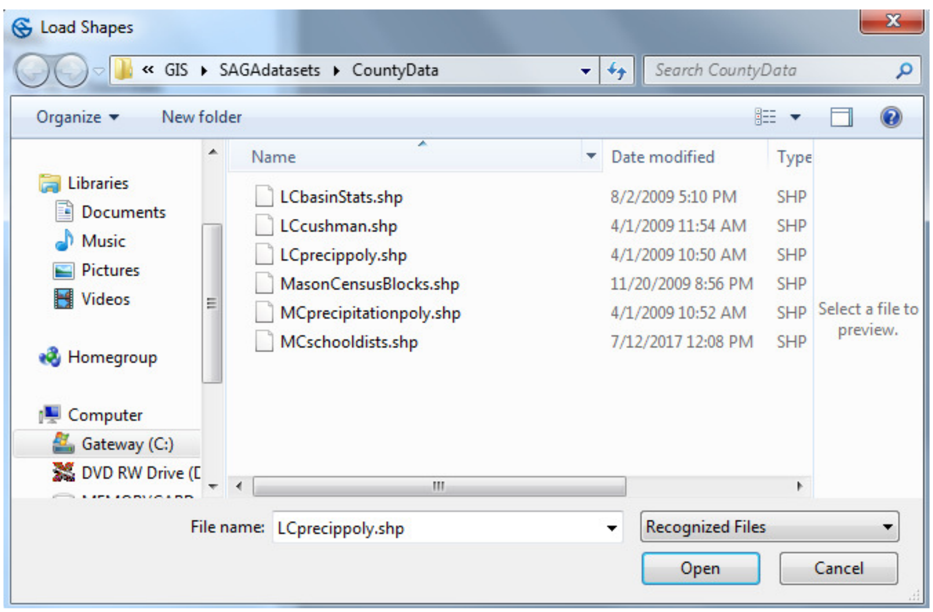


Figure 2-21. The 'Load Shapes' dialog window.

The dialog window in Figure 2-21 displays a list of files stored in my "CountyData" folder. Although the "CountyData" folder contains both shape and grid layers, only the shape layer file names display in the 'Load Shapes' dialog window.

When I look in the data field to the right of the "File name:" data field I see that the default file type is "Recognized Files". Two other choices for file type are "ESRI Shape Files (*.shp)" and "All Files". If I click on the small black triangle in the right side of the data field, the other two choices are available. The "ESRI Shape Files (*.shp)" also loads shape layers. The "All Files" displays a list of all files in the storage location. Using this option I can only load .shp files in the list.

I can choose the shape layer I want to load by clicking with the mouse on the file name and it becomes highlighted. If I want to open more than one layer, I can add additional selections by simultaneously pressing the keyboard Shift or Ctrl keys when I click on additional file names. The names will be entered automatically in the "File name:" data entry field. Or, I could key in file names in the data entry field using the keyboard. Once the correct file name(s) displays in the data field, the file(s) is loaded when I click on the Open button.

File: Shapes: recent loads
The lower part of the "Shapes" popup list of options displays up to seventeen of the most recently loaded shape files. The most recent are at the top of the list. I can load any of the files in the list by clicking with the mouse on the file name.

File: Point Cloud - Overview
A point cloud is a set of vertices in a three-dimensional coordinate space. The X and Y coordinates define horizontal position and the Z coordinate is for vertical position.

The .las file exchange format is a binary format that supports information that is specific to airborne Light Detection and Ranging (LIDAR) sensors. The SAGA tool *Import/Export-LAS/Import LAS Files* imports the .las exchange format. Once a .las file format is imported to SAGA, it is saved as a SAGA point cloud layer (.spc). Also, SAGA point cloud layers can be created from point shape files, grids, or raw ASCII files. An important capability of the SAGA point cloud format is its' optimization for processing datasets with millions of points.

Numeric attributes imported as part of the .las format are stored as vertex attributes in the SAGA point cloud layer file. This approach is different from how attributes are handled for shape layers where they are stored in a separate data base file.

LIDAR data is available that has been post-processed and is available in a format different from .las. For example, the Puget Sound LIDAR Consortium distributes LIDAR data for many projects using the ESRI .e00 format.

File: Point Cloud: Load
The "Load" option in the "Point Cloud" dropdown list of options is used to load a SAGA point cloud layer. This layer can be in one of three formats: *.spc, *.sg-pts, *.sg-pts-z. If I click on the "Load" command, the dialog in Figure 2-22 displays.

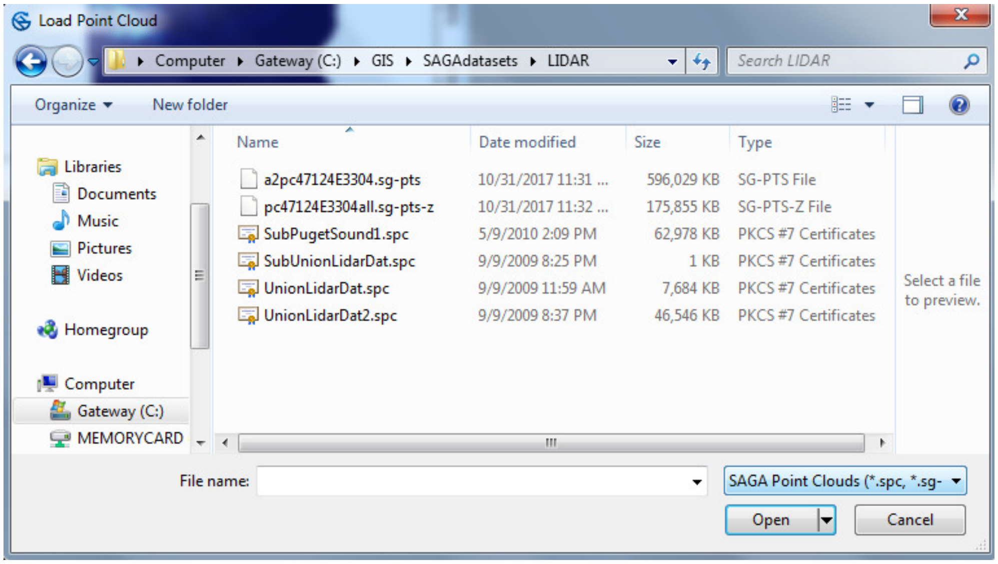


Figure 2-22. The 'Load Point Cloud' dialog window.

The dialog window in Figure 2-22 displays a list of files stored in my "LIDAR" folder where I store downloaded LIDAR .las data files and SAGA point cloud layers. This folder contains files stored in several different file formats, only the SAGA point cloud (.spc, .sg-pts, .sg-pts-z) layers show up in the list. If I look in the data field to the right of the "File name:" data field I see that the default file type is "SAGA Point Clouds (*.spc, *.sg-pts, *.sg-pts-z)". These are the default file types and the only file types supported in the 'Load Point Cloud' dialog window.

The .spc and .sg-pts formats are uncompressed point cloud formats and the.sg-pts-z is a compressed point cloud format (it is actually a zip file). If I click on the small black triangle in the right side of the data field displaying "SAGA Point Clouds (*.spc, *.sg-pts, *.sg-pts-z)", a second option can be selected called "All Files". This option allows me to view the full file list of all file types stored in the folder but I will not be able to load any file format other than the three point cloud file types.

File: Point Cloud: Recent Loads

The bottom portion of the "Point Cloud" popup list displays the names of up to 17 of the most recently loaded point cloud files. The most recent are at the top of the list. I can load any of the point cloud files in the list by clicking on the file name.

File: T.I.N. - Overview

The Triangulated Irregular Network or T.I.N. data structure is a variation of a vector structure designed primarily for modeling digital elevation data. It avoids the redundancy of elevations in a grid layer and is more efficient for some terrain analysis processes, such as slope and aspect. It is a terrain model that uses a sheet of continuous, connected triangular facets based on a Delaunay triangulation of irregularly spaced nodes or observation points. Unlike the standard digital elevation model or matrix, the TIN allows extra information to be available in areas of complex relief without the need for huge amounts of redundant data to be considered for areas of simple relief.

The tools in the TIN library were developed in 2004.

File: TI.N: Load
Functions and TIN related tools are still in a developmental stage focusing mainly on converting from and to raster or vector formats. TIN’s can be created using the *TIN - Tools/Grid to TIN* and *TIN - Tools/Shapes to TIN* tools. TINs created with these tools can be saved. They are stored as shape layers.

The save process is started by choosing the "Close" option. As part of the "Close" process, the question "Do you want to delete the selection?" displays. Because the TIN has not been saved yet, if I click on the Yes button, the 'Save Modified Data' dialog displays. This is the opportunity for saving the TIN file. The file is stored as a shape layer but when loaded, it loads as a TIN layer.

If the TIN file has already been saved, when I click on the Yes button as described above, the file will close and is removed from the work session.

A TIN layer can be input to the *TIN - Tools/TIN to Shapes* tool, and a set of vector "TIN" layers produced. These layers include ones for a point shapes TIN centroids, polygon shapes triangles, polygon shapes Voronoi's, and a TIN centroids layer. These layers can be saved and re-loaded using the TIN 'Load' command.

I am not familiar with TIN layers so I cannot verify whether the TIN layers produced by SAGA are valid. The process involving the "Close" option for saving the output layer from the *TIN - Tools/Grid to TIN* and *TIN - Tools/Shapes to TIN* tools does not feel smooth but it works.

File: TIN: recent loads
The lower portion of the "TIN" popup list of options displays a list of recently loaded TIN files (up to seventeen). The most recent are at the top of the list. I can load any of the TIN files in the list by clicking on the TIN file name.

File: Grid - Overview
A grid layer is a matrix of rows and columns. The grid cells defined by the intersections of the rows and columns are rectangular in shape. Generally, most grids used in GIS spatial analysis consist of square shaped grid cells. Other terms used to refer to grids include raster and pixels. These latter terms are most often associated with images such as satellite images or scans of aerial photography. Pixel is an abbreviation for picture element.

File: Grid: Load
The "Load" option on the "Grid" dropdown list of options is used to load SAGA grid layer files store in the grid .sgrd and .sg-grd-z formats. The .sg-grd-z file type is a zip file.

The "Load" option will load file formats not listed as supported. For example, the .dgm format that was supported in SAGA v1.2 and earlier can be loaded. The .sgrd format replaced .dgm in SAGA v2.0. Also, I found that many graphic formats can be loaded, e.g., .jpg, .tiff, and .png. It will even load a .pdf file.

If I click on the "Load" option, the dialog window in Figure 2-23 displays.

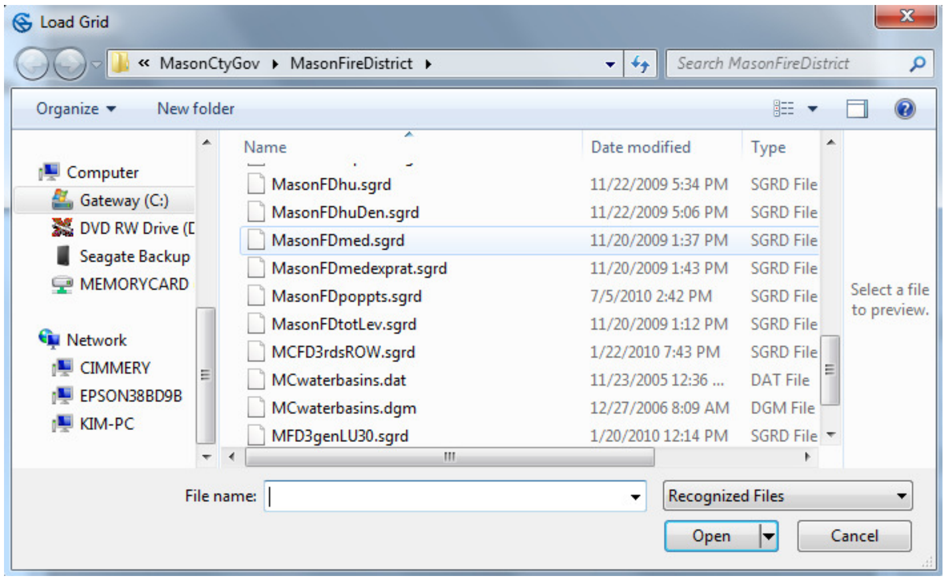


Figure 2-23. The 'Load Grid' dialog window.

The dialog window in Figure 2-23 displays a list of files contained in my "MasonFireDistrict" folder. I see in the data field to the right of the "File name:" data field that the default entry is "Recognized Files". This means that data files not related to grid layers also appear on the list.

If I click on the small black triangle in the right side of the data field displaying "Recognized Files", I see two additional options: "SAGA Grid Files (*.sgrd, *.sg-grd-z)" and "All Files".

Choosing the option "SAGA Grid Files (*.sgrd, *.sg-grd-z)" means files in the .sgrd and .sg-grd-z formats can be loaded. In addition, grid layers using the older SAGA format .dgm can also be loaded. The .sgrd format is the current SAGA grid layer format.

The "All Files" option displays a view of the full file list for the folder. The "Load" command will only load .sgrd, ,sg-grd-z or .dgm files, a few graphic format file types, and the .pdf file format. The intention is to use the File: Grid: Load option to load .sgrd or .dgm files.

I can choose the grid layer I want to load by clicking with the mouse on the file name and highlighting it. If I want to open more than one layer, I can add additional selections by simultaneously pressing the Shift or Ctrl keyboard keys when I click on additional file names. The names will automatically enter into the data entry field to the right of the "File name:" label. Or, I could key in the name into the data entry field using the keyboard. Once the correct grid data file name(s) is displayed in the data field, the file is loaded when I click on the Open button.

The tool libraries *Import/Export – Grids* and *Import/Export – Grids using GDAL* have special tools designed for importing other grid layer formats. Imported files are converted to the SAGA .sgrd file format as part of the importing process. If I do not save the imported file it will close and disappear when I quit the SAGA work session.

File: Grid: recent loads
The lower part of the "Grid" popup menu displays up to seventeen of the most recently loaded grid layers. The most recent are at the top of the list. I can load any of the files in the list by clicking on the name.

File: Grid Collection: Overview
This is a new data object type implemented for the first time in SAGA version 5.0. A grid collection is two or more grid layers, of the same grid system, that are selected together, and saved as a single "multi-grid" object.

Implementation of the grid collection data object is in development. Currently the grid collection library includes three tools. The *Grid Collection - Grid Collection Tools/Create a Grid Collection* is used to create the multi-grid data object. The *Grid Collection - Grid Collection Tools/Delete Grids from a Grid Collection* tool is used to delete a grid from an existing grid collection. The user can create individual grid layers from each of the individual grid layers of a grid collection using the *Grid Collection - Grid Collection Tools/Extract Grids from a Grid Collection* tool.

Some existing analysis tools in SAGA do accept a grid collection as input, e.g., the *Grid - Calculus/Grid Calculator* tool. Each individual grid layer of the input grid collection is addressed as a variable in the formula, referenced as a, b, c, etc., or g1, g2, g3, etc.

A grid collection data object is saved as a .sg-gds-z file format. See discussion in next section.

File: Grid Collection: Load
Functions and grid collection related tools are still in a developmental stage. This option may not be consistently working, particularly the loading of grid collections into a work session. For example, it appears that the grid collection "Load" command only works if the Data tab area of the Manager is displayed at the time it is executed. The grid collection "Load" command displays the parameters window in Figure 2-24.

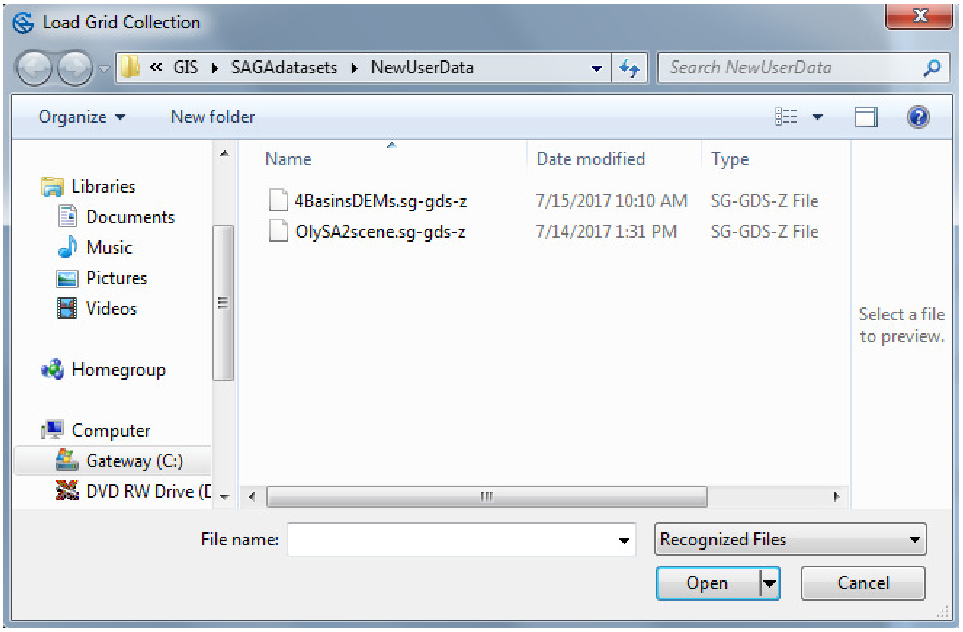


Figure 2-24. The parameters window for the "Load Grid Collection" command.

In the example above, the list includes two grid collections: 4BasinsDEMs.sg-gds-z and OlySA2scene.sg-gds-z. The grid collection file names display including the file format suffix ".sg-gds-z".

At the bottom of the parameter window is an entry field for "File name:". To its right is a popup list of file formats supported by the grid collection "Load" command. The default entry is "Recognized Files". The dropdown list of options includes three additional ones: SAGA Compressed Grid Collection (*.sg-gds-z), SAGA Uncompressed Grid Collection (*.sg-gds), and All Files.

File: Grid Collection: recent loads

The bottom part of the ‘Load’ grid collection popup menu displays the seventeen most recently loaded grid collection files. The most recent are at the top of the list. I can load any of the files in the list by clicking on its’ name.

File: Exit

The last option on the File dropdown list is "Exit". Clicking on "Exit" displays the dialog in Figure 2-25.

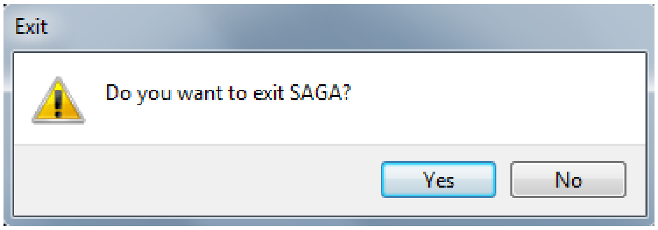


Figure 2-25. The ‘Exit’ dialog window.

In the work session, if I do not create any new layers or tables that have not been saved as permanent files, when I click on the Yes button, the SAGA program will end. On the other hand, if I have created new layers or tables that have not been saved as permanent files, the ‘Close and save modified data sets…’ dialog window in Figure 2-26 will display.

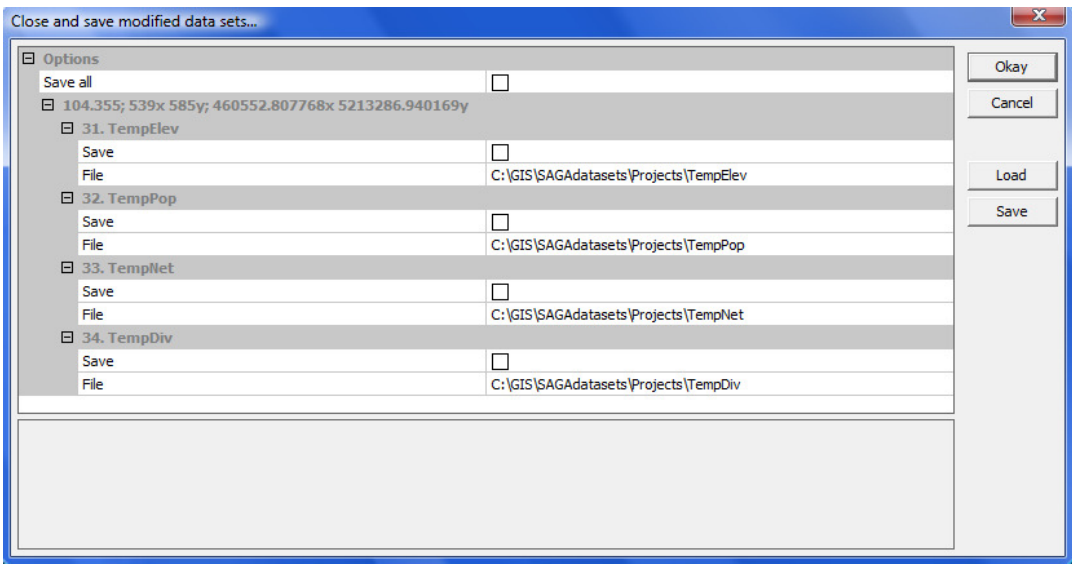


Figure 2-26. Using the ‘Save’ parameter in the ‘Close and save modified data sets…’ dialog window.

Layers and tables that have not been saved or have been modified and not saved with their changes will be listed in the ‘Close and save modified data sets…’ window. For this example, when I clicked on the "Exit" command to end the work session, I had four grid layers that had not been saved.

The first option at the top of the window is ‘Save all’. If I want to save all four of the files, I can place a check in the toggle check box to the right of the ‘Save all’ option. When I place the check in the ‘Save all’ box, checks will automatically appear in each of the toggle check boxes for the four files. Before clicking on the Okay button, I can edit the storage location path and file names. If I click in the value field to the right of the ‘File’ parameter, an ellipsis appears. When I click on the ellipsis the ‘Save’ dialog window displays. This dialog window allows me to navigate to the desired storage location as well as to edit the file name to use. After each file name edit or storage edit, I return to the ‘Close and save modified data sets…’ window. Once I make the changes, I click on the Okay button, the files will be saved and the program will end.

I can use the ‘Save all’ option if I do not want to save any of the four files. Instead of clicking in the empty toggle check box and adding a check, I can leave it blank and click on the Okay button. The program will end without saving the files.

When I want to save only one (or more than one but not all four) of the four files, I can do that by placing a check in the toggle check box to the right of the ‘Save’ parameter for each file to save. I can also edit the storage location and file name by clicking on the ellipsis that appears in the right side of the value field to the right of the ‘File’ parameter. Once I make the changes for the file or files I want to save, I click on the Okay button. The SAGA program will end, and only the file(s) with checked boxes are saved.

In Figure 2-4 the dropdown menu of options is displayed for the Menu Bar File title. I saw that moving the mouse pointer over one of the dropdown menu labels, another list of options displays. These options were introduced to you in this chapter. Most of these choices can also be chosen when I right-click with the mouse pointer on the major section headings (i.e., Data, Grids, Shapes, and Table) in the Data tab area of the Manager window. Figure 2-27, on the left, displays the popup list of project options that appears when I right click on the “Data” at the top of the Manager window. On the right is the popup list that appears when I click on the “Grids” section heading.

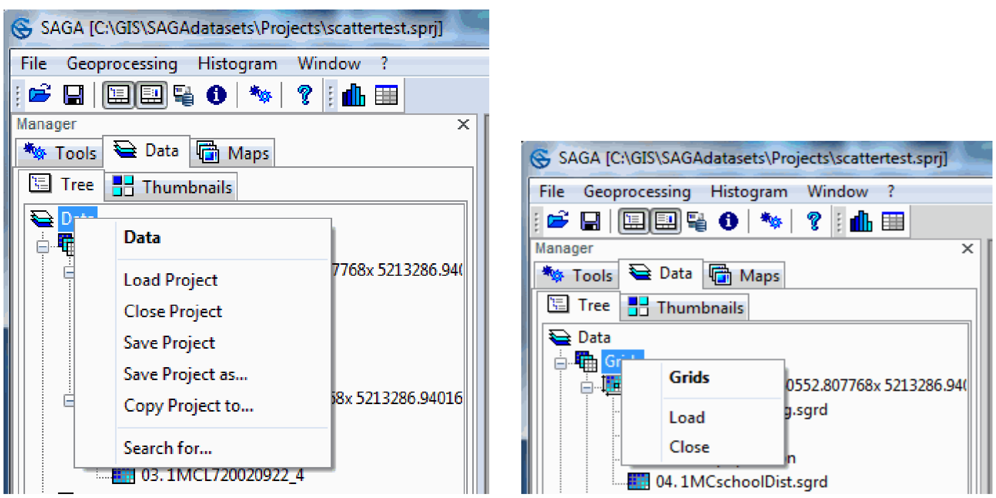


Figure 2-27. Accessing File options from the “Data” and “Grids” sections in the Data tab area of the Manager window.

The Data and other tab areas of the Manager are discussed in Chapters 3, 4, and 5.

Menu Bar: Geoprocessing

The next Menu on the Menu Bar is Geoprocessing. Geoprocessing tools, commands, functions, etc., support traditional GIS functions as well as very sophisticated discipline-oriented spatial analysis. Chapter 3 provides more information on SAGA tools. Some tools are very specific to analysis procedures within disciplines that lend themselves to spatial processing.

Besides providing options for selecting a library tool, there are two other options: Load Tool Library and Find and Run Tool.

Geoprocessing: Load Tool Library
This command allows the user to navigate on a desktop to folders where tool libraries are stored, to choose one or more tool libraries, and to load them. There may be situations where the SAGA tool libraries are not all stored together in the same folder or location. The name for the default folder for storing tool libraries is “tools”. Once a tool or tool library is loaded for the first time and not closed before exiting from SAGA, the tool is automatically loaded when the next SAGA work session starts, regardless of which folder it is stored. This is because the tool storage paths are saved in a configuration file (an .ini file format) when the work session and SAGA is exited.

If I choose the "Load Tool Library" command on the Geoprocessing dropdown list of options, a dialog window similar to the one in Figure 2-28 displays.

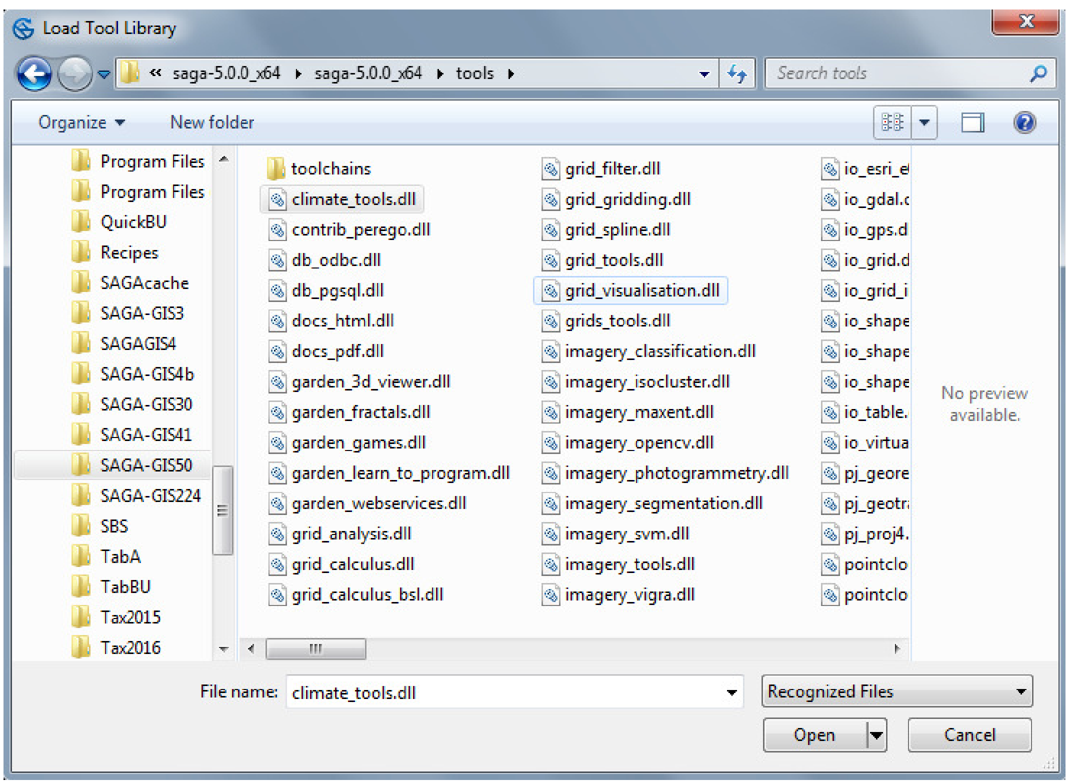


Figure 2-28. The ‘Load Tool Library’ dialog window.

I can use the standard windows navigation methods to navigate to the folder where I have a SAGA tool library stored that I want to bring into the SAGA work session environment.

Once I have navigated to the folder containing the tool library I want to load, I choose it by clicking on the tool file name with my mouse and highlighting it. The name is entered automatically into the data entry field to the right of the "File name:" text. Or, I could key the name into the data entry field using the keyboard. When the correct file name displays in the data field, it is loaded when I click with the mouse on the Open button. After it is loaded, its' name is added to the list of available tool libraries that appears in the Geoprocessing dropdown menu.

Geoprocessing: Find and Run Tool
I can use this option to search for a tool using the tool name or a phrase or text in the tool description. This search can end up with more than one tool meeting the search criteria. The correct tool is selected from the found list and it executes. The first part of this option, the "Find" part, displays in Figure 2-29. It is the 'Run Tool' dialog window.

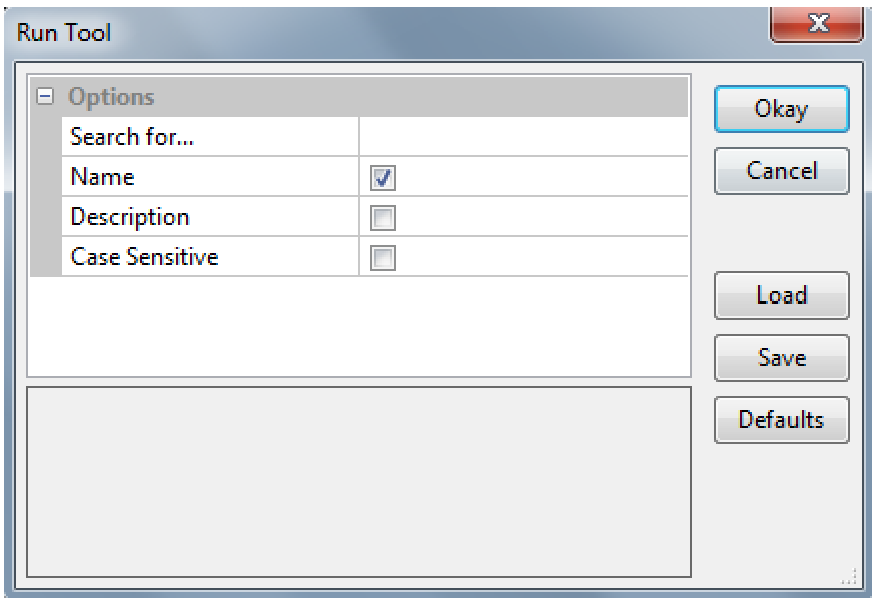


Figure 2-29. The first 'Run Tool' dialog window.

The 'Search for....' parameter on the 'Run Tool' dialog is for entering the name of the tool I am looking for (if known) or text that is part of the tool name or description. The 'Name', 'Description' and 'Case Sensitive' parameters are used to identify how the search is applied. These are toggle check box parameters. The default is for tool names to be searched. All three parameters can be checked to on status. The 'Case Sensitive' parameter is used when I want the exact text entry, lower and upper case, to be searched for.

The second part of the option, "Run", displays in Figure 2-30. In this example I entered "slope" for the 'Search for...' parameter and used the default 'Name' to be searched.

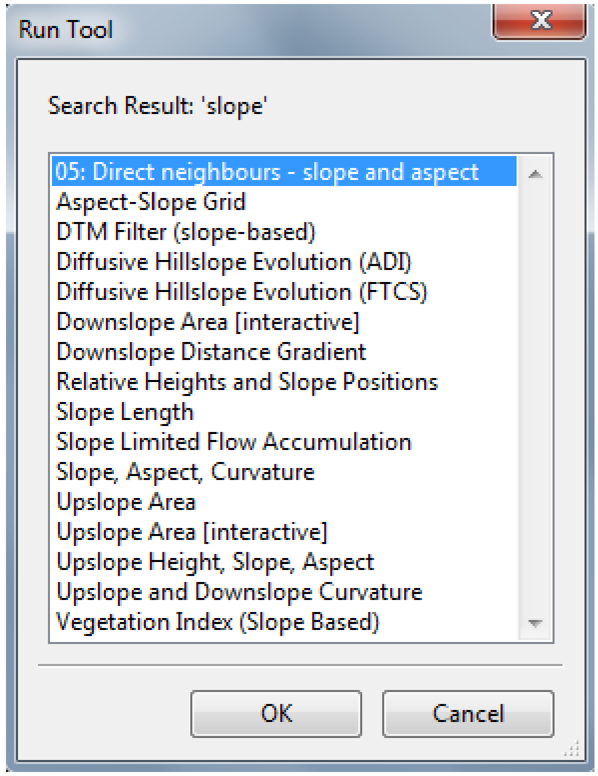


Figure 2-30. The second 'Run Tool' dialog window.

Not surprisingly, a number of tools are found having "slope" in their titles. I move the mouse pointer over the one I want to execute and press the left mouse button twice. The tool then executes.

The set of tool libraries and tools distributed with SAGA 5.0 are named:

Climate: Tools

Garden: Fractals, Games, Introducing Tool Programming, Web Service Data Access

Grid: Analysis, Calculus, Calculus BSL, Filter, Filter (Perego 2009), Gridding, Spline Interpolation, Tools

Grid Collection: Grid Collection Tools

Imagery: Classification, ISODATA Clustering, Maximum Entropy, OpenCV, Photogrammetry, SVM, Segmentation, Tools, ViGrA

Import/Export: DXF, ESRI E00, GDAL/OGR, GPS Tools, Grids, Images, LAS, ODBC/OTL, PostgreSQL, Shapes, Tables, Virtual

Projection: GeoTrans, Georeferencing, Proj. 4

Reports: HTML, PDF

Shapes: Grid Tools, Lines, Point Clouds, Points, Polygons, Tools, Transects

Simulation: Cellular Automata, Erosion, Fire Spreading Analysis, Geomorphology, Hydrology, Hydrology: IHACRES, Modeling the Human Impact on Nature, QM of ESP, RivFlow

Spatial and Geostatistics: Grids, Kriging, Points, Regression

TIN: Tools, Visualization

Table: Calculus, Tools

Terrain Analysis: Channels, Compound Analyses, Hydrology, Lighting Visibility, Morphometry, Preprocessing, Profiles, Slope Stability

Tool Chains: Climate, Files, Grid Collection, Imagery, Terrain Analysis, Tool Chains, Travel Time Analysis

Visualization: 3D Viewer, Grids, Point Clouds Viewer

There are 16 primary library categories and 82 sub-libraries with over 700 tools.

The last seven tools executed in the current work session list at the bottom of the Geoprocessing dropdown menu.

Menu Bar: Window
The third primary Menu of options on the Menu Bar is the Window Menu. The dropdown list of options for the Window menu displays in Figure 2-31.

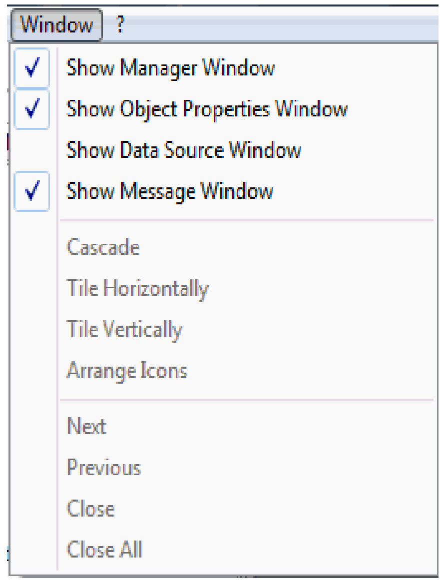


Figure 2-31. The Menu Bar Window dropdown menu of options.

The Window options provide tools for users to control how four work and information windows are placed and display in the SAGA work space.

The first four options provide control to display or not display the SAGA Manager window, parameter settings for SAGA objects, information related to the data source, and operational messages related to SAGA processing. Figure 2-32 shows the SAGA work area with no windows showing.

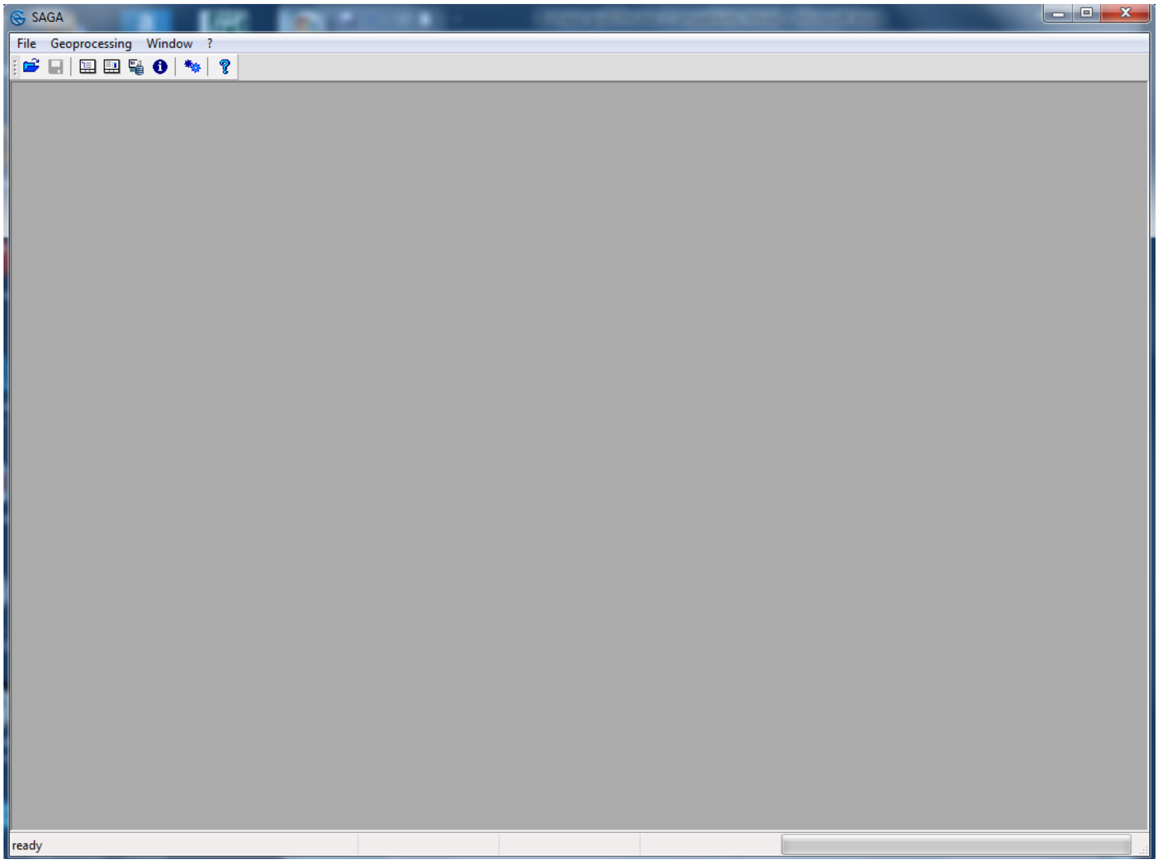


Figure 2-32. The SAGA display with no windows showing.

The top four choices in the Menu Bar Window dropdown menu act as on/off switches. When in on status, a check appears to the left of the option and the feature window appears in the work area; when it is off, the check does not appear and the feature does not appear. The four sections can display at the same time although this reduces the size of the work area available for displaying maps, graphics, and tables.

Window: Show Manager

Figure 2-33 shows the SAGA display with the "Show Manager Window" checked to on and the three other windows in off status.

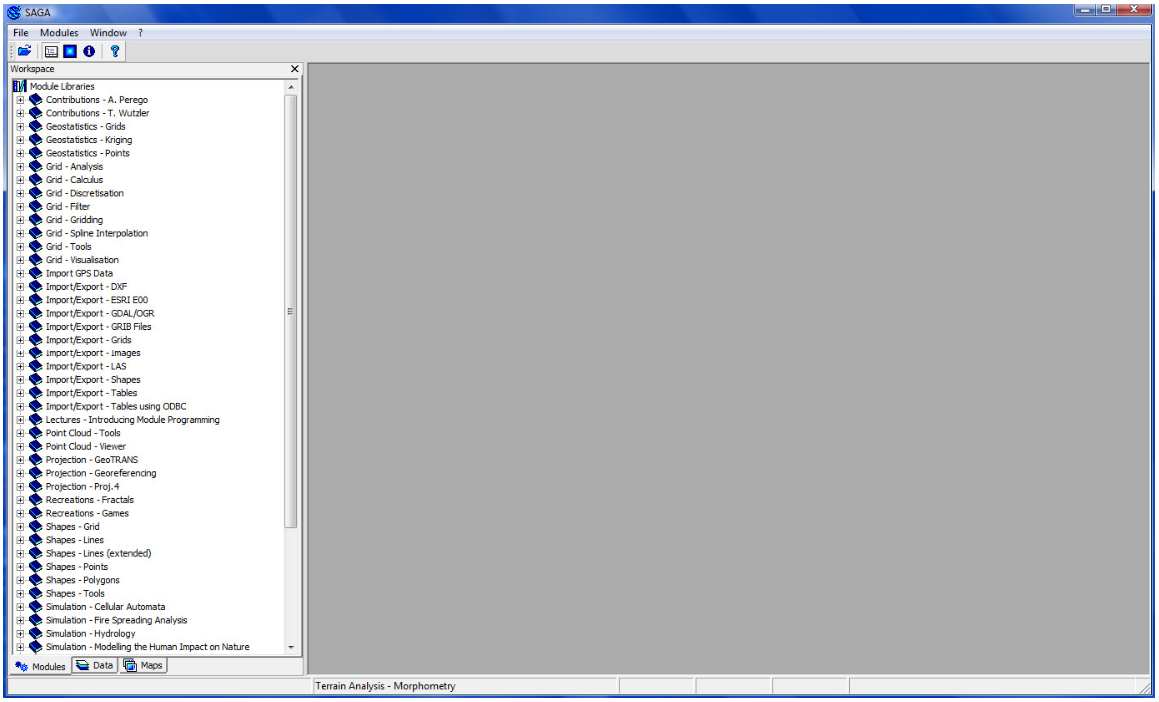


Figure 2-33. The SAGA Manager window.

The Manager window is "docked" to the left side of the work area. I can close any of the four windows from the work area by clicking on the particular window option in the Window dropdown menu. Any window can also be closed by clicking on the small ‘x’ or close box in the upper right corner of the window.

I can re-position or re-align a window by clicking with my mouse pointer in the window title bar where the window title or name appears and dragging vertically or horizontally depending on the current size and location and where I want it to be placed. As I drag the window near the left, right, top or bottom edges of the SAGA display, I see a dim blue-gray horizontal or vertical oriented box (it sort of looks like a shadow) appear along the edge. If I release the mouse pointer while the blue-gray box appears, the dragged window will dock onto the adjacent side of the display window, replacing the box. It takes a little practice to smoothly re-locate the window. I can also position the window anywhere within the work space without docking it.

The horizontal and vertical scroll bars assist in viewing a long list in the Manager. The Manager window can be re-sized using the mouse. I move the mouse to the right or left border (depending on the location of the window), when the cursor is over the border I can click and drag the mouse to expand or decrease the width of the Manager.

I see three tabs located near the top of the Manager window. The three tabs identify selectable information areas of the Manager: Tools, Data, and Maps. When I click on one, that particular section of the Manager becomes visible.

The Tools tab area contains a list of the available tool libraries and their functions. The Data and Maps tab areas list layers and map view windows for a work session. How the lists appear depends on which view mode, tree or thumbnails is active. The default view, when I first click on one of the tabs is the tree view, as if I had clicked on the Tree tab. The other view is the thumbnails view. When I click on the Thumbnails tab, the list in the Manager will convert from its' tree view default to a thumbnails-like view of the content.

The Data area displays loaded grid, shapes, and point cloud layers and tables. The Maps area is like a table of content for map view windows. The Maps tab area shows me a list of existing map view windows and which layers (grid, shapes or point cloud) are being displayed in each map view.

Additional SAGA options become available when the Data tab section of the Manager is active. Figure 2-34 displays options that are available when I right-click with my mouse on a grid or shape layer in the list of layers displayed either in the tree or thumbnails views.

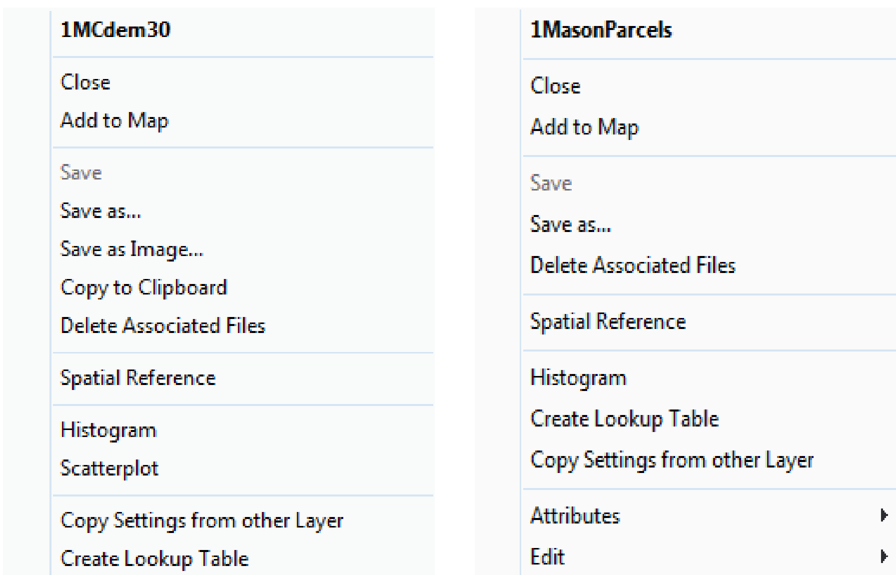


Figure 2-34. Options available in the Data area of the Manager.

The dropdown list of options on the left in the figure is the list of options that displays when I right-click on a grid layer name in the list of layers in the Data area of the Manager. At the top of the list of options is the name of the active layer.

The dropdown list of options on the right in the figure is the list of options displayed when I right-click on a shape layer name in the list of layers in the Data area of the Manager. At the top of the list of options is the name of the active vector layer. Comparing the two option lists I can see there are similarities and there are differences. The options displayed in Figure 2-34 are explored in detail in Chapter 4.

Window: Show Object Properties Window

The second option in the Window dropdown menu is "Show Object Properties Window". Objects in the SAGA GUI include tools, projects, grid systems, grid layers, shape layers, and tables. Some features in SAGA that are not referred to as objects, for example 3D-Views, have property windows that can be viewed, very similar to objects.

The Object Properties window has five information areas that are chosen by tabs at the top of the window. The five areas are: Settings, Description, Legend, History and Attributes. All five of the tabs may not be available depending on the type of object currently active.

Figure 2-35 shows the Object Properties window. In this example, it is docked to the right side of the SAGA work area. The methods for closing, changing the window size, re-orienting the window, etc., discussed in the previous section for the Manager window apply for all of the windows.

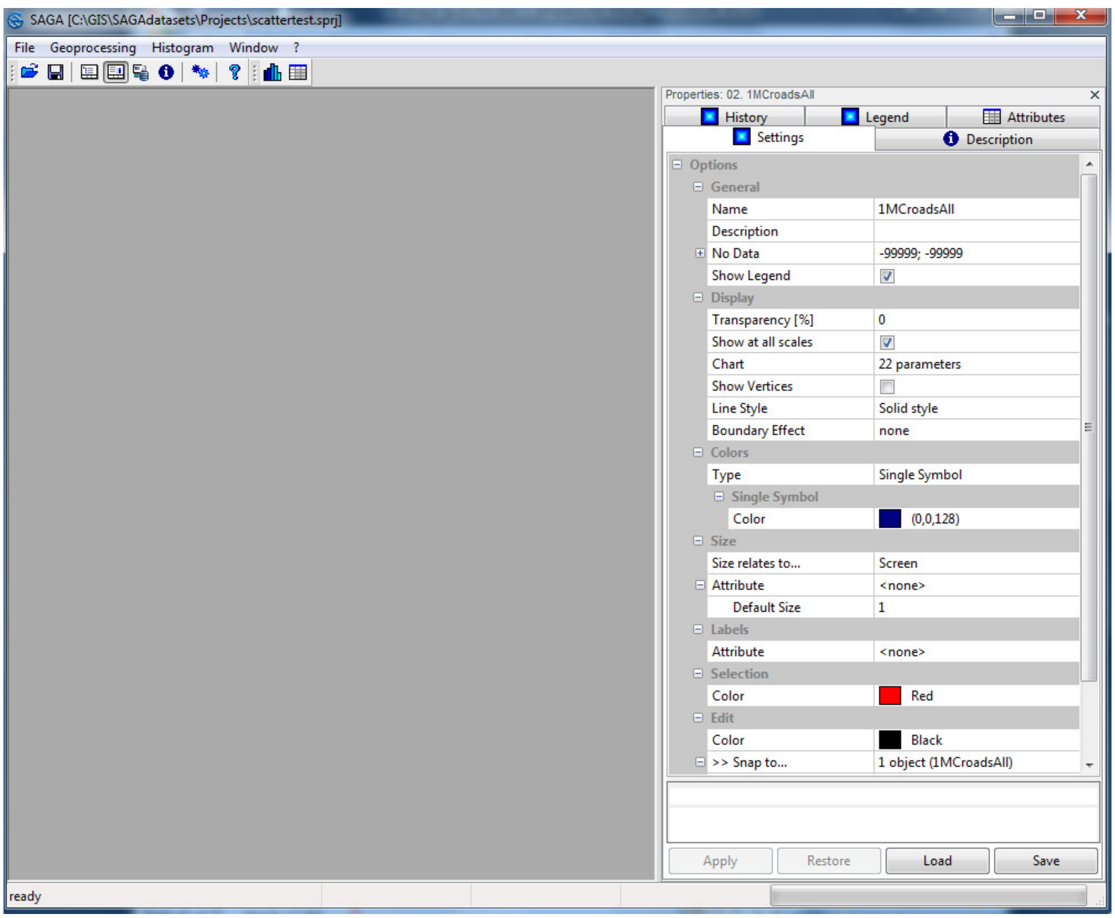


Figure 2-35. The Object Properties window of the SAGA display.

The five tabs act in a similar manner to the tabs used in the Manager window. The Settings tab is active in Figure 2-35. The other four tabs are Description, Legend, History and Attributes. All of these tabs are discussed in detail in later chapters. I will briefly introduce them here. Layers are the objects used in the examples in this chapter.

The Settings tab area provides users the opportunity to make adjustments to how a layer appears in a map view window. The parameters displayed in the ‘Settings’ area are for the currently active (i.e., highlighted) layer in the list of layers in the Manager Data area. The color patterns can be changed. The range of data values displayed can be changed without actually changing data values. There are a variety of layer dependent factors that can be edited and viewed that are parameters in the ‘Settings’ area. Figure 2-36 shows an expanded view of the Settings tab area for the Mason DEM layer.

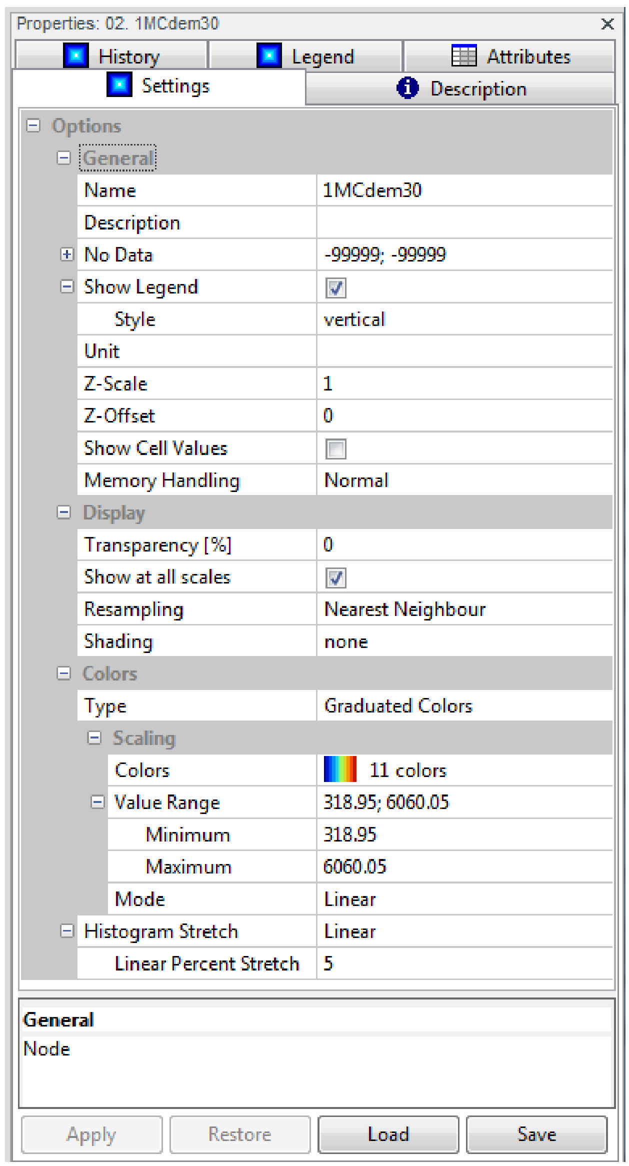


Figure 2-36. The grid layer ‘1MCdem30’ Settings tab area of the Object Properties window.

The next tab area is Description. Data displayed in this area is information only. It cannot be edited by the user like the parameters in the Settings tab area can. Figure 2-37 displays the Description area for the Mason DEM layer.

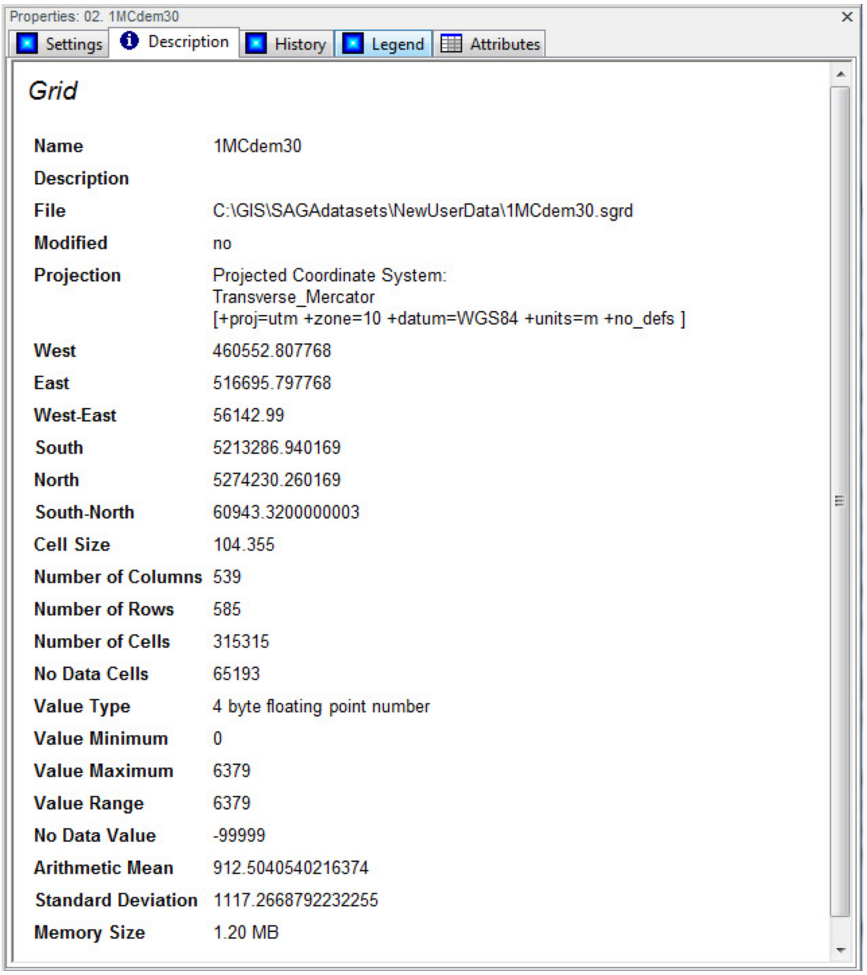


Figure 2-37. The Description tab area for the '1MCdem30' layer in the Object Properties window.

The third tab for the Object Properties window is Legend. If I click on this tab, the data legend for the currently active layer displays. Figure 2-38 displays two examples of legends. It shows the legend for the '1MCdem30' grid layer on the left and the legend for the '1MCrrlines' shape layer on the right. This tab will not be available for non-layer objects.

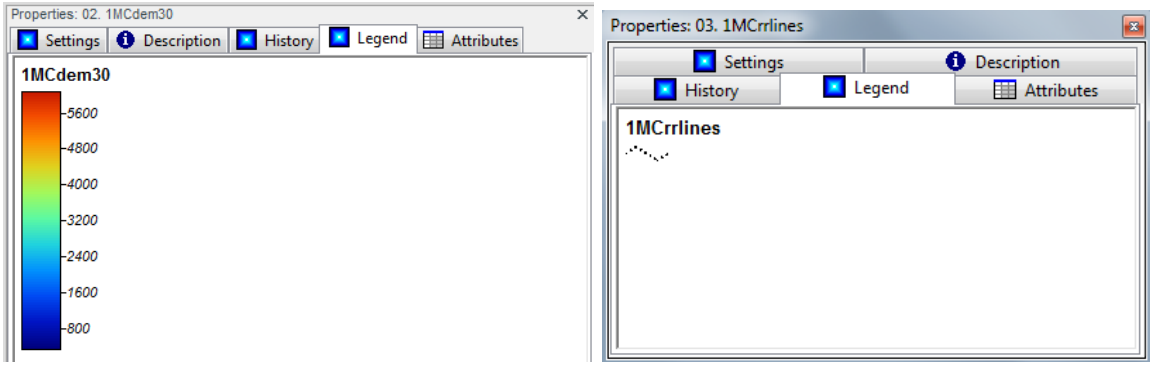


Figure 2-38. The Legend tab display in the Object Properties Window for a DEM grid layer and a railroad line shape layer.

The heading for the legend is the entry for the 'Name' parameter in the Object Properties window for the layer. I can edit the name for a more appropriate legend title (see Figure 2-39).

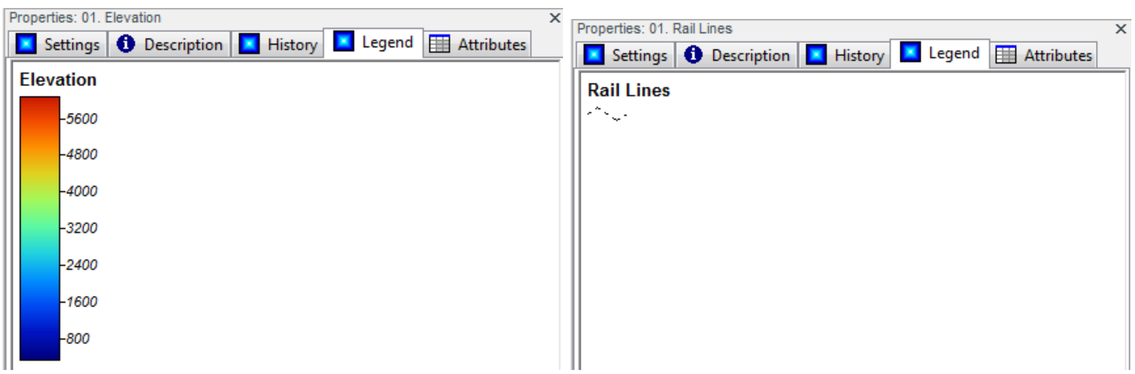


Figure 2-39. Displaying the "Elevation" and "Rail Lines" legends.

The fourth tab is History. This window displays the processing history for the selected object. Figure 2-40 displays an example of this information for a grid layer created by the *Terrain Analysis - Preprocessing/Sink Removal* tool. The input to the tool is the 'MCdem30' grid layer containing digital elevations. The entries for the tool options are listed. The task is to fill pits to support subsequent hydrology analysis.

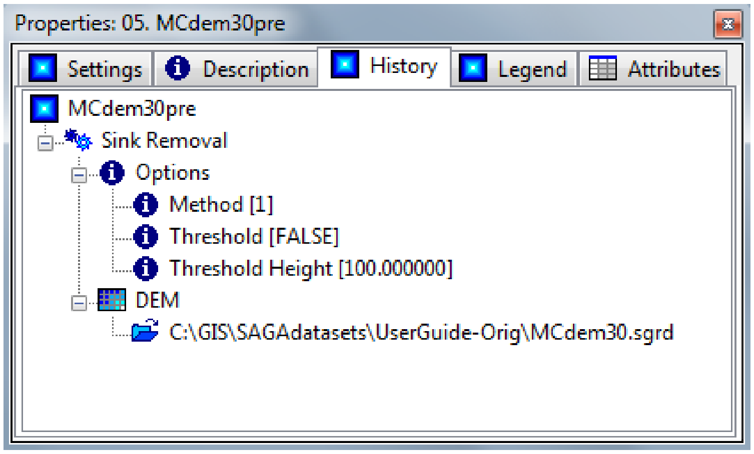


Figure 2-40. The History tab display in the Object Properties window for a layer created by the *Terrain Analysis - Preprocessing/Sink Removal* tool.

The fifth tab is Attributes. The Action tool is used to select one or more grid cells of a grid map or an object of a shape layer. In the case of selected grid cells, the data values for the one or more grid cells display in the Attributes tab area in a row/column structure. If the selection is an object of a shape layer, the attributes and their entries for the selected object display in the Attributes tab area. Figure 2-41 is an example for a polygon shape layer.

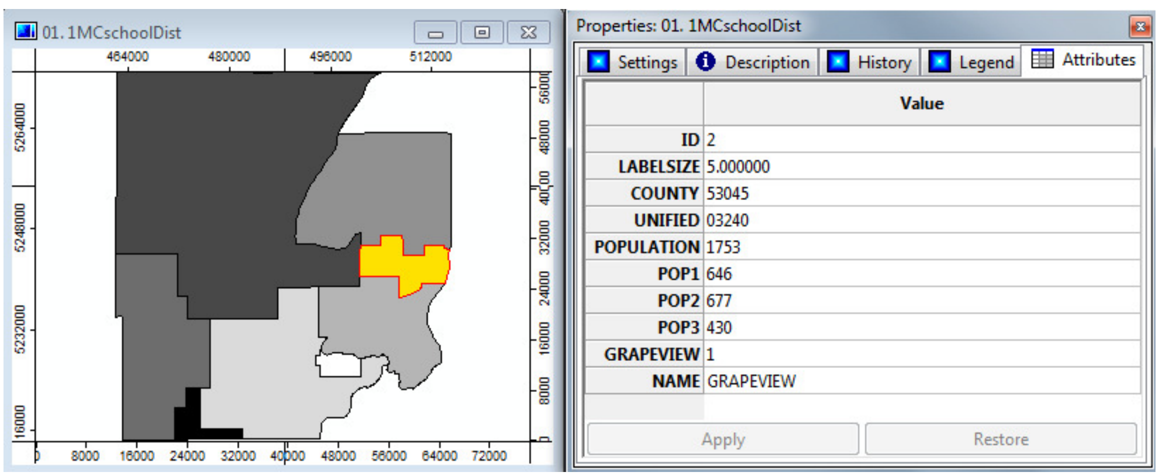


Figure 2-41. Displaying data for the '1MCschoolDist' layer in the Attributes tab area.

The map on the left is for school districts in Mason County, Washington. The school district polygon highlighted in yellow was selected using the Action tool from the toolbar. Once it was selected, the information in the attribute table linked to the school district "object" or polygon is displayed in the Attributes tab area of the object properties window.

Window: Show Data Source Window
The Data Sources window displays information related to the storage area or data base management system managing the current dataset. The window displays three tabs at the top of the window: File System, ODBC, and PostgreSQL.

ODBC stands for "Open Database Connectivity". I have not used ODBC but I assume if you are familiar with ODBC statements you can access with an ODBC application programming interface a database such as Access or dBase.

PostgreSQL is an object-relational database management system. I am not familiar with it but I assume that SAGA supports data access using SQL requests.

The File System tab I am familiar. This tab allows me to navigate on my desktop operating system to where I store GIS layers and tables. Once I have navigated to the specific folder, the folder contents are listed. I am able to use the mouse to select layers that will directly load into the current work session. I move the mouse pointer over a grid or shape layer name and click on it. The layer loads into SAGA just as if I had used a "Load" command. Using the File System tab may be a convenient, time-saving short-cut for loading layers and tables, depending on how GIS data is being stored.

Window: Show Message Window
The fourth option in the Window dropdown menu is "Show Message Window". Figure 2-42 displays a portion of a typical "Show Message Window" section.

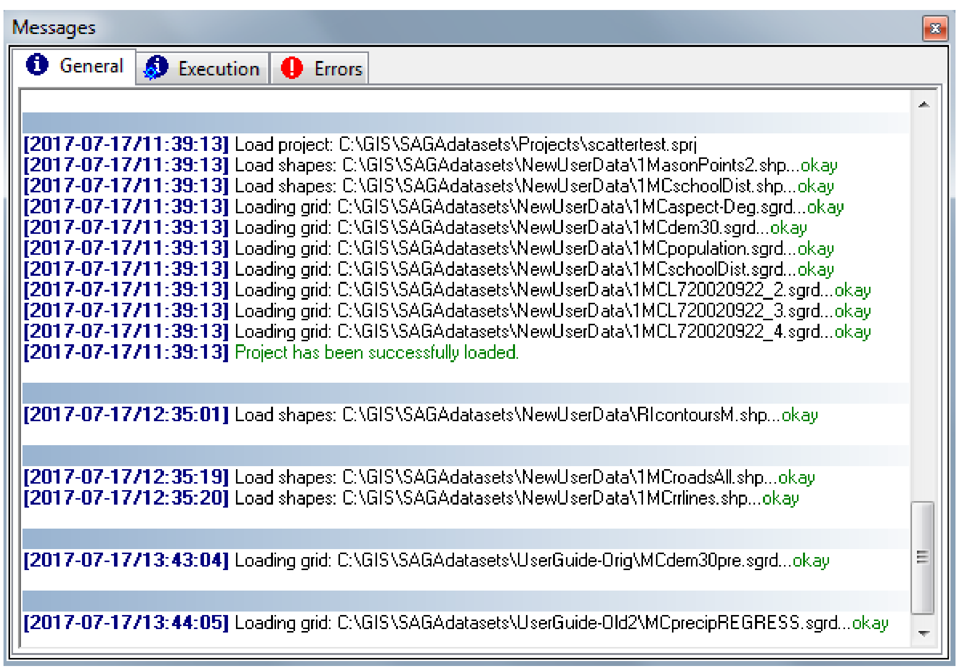


Figure 2-42. A typical "Show Message Window" display.

There are three tabs at the top used for selecting the display of different types of messages.

The General tab includes messages related to the default loading of tool libraries or whenever a project or layer is loaded or closed. When a tool is executed, the tool name and the starting time for the execution lists. When the tool ends, the ending time is posted. The top half of the window display illustrates entries for when a project named "scattertest" is loaded. I see an entry, including a date-time stamp for each layer that is part of the project when it is loaded into the work session.

The Execution tab displays messages related to tool executions. Figure 2-43 shows an example when the tool *Terrain Analyses - Morphometry/Slope, Aspect, Curvature* is executed.

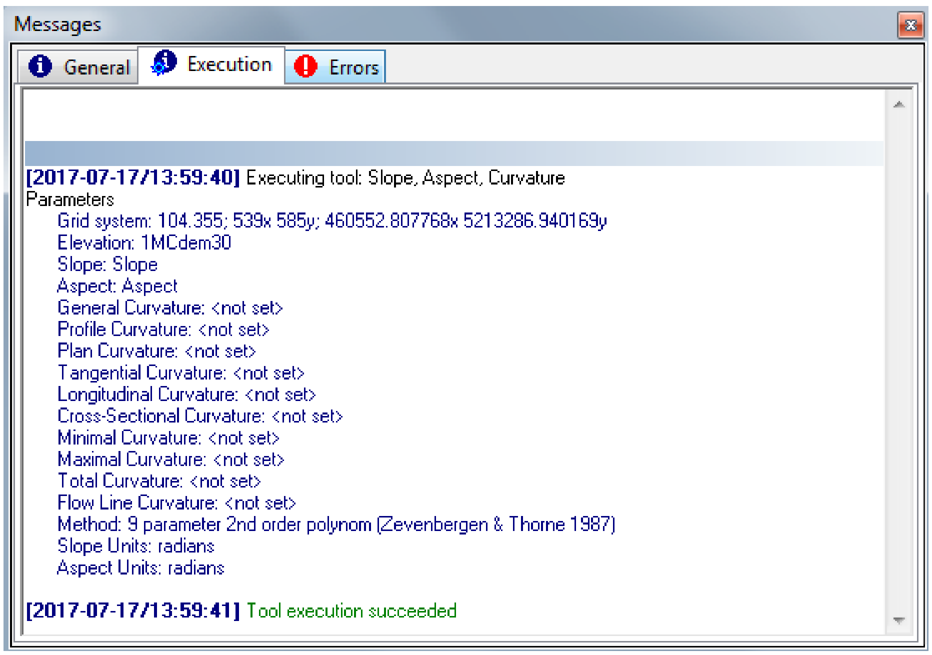


Figure 2-43. Execution tab information in the Messages window for the 'Calculator' tool.

The input grid layer for the tool is the '1MCdem30' grid layer. The tool supports 12 output grid layers. Only the "Slope" and "Aspect" grid layers are output in this specific execution. The units options for slope and aspect units is "radians". I can see this in the last two entries of the list. The other choices are "degrees" and "percent". A date-time stamp for the start and ending of execution is output by SAGA. The message "Tool execution succeeded", in green text, displays after the ending date-time stamp. Another message, "Tool execution failed", displays in red, if for some reason the tool execution is not successful.

The third tab is for messages related to Errors. This message area should be checked, particularly if the "Tool execution failed" message displays in the Execution tab area. Information for the failure may appear in the Errors tab area.

The four "Show ... Window" options of the Window menu have now been described. The last part of this chapter looks at the rest of the functions in the Window dropdown list of options.

Window: Cascade

When I have two or more map view windows open in the work area, clicking on the "Cascade" option creates a stack of the windows. I can see on the left side of Figure 2-44 that there are four map view windows randomly located in the work area. Map 03 is the active one since it is at the top of the map view windows. I can see that the map view title bar is highlighted. After choosing the "Cascade" option, the map view windows organize as displayed on the right in the figure.

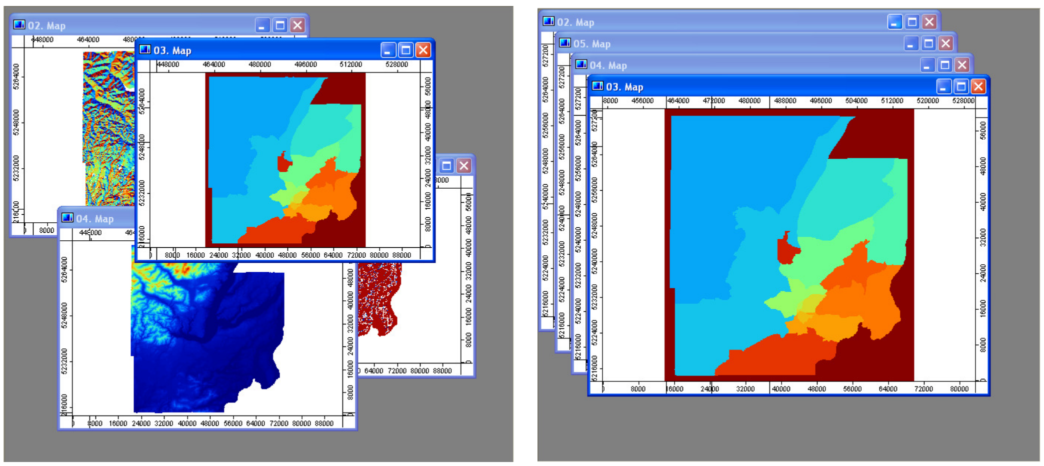
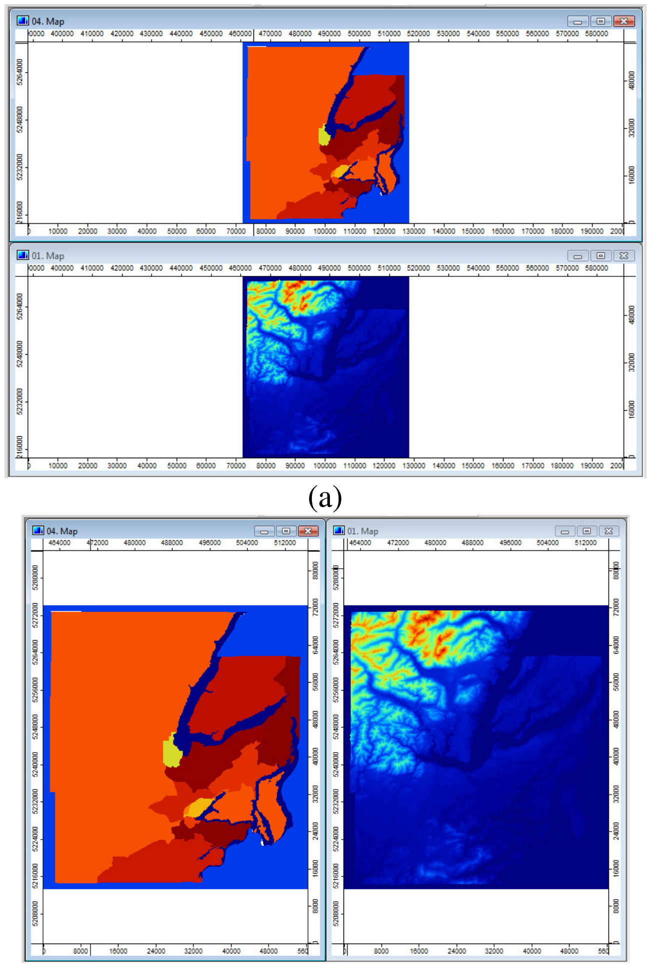


Figure 2-44. Using the "Cascade" option to organize map view windows.

Clicking with the mouse on any of the exposed part of a map view window that is part of the "Cascade" view brings that window to the forefront and it becomes the active one.

Window: Tile Horizontally and Tile Vertically

In this example, I am using two map view windows. The "Tile Horizontally" option was used for the two map view windows in Figure 2-45 (a) and "Tile Vertically" was used for the same two in Figure 2-45 (b). I can see that the difference between the two options is orientation, landscape verse portrait.



(a)

(b)

Figure 2-45. Using the "Tile" option to organize map view windows.

Window: Arrange Icons
This command sorts all minimized map view windows (i.e., their "icons") in a row beginning in the lower left corner of the SAGA screen.

The last section of the Window dropdown menu (see Figure 2-31) has four functions: Next, Previous, Close, and Close All.

Window: Next; Window: Previous
These two options choose either the "next" map view window or the "previous" map view window in the work area to become the active map view window.

Window: Close; Window: Close All
The "Close" command closes the current selected map view window. The "Close All" command closes all of the map view windows displayed or minimized in the work area. The map view windows are not deleted, they are still listed and available in the Maps tab area of the Manager window. The closed map or maps can be re-displayed by double-clicking on their names in the Maps tab area.

Chapter 3 – About Tools and the Manager Window Tools Tab Environment

There are three primary tab areas that access the SAGA Manager window. The tabs, available at the top of the Manager window, are Tools, Data and Maps. The Data and Maps tab areas have two sub-tabs for viewing Manager content in either a tree or thumbnail structure. The Data tab is explored in detail in Chapter 4 and the Maps tab area is discussed in Chapter 5. This chapter is a brief introduction to the functions and capabilities related to tools.

In earlier versions of SAGA, tools were called modules. Much of the documentation available for SAGA uses the modules terminology. This is also true for most tutorials. As you read this new User Guide, please be aware of this terminology change.

In SAGA, tools are packaged and accessed in tool libraries. A tool library contains a set of tools organized around a common theme. The SAGA Application Programming Interface (API) is used to develop tools. Users can develop their own routines to enhance the core spatial analysis functions of SAGA using grid and shape layers, point clouds, tables, etc.

When I execute the SAGA GUI at the start of a work session, tool library files automatically load from their storage locations. The libraries are normally stored in a folder named “tools” somewhere in the SAGA directory, sub-directory structure. They can be also be stored in locations outside of the tools folder and still be accessible in a work session. Once a tool has been loaded into a work session, regardless of its’ storage folder, as long as that specific tool is not closed before exiting the session, it will become part of the automatic load for tools for the next work session. Its' storage folder path is saved as part of what is called the .ini file that always saves when you exit from SAGA.

Accessing Tools
There are two methods for accessing the capabilities provided by tools. Clicking on the Menu Bar Geoprocessing menu displays a dropdown listing for all of the loaded tool categories (Figure 3-1).

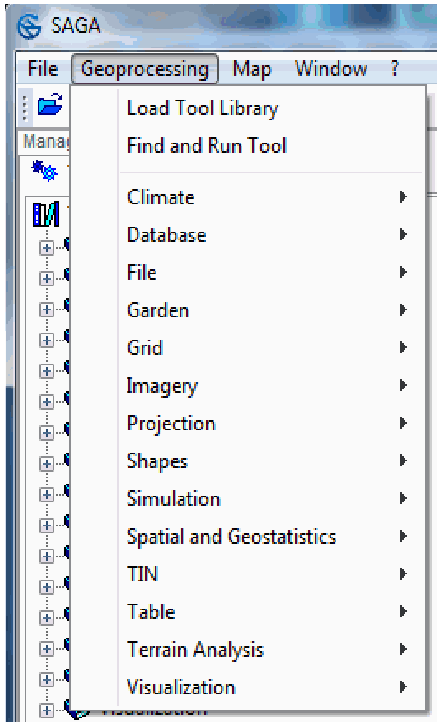


Figure 3-1. The Menu Bar Geoprocessing dropdown menu of options.

There are 14 categories of tools supported in SAGA Version 5.0. A detailed list of the tool libraries and tools is at the end of this chapter.

In addition to providing access to the tool routines, the Georeferencing dropdown menu also includes the "Load Tool Library" and "Find and Run Tool" options at the top of the menu.

Load Tool Library

Tool library files are normally stored in the default tools folder. They can be stored in other locations. If I want to load a tool library that has not been previously loaded, I use the "Load Tool Library" option. When I execute this option, the 'Load Tool Library' dialog window displays (Figure 3-2).

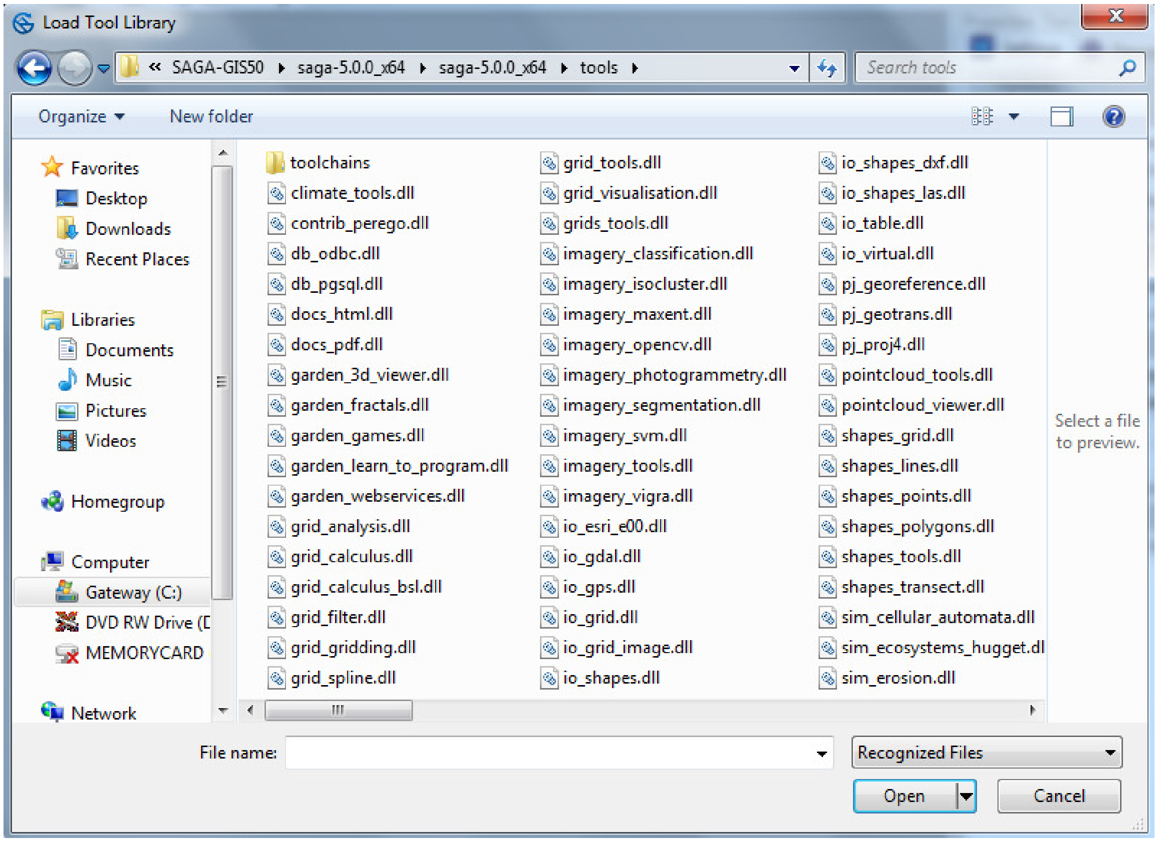


Figure 3-2. The 'Load Tool Library' dialog window.

Using the 'Load Tool Library' window, I can browse to the folder where the library I want to load is stored and enter the names of the tools in the folder into the "File name:" data field. Then I click on the Open button and SAGA loads the tool library tools.

This option can be executed multiple times if I have more than one tool library to load. Another approach for loading more than one tool library is to add additional tool library selections in the "File name:" data entry field using the Shift or Control keys when clicking with the mouse on additional library names. The names will be automatically entered in the data entry field for "File name:". If I need to load all the libraries at one time, I can use the CTRL-A command to select all the tools within the folder.

Once I have followed the process above for loading a tool library from a storage folder, when I exit SAGA, the path for the storage folder and the tool names, is stored for the next SAGA startup. The next time I restart SAGA, the tools load automatically and I do not have to repeat the above process.

Find and Run Tool

There are over 700 tools available in the 14 tool categories. There may be times when I cannot recall the name of a tool that I used. The "Find and Run Tool" option on the Geoprocessing dropdown menu provides a function to search the tool categories looking for a tool by name or by descriptive wording. The dialog window in Figure 3-3 displays the 'Run Tool' dialog window.

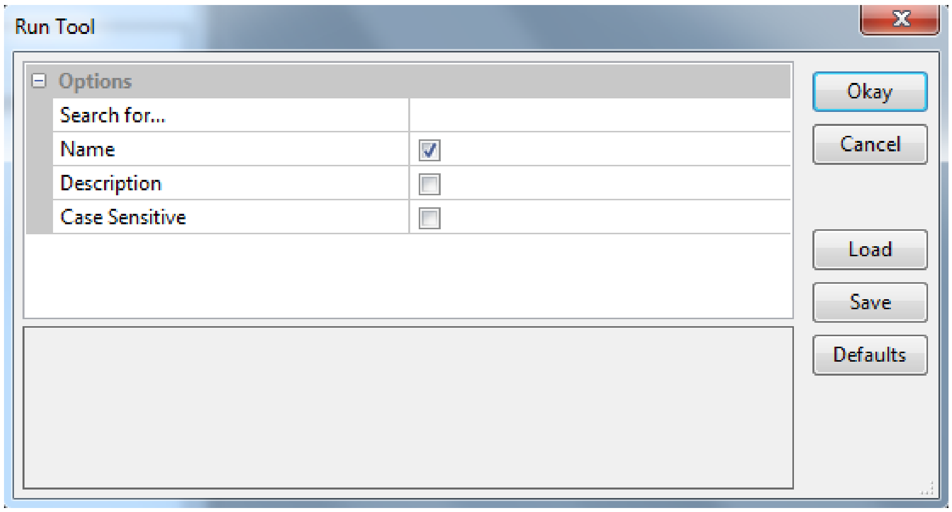


Figure 3-3. The 'Run Tool' dialog window.

There are three toggle check box options. The default is for the 'Name' option to be on. I can tell this parameter is in on status in Figure 3-3 because a check mark displays in the check box. If I know the actual name of the tool, or part of the name, I can use the default 'Name' parameter. I enter the tool name or a word in the name into the value field to the right of the 'Search for...' parameter at the top of the window. The search compares what I entered to the tool names.

In the instance where I can remember text that might describe the tool, I can click on the toggle check box in the value field to the right of the 'Description' parameter. A check mark appears in the box indicating the option is on. I enter the descriptive text into the value field to the right of the 'Search for...' parameter. Note that this search option searches all text included in a tool description, even the text for a reference listed as part of the description.

The third option is used when I want the case of characters to be considered in the search. I enter "Clip" for the text search. The text "clip" does not meet the search but "Clip" in "Clip Grid" does meet the search criteria.

Once I set the parameters and enter the text to search on, the command searches through the tool libraries for the entered text. If the text is found, a second 'Run Tool' dialog window displays.

As an example, the 'Description' option is toggled on and the text "Elonen" entered for the 'Search for...' parameter in the main 'Run Tool' dialog window. "J. Elonen" is an author for one of the technical references listed in the descriptions for a couple tools.

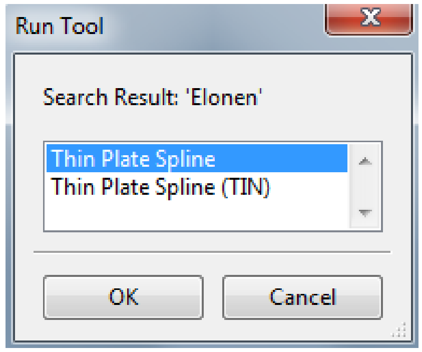


Figure 3-4. A second 'Run Tool' dialog window.

The second 'Run Tool' dialog window with the search results displays in Figure 3-4. The descriptions for the two tools found by the search, *Thin Plate Spline* and *Thin Plate Spline (TIN)*, include a reference to one of J. Elonens' publications.

The Menu Bar Geoprocessing Menu

Figure 3-5 shows the dropdown list of options that displays when I click on the Geoprocessing menu on the Menu Bar. To the right of each of the fourteen tool categories there is a small triangle. When I hold the mouse pointer over or click on any of the entries, a list of the tools in the category displays. It is possible that rather than a set of tools, a set of tool sub-categories displays. Clicking and choosing any of the displayed functions executes the tool.

Figure 3-5 provides an example of choosing the *Grid Buffer* tool on the Geoprocessing dropdown list of options.

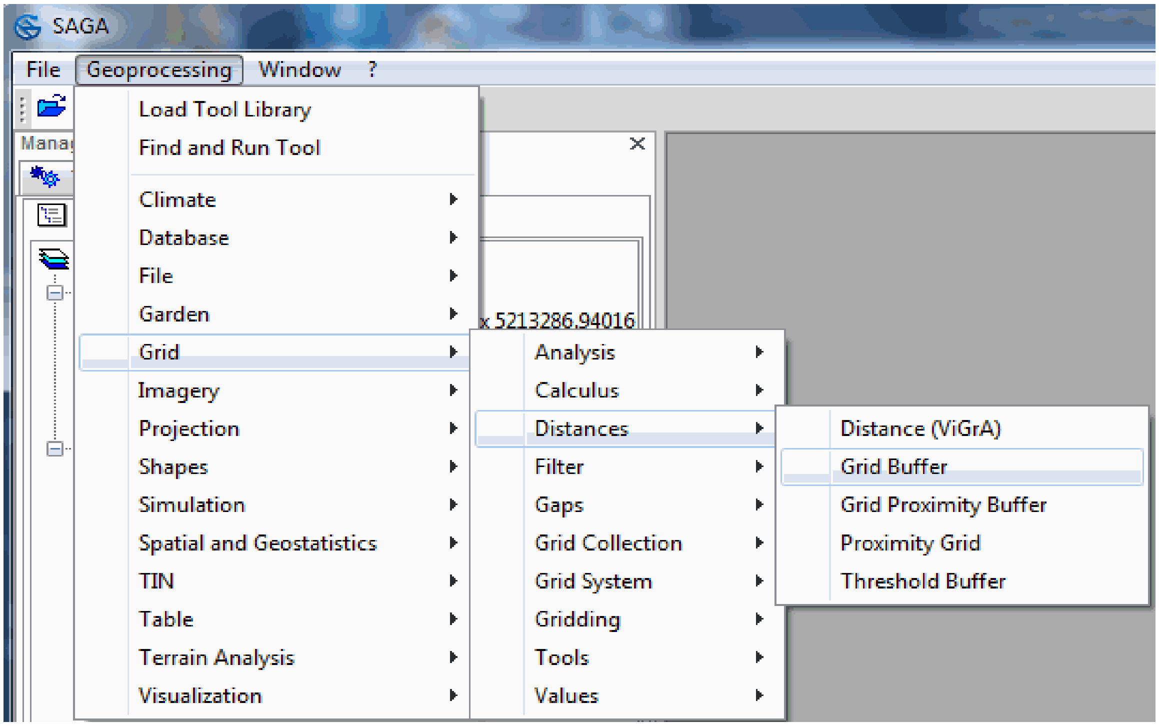


Figure 3-5. Selecting the *Grid Buffer* tool for execution.

On the far left in Figure 3-5, I clicked on the Geoprocessing menu on the menu bar. A dropdown list of tool categories displays. I move the mouse pointer over the *Grid* category. A popup list of sub-categories displays. Again, I move the mouse pointer over another label, *Distances*. I can choose from: *Distance (ViGrA)*, *Grid Buffer, Grid Proximity Buffer, Proximity Grid* and *Threshold Buffer*. I click the mouse pointer on the *Grid Buffer* tool and it executes.

The Manager Tools Tab

The second approach for choosing a SAGA tools library function is using the Tools tab at the top of the Manager window. Figure 3-6 shows the full list of tool libraries that displays when I click on the Tools tab.

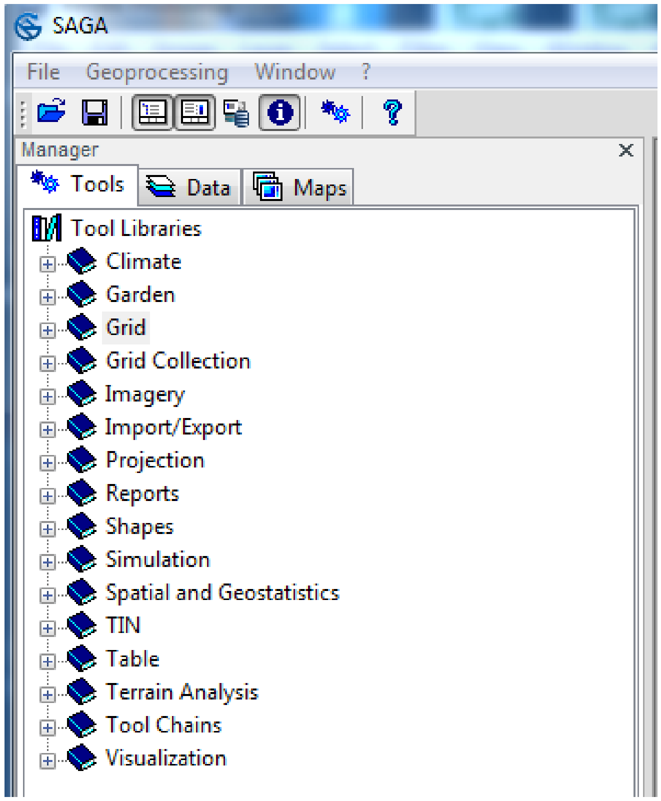


Figure 3-6. The Tools tab list of tool libraries.

Comparing the list of tool libraries in Figure 3-6 to the list of tool categories in Figure 3-1 I observe 14 categories of tools in Figure 3-1 and 16 general tool libraries in Figure 3-6. There are several differences between tool categories and tool libraries. For example the *Grid Collection* library is included in the *Grid* category rather than as a separate category. Nevertheless, I can execute a tool from either location, i.e., from within the tool categories or from within the tool libraries list.

To the left of each of the tool libraries, in Figure 3-6, I see a + symbol. This is a toggle between + and - representing "expand" and "minimize" the tool library list. For example, when I click on the + symbol to the left of *Grid*, the category expands to include eight tool sub-libraries. Figure 3-7 shows an example of this. Notice how the + symbol changes to a - symbol.

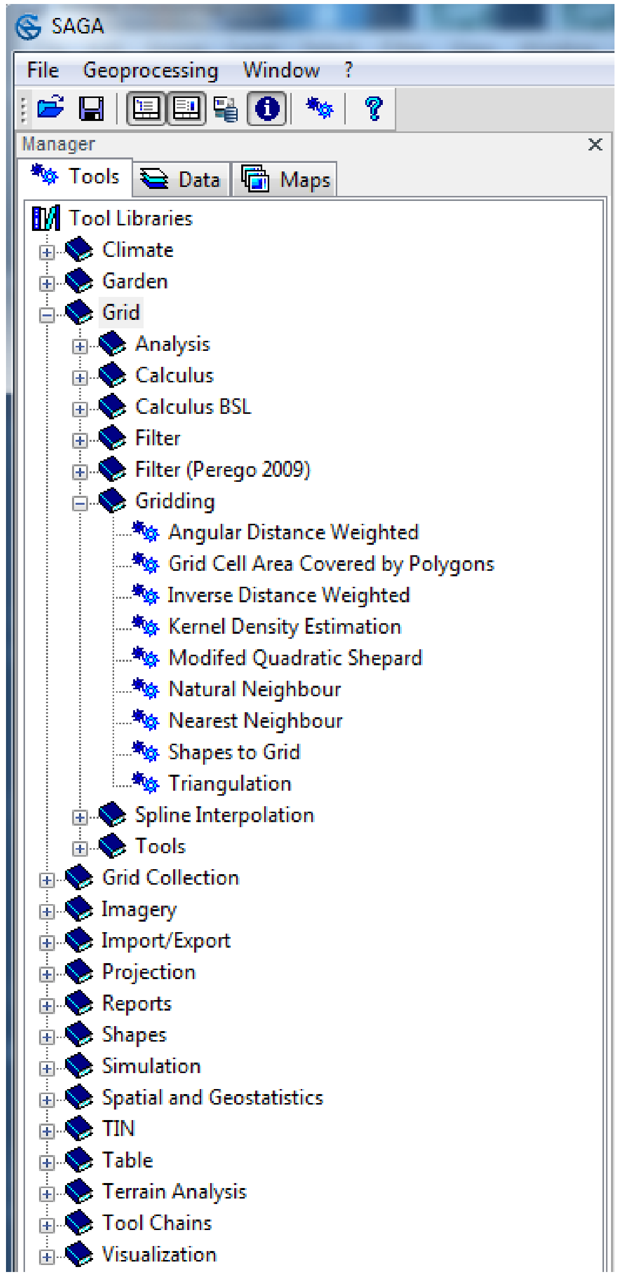


Figure 3-7. An expanded option list for *Grid - Gridding*.

I clicked on the + to the left of the *Grid* label to expand the list. I can see that the + changed to a - and displays the names of eight sub-libraries. I then clicked on the + to the left of the *Gridding* sub-library and expanded it to list the nine tools it includes. All of the tools available in the Menu Bar Geoprocessing menu are available in the Manager window Tools tab area. However, as I have seen there are some minor differences in how they are organized and listed.

The Tool Parameter Settings Page

Generally, when I execute a tool, a parameters window immediately displays. Figure 3-8 displays the parameters window ‘Morphometric Features’ that appears when I execute the *Terrain Analysis – Morphometry/Morphometric Features* tool.

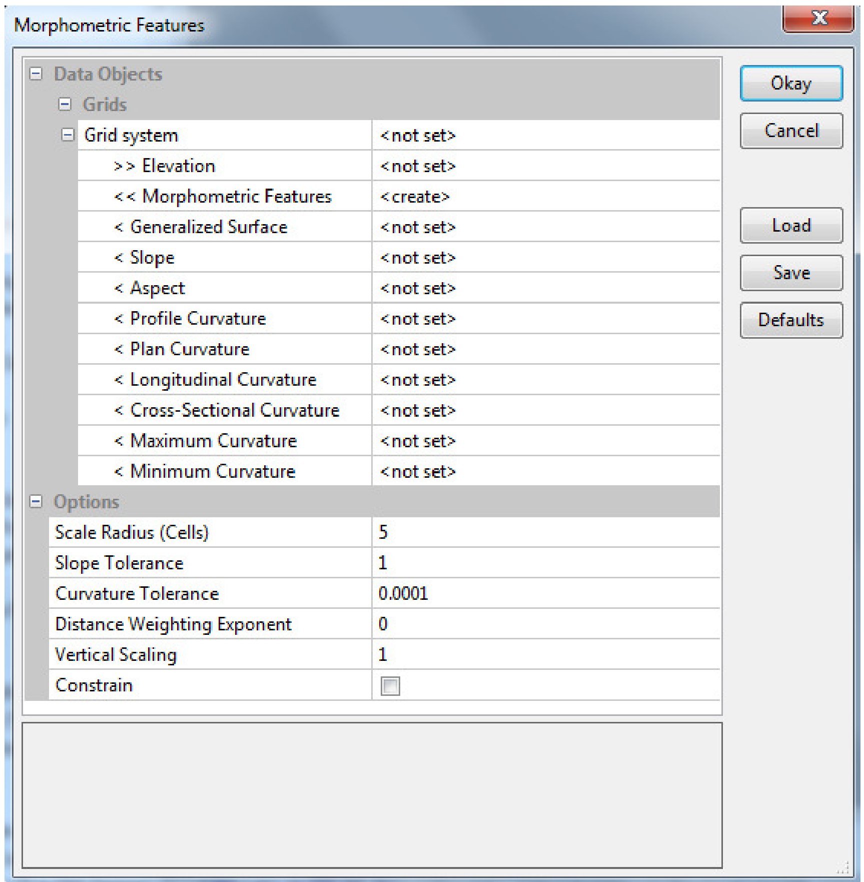


Figure 3-8. The parameter settings page for the *Morphometric Features* tool.

All tool parameter settings windows have the same basic structure. The parameters section consists of two columns. The left column lists the parameter names or labels. The column on the right lists their corresponding value fields or data entry fields. The value fields are where the user provides input data for the tool parameters.

There can be parameters representing mandatory or optional layer input, either grid or shapes. There can be mandatory or optional layer parameters for output. The same input and output parameter types can be available for tabular output, analysis methods, and others.

On the right side of the page are five buttons. The Okay button is clicked on when the user has finished making entries in the parameter value fields. The Cancel button can be clicked on to terminate data entry for the tool and close the page.

The Load and Save buttons are used if I want to save a set of parameter settings for a repeat execution of the tool or for documentation. The saved settings can be re-loaded using the Load button. Settings are saved in a .sprm file type.

The Defaults button can reset parameter option entries to their defaults for tools previously executed in the current work session.

Notice to the left of the section names, "Data Objects", "Grids", "Grid system", etc., the - (minus) symbols. These will toggle between - and + to minimize or expand the content of the section.

Returning to Figure 3-8, in the "Grid system" section I see variables identified for input and output. A mandatory layer input parameter will have the double ">>" in front of the parameter name. The one mandatory layer input parameter is “Elevation” displayed as ‘>> Elevation’.

The double "<<" precedes parameters that are mandatory layer outputs. I can see in Figure 3-8 that the one mandatory output layer is named “Morphometric Features” and preceded with "<<".

There are nine optional outputs. Each of their parameter names are preceded with the symbol "<". These optional outputs appear in the example as ‘< Generalized Surface’, ‘< Slope', ‘< Aspect', etc. An optional input parameter is indicated by the symbol ‘>’.

The last section of the parameter settings page is the “Options” section. There are six options, including five that require numeric entries. The sixth one is a toggle check box indicating on or off status. Other tools may have options where the user makes a choice on a parameter dropdown list of choices. In particular, many tools provide options related to selection of methods.

The defaults entered for the layer value fields vary depending on the tool. The standard default entries include “<not set>” and “<create>”. Some defaults are a numeric entry. A mandatory layer input, like the one for the '<< Elevation' parameter, must have an entry other than the default “<not set>”.

If I click in the value field to the right of the 'Grid system' parameter, a dropdown list of the grid systems active in the work session displays. I choose the grid system, in this case, that the elevation grid layer is a part. Next I move the mouse pointer into the value field to the right of the '>> Elevation' input parameter and click the left mouse button. A dropdown list of existing layers displays for the grid system chosen for the ‘Grid system’ parameter (which must be specified first). I can choose one of the layers on the list for input in the value field. If I leave the “<not set>” default, the tool will not execute.

The tool does not check whether I choose an appropriate layer. For example, if the input parameter expects an elevation layer to be identified and I choose a grid layer that represents land ownership, the tool will not know that I made an incorrect choice. It is up to the user to identify the appropriate layer inputs. Tools, by use of input types, do differentiate between using a grid or shape layer, as an input. They just don't check whether the layer contains the expected type of data values for the tool.

A mandatory output parameter may have the default entry "<create>" in the value field. If I click in the value field when the small triangle displays, a dropdown list of layers for the selected grid system displays. If I change the default from “<create>” to an existing layer, the output from the tool overwrites the content of the existing layer that was chosen. Normally, I will leave the entry as “<create>”. I can rename the new layer something more appropriate after it is created and I have reviewed it. Remember, if I choose an existing layer for an output parameter, the content of the chosen existing layer may be overwritten by the tool output. There are a few shape tools that are exceptions to this overwrite behavior. This is useful when a tool is executed repeatedly to refine parameter settings and I don’t want the tool to generate new output files each time.

Optional layer outputs can use the default “<not set>” entry in the value field if the output is not wanted. The tool, in this case, will not produce a layer or table (depending on the output parameter) for the parameter. If I want to produce the optional layer, when the list of layers displays when I click in the value field, I scroll to the bottom of the list and choose “<create>”.

The Tool Parameter Types
All tools use a subset of the tool parameter types supported by the SAGA Application Programming Interface or API to define the tool parameter settings. These parameter types always have the same meaning and function.

1) general: available input/output parameter definitions.
* input, mandatory >>
* input, optional >
* output, mandatory <<
* output, optional <

2) available parameter types.
* data objects:

Table	Table choices list (now available *.txt, *.csv, *.dbf tables and tables from shapes)
Table List	Input process to select multiple tables
FixedTable	lookup table editor dialog
Table_Field	choice of a table field
Grid_System	Grid System choices list
Grid	Grid dataset choices list
Grid List	Input process to select multiple grids
PointCloud	PointCloud dataset choices list
PointCloud List	Input process to select multiple PointClouds

Shapes	Shapefile dataset choices list (may be restricted to either point, line or polygon)
Shapes List	Input process to select multiple shapefiles
TIN	TIN dataset choices list
TIN List	Input process to select multiple TIN datasets
DataObject Output	undefined output dataset

* numbers:

Integer	integer number
Double	floating point number
Degree	floating point number, unit degree
Range	floating point number range (min/max)

* tokens:

String	text

* selections:

Bool	checkbox
Choice	dropdown choices list

* files:

FilePath	file dialog to select a file path

* display:

Font	font selection dialog
Color	color choices list
Colors	color ramp palette dialog

* parameters:

Parameters	opens up dialog for further parameter settings (with all options available listed above)

Tool Documentation

A limited amount of tool documentation is available. Here is an example using the *Grid - Calculus/Grid Normalisation* tool.

First, I make sure the Object Properties window is displayed somewhere in the work area. Usually, in my work sessions, I have it docked to the right side of the work area. Next, I choose the Tools tab at the top of the Manager window. I navigate in the list to the *Calculus* sub-library in the *Grid* library. I move the mouse pointer over the tool name *Grid Normalisation*, and click on it so it is highlighted (a light gray background displays).

The *Grid Normalisation* tool name is active, i.e., it is selected. I click on the Settings tab in the Object Properties window. The properties for the tool display (Figure 3-9).

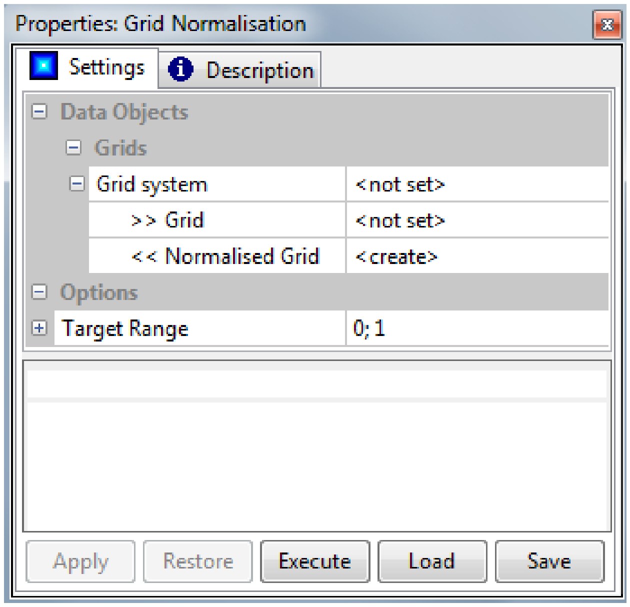


Figure 3-9. The Settings tab area of the Object Properties window for the *Grid Normalisation* tool.

The documentation available for the tool is displayed in the Object Properties window when I click on the Description tab. Figure 3-10 displays the documentation for the *Grid Normalisation* tool.

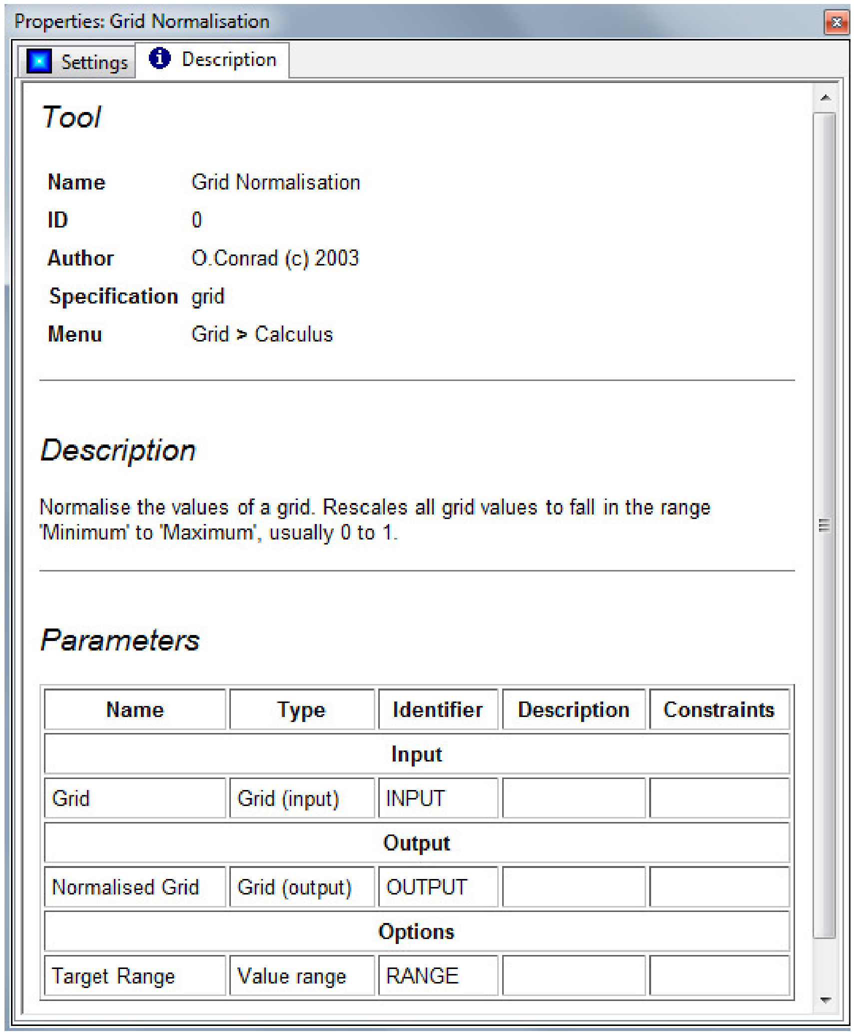


Figure 3-10. The documentation in the Description tab area for the *Grid Normalisation* tool.

The documentation available for any tool is viewed as described for the *Grid Normalisation* tool. This description information is also available on the SAGA website via wiki.

Discussion of Standard Tool Entry Procedures
This section of the chapter presents information related to a few parameters and procedures used in many tools. Once you understand how to use them in one tool you find they behave the same way in other tools. Hopefully, your learning curve is shortened by the explanation provided in this section.

The Grid System Parameter
This parameter is encountered in nearly every tool involving grid layers. When no grid layer has been loaded in a work session, the default entry for the parameter value field is “<no choice available>”. If a grid layer has been loaded, or a project that includes a grid layer has been loaded, the grid system of the layer also becomes available. Once a grid

system is available in the work session, the default entry for the grid system parameter, therefore, will be “<not set>”.

The choice I make for the ‘Grid system’ parameter is the one the grid layer I want to choose as input is a member. In this discussion, assume that the grid layer I want to choose is available in the current work session. I move the mouse into the value field to the right of the ‘Grid system’ parameter and click the mouse button, a list of available grid systems for the work session displays. I should choose the grid system the input grid layer I am going to choose is a part. If I choose a different available grid system, the grid layer I want to choose is not available for selection as an input.

I move the mouse pointer over a grid system on the list and the entry becomes highlighted. I click the mouse button while the entry is highlighted, choosing the grid system. I am now ready to choose the grid layer input. But the grid layer I want to choose does not appear in the list of layers for the selected grid system. This means one of two things; either the grid layer has not been loaded or, if it has been loaded, the wrong grid system is chosen, i.e., a grid system other than the one the input grid layer is a part was erroneously chosen. If the first case is true, I can use the File: Grid: Load option in the Menu Bar File menu to load it. If the latter case is true, I check in the Data tab area of the Manager and identify the correct grid system. I note the grid system definition and then execute the tool again, and re-select the correct grid system as outlined above.

There is a short-cut that might help to keep track of grid systems during a work session. Click on the Data tab in the Manager window. I move the mouse pointer over an available grid system entry and click on it. Notice in the Settings tab area of the Object Properties window that there is a single parameter 'Name'. If I move the mouse pointer into the value field to the right of the 'Name' parameter I can edit the entry to something easier to identify. For example, I re-name the numeric definition to a project name having more meaning. The edited name is available for the work session and reverts to the numeric definition when I exit from SAGA. This is not a parameter saved as part of a project definition or in the configuration file.

Figure 3-11 displays the Data tab area of the Manager window for a work session.

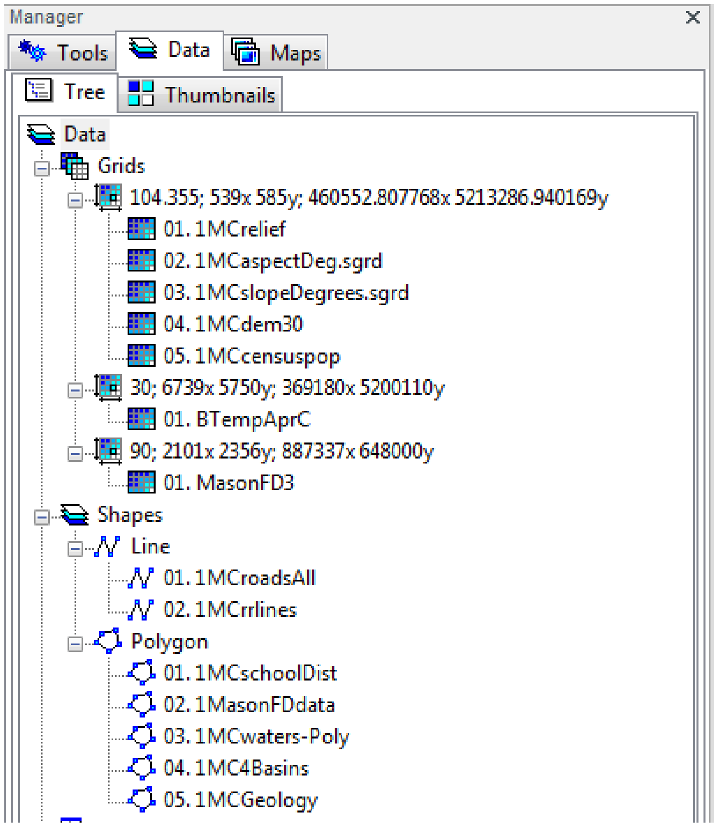


Figure 3-11. The Data tab area of the Manager for a work session.

There are three grid systems loaded in this session. They list in the "Grids" section of the listing. The three are:

104.355; 539x 585y; 460552.807768x 5213286.940169y
30; 6739x 5750y; 369180x 5200110y
90; 2101x 2356y; 887337x 648000y

The grid layer that I want to choose for input for the tool is the one named ‘1MCdem30’. It is a part of the 104.355; 539x 585y; 460552.807768x 5213286.940169y grid system.

Figure 3-12 displays the *Grid - Filter/Gaussian Filter* tool parameters window while the entry is being made for the ‘Grid system’ parameter.

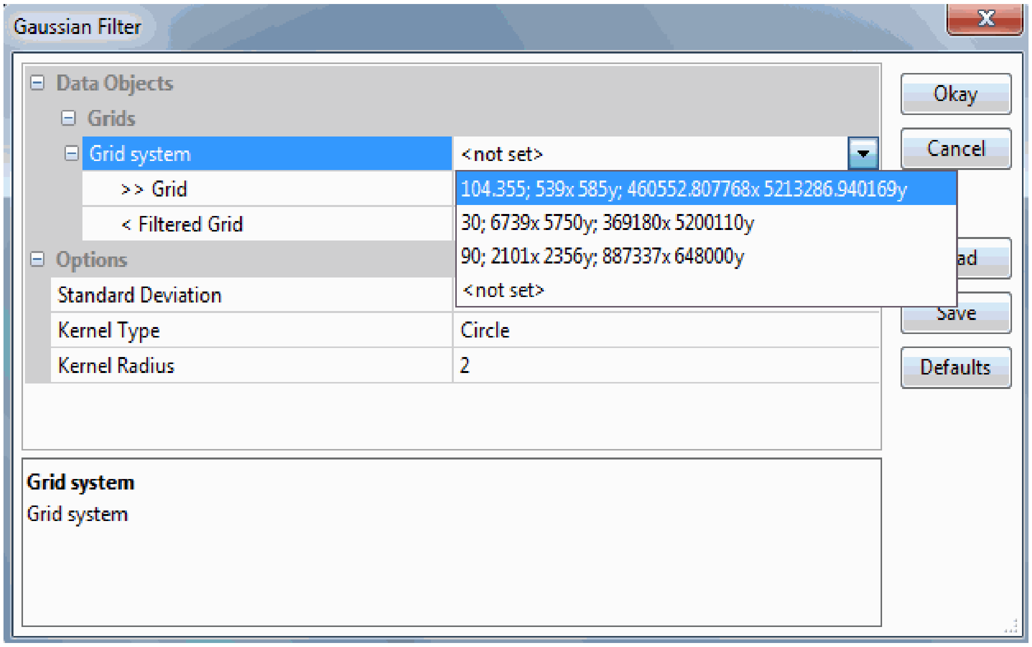


Figure 3-12. Choosing the grid system for the 'Grid system' parameter.

In Figure 3-12, the mouse pointer has been moved into the value field to the right of the 'Grid system' parameter and the left mouse button clicked. A dropdown list with the three loaded grid system names displays. I use the mouse to select the first one in the list.

>> Grid or > Grid Parameters
The ">>" symbols mean the parameter is mandatory and the ">" symbol identifies it as an optional parameter. Regardless of this status, the process for choosing an entry for the value field is identical.

As explained in the discussion of the grid system parameter, the grid system the grid layer is a part must be chosen for the grid system parameter in order for the layer to be available as a choice for the >> Grid' parameter.

When I move the mouse pointer into the value field to the right of the '>> Grid' label and click the mouse button, a dropdown list of grid layers that are loaded for the chosen grid system appears. I move the mouse pointer over an entry in the list and press the left mouse button. This highlights the entry and selects it for the input parameter.

In this example, the '1MCdem30' grid layer is the input grid layer. Looking at Figure 3-13, this layer is listed as loaded and a member of the 104.355; 539x 585y; 460552.807768x 5213286.940169y grid system. That particular grid system is chosen for the 'Grid system' parameter. Figure 3-13 displays the tool parameter settings page while the grid layer is being chosen for the '>> Grid' parameter.

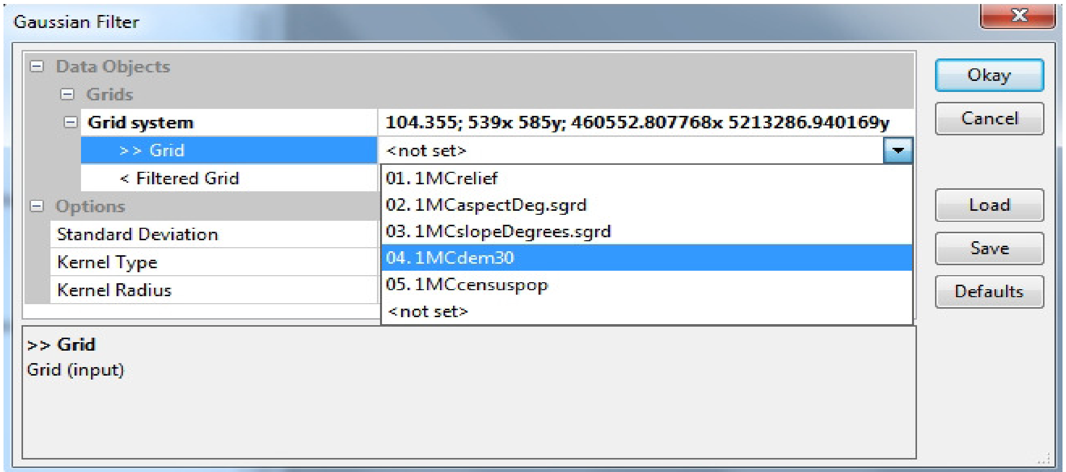


Figure 3-13. The tool settings page showing the input '>>Grid' parameter being chosen.

In Figure 3-13, I have moved the mouse pointer into the value field to the right of the '>> Grid' parameter and pressed the left mouse button. The names of the five grid layers available for the chosen grid system display in a dropdown list. I can see that the mouse pointer is over the fourth one in the list ('1MCdem30') as it is highlighted. Clicking with the left mouse button chooses that specific grid layer for the '>> Grid' parameter.

>> Grids Parameter

There are tools where one or more grid layers can be chosen for an input parameter. In these cases, the input parameter may be listed as ">> Grids" as compared to ">> Grid". For example, the *Grid – Calculus/Grid Calculator* tool input parameter is named ">> Grids". In the value field to the right of the '>> Grids' label, instead of the default "<not set>" text, the text "No objects" appears.

The tools supporting choosing one or more grid layers for input display a dialog window for building an input list of layers. When I move the mouse pointer into the value field, the value field becomes highlighted and an ellipsis is displayed on the right side of the field. I click the mouse pointer on the ellipsis and a 'Grids' dialog window appears (see Figure 3-14).

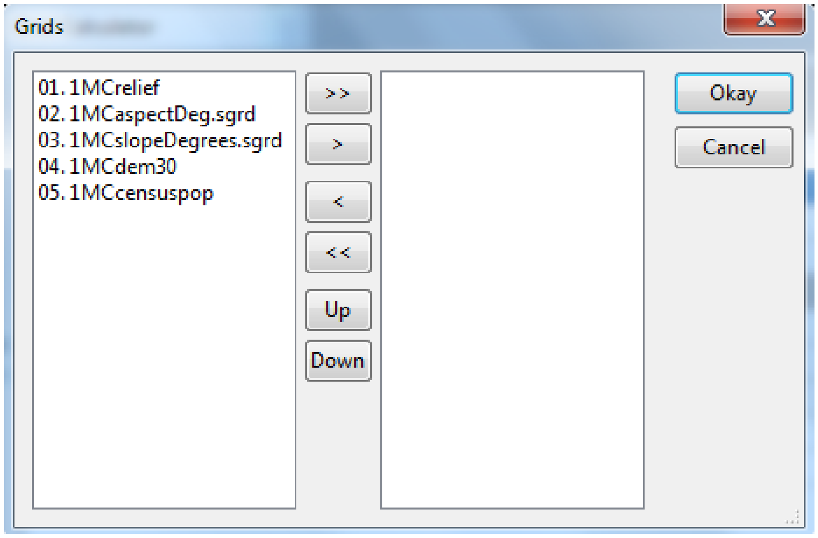
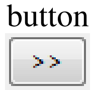
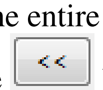


Figure 3-14. The 'Grids' dialog window for building an input list.

The 104.355; 539x 585y; 460552.807768x 5213286.940169y grid system has been chosen for the grid system. The grid layers displayed on the left are available in the work session for the chosen grid system 104.355; 539x 585y; 460552.807768x 5213286.940169y.

The dialog window has three components. The list of layers to choose from is on the left. When a layer is chosen in the list on the left it is moved to the list area on the right.

When I move the mouse pointer over a grid layer and press the mouse button, the name becomes highlighted and it is in a selection status. Additional layers can be added to the selection by depressing and holding the Control or Shift keys when I press the mouse button. I can de-select a layer by moving the mouse pointer over the highlighted selection, press the Control or Shift keys, and press the mouse button.

In the middle, between the two list areas, are four buttons used for moving layers back and forth between the two lists. The  button moves selected layers in the left panel to the right panel and the  button does the reverse, moving selected layers on the right panel to the left panel. The  button moves the entire list in the left panel (regardless of selection status) to the right panel and the  button does the reverse.

I can also move layers back and forth between the two lists by double-clicking with the mouse pointer positioned on the file I want to move.

The Up, Down buttons change the position of a layer in the input list on the right, either up in the list or down in the list. The position of a layer in the input list may or may not be important for the tool. In the case of the *Grid Calculator* tool it is important because the equation entered for the Formula parameter uses alpha/numeric character references for the layers specific to their order in the list. The order may not make a difference for other tools.

There are a few tools, that because of their purpose, support choosing grid layers from more than one grid system. The *Grid – Tools/Mosaicking* tool is an example. Figure 3-15 displays the ‘Input Grids’ dialog window for inputting grid layers for this tool. The window has a similar structure to the one displayed in Figure 3-14.

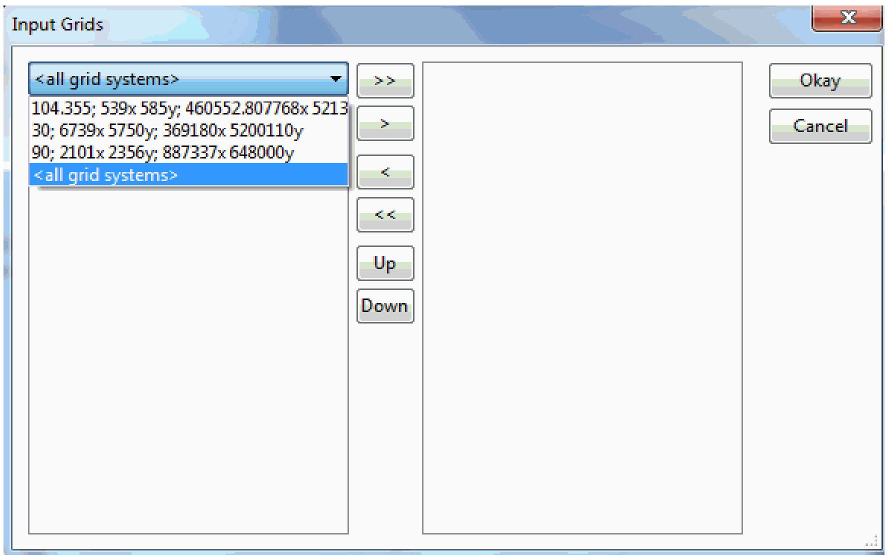


Figure 3-15. The 'Input Grids' window for the *Mosaicking* tool.

The three grid systems available in the current work session are listed in the left panel when this dialog window first opens. The current option is "< all grid systems>". I can move the mouse pointer over one of the three grid systems in the list, click on it, and a list of the grid layers loaded for the selected grid system replaces the list of grid systems. I can proceed to chose one or more of the layers in the list as inputs, moving them to the right panel. If I have more grid layers I want to select as inputs that are members of the two other available grid systems, I move the mouse pointer over the small triangle on the left to the right of the option "< all grid systems>" at the top of the panel. Then I can select another grid system from the list and continue to choose grid layers for input.

The Three Defaults

As noted earlier, if no grid system is loaded in the current work session, the ‘Grid system’ parameters will display “<no choice available>”. Most of the other parameters used for choosing a grid or shape layer, depending on whether they are input or output parameters, will display either “<not set>” or “<create>”.

Tools executed having mandatory input parameters that are set with the “<not set>” choice will not execute. Likely, you will see a message similar to the one in Figure 3-16.

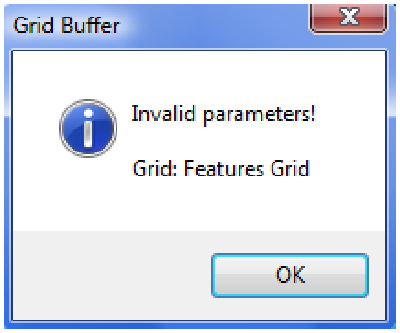


Figure 3-16. The "Invalid parameters!" message.

Using the "<not set>" choice for optional parameters generally does not cause any execution problems.

Mandatory output parameters will have the default choice of "<create>". Optional output parameters will have the default choice of "<not set>". Both types of outputs have a third choice. Figure 3-17 displays the dropdown list when I click in the value field to the right of an output parameter.

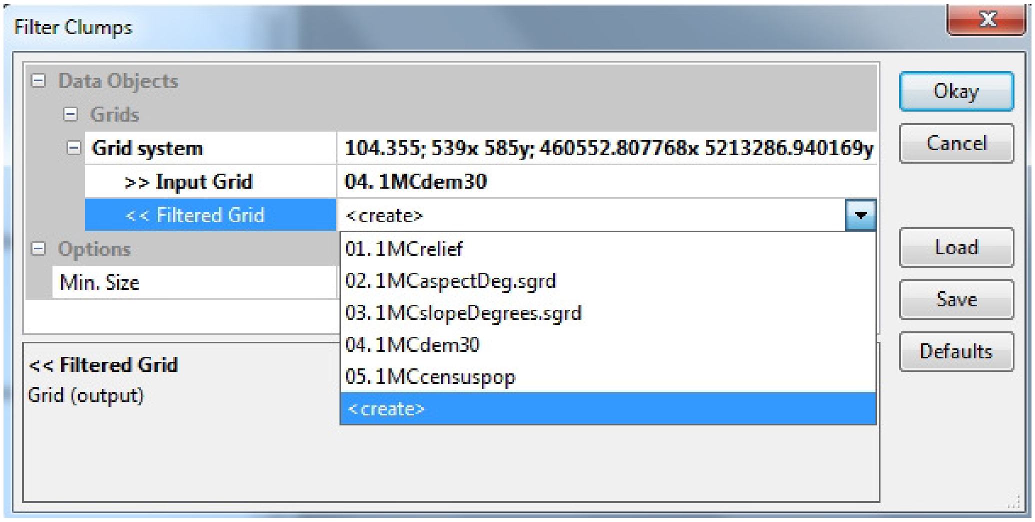


Figure 3-17. Looking at the choices for an output parameter.

The tool settings page in Figure 3-17 has an output parameter called '<< Filtered Grid'. I can tell by the "<<" symbols that this is a mandatory output. The default entry in the value field is "<create>". If I move the mouse pointer into the value field and click the mouse button, the dropdown list shows that, in addition to the "<create>" choice at the bottom of the list, I could choose an existing grid layer. This is not unusual for output parameters involving grid or shape layers.

When I choose an existing layer to replace the "<create>" choice, the tool output will overwrite the data of the layer I choose. If this is my intent, it is not a problem. If I want to be safe, the best choice is to use "<create>" and rename the output as desired.

Shapes Input and Output Parameters
Shape data layers support four shape or object types: points, multipoint, lines, and polygon. Many tools that work with shape layers are type dependent. The input and/or output parameters will be specific to a shape type. Tools that are not specific to a shape type may use ">> Input" or ">> Shape" as input parameter names. Tools that are type dependent, may use input parameter names ">> Points", ">> Lines", and ">> Polygons" depending on the tool function.

Output parameters can also be type dependent with names such as "<< Points", "<< Lines", and "<< Polygons". The selection procedures discussed earlier apply to these parameters with the exception that shape layers are not involved with grid systems so there is not a “grid system” parameter for shape layers. However, unlike grid layers that are single theme, shape layers are multi-variable.

Each shape layer has a linked attribute table to provide descriptive data for the objects it contains (points, multipoints, lines, or polygons). These attribute tables are stored as dBase or text files, most often dBase. Often, a tool will have one or more shape layer input parameters and each parameter also involves attributes. The shape layer attributes chosen are the sources of data values used in the tool execution.

Figure 3-18 displays the *Shapes - Points/Add Polygon Attributes to Points* tool settings page. This tool adds attributes from polygon objects of a polygon shape layer to attributes of point objects of a point shape layer that fall within the polygon objects.

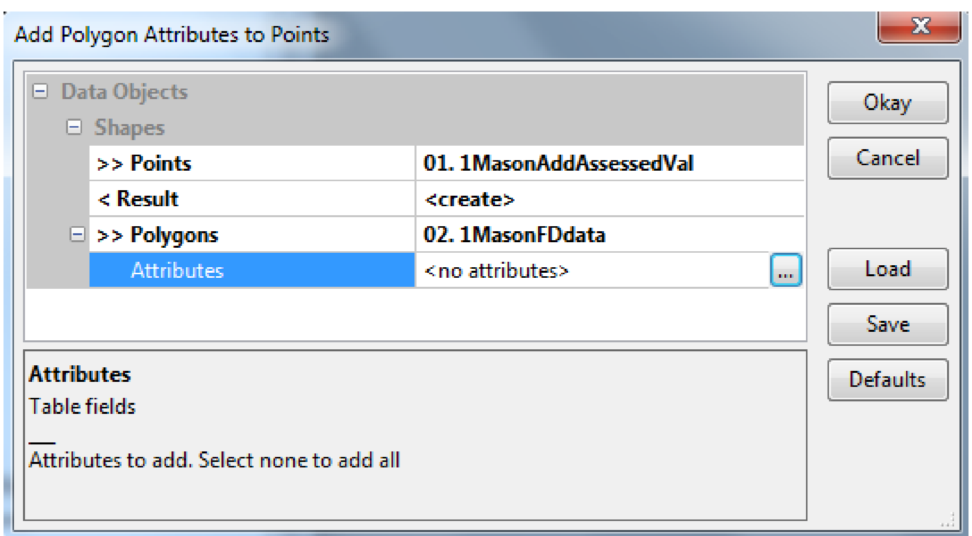


Figure 3-18. The settings page for the *Shapes - Points/Add Polygon Attributes to Points* tool.

A point shape layer, ‘1MasonAddAssessedVal’, is chosen for the mandatory ‘>> Points’ input parameter. The '1MasonFDdata' polygon shape layer is chosen for the input '>> Polygons' parameter. The ‘Attributes’ parameter is the last entry in the dialog window.

The default entry for it is “<no attributes>”. I click the mouse pointer on the ellipsis that displays on the right in the value field. The 'Parameters' window in Figure 3-19 displays.

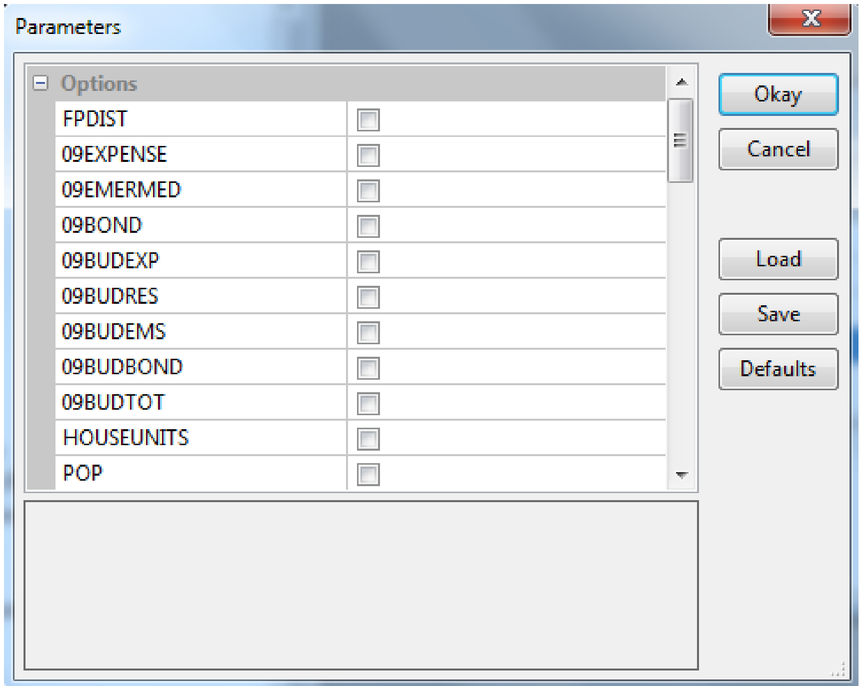


Figure 3-19. The 'Parameters' window for selecting one or more attributes for data values.

There are 44 attributes in the attribute table linked to the '1MasonFDdata' polygon shape layer. The scroll bar on the right is used to view rows of the table not in the current view.

One or more of the 44 attributes can be chosen for the ‘Attributes’ parameter. These are toggle check box type parameters. When I move the mouse pointer into the toggle check box in the value field to the right of the ‘Attribute’ name and click the mouse button, a check appears in the box. The attribute can be un-selected by clicking with the mouse button a second time in the toggle check box. A check mark in the check box means the attribute is chosen and no check mark means it is not chosen.

Default Names for Tool Output

Generally, I cannot assign a name to an output layer or table. In most cases (at least one exception involves tabular output) the tool uses a default name. The default name may be directly related to the tool output parameter. For example, output from the *RGB Composite* tool is called “Composite” which happens to be the name for the output parameter. Some outputs include the name of the input layer and concatenate text related to the tool purpose. For example, '1MCdem30 [Laplace Filter]' is the name for the output from the *Grid - Filter/Laplacian Filter* tool when the '1MCdem30' grid layer is the input. One exception is the *Grid Calculator* tool.

For the *Grid Calculator* tool, there is a 'Name' parameter for the output. The default entry is "Calculation". I can enter an alternative. There is also an option to use the entry for the 'Formula' parameter as the name for the output. The 'Take Formula' parameter is a toggle box parameter. If I change it to on status, the output name will include the formula.

For example, I produce a low elevation layer using the formula "ifelse(lt(g1,1000),g1,-99999)" where an elevation DEM is the input. If I click in the toggle box for the 'Take Formula' parameter (turning the parameter on), the output will be named "Calculation [ifelse(lt(g1,1000),g1,-99999)]". The other option would be to enter a name like "LowElev" for the 'Name' parameter and leave the 'Take Formula' parameter in off status.

Shape polygon tools tend to generate default outputs with longer names. For example, the *Polygon Union* tool uses "Union" plus the names of the two input shape layers. The 'Union [1MCshoolDist]-[1MasonFDdata]' name is assigned to the output involving the '1MCschoolDist' and '1MasonFDdata' polygon shape layers.

Tool Libraries Parameter Settings
The parameter settings for Tool Libraries can be displayed in the Settings tab area of the Object Properties window. I click with my mouse on the "Tool Libraries" heading at the top of the Tools tab area of the Manager (Figure 3-20).

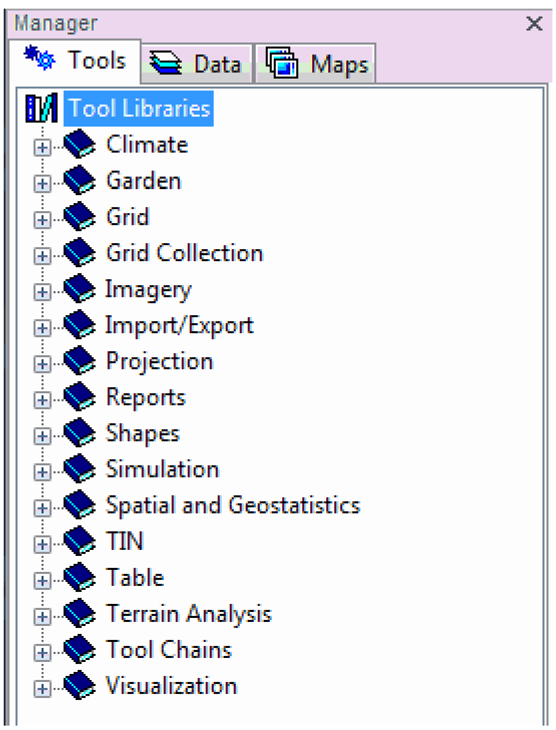


Figure 3-20. The "Tool Libraries" heading selected.

The parameter settings for "Tool Libraries" display in the Object Properties window (Figure 3-21).

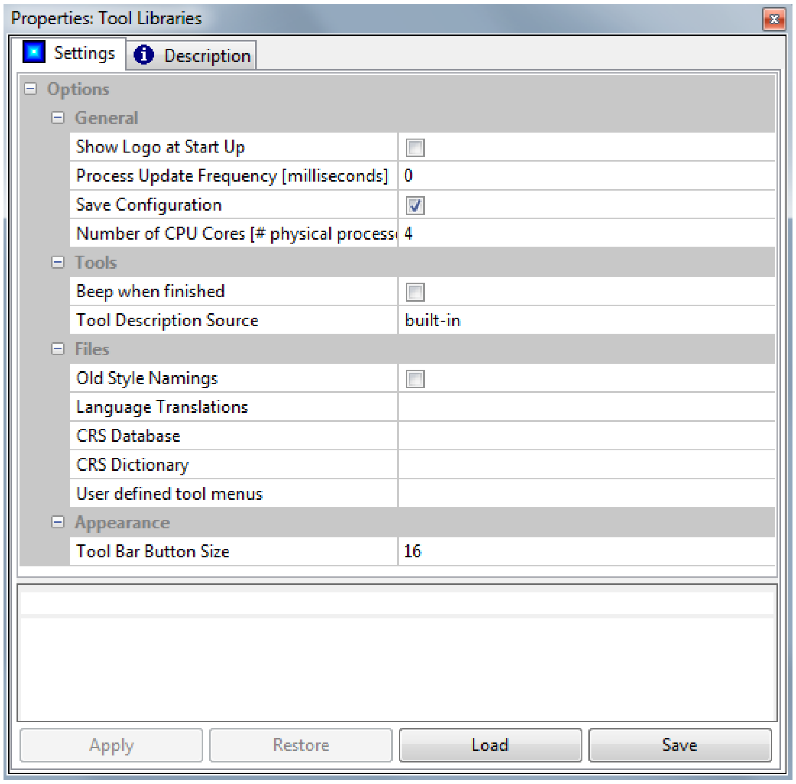


Figure 3-21. The parameter settings for the Tool Libraries.

Let's discuss these parameters.

General: Show Logo at Start Up
The SAGA logo is displayed in Figure 3-22.

Figure 3-22. The SAGA startup logo.

This is a toggle check box parameter. The on-off status of this parameter is controlled by clicking in the check box with the mouse pointer. The logo displays while the SAGA program is starting up if the toggle check box is in on status. If a check mark appears in the check box, the parameter is in on status.

General: Process Update Frequency (Milliseconds)
A numeric entry representing milliseconds is expected for this parameter. The default is 0. I experimented using values between 0 and 60 and could not discern any difference in execution or performance.

General: Save Configuration
This toggle check box parameter relates to whether a removed tool library is reloaded after having been removed during the prior work session. A check mark in the box means the parameter is disabled. When this parameter is in on status and I close a tool library (removing it from the list of available tool libraries for the work session), the tool library will not be reloaded for the next work session.

I can explicitly reload an existing tool library from the "tools" folder using an option available in the Tools tab area. I right click with the mouse on the "Tool Libraries" heading and choose the "Load Tool Library" option on the dropdown list of options.

Background Information
It appears that there are two files related to the configuration of a work session. The 'Saga_gui.cfg' file stores display settings related to layers and map view windows available for the work session for the most recent SAGA exit.

The second file is the 'Saga_gui.ini' file. This file stores parameter values related to operational settings for the most recent work session. File paths for layer loading are stored are in the "FileDialogs" section of this file. The "Tools" section is where the entries for the tool libraries parameter settings are saved. This particular setting, 'Save Configuration', is listed in this section as SAVE_CONFIG=1. The entry 1 means the parameter is turned on.

The last section of the .ini file lists the file paths for tool libraries. Here are the file paths for 8 terrain analysis sub-libraries:

LIB_019=tools\\ta_slope_stability.dll
LIB_020=tools\\ta_profiles.dll
LIB_021=tools\\ta_preprocessor.dll
LIB_022=tools\\ta_morphometry.dll
LIB_023=tools\\ta_lighting.dll
LIB_024=tools\\ta_hydrology.dll
LIB_025=tools\\ta_compound.dll
LIB_026=tools\\ta_channels.dll

The .cfg and .ini files are saved whether the 'Save Configuration' parameter is on or off.

General: Number of CPU Cores (# physical processors)
The number of CPU cores or physical processors makes a difference in performance for tools and system operations that can run in parallel with multiple processors. Logically,

the more processors available, the better the performance. This parameter lets the user identify how many processors are available for the host desktop.

Tools: Beep when finished
A system beep sounds when a SAGA operation completes if this toggle check box parameter is in on status. The default status for this parameter is for it to be off. The check box will not display a check mark. I can click with the mouse in the check box to toggle the status from off to on. A check mark appears in the check box. I must click on the Apply button at the bottom of the Object Properties window for the change in status to have an effect.

Tools: Tool Description Source
Two sources for tool descriptions exist: built-in and online. These two options are available in the value field to the right of the 'Tool Description Source' parameter. The default is to use the "built-in" descriptions that are part of the SAGA code. This parameter is not currently working. It is expected to be operational in future releases of SAGA.

Files: Old Style Naming
This is a toggle check box parameter. When I change the status from on to off or from off to on the change takes effect for the next startup of SAGA. The dialog window in Figure 3-23 displays.

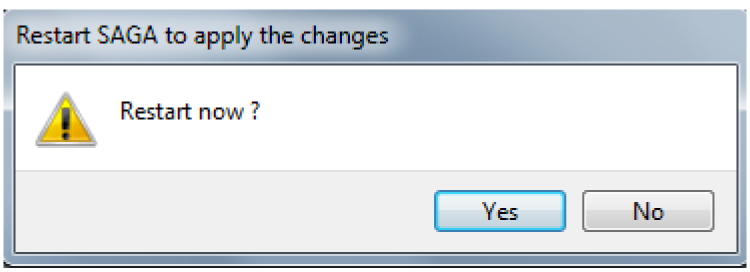


Figure 3-23: The 'Restart SAGA to apply the changes' window.

If I click on the Yes button, the current SAGA work session ends but SAGA does not restart. If I click the No button I can continue in the current work session but the change will not be in effect until the next work session.

Using "Old Style Namings" means, for example, that rather than the relatively new "Geoprocessing" title on the Menu Bar, the older "Modules" title is used. Also, the older Modules tab in the Manager window will replace the newer Tools tab.

This parameter is not working properly in Version 50. It is anticipated that it will be fixed in future version releases. In some executions, using this parameter may cause a system crash.

Files: Language Translations
This parameter supports the use of a language other than what SAGA is currently using. The saga.lng file is an ASCII template file that can be used with a text editor. The file includes two columns; column 1 is a list of supported strings; column 2 is for translations of the supported strings.

SAGA is delivered with two translation files: saga.ger.txt (German) and saga.bra.txt (Brasilian). The storage path for the translation file is entered for this parameter.

Files: CRS Database; Files: CRS Dictionary
SAGA uses a standard storage location for files supporting coordinate reference system and dictionary tools and functions. If the support files are not available at the standard storage location, SAGA will use the storage paths entered for these two parameters.

Files: User defined tool menus
A path can be entered to the storage folder for any user defined tool menus.

Appearance: Toolbar Button Size
This parameter adjusts the size of toolbar buttons. The default is 16. Figure 3-24 compares the default 16 to a size 24 for the Help icon button. Note that the numbers for this parameter are for font size.

Figure 3-24. Comparing button sizes 16 and 24.

Tool Libraries
This last section of the chapter is a list of the tool libraries and their functions as delivered in SAGA version 5.0. This list is compiled from the Manager window Tools tab area. There are over 700 individual tools available. I am conserving space by allotting a paragraph for each library and listing the tools, separated by commas, in the paragraph.

Climate - Tools
Annual Course of Daily Insolation, Bioclimatic Variables, Daily Insolation over Latitude, Daily to Hourly ETpot, ETpot (after Hargreaves, Grid), ETpot (after Hargreaves, Table), Earth's Orbital Parameters, Frost Change Frequency, Frost Change Frequency [interactive], Growing Degree Days, Monthly Global by Latitude, Multi Level to Points Interpolation, Multi level to Surface Interpolation, Snow Cover, Soil Water Balanace [interactive], Sunrise and Sunset, Thermic Belt Classification, Tree Growth Season, Wind Effect Correction.

Garden - Fractals
Bifurcation, Fractal Dimension of Grid Surface, Gaussian Landscapes, Mandelbrot Set [interactive], Newton-Raphson [interactive], Pythagoras' Tree.

Garden - Games

Mine Sweeper [interactive], Sudoku [interactive].

Garden - Introducing Tool Programming
01: My first module, 02: Pixel by pixel operations with two grids, 03: Direct neighbours, 04: Direct neighbours – more…, 05: Direct neighbours – slope and aspect, 06: Extended neighbourhoods, 07: Extended neighbourhoods – catchment areas (trace flow), 08: Extended neighbourhoods – catchment areas (parallel), 09: Extended neighbourhoods – catchment areas (recursive), 10: Dynamic Simulation – Life, 11: Dynamic Simulation – Soil Nitrogen Dynamics, 12: First steps with shapes, 13: Reprojecting a shapes layer, 14: Vectorising channel lines.

Garden - Web Service Data Access
Import a Map via Web Map Service (WMS), Import from Open Street Map [interactive].

Grid - Analysis
Accumulated Cost, Accumulation Functions, Aggregation index, Analytical Hierarchy Process, Change Vector Analysis, Covered Distance, Cross-Classification and Tabulation, Diversity of Categories, Fragmentation (Alternative), Fragmentation (Standard), Fragmentation Classes from Density and Connectivity, IMCORR - Feature Tracking, Layer of extreme value, Least Cost Path [Interactive], Least Cost Paths, Ordered Weighted Averaging (OWA), Pattern analysis, Soil Texture Classification, Soil Texture Classification for Tables.

Grid - Calculus
Function Plotter, Fuzzify, Fuzzy Intersection (AND), Fuzzy Union (OR), Geometric Figures, Gradient Vector from Cartesian to Polar Coordinates, Gradient Vector from Polar to Cartesian Coordinates, Grid Calculator, Grid Difference, Grid Division, Grid Normalisation, Grid Standardisation, Grid Volume, Grids Product, Grids Sum, Metric Conversions, Random Field, Random Terrain, Spherical Harmonic Synthesis.

Grid - Calculus BSL
BSL, BSL from File.

Grid - Filter
Binary Erosion-Reconstruction, Connectivity Analysis, DTM Filter (slope-based), Filter Clumps, Gaussian Filter, Geodesic Morphological Reconstruction, Laplacian Filter, Majority Filter, Mesh Denoise, Morphological Filter, Multi Direction Lee Filter, Rank Filter, Resampling Filter, Sieving Classes, Simple Filter, Simple Filter (Restricted to Polygons), User Defined Filter (3x3), Wombling (Edge Detection), Wombling for Multiple Features (Edge Detection).

Grid - Filter (Perego 2009)
Average With Mask 1, Average With Mask 2, Average With Threshold 1, Average With Threshold 2, Average With Threshold 3, Destriping, Destriping with Mask, Directional Average.

Grid - Gridding
Angular Distance Weighted, Grid Cell Area Covered by Polygons, Inverse Distance Weighted, Kernel Density Estimation, Modified Quadratic Shepard, Natural Neighbour, Nearest Neighbour, Shapes to Grid, Triangulation.

Grid - Spline Interpolation
B-Spline Approximation, Cubic Spline Approximation, Multilevel B-Spline Interpolation, Multilevel B-Spline Interpolation (from Grid), Multilevel B-Spline Interpolation for Categories, Thin Plate Spline, Thin Plate Spline (TIN).

Grid - Tools
Aggregate, Change Cell Values [interactive], Change Data Storage, Change Grid Values, Change Grid Values – Flood Fill [interactive], Change a Grid's No-Data Value, Clip Grids, Clip Grids [interactive], Close Gaps, Close Gaps with Spline, Close Gaps with Stepwise Resampling, Close One Cell gaps, Combine Classes, Combine Grids, Constant Grid, Copy Grid, Create Grid System, Crop to Data, Grid Buffer, Grid Cell Index, Grid Masking, Grid Proximity Buffer, Grid Value Request [interactive], Grids from classified grid and table, Invert Data/No-Data, Invert Grid, Mirror Grid, Mosaicking, Patching, Proximity Grid, Reclassify Grid Values, Resampling, Select Grid from List, Shrink and Expand, Threshold Buffer, Tiling, Transpose Grids.

Grid Collection - Grid Collection Tools
Create a Grid Collection, Delete Grids from a Grid Collection, Extract Grids from a Grid Collection.

Imagery - Classification
Confusion Matrix (Polygons / Grid), Confusion Matrix (Two Grids), Decision Tree, K-Means Clustering for Grids, Supervised Classification for Grids, Supervised Classification for Shapes, Supervised Classification for Tables.

Imagery - ISODATA Clustering
ISODATA Clustering for Grids.

Imagery - Maximum Entropy
Maximum Entropy Classification, Maximum Entropy Presence Prediction.

Imagery - OpenCV
Artificial Neural Network Classification (OpenCV), Boosting Classification (OpenCV), Decision Tree Classification (OpenCV), Fourier Transformation (OpenCV), K-Nearest Neighbours Classification (OpenCV), Morphological Filter (OpenCV), Normal Bayes Classification (OpenCV), Random Forest Classification (OpenCV), Single Value Decomposition (OpenCV), Stereo Match (OpenCV), Support Vector Machine Classification (OpenCV).

Imagery - Photogrammetry
Colorisation (PC), Resection (Terrestrial).

Imagery - SVM
SVM Classification.

Imagery - Segmentation
Grid Skeletonization, Seed Generation, Seeded Region Growing, Watershed Segmentation.

Imagery - Tools
Automated Cloud Cover Assessment, Colour Normalized Brovey Sharpening, Colour Normalized Spectral Sharpening, Enhanced Vegetation Index, IHS Sharpening, Landsat Import with Options, Local Statistical Measures, Principal Components Based Image Sharpening, Tasseled Cap Transformation, Textural Features, Top of Atmosphere Reflectance, Vegetation Index (Distance Based), Vegetation Index (Slope Based).

Imagery - ViGrA
Distance (ViGrA), Edge Detection (ViGrA), Fourier Filter (ViGrA), Fourier Transform (Real, ViGrA), Fourier Transform (ViGrA), Fourier Transform Inverse (ViGrA), Morphological Filter (ViGrA), Random Forest Classification (ViGrA), Random Forest Presence Prediction (ViGrA), Random Forest Table Classification (ViGrA), Smoothing (ViGrA), Watershed Segmentation (ViGrA).

Import/Export - DXF
Import DXF Files.

Import/Export - ESRI E00
Import ESRI E00 File.

Import/Export - GDAL/OGR
Create Raster Catalogue from Files, Create Raster Catalogues from Directory, Export GeoTIFF, Export Raster, Export Shapes, Export Shapes to KML, GDAL Formats, Import NetCDF, Import Raster, Import Shapes, Import TMS Image.

Import/Export - GPS Tools
GPSBabel, GPX to shapefile.

Import/Export - Grids
Export ESRI Arc/Info Grid, Export Grid to XYZ, Export Surfer Grid, Export True Color Bitmap, Export WRF Geogrid Binary Format, Import Binary Raw Data, Import CRU Grids, Import ESRI Arc/Info Grid, Import Erdas LAN/GIS, Import Grid from Table, Import Grid fro XYZ, Import OLA Grid (MEGDR), Import SRTM30 DEM, Import Surfer Grid, Import USGS SRTM Grid, Import WRF Geogrid Binary Format, Import Clip and Resample Grids.

Import/Export - Images

Export Grid to KML, Export Image (bmp, jpg, pcx, png, tif), Import Grids from KML, Import Image (bmp, jpg, png, tif, gif, pnm, xpm).

Import/Export - LAS
Export LAS Files, Import LAS Files, LAS Info.

Import/Export - ODBC/OTL
Commit/Rollback Transaction, Connect to ODBC Source, Disconnect All, Disconnect from ODBC Source, Drop Table, Execute SQL, Export Table, Import Table, Import Table from SQL Query, List ODBC Servers, List Table Fields, List Tables.

Import/Export - PostgreSQL
Begin Transaction, Commit/Rollback Transaction, Connect to PostgreSQL, Create Database, Disconnect All, Disconnect from PostgreSQL, Drop Database, Drop Table, Execute SQL, Export Raster to PostGIS, Export Shapes to PostGIS, Export Table, Import Raster from PostGIS, Import Shapes from PostGIS, Import Shapes with Joined Data from PostGIS (GUI), Import Single Raster Band from PostGIS, Import Table, Import Table from SQL Query, Import Table from SQL Query (GUI), List PostgreSQL Connections, List Table Fields, List Tables, Update Raster SRID, Update Shapes SRID.

Import/Export - Shapes
Export Atlas Boundary File, Export GPX, Export GStat Shapes, Export Point Cloud to Text File, Export Polygons to HTML Image Map, Export Scalable Vector Graphics (SVG) File, Export Shapes to Generate, Export Shapes to XYZ, Export Simple Features to Well Known Text, Export Surfer Blanking File, Export TIN to Stereo Lithography File (STL), Export WASP terrain map file, Import Atlas Boundary File, Import Building Sketches from CityGML, Import GPX, Import GStat Shapes, Import Point Cloud from Shape File, Import Point Cloud from Text File, Import Shapes from XYZ, Import Simple Features from Well Known Text, Import Stereo Lithography File (STL), Import Surfer Blanking Files, Import WASP terrain map file.

Import/Export - Tables
Export Text Table, Import Text Table, Import Text Table (Fixed Column Sizes), Import Text Table with Numbers only.

Import/Export - Virtual
Create Tileshape from Virtual Point Cloud, Create Virtual Point Cloud Dataset, Get Grid from Virtual Point Cloud, Get Grid from Virtual Point Cloud [interactive], Get Subset from Virtual Point Cloud, Get Subset from Virtual Point Cloud [interactive], Remove Overlap from Virtual Point Cloud Tiles.

Projection - GeoTRANS
GeoTRANS (Grid), GeoTrans (Shapes).

Projection - Georeferncing

Create Reference Points [interactive], Define Georeference for Grids, Direct Georeferencing of Airborne Photographs, Move Grid [interactive], Rectify Grid, Warping Shapes, World File from Flight and Camera Settings.

Projection - Proj..4
Change Longitudinal Range for Grids, Coordinate Reference System Picker, Coordinate Transformation (Grid List), Coordinate Transformation (Grid), Coordinate Transformation (Point Cloud List), , Coordinate Transformation (Point Cloud), Coordinate Transformation (Shapes List), Coordinate Transformation (Shapes), Geographic Coordinate Grids, Geographic Distances, Geographic Distances (Pair of Coordinates), Geographic Distances [interactive], Latitude/Longitude Graticule, Set Coordinate Reference System, Tissot's Indicatrix, UTM Projection (Grid List), UTM Projection (Grid), UTM Projection (Point Cloud List), UTM Projection (Point Cloud), UTM Projection (Shapes List), UTM Projection (Shapes), [deprecated] Proj.4 (Command Line Arguments, Grid), [deprecated] Proj.4 (Command Line Arguments, List of Grids), [deprecated] Proj.4 (Command Line Arguments, List of Shapes Layers), [deprecated] Proj.4 (Command Line Arguments, Shapes), [deprecated] Proj.4 (Dialog, Grid), [deprecated] Proj.4 (Dialog, List of Grids), [deprecated] Proj.4 (Dialog, List of Shapes Layers), [deprecated] Proj.4 (Dialog, Shapes).

Reports - HTML
Create Web Content [interactive], SVG Interactive map.

Reports - PDF
Shapes Report, Shapes Summary Report, Terrain Path Cross Sections.

Shapes - Grid Tools
Add Grid Values to Points, Add Grid Values to Shapes, Clip Grid with Polygon, Clip Grid with Rectangle, Contour Lines from Grid, Gradient Vectors from Direction and Length, Gradient Vectors from Directional Components, Gradient Vectors from Surface, Grid Classes Area for Polygons, Grid Statistics for Points, Grid Statistics for Polygons, Grid System Extent, Grid Values to Points, Grid Values to Points (randomly), Local Minima and Maxima, Vectorising Grid Classes.

Shapes - Lines
Convert Points to Line(s), Convert Polygons to Lines, Line Crossings, Line Dissolve, Line Properties, Line Simplification, Line Smoothing, Line-Polygon Intersection, Split Lines at Points, Split Lines with Lines.

Shapes - Point Clouds
Cluster Analysis for Point Clouds, Drop Point Cloud Attribute, Merge Point Clouds, Point Cloud Attribute Calculator, Point Cloud Cutter, Point Cloud Cutter [interactive], Point Cloud Reclassifier / Subset Extractor, Point Cloud Thinning (simple), Point Cloud from Grid Points, Point Cloud from Shapes, Point Cloud from Table, Point Cloud to Grid, Point Cloud to Shapes, Transform Point Cloud.

Shapes - Points
Add Coordinates to Points, Add Polygon Attributes to Points, Aggregate Point Observations, Clip Points with Polygons, Convert Lines to Points, Convert Multipoints to Points, Convert Table to Points, Convex Hull, Count Points in Polygons, Create Point Grid, Fit N Points to shape, Point Distances, Points Filter, Points Thinning, Remove Duplicate Points, Select Points [interactive], Separate points by direction, Snap Points to Grid, Snap Points to Lines, Snap Points to Points, Thiessen Polygons.

Shapes - Polygons
Add Point Attributes to Polygons, Convert Lines to Polygons, Convert Polygon/Line Vertices to Points, Difference, Flatten Polygon Layer, Identity, Intersect, Point Statistics for Polygons, Polygon Centroids, Polygon Clipping, Polygon Dissolve, Polygon Parts to Separate Polygons, Polygon Properties, Polygon Self-Intersection, Polygons to Edges and Nodes, Shared Polygon Edges, Symmetrical Difference, Union, Update.

Shapes - Tools
Convert Vertex Type (2D/3D), Copy Selected Shapes, Copy Selected Shapes [interactive], Copy Selection to New Shapes Layer, Create Chart Layer (bars/sectors), Create Graticule, Create New Shapes Layer, Delete Selection from Shapes Layer, Generate Shapes, Get Shapes Extents, Invert Selection of Shapes Layer, Land Use Scenario Generator, Merge Layers, Merge Tables, Polar to Cartesian Coordinates, QuadTree Structure to Shapes, Remove Invalid Shapes, Select Shapes from List, Select by Attribute... (Numerical Expression), Select by Attributes.. (String Expression), Select by Location..., Shapes Buffer, Split Shapes Layer, Split Shapes Layer Completely, Split Shapes Layer Randomly, Split Table/Shapes by Attribute, Transform Shapes.

Shapes - Transects
Transect through polygon shapefile.

Simulation - Cellular Automata
Conway's Game of Life, Wa- Tor.

Simulation - Erosion
MMF-SAGA Soil Erosion Model.

Simulation - Fire Spreading Analysis
Fire Risk Analysis, Simulation.

Simulation - Geomorphology
Gravitational Process Path Model.

Simulation - Hydrology
Concentration, Diffuse Pollution Risk, Kinematic Wave Overland Flow, Soil Moisture Content, Surface and Gradient, Surface Gradient and Concentration, TOPMODEL, Water Retention Capacity.

Simulation - Hydrology: IHARES
IHACRES Basin, IHACRES Calibration (2), IHACRES Elevation Bands, IHACRES Elevation Bands Calibration, IHACRES Version 1.0.

Simulation - Modelling the Human Impact on Nature
01: A Simple Litter System, 02: Carbon Cycle Simulation for Terrestrial Biomass, 03: Spatially Distributed Simulation of Soil Nitrogen Dynamics.

Simulation - QM of ESP
Diffusive Hillslope Evolution (ADI), Diffusive Hillslope Evoluton (FTCS), Fill Sinks (QM of ESP), Flow Accumulation (QM of ESP), Successive Flow Routing.

Simulation - RivFlow
GridCombination, GridManipulation [interactive], LandFlow Version 1.0 (build 3.f.1b), RiverBasin, RiverGridGeneration.

Spatial and Geostatistics - Grids
Categorical Coincidence, Directional Statistics for Single Grid, Fast Representativeness, Focal PCA on a Grid, Global Moran's I for Grids, Inverse Principle Components Rotation, Longitudinal Grid Statistics, Meridional Grid Statistics, Multi-Band Variation, Principle Components Analysis, Radius of Variance (Grid), Representativeness (Grid), Residual Analysis (Grid), Save Grid Statistics to Table, Statistics for Grids, Zonal Grid Statistics.

Spatial and Geostatistics - Kriging
Ordinary Kriging, Regression Kriging, Simple Kriging, Universal Kriging, Variogram (Dialog).

Spatial and Geostatistics - Points
Minimum Distance Analysis, Spatial Point Pattern Analysis, Variogram, Variogram Cloud, Variogram Surface.

Spatial and Geostatistics - Regression
GWR for Grid Downscaling, GWR for Multiple Predictor Grids, GWR for Multiple Predictors, GWR for Multiple Predictors (Gridded Model Output), GWR for Single Predictor (Gridded Model Output), GWR for Single Predictor Grid, Multiple Linear Regression Analysis, Multiple Linear Regression Analysis (Shapes), Multiple Regression Analysis (Grid and Predictor Grids), Multiple Regression Analysis (Points and Predictor Grids), Polynomial Regression, Polynomial Trend from Grids, Regression Analysis (Points and Predictor Grid), Trend Analysis, Trend Analysis (Shapes), Zonal Multiple Regression Analysis (Points and Predictor Grids).

TIN - Tools
Flow Accumulation (Parallel), Flow Accumulation (Trace), Gradient, Grid to TIN, Grid to TIN (Surface Specific Points), Shapes to TIN, TIN to Shapes.

TIN - Visualizaiton
[deprecated] TIN Viewer.

Table - Calculus
Aggregate Values by Attributes, Clusteer Analysis, Cluster Analysis (Shapes), Field Calculator, Field Calculator [Shapes], Field Statistics, Fill Gaps in Records, Find Field of Extreme Value, Function Fit, Minimum Redundancy Feature Selection, Principle Components Analysis, Record Statistics, Record Statistics (Shapes), Running Average.

Table - Tools
Add Indicator Fields for Categories, Append Fields from another Table, Change Color Format, Change Date Format, Change Field Type, Change Time Format, Copy Selection, Create New Table, Delete Fields, Delete Selection, Enumerate Table Field, Invert Selection, Join Attributes from a Table, Join Attributes from a Table (Shapes), Replace Text, Select by Numerical Expression, Select by String Expression, Transpose Table.

Terrain Analysis - Channels
Channel Network, Channel Network and Drainage Basins, Overland Flow Distance to Channel Network, Strahler Order, Valley Depth, Vertical Distance to Channel Network, Watershed Basins, Watershed Basins (extended).

Terrain Analysis - Compound Analyses
Basic Terrain Analysis.

Terrain Analysis - Hydrology
Cell Balance, Downslope Area [interactive], Edge Contamination, Flow Accumulation, (Flow Tracing), Flow Accumulation (Mass-Flux Method), Flow Accumulation (Recursive), Flow Accumulation (Top-Down), Flow Depth [interactive], Flow Path Length, Flow Sinuosity [interactive], Flow Width and Specific Catchment Area, Isochrones Constant Speed [interactive], Isochrones Variable Speed [interactive], LS Factor, LS-Factor Field Based, Lake Flood, Lake Flood [interactive], Maximum Flow Path Length, Melton Ruggedness Number, SAGA Wetness Index, Slope Length, Slope Limited Flow Accumulation, Stream Power Index, TCI Low, Topographic Wetness Index (TWI), Upslope Area, Upslope Area [interactive]

Terrain Analysis - Lighting, Visibiity
Analytical Hillshading, Potential Incoming Solar Radiation, Sky View Factor, Topographic Correction, Topographic Openness, Visibility (points), Visibility (single point) [interactive].

Terrain Analysis - Morphometry
Convergence Index, Convergence Index (Search Radius), Curvature Classification, Diurnal Anisotropic Heating, Downslope Distance Gradient, Effective Air Flow Heights, Fuzzy Landform Element Classification, Hypsometry, Land Surface Temperature, Mass Balance Index, Morphometric Protection Index, Multi-Scale Topographic Position Index (TPI), Multiresolution Index of Valley Bottom Flatness (MRVBF), Real Surface Area,

Relative Heights and Slope Positions, Slope Aspect Curvature, Surface Specific Points, TPI Based Landform Classification, Terrain Ruggedness Index (TRI), Terrain Surface Classification (Iwahashi and Pike), Terrain Surface Convexity, Terrain Surface Texture, Topographic Position Index (TPI), Upslope and Downslope Curvature, Valley and Ridge Detection (Top Hat Approach), Vector Ruggedness Measure (VRM), Wind Effect (Windward / Leeward Index), Wind Exposition Index.

Terrain Analysis - Preprocessing
Burn Stream Network into DEM, Fill Sinks (Planchon/Darboux, 2001), Fill Sinks (Wang & Liu), Fill Sinks XXL (Wang & Liu), Flat Detection, Sink Drainage route Detection, Sink Removal

Terrain Analysis - Profiles
Cross Profiles, Flow Path Profile [interactive], Profile [interactive], Profile from points, Profiles from lines, Swath Profile [interactive].

Terrain Analysis - Slope Stability
ANGMAP, SAFETYFACTOR, SHALSTAB, TOBIA, WEDGEFAIL, WETNESS.

Tool Chains - Climate
Lapse Rate Based Temperature Downscaling, Lapse Rate Based Temperature Downscaling (Bulk Processing).

Tool Chains - Files
Import Text Tables.

Tool Chains - Grid Collection
Simple Filter.

Tool Chains - Imagery
Local Climate Zone Classification, Object Based Image Segmentation.

Tool Chains - Terrain Analysis
Relief Segmentation, Terrain Clustering, Topographic Wetness Index (One Step), Upslope Height Slope Aspect.

Tool Chains - Tool Chains
Contour Lines from Points, Gridding of Points, Largest Circles in Polygons, Sieve and Clump, Simple Filter for Multiple Grids.

Tool Chains - Travel Time Analysis
Land Cover Scenario Offset, Travel Time Calculation.

Visualization - 3D Viewer
3D Shapes Viewer, Globe Viewer for Grids, Grid Collection Viewer, Multiple Grids Viewer, Point Cloud Viewer, TIN Viewer.

Visualization - Grids
Aspect-Slope Grid, Color Palette Rotation, Color Triangle Composite, Create 3D Image, Fit Color Palette to Grid Values, Grid Animation, Histogram Surface, RGB Composite, Select Look-up Table for Grid Visualization, Split RGB Composite, Terrain Map Viewer.

Visualization - Point Clouds Viewer
[deprecated] Point Cloud Viewer.

Even using this abbreviated approach for listing the over 700 tools, one is aware of the immense spectrum of spatial analysis supported in SAGA.

Chapter 4 – The Data Tab in the Manager Window

This chapter provides an overview of the Data tab environment and a variety of functions and commands available in the Manager window.

The Manager Window Data Tab Area

The Data tab selects the area of the Manager window for viewing the list of grid and shape layers, point clouds, and tables available in a work session. Each layer has its' own set of parameters that can be viewed in the Object Properties window and customized. For example, I can choose a different color palette to use with a layer rather than use the default or I can display a narrower data value range to emphasize certain map features.

Grid layers all have the same set of parameters. Shape layers have a different set of parameters but have some of the same ones as grid layers. Due to their multi-attribute nature and vector character, some of the shape layer parameters deal with labels and their display. Grid and point cloud layers do not have label related parameters. As with grid layers, the same set of parameters is available for each shape layer. The same is true for point cloud layers.

We will explore the parameter sets available for the three layer types in SAGA. The properties related to grid layers are described in Chapter 9. Chapter 10 explores the properties related to the different types of shape layers and Chapter 11 describes the properties for point cloud layers.

There is another set of parameters that relate to defaults. For example, there is a parameter that controls the precision level of numeric information, and, others on how file caching operates. Some parameters provide default options on how new map view windows appear or setting the default color palette for displaying layer data. We will discuss these "default" parameters before addressing the parameters related to individual layers later in this Guide. These "default" parameters are the subject of this chapter.

I can view these default parameters when I am in the Data tab area of the Manager window. I click the mouse on the Data tab. The Tree tab is already selected for a tree-like structure list rather than a thumbnail view of the list. I click the mouse on the "Data" text near the top of the Manager window. The parameter display in the Settings tab area of the Object Properties window updates.

Changes I make to these parameters may not take effect immediately. Some of the parameter changes take effect after I re-start SAGA. Others can take effect if I load a new project. Still others take effect immediately after I click on the Apply button at the bottom of the Object Properties window.

A general outline of these parameters displays in Figure 4-1.

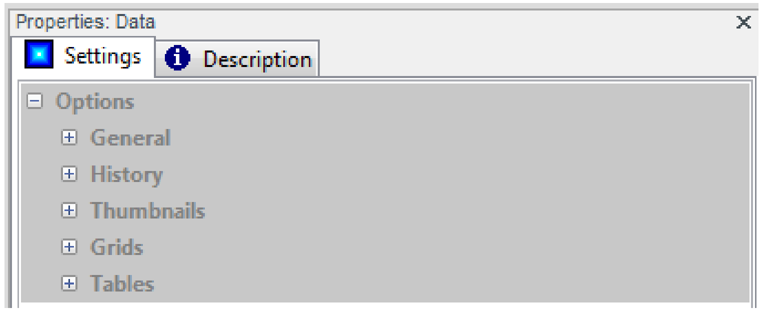


Figure 4-1. A general outline of the "Data" parameters.

There are five parameter categories: General, History, Thumbnails, Grids, and Tables. The individual parameters in each category are described below. Notice the + symbol to the left of the category name. If I click the mouse pointer on the plus symbol, a list of the individual parameters displays for the category. The + symbol changes to a -. Let's look at these parameters by category.

General
The parameters and their default settings in the "General" section are displayed in Figure 4-2.

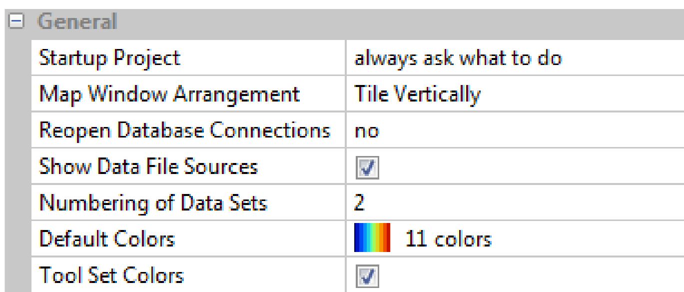


Figure 4-2. The "General" parameters and their settings.

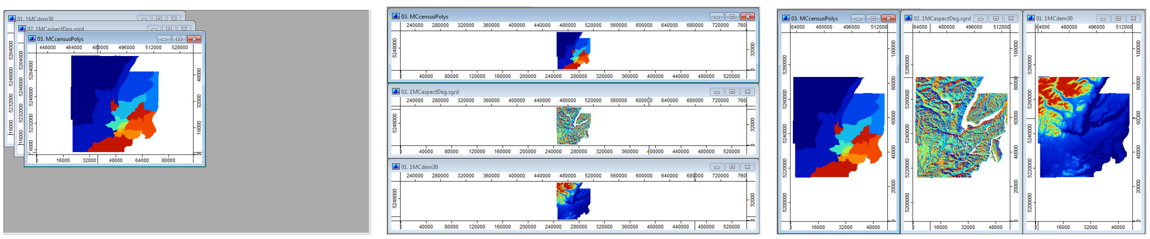
General: Startup Project
This particular parameter should be familiar to you if you have read Chapter 2 of this User Guide. Early in Chapter 2, the options on the File menu available on the Menu Bar were discussed. The 'Startup Project' parameter is described in the File: Project - Overview section. Briefly, three options are available for this parameter: empty, last state, and always ask what to do. The "always ask what to do" option is the default.

When the "always ask what to do" option is used, the Startup Project opening dialog includes choices for "[empty]", "[last state]", and selection of a project from the most recent 17 loaded projects. If the "[empty]" option is chosen for this parameter, SAGA opens the work session without loading a project or any layers, maps, or tables and uses defaults for various environment related parameters. Using the "[last state]" choice, SAGA opens the work session with the layers, maps, tables, and environmental settings for when the previous work session closed.

General: Map Window Arrangement
When I exit a SAGA work session, I often will have two or more maps visible in the work area. If I do not close these map definitions they are saved as part of a configuration file. They can also be saved as part of a project definition.

Related to the configuration file, the map view windows are restored when I select the "last state" option on the opening 'Select Startup Project' dialog window. They are also restored if I select a project that was created when the map view windows were active in the Maps tab area of the Manager. The option I set for the 'Map Window Arrangement' parameter determines how these map view windows display upon loading a project or starting a new SAGA work session.

This parameter has three options available: Cascade, Tile Horizontally, Tile Vertically. Figure 4-3 displays the effects of these options using three map view windows in a work area. After choosing a parameter option, I click on the Apply button at the bottom of the window. The option does not take effect until I restart SAGA or load a project.



a. Cascade. *b. Tile horizontally.* *c. Tile vertically.*

Figure 4-3. The 'Map Window Arrangement' parameter options.

In summary, this parameter determines how any map view windows display at startup or display as a result of loading a project in the work area.

General: Reopen Database Connections
This parameter setting is a no or yes option and no is the default. I do not use SAGA in a network environment so I am not familiar with interfacing SAGA with a database either via the network or on a host desktop.

This parameter, if changed to yes, instructs SAGA to open a prior PostgreSQL database connection for the next SAGA startup. The status of this parameter is stored in the configuration file along with a path for the PostgreSQL. A change in status must be followed by clicking on the Apply button. The change will take effect when SAGA is re-started.

General: Show Data File Sources
This is a toggle check box type parameter. The default is for this parameter to be in on status displaying a check mark in the box. Switching this parameter back and forth between on and off status does not cause any visible difference in the work area.

I believe, when this parameter is in on status, the Data Source Window is updated as to the source of layers being loaded.

General: Numbering of Data Sets

Layers and maps are assigned a number when displayed in the Data and Maps tab areas of the Manager. This number is the position of the layer or map in the category list of layers, maps or tables in the Manager. The default is for the number to be a 2 digit integer. This parameter sets the number display. The name of the layer, map or table follows the number. This name is the entry for the 'Name' parameter for the layer or table.

I can turn off numbering by entering -1 for the parameter and clicking with the mouse on the Apply button. Figure 4-4 shows a comparison of a setting of 3 versus -1 for this parameter.

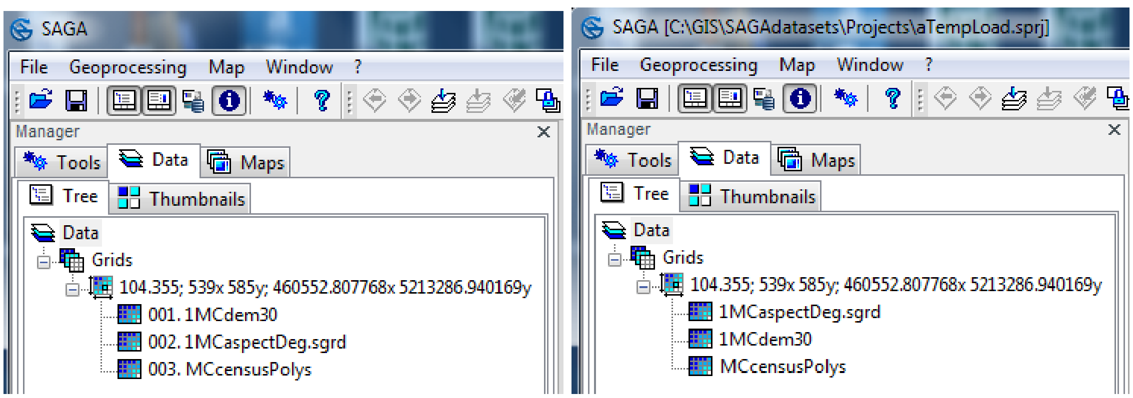


Figure 4-4. A comparison showing 3 integers for numbering versus no numbering.

A change in this parameter takes affect if I load a different project or restart the SAGA program. If I load a different project without closing existing layers, the numbering option for current layers does not change but the numbering for layers associated with a reloaded project changes accordingly.

General: Default Colors

This parameter sets the default color ramp or palette for a grid or point cloud layer that is loaded into a SAGA work session using a load command or for a new layer created by a tool. Grid or point cloud layers loaded into a work session as part of a project or by the configuration file are not affected as their display parameters are saved with the project and the configuration.

General: Tool Set Colors

The intent for this parameter is to provide tools the optional capability to "change data set colors programmatically". This parameter provides an alternative to the 'Default Colors' parameter for tools that produce layer output.

History

There are two parameters in the "History" section.

History	
History Depth	-1
Ignore Input Lists	☑

Figure 4-5. The "History" parameters.

History: History Depth
This parameter allows users to control whether a layer history file is updated or not. The default is for this parameter to be set to -1 for the history file to be updated. Entering a 0 turns the history update option to off status and the file is not updated.

When a tool creates a new layer, if the 'History Depth' parameter is set to -1, the new history file for the layer will include history information about the tool that created the layer. For example, the name of the tool creating the layer may be listed along with settings for options and the file path and name for the input layer.

Not updating the history file, when the parameter is set to 0, does not result in an error. One reason for turning this parameter off and for even deleting the history file, is because a history file might get quite large. This can be the source of long processing times involving the layer. The workaround is to delete the history file associated with the layer. This improves performance. The downside is that you may forget something important related to the tool options or tool creating the layer.

It is possible that current tools may not be consistent in updating the history file.

History: Ignore Input Lists
This is a toggle check box parameter. The default is for the History: Ignore Input Lists parameter to be in on status. I have experimented with this parameter using on and off status and am unable to see an affect. In particular, I executed several tools that output options to an output layer history file. I checked the history files for the output layers using the two different settings and saw no difference between the history files.

Thumbnails
The three parameters in the "Thumbnails" section are Thumbnail Size, Show Categories (a toggle check box parameter), and Selection Color.

Thumbnails	
Thumbnail Size	75
Show Categories	☑
Selection Color	(160,160,160)

Figure 4-6. The "Thumbnails" section parameters.

These three parameters affect the display of thumbnails in the Thumbnail tab view of the Data tab area.

Thumbnails: Thumbnail Size
The entry for the 'Thumbnail Size' parameter sets the size of a thumbnail in the Manager window. The units for the entry are screen pixels. The default size is 75. The minimum size is 10. Any change in the number takes effect when I click on the Apply button.

Thumbnails: Show Categories
The 'Show Categories' toggle check box parameter is used to turn on or off the display of category titles in the Thumbnails view of the Data tab area. The default is for titles to display.

When I click in the check box and change this parameter to off status the check mark in the box disappears. I click on the Apply button near the bottom of the window and the category names, i.e., the grid system definition and shape categories like lines, points, etc., disappear from the display.

Thumbnails: Selection Color
I click with the mouse on a layer name in the Tree display of the Data tab area. The layer name is selected and becomes highlighted. When I click on a layer thumbnail in the Thumbnail display of the Data tab, a colored frame surrounds the selected thumbnail. The 'Selection Color' parameter sets the color used for the colored frame.

I click with the mouse twice on the color box in the value field to the right of the 'Selection Color' parameter name. A dropdown column of color options displays. The mouse is used to make a color choice. A new selection takes effect after I click on the Apply button at the bottom of the window.

Grids

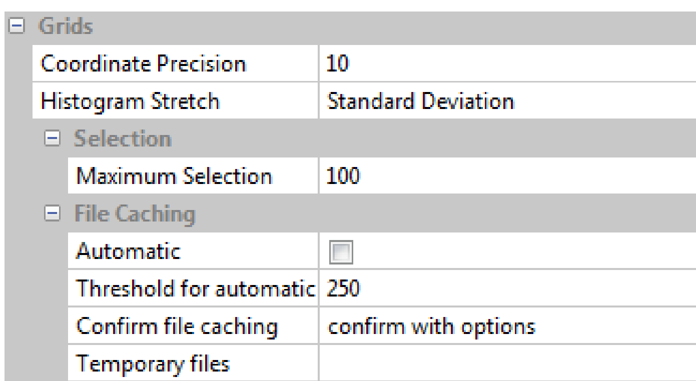


Figure 4-7. The "Grids" section parameters.

Grids: Coordinate Precision
This parameter sets the precision, i.e., the number of places past the decimal, for a grid system loaded into a work session. The default entry is 10 and 0 is the minimum value that can be used. The coordinate display on the Description tab in the Object Properties window for a layer is one place where the effect of this parameter is visible. In this case it is the coordinates for West, East, etc. The main use of this parameter is with datasets that due to minor differences in coordinate precision are loaded as independent grid systems.

Using less coordinate precision can result in such datasets loaded as part of the same grid system.

Grids: Histogram Stretch

This parameter sets the histogram stretch applied, by default, to the data values of a grid layer loaded into a work session or a new one produced by the application of a tool. The three options are: Minimum/Maximum, Standard Deviation, and Percentile. In order to understand how these three options work, we also must pay attention to several layer parameters in the Object Properties window for the loaded layer: Value Range, Mode, and Histogram Stretch.

I am going to use an elevation grid layer ('1MCdem30') to explore the histogram stretch options. The data value range for this layer is from 0 to 6379 with a mean of 912.504 and a standard deviation of 1117.267.

I click in the value field to the right of the Grids: Histogram Stretch parameter and choose the "Minimum/Maximum" option from the three choices. Next, I click on the Apply button at the bottom of the Object Properties window for the "Data" label in the Data tab area of the Manager. Using this setting, I load the '1MCdem30' grid layer.

I click with the mouse on the layer name in the Data tab area of the Manager window. Now I can view the layers' parameter settings in the Settings tab area of the Object Properties window. I note that the values for the 'Value Range' parameter are 318.95 for the minimum and 6060.05 for the maximum. I know that the data value range for the layer is from 0 to 6379. Why are these values different?

The entry for the layer 'Histogram Stretch' parameter is "Linear". The entry (default) for the 'Linear Percent Stretch' parameter is 5. This means, for display purposes, 5 percent of the data value range has been trimmed from each end of the range. These data values are not deleted. Five percent of 6379 is 318.95. This explains the minimum 318.95 value. Subtracting 318.95 from 6379, I get 6060.05. This is the maximum value.

I can view the full range of data values by changing the entry for the 'Linear Percent Stretch' parameter from 5 to 0. I close the 1MCdem30' layer.

Let's look at how the "Standard Deviation" option operates. I click in the value field to the right of the right of the Grids: Histogram Stretch parameter and choose the "Standard Deviation" option from the three choices. Next I click on the Apply button at the bottom of the Object Properties window for the Data tab. Using this setting, I load the '1MCdem30' grid layer a second time.

I click with the mouse on the layer name in the Data tab area of the Manager window to make it the active layer. Now I can view its parameter settings in the 'Settings' tab area of the Object Properties window. I note that the values for the 'Value Range' parameter are 0 for the minimum and 3147.04 for the maximum.

The entry for the layer 'Histogram Stretch' parameter is "Standard Deviation". The next row below this one is a new parameter named 'Standard Deviation'. The number 2 is entered in the value field. This means that 2 standard deviations are applied to determine the display range.

The arithmetic mean for the layer is 912.504 and one standard deviation is 1117.267. The 2 for the "Standard Deviation" parameter means that the maximum data value for display purposes is 2 standard deviations above the mean. Adding 2 standard deviations (2234.54) to the mean results in 3147.044, the maximum value noted earlier. Subtracting 2 standard deviations from the mean is a negative number so the minimum value 0 is used for the minimum. I close the '1MCdem30' layer.

The third option for the Grids: Histogram Stretch parameter is "Percentile". This option works with quantity of grid cells and a spectral range of data values. I click in the value field to the right of the right of the Grids: Histogram Stretch parameter and choose the "Percentile" option from the three choices. Next, I click on the Apply button at the bottom of the Object Properties window for the Data tab. Using this setting, I load the '1MCdem30' grid layer a third time.

I click with the mouse on the layer name in the Data tab area of the Manager window to make it the active layer. Now I can view its parameter settings in the Settings tab area of the Object Properties window. I note that the values for the 'Value Range' parameter are 0 for the minimum and 4300 for the maximum. The entry for the 'Histogram Stretch' parameter is "Percentile". The next row below this one is a new parameter named 'Percentile'. The number 2 is entered in the value field to the right of it. It means 2 percent.

There are 315,315 grid cells in the map extent. Of these, 65193 are no data values. This means there are 250,122 grid cells with data values. The percentile value is applied to the number of grid cells with data values. It happens 2 percent of the grid cells is 5,002 cells. If I subtract 5,002 from the total number of grid cells the result is 245,120. The data value at that point in the cumulative histogram is 4300. Unlike the linear option that truncates a percent of the data range, the percentile option establishes a maximum data range based on truncating a percentage of grid cells.

As noted earlier, these parameters relate to how data ranges display, in particular using a histogram of data values. These parameters do not change data values. They are important to understand because they determine the initial data value range display for a new grid layer.

Grids: Histogram Stretch: Selection: Maximum Selection
This parameter sets the maximum number of rows and the maximum number of columns of grid cells that can be selected on a grid layer using the Action tool. The default entry is 100. I experimented using the Action tool to select a block or rectangle of grid cells in an elevation grid layer. I can select up to 100 rows and up to 100 columns of grid cells. If I exceed that number, either in rows or columns, the selection defaults to 100 regardless.

Grids: Histogram Stretch: File Caching: Automatic
File caching can only be enabled for grid layers. It works best with iterative tasks involving rows and columns of grid layers and is less effective in random access of grid cells.

The entry for the File Caching: Threshold for automatic mode (MB) parameter determines when file caching is implemented. Generally, all SAGA operations on grid layers require the data to be loaded into the memory. When the needed data is too large to be resident in memory, file caching can be enabled.

What is file caching? File caching involves the swapping of data between storage and memory as needed for computations. Operations involving large amounts of data can continue. Performance may be degraded because of the ongoing data swapping.

The default is for this parameter to be in off status. This is a toggle check box parameter and is in off status if a check mark does not display in the box. I can turn the parameter on by clicking with the mouse in the toggle check box.

As layers are loaded into SAGA and as tools, functions, commands are applied, SAGA compares the amount of memory use to the "threshold" entered for the File Caching: Threshold for automatic mode (MB) parameter. When that threshold is reached, SAGA can automatically implement file caching.

Grids: Histogram Stretch: File Caching: Threshold for automatic mode (MB)
This parameter provides the threshold value used by the File Caching: Automatic parameter. The default entry is 250 (i.e., representing 250 MB). The minimum entry is 0.

This parameter is used when the 'Automatic' parameter is in on status. The entry is a memory threshold in megabytes (MB). As SAGA processes grid layers with SAGA tools, the amount of memory space used is monitored. When the amount of memory space exceeds the entry for this parameter, SAGA can automatically implement file caching.

This parameter is ignored when the 'Automatic' parameter is in off status.

Grids: Histogram Stretch: File Caching: Confirm file caching
The options for this parameter determine how SAGA implements file caching. When I click with the mouse pointer in the value field, a small triangle appears and a popup list of three options displays. The parameter options are: do not confirm, confirm, confirm with options.

The third option, "confirm with options", is the default entry. When the entry value for the File Caching: Threshold for automatic mode (MB) is reached for memory usage, I am asked to specify the size of the memory buffer to use before caching is actually started.

The second option, "confirm", provides the user the option to confirm the start of file caching. If the user declines to confirm, file caching does not start.

The "do not confirm" option causes file caching to proceed as soon as the actual memory usage exceeds the threshold value.

Grids: Histogram Stretch: File Caching: Temporary files
This parameter identifies a folder and folder path for the storage of temporary cache files. I click with the mouse pointer in the value field to the right. An ellipsis appears and I click on it. A 'Choose Directory' dialog window displays. I can navigate or browse to the storage location I want to specify for temporary cache file storage. When the path and folder name display, I click on it. The path and folder name are copied into the value field to the right of the 'Temporary files' parameter. I click on the Apply button at the bottom of the Object Properties window and the change takes effect.

Tables

Tables	
Floating Point Numbers	maximum number of significant decimals
Decimals	6

Figure 4-8. The "Tables" section parameters.

Tables: Floating Point Numbers
The Tables: Floating Point Numbers and Tables: Decimals parameters are applied when a table is loaded into a SAGA work session. They affect how floating point numbers display in tables. Changing the entries for these parameters does not affect tables already available in the work session. The same parameters are available for an existing table and changing the entries for them does affect the existing table.

When the "maximum number of significant decimals" option is used, the number of digits past the decimal for a data value truncates at the number entered for the Tables: Decimals parameter. For example, I have entries 5.123456 and 10.123. These values display as entered when the entry for 'Decimals' is 6. The first number uses six places past the decimal. However, if the entry for the 'Decimals' parameter is 4, the first number will display as 5.1235. The second number display will not change.

The number of places past the decimals when the "system default" is chosen is 6. The entry for the 'Decimals' parameter is ignored when this option is used.

The entry for the 'Decimals' parameter determines the number of places past the decimal when the "fix number of decimals" option is chosen. If the data value only has 2 places past the decimal, if the entry for the 'Decimals' parameter is larger than 2, the data value will include following zeros. For example, if the data value is 5.12 and the entry for the 'Decimals' parameter is 4, the data value 5.12 becomes 5.1200 in the table.

Tables: Decimals
This parameter provides the value for the number of digits past the decimal for the option chosen for the Tables: Floating Point Numbers parameter. The value for this parameter is used with the "maximum number of significant decimals" and "fix number of decimals" options. It is not used with the "system default" option.

This ends the discussion of the parameters available from the "Data" title in the Data tab area of the Manager window. These parameters are related to what might be considered as defaults as they are applied to any layers and tables loaded into a work session. Now we will start discussing other features related to the Data tab area itself. Some of these features control how the list of layers displays. There are also sets of functions and commands available in the Data tab area for each category of object: grid layers, point clouds, and shapes.

The Tree and Thumbnails tabs
When I click on the Data tab, two tabs related to viewing Data tab area content are available. These additional tabs, Tree and Thumbnails, control how the list of objects in the Data tab area appears. The default is to use the Tree tab for a tree-like structure view of the display area. The alternative is to click on the Thumbnails tab and convert the display from the tree-like structure to a set of visible thumbnails. Figure 4-9 displays these two views of the Data tab area, side-by-side for comparison.

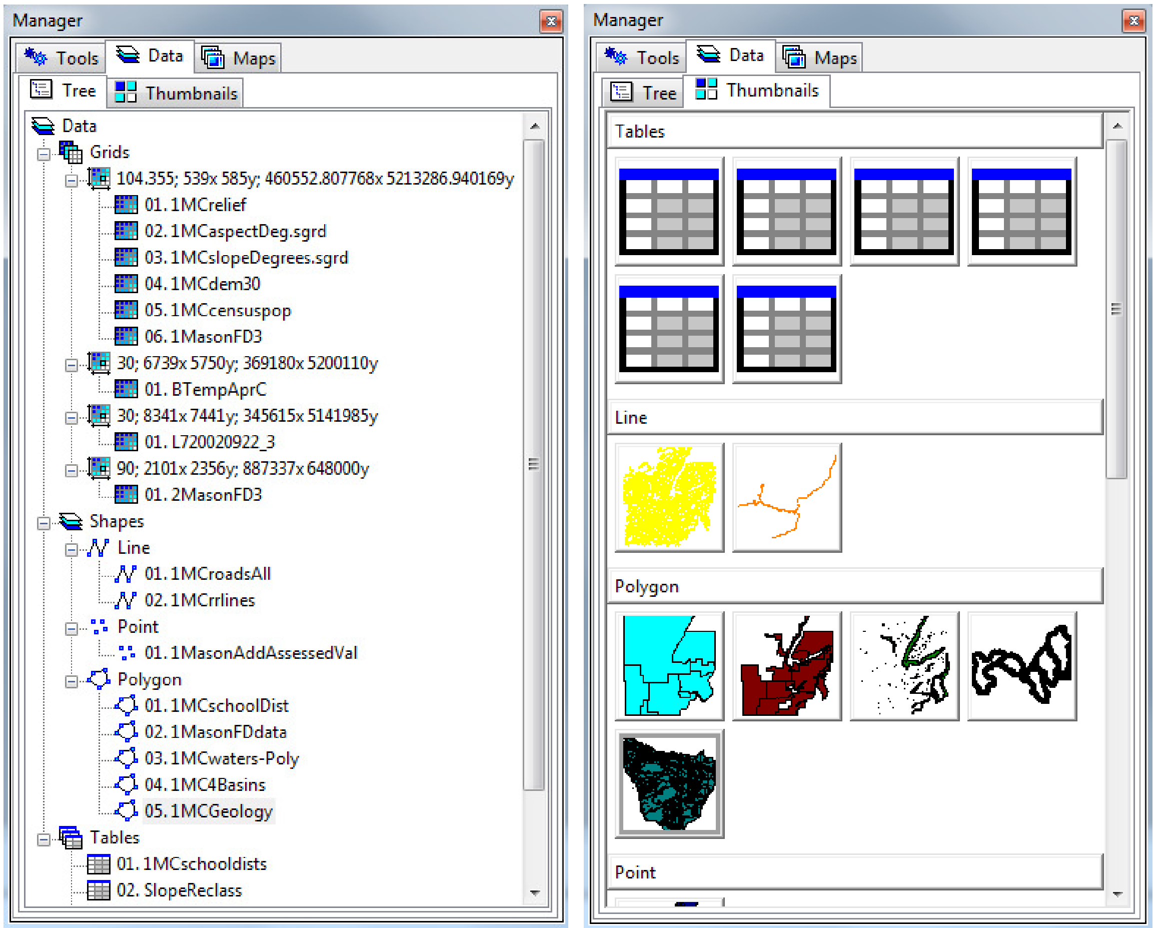


Figure 4-9. Comparing the tree and thumbnail views of the Data tab area in the Manager.

If I look closely toward the top in Figure 4-9, I notice the Tree tab is forward for the tree structure view (on the left) and the Thumbnails tab is forward for the thumbnails view.

Let's discuss Figure 4-9, the comparison of the two display types: text and graphic.

The obvious major difference is text versus graphic. Both views are structured around the layer categories and tables. The thumbnail view sorting order is the opposite of the tree structure. The tree structure is ordered by grid systems, shape type, and last by tables. The thumbnail view is ordered by tables, shape types, and grid systems.

Various icons appear in the Tree tab display (see Figure 4-10). SAGA uses these icons as identifiers for the different types of layers and layer categories.

Data
Grids
Grid System
Grid layer
Point Cloud layer
Shapes
Line Shapes layer
Point Shapes layer
Polygon Shapes layer
Tables
Table file

Figure 4-10. Icons used in the tree display.

The two icons used for the point cloud and point shape layers are identical.

In addition to the Table, Shapes, TIN, Point Cloud and Grid options displayed in Figure 4-10, is one that is not included called Project.

A SAGA project entity is quite efficient for logically linking together layers, tables, and map windows for a particular project or theme. It also captures the display characteristics for the layers, tables, and map windows in the work session at the time the project is saved. A project is somewhat like storing a group of layers, map windows and tables having a common theme or purpose in the same folder without physically moving them into the folder from their current storage locations. A layer can be part of more than one project and can be included in the definition of as many projects as necessary.

When a layer or table is part of a project, the storage location for the layer or table must not change. The name and path for the layer or table is part of the project definition. If the name or path changes the layer or table will not be reloaded as part of the project.

It is not the actual layer that is stored as part of a project. As part of the definition of a project, layer, map, and table parameters as well as paths to their storage location are maintained and saved as the definition of the project and its' environment. It is important to understand that when you exit a SAGA work session, the same data saved for a project is saved in a configuration file (.cfg). The .cfg file can be an option for the starting layer and map parameter environment for the next work session. These parameters are described in the layer chapters that follow.

Each layer has a set of default parameters set by the graphical user interface when a layer is loaded into a SAGA work session using a load command or created by a tool. These default parameters are not stored as part of the layer. However, these parameters can be edited to change the way a layer is viewed, how the data values are displayed, etc. As noted above the settings for these parameters save as part of the project environment.

When the saved project is loaded into a work session, the parameter values at the time the project was last saved are restored.

I have a project named "Mason". When I want to re-load my Mason project and all of the associated layers, I click with the mouse pointer on the File menu on the Menu Bar. I move the mouse pointer over the "Project" option and another popup list of options appears. I move the mouse pointer over the popup list of options and click on "Load Project". When the dialog window displays, I browse to where I have the project definitions stored and choose the one called “Mason”. I highlight the name and click the Open button. All of the data files I have associated with the project are loaded into SAGA and are available for use by tools and for map displays. Figure 4-11 displays a portion of the Data tab area of the Manager after I load the “Mason” project.

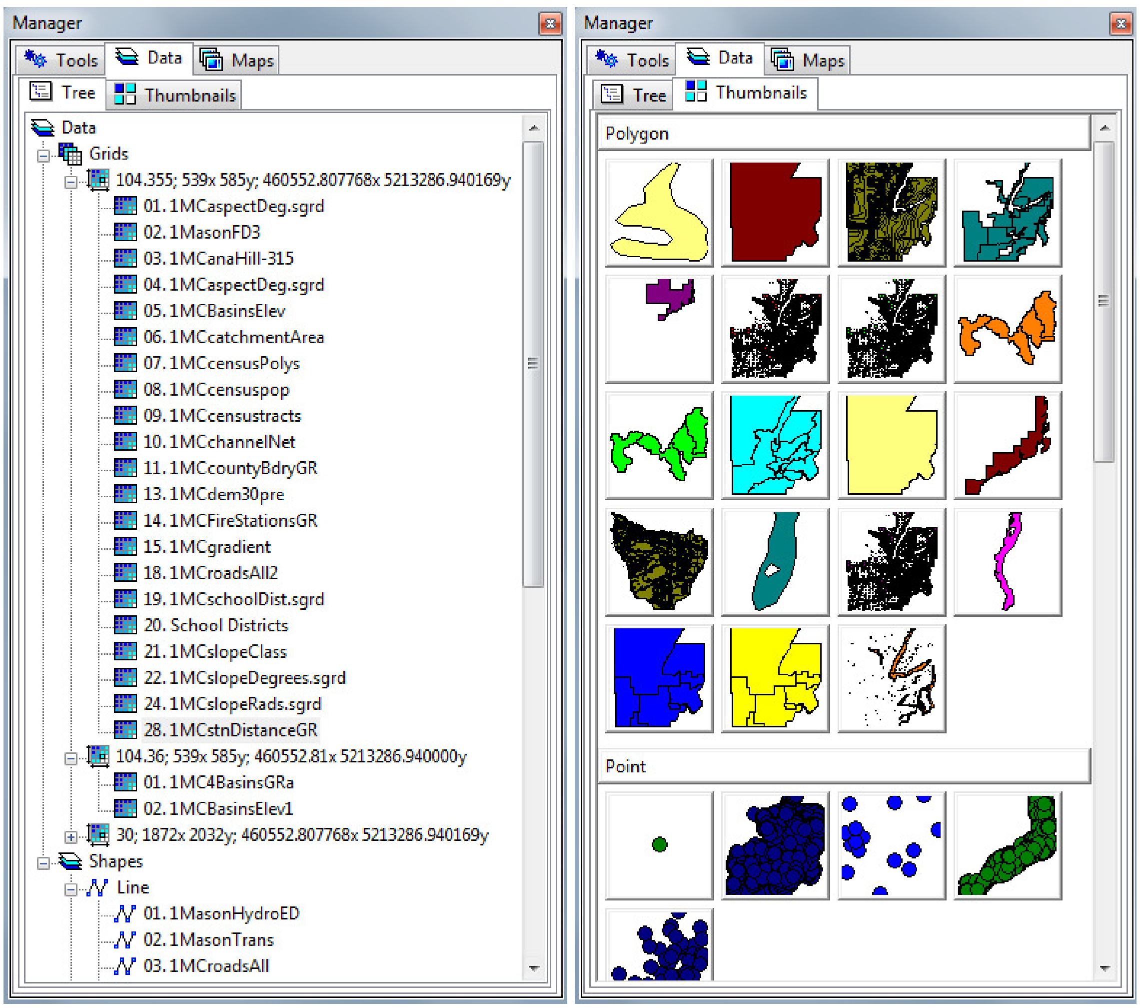


Figure 4-11. A portion of the Data tab area of the Manager.

Each layer listed in the Data tab area of the Manager window has an associated set of parameters that can be viewed in the Object Properties window.

If the Object Properties window is not visible in the work area, I can activate it by choosing the "Show Object Properties" option in the dropdown menu for the Windows menu on the Menu Bar. When a window is activated, it normally displays along the side of the work display area where it was last "docked". If a window is already in that position the newly activated window will "dock" adjacent to the existing window.

I can re-position the window. I click in the window title bar area of the Object Properties window and drag the window to another side of the work display area or I can let it display like a floating window in the work space. As I move it closer to a side of the work display area a blue background shadow appears showing where it will dock if I stop dragging it around.

Options and Features Available in the Data Tab Area of the Manager Window

The set of File: Project commands discussed in Chapter 2 are accessible by moving the mouse pointer over the "Data" text at the top of the Data tab area in the Manager, pressing the left mouse button to highlight the title, and pressing the right mouse button. A popup list of options displays. Each of these options is discussed in Chapter 2.

Additional options and functions become available when layers have been loaded and list in the Data tab area of the Manager window. These options become available for choice when I move my mouse pointer over a layer name in the list and press the right mouse button. A popup list of options appears. The options available depend on the type of layer: Grid, Shapes, or Point Cloud.

Table 4-1: Summary of Layer Options

Grid Type	Shapes Type	Point Cloud Type
Close	Close	Close
Add to Map	Add to Map	Add to Map
Save	Save	Save
Save as...	Save as...	Save as...
Delete Associated Files	Delete Associated Files	Delete Associated Files
Spatial Reference	Spatial Reference	Spatial Reference
Histogram	Histogram	Histogram
Copy Settings from other Layer	Copy Settings from other Layer	Copy Settings from other Layer
Create Lookup Table	Create Lookup Table	Create Lookup Table
==========	==========	==========
Save as Image	Attributes >	Classification >
Copy to Clipboard	Show	Set Range to Min/Max
Scatterplot	Diagram	Set Range to St. Dev.
(1.5)		
	Scatterplot	Set Range to St. Dev.
(2.0)		
	Save Attributes as...	Attributes >
	Edit >	Table
	Edit Selection	Show
	Add Shape	
	Delete Selection	
	Invert Selection	
	Clear Selection	

Actions Common to All Three Layer Types

The following discussion of these options starts with the options common to all three layer types. These are: Close, Add to Map, Save, Save as..., Delete Associated Files, Spatial Reference, Histogram, Copy Settings from other Layer, and Create Lookup Table. In Table 4-1, these options are listed above the double line. The options below the double line are unique to the specific layer type and addressed later.

Close

When I choose the "Close" option, a ‘Delete’ dialog displays (Figure 4-12).

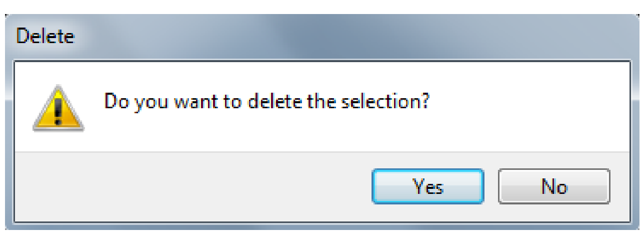


Figure 4-12. The ‘Delete’ dialog window.

The question in the dialog is: “Do you want to delete the selection?” The "Close" option is not necessarily a delete action. If I click with my mouse pointer on the Yes button, the chosen layer is removed from the list of layers for the work session. If the layer has been previously saved it remains saved as before and can be loaded into a work session using the load command. Also, it remains part of any project it may be associated. Clicking on the No button cancels the "Close" option.

On the other hand, if the layer is new and has never been saved, when I click on the Yes button, a second dialog (Figure 4-13) appears because SAGA recognizes that the layer is in a non-saved status.

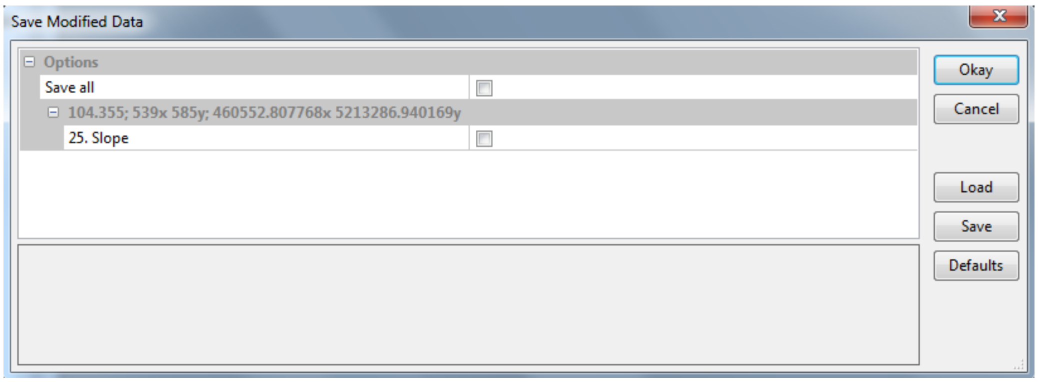


Figure 4-13. The 'Save Modified Data' dialog window.

The 'Save Modified Data' dialog window provides the opportunity to save the layer before SAGA removes it from the work session. Remember, the layer is in a non-saved status; it has never been saved. If the layer is removed from the work session without being saved, it is a delete action and the layer is not available in the future.

The dialog window provides two approaches for saving the layer. First, if I click in the toggle check box to the right of the 'Save all' parameter, a check mark is placed in the toggle box as well as in the toggle box on the last line. Also, a 'File' parameter appears as a new row below the row for the layer. A default path and file name display in the value field to the right of the 'File' parameter label. When I click the Okay button, the layer (or all layers if more than one is listed) will be saved using the default path and file name displayed in the value field to the right of the 'File' parameter.

I use the second approach if I want to change the default storage location or name for the layer file. In this example, since there is only one layer being considered, I can use either of the toggle check boxes in the 'Save all' or 'Save' parameters. I click in the check box to the right of the 'Save' parameter. Next, I click with my mouse pointer in the value field to the right of the new 'File' parameter; an ellipsis symbol appears in the value field to the right. I click on the ellipsis and a 'Save' dialog window displays (Figure 4-14).

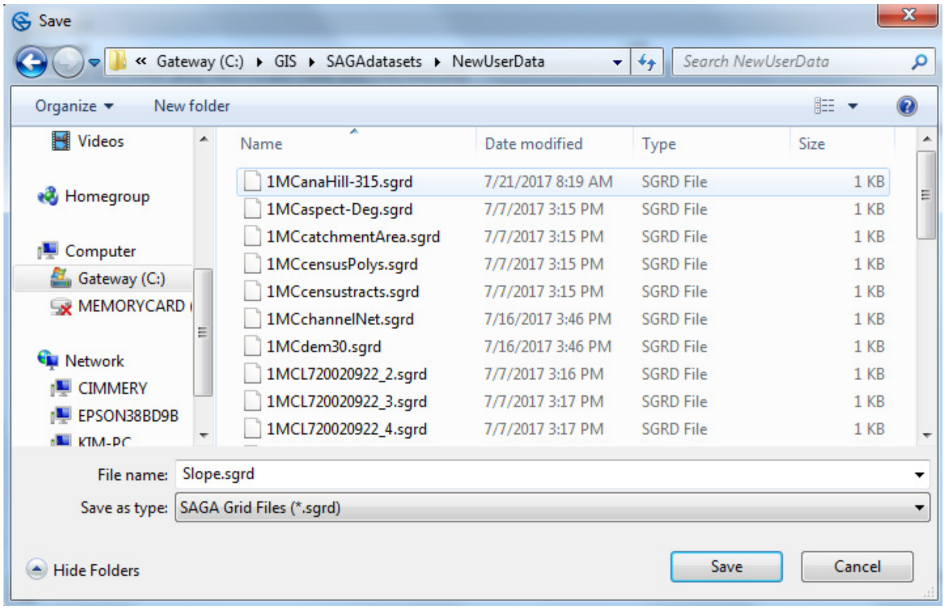


Figure 4-14. The ‘Save’ dialog window for entering a file name and storage path.

I can browse to a folder (storage location) I want to use for the layer. The path and folder display in the data field at the top of the window. I can also change the default file name displayed in the "File name:" data field. This information changes the default entry for the 'File' parameter on the 'Save Modified Data' window in Figure 4-13. I click with the mouse on the Save button and return to the ‘Save Modified Data’ window. I click the Okay button on the window and the layer is stored using the path and name.

The above explains how to save a file. If I do not click with the mouse in either of the check boxes (to the right of the 'Save all' or 'Save' parameters), and click with the mouse on the Okay button, the selected layer is removed from the list of available layers (deleting it) without saving it.

The dialog window in Figure 4-13 can also appear when I exit from SAGA. It works very similar to the description above for use with one file. If one or more data files are in the non-saved status, they list in the ‘Save Modified Data’ window in the same way as a single file in Figure 4-13. If I click in the toggle check box in the value field to the right of the ‘Save all’ parameter, all the data files save using the default paths and filenames displayed to the right of the ‘File’ parameters. Or, if I edit any of the default paths or filenames, the updated information is used for saving the files.

If I do not use the ‘Save all’ parameter, I can use the ‘Save’ parameter for any individual layers I want to save. When I click in the toggle check box to the right of the ‘Save’ label, a check appears. I can change the storage path and/or the file name to use in the value field to the right of the ‘File’ parameter. When I click on the Okay button, SAGA saves only the layers I have identified with checks using the path and file name displayed in the value field to the right of the ‘File’ parameter.

The "Close" option works the same for each of the layer types. One difference I have noticed is in the ‘Save’ window (Figure 4-14). The file suffix listed in the ‘Save as type’ field varies depending on the layer type.

Add to Map
This option is for displaying the selected layer (grid, point cloud, or shapes) in a new map view window or to add it to an existing map view window.

When a map view window has not yet been used in a work session, this command directly displays the selected layer in a new map view window in the work area. If one or more map view windows already exist, a list of map view windows displays (Figure 4-15), and I have the choice of adding the selected layer to an existing map view window or displaying it in a new window.

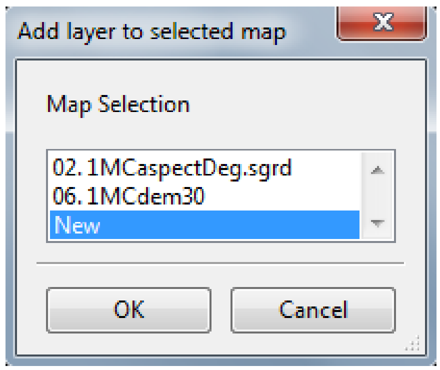


Figure 4-15. The 'Add layer to selected map' dialog window.

I have moved the mouse pointer over the line shape layer for Mason County roads on the list in the Data tab area of the Manager and pressed the right mouse button, selecting the layer. I choose the "Add to Map" option from the popup list of options. I want to display this layer in the same map view window that displays the county DEM and school district layers. These two layers have similar map extents and use the same coordinate reference system. This map view window appears in the list in Figure 4-15 as "06. 1MCdem30". I move the mouse pointer over "06. 1MCdem30" in the list and click on it. The roads layer is now displaying in the selected map view window.

The roads layer also has the same map extent as the other two layers in the map view window and uses the same coordinate reference system. The layers overlap. Any layers can use the same map view window, whether they cover the same spatial extent or overlap or not. They should all use the same coordinate reference system.

Another option in the list in Figure 4-15 is "New". When I choose this option the selected layer is displayed in a new map view window in the work area.

Save
The "Save" option is normally grayed out in the popup list displayed when I right-click on either of the three layer types. If I create a new layer from a SAGA tool and right-click

on the newly created layer name in the list, this command is still grayed out and not available for selection.

If I make a change to a layer that has previously been stored, the "Save" option becomes available in the popup list of options for the layer. For example, I may have changed a data value for a grid cell using the SAGA tool *Grid – Tools/Change Cell Values [Interactive]* or used one of the shape edit tools on a shape layer. An edit is a change in the layer. SAGA recognizes the change and the "Save" option for the layer is no longer grayed out (as long as the layer has been previously saved or stored) and becomes available.

A dialog is not displayed when I use this command. SAGA saves the layer file using the current file name.

Save As...

The "Save As..." option is available for all three layer types. This discussion describes using the "Save As…" option to save a grid layer. The usage is similar for all three layer types. The 'Save Grid' dialog window in Figure 4-16 displays when I choose this tool for saving a grid layer. The 'Save Point Cloud' and 'Save Shapes' dialog windows display when saving a point cloud or shape layer.

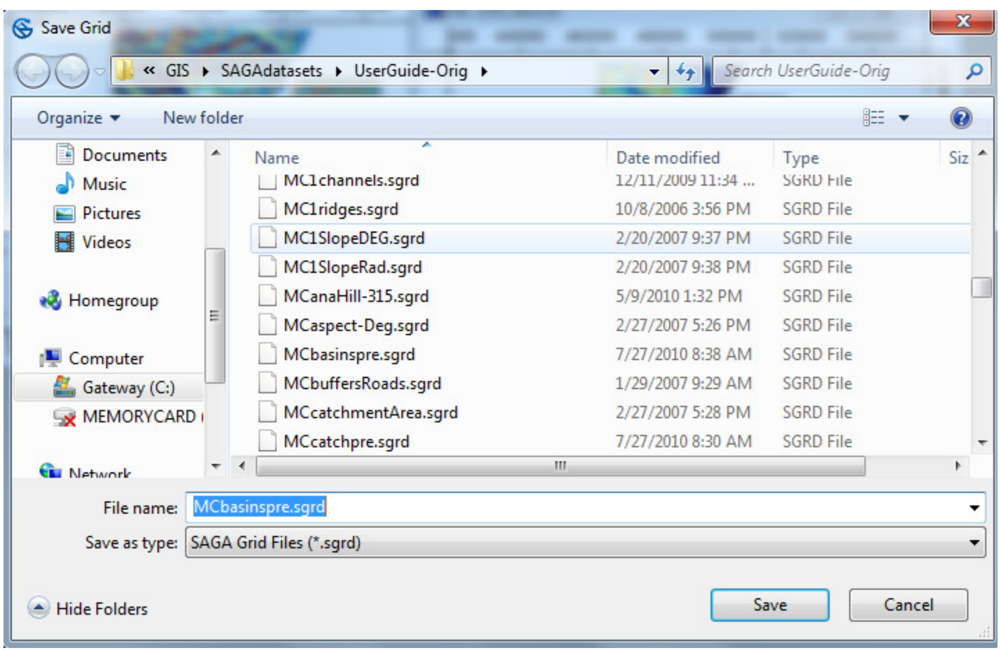


Figure 4-16. The 'Save Grid' dialog window used with the "Save As…" option.

This command can be used to save a new layer, e.g., one just produced by a tool execution, to re-save an existing layer using the same or a different name, or to save the layer in a different storage location.

The dialog window allows me to browse to a folder or storage location for the layer and enter a name for the file in the “File name:” data field. When I click on the Save button at the bottom of the window, the layer file is saved.

The differences I see between the "Save As..." options, for the three layer types, are in the names for the dialog windows and the file types displayed in the "Save as type:" data field.

Delete Associated Files
This command is only available for grid, point cloud, and shape layers that are already stored and available in the current work session. The purpose of this command is to delete the current stored set of files representing the layer. After executing this command, the layer remains available in the Data tab area of the Manager (it is still in memory) for the work session in a non-saved status. The files associated with the layer are deleted from their storage location.

After applying this command to a layer, if I use the "Close" option with the layer, SAGA interprets the layer as in non-saved status. I will be asked if I want to save it, etc., as described earlier in this chapter.

Spatial Reference
All layers have a coordinate reference system. In the case where the name of the coordinate reference system has not been associated with the layer, the reference in the Description tab for the layer displays "Undefined Coordinate System" for the "Projection" information field. The 'Spatial Reference' parameter is to "define or pick a Coordinate Reference System" for the layer. The definition of the coordinate reference system (CRS) is saved in a .prj file for grid and shape layers. The definition is saved in the single file for a point cloud.

This command is identical to the tool *Projection - Proj4/Coordinate Reference System Picker*. The tool is used to identify the correct CRS for a layer in the case that one has not previously been chosen. It can also be used to replace an incorrect CRS that had been chosen.

The Description tab in the Object Properties window for a layer includes CRS information if a CRS is identified for the layer. If CRS information is listed in the Description tab as "Undefined Coordinate System" it means that a .prj file does not exist for the layer (or the information is not included in a point cloud) and various elements related to the coordinate system, projection, datum are unknown. Without this information, i.e., without a .prj file, it is not possible to convert from one coordinate reference system to another, for example, converting from the Universal Transverse Mercator Zone 10 to the Washington State Plane Coordinate System South Zone. If no layer in a map view window has a .prj file it is not possible to create a graticule or base map layer for the map view window displaying.

Figure 4-17 displays the 'Coordinate Reference System Picker' parameters window.

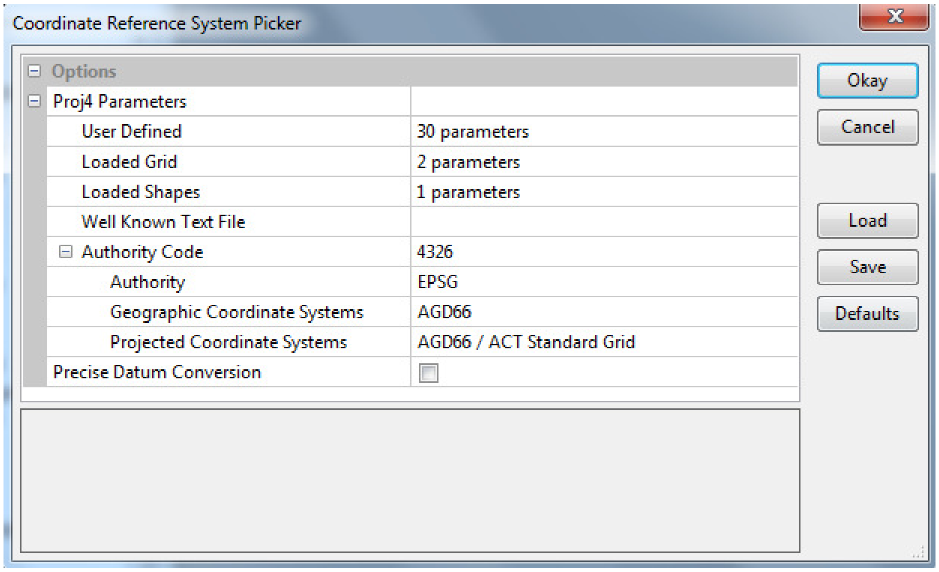


Figure 4-17. The 'Coordinate Reference System Picker' parameters window.

The "Spatial Reference" option, and georeferencing tools in SAGA, are supported by projection routines in the Proj. 4 Cartographic Projection Library developed by Gerald Evenden of the U.S. Department of Interior, Geological Survey.

The information required for the 'Coordinate Reference System Picker' parameters window normally is available as part of the documentation or metadata accompanying a layer from its source. Sometimes this information is included in a text or read-me file or a html file. It is also possible it is included in a special projection or georeferencing file.

The 'Coordinate Reference System Picker' parameter does not change coordinates of a layer from one system to another system. It does not apply a transformation. It's purpose is to provide the correct information describing the coordinate system being used for the layer.

Histogram

The "Histogram" command is available for all three layer categories. This option may not be as effective with shape layers as it is with grid and point cloud layers. With shape layers, the histogram x-axis (horizontal) displays the range of data values for a numeric attribute in the attribute table linked to the shape layer. The y-axis (vertical) is for the frequency of occurrence of objects having the same data value. The y-axis for grid and point cloud layers is the number of grid cells or points having the same data value. Most of my experience with the histogram has been with grid layers. This discussion will focus on using histograms with grid layers.

The "Histogram" option is executed by right-clicking on a grid, point cloud or shape layer name in the Data tab area and choosing the "Histogram" option from the popup menu of options.

A histogram for a grid layer displays, graphically, the distribution and frequency of occurrence of grid cell data values. The histogram does not include the no data values. I can include no data values by changing the no data value to another value. The original no data value is then interpreted as a real data value and included in the histogram. The range of data values (either for grid cells or a shape attribute for objects) display along the horizontal or x-axis. The count of features (grid cells, points or objects) is along the vertical or y-axis.

When displaying the histogram for a grid layer, I need to pay attention to the setting for the Colors: Type parameter for the layer. This setting has seven options. The Single Symbol and RGB Coded Values options do not support a histogram. The Lookup Table, Discrete Colors, Graduated Colors, Shade, and RGB Composite options do support a histogram.

The same options, to a lesser degree, exist for a point cloud layer. There are five options for the Colors: Type parameter for point cloud layers. The Single Symbol and RGB options do not support a histogram. The Lookup Table, Discrete Colors, and Graduated Colors options do support a histogram.

Several of the type options use a default for the number of classes as 100. Once a histogram is created, the number of classes can be changed using the "Change Number of Classes" option on the Menu Bar Histogram menu, explained in Chapter 7.

Let's look at the elevation grid layer '1MCdem30' to see how the histogram command works.

Figure 4-18 displays the digital elevation model (DEM) grid layer for Mason County, Washington with its histogram on the right. The setting for the Colors: Type parameter is "Graduated Colors".

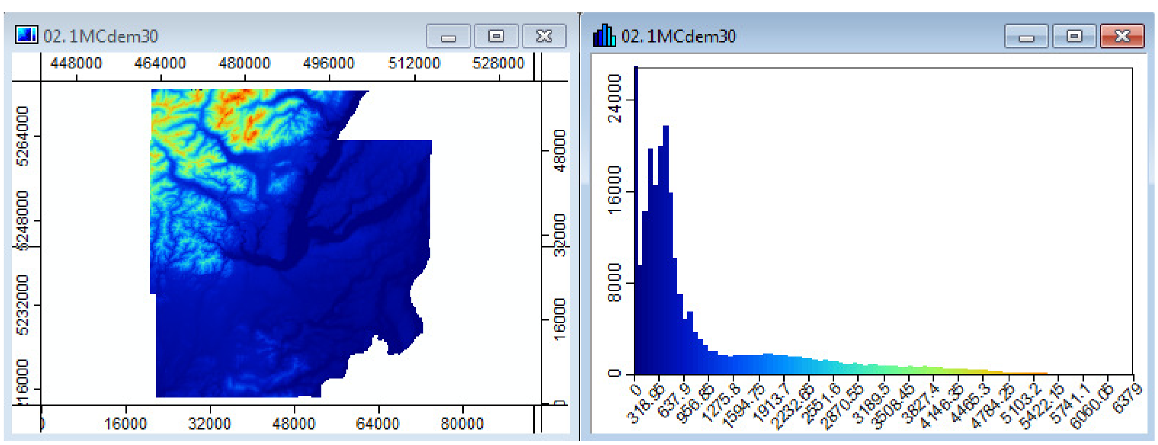


Figure 4-18. A histogram for a DEM grid layer.

The grid cell data values in the histogram are displayed along the bottom on the x-axis. The frequency of occurrence for the cell values displays on the vertical y-axis. The color palette used in the histogram, where lower elevation values are in tones of blue and higher values tend toward red, is the same color palette scheme used for the data values in the map view window for the grid layer. Figure 4-19 shows the legend for the DEM grid layer.

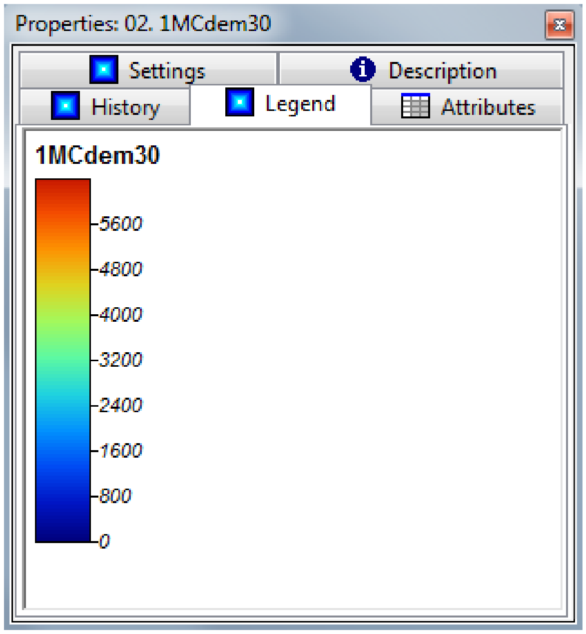


Figure 4-19. The legend for the 'MCdem30' DEM grid layer.

An interesting and valuable feature of the histogram view window is that I can use the mouse pointer to adjust the value range for the color palette using the histogram window.

Here is an example. I am going to use the mouse pointer to select the lower end of the grid cell values on the x-axis of the histogram. I click and drag from the low value I want and drag to the upper value and let up on the mouse button. The range I selected is approximately from 0' to 2300'. Figure 4-20 displays the same graphics in Figure 4-18 as adjusted by my mouse selection.

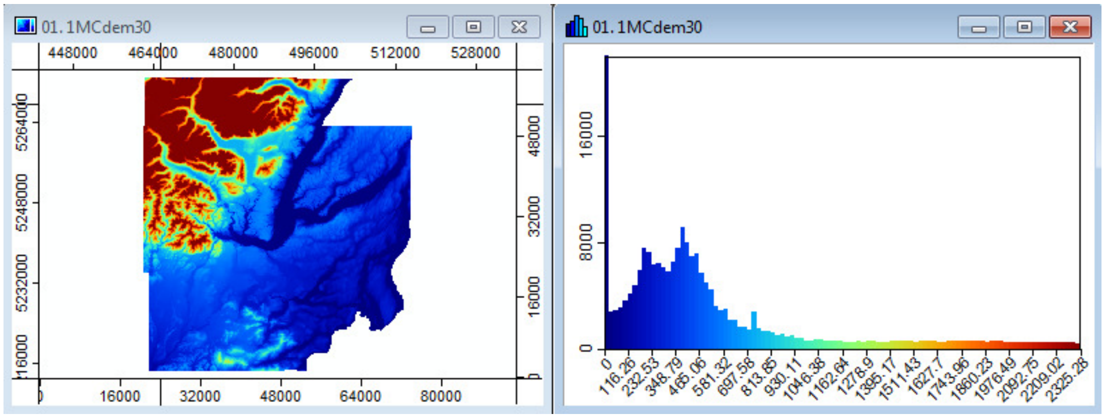


Figure 4-20. Using the histogram to adjust a grid layer color display.

I can see, in Figure 4-20, that the data range the color ramp is applied has been adjusted for 0’ to about 2300’ rather than the original 0’ to 6400’. Notice in the map view window how detail was lost in the higher relief areas (in the northwest quadrant in particular) and more detail was picked up in the lower relief, lower elevation areas. Elevations between 2300 and 6400 display in red tones. I can observe this comparing the two map views in Figures 4-18 and 4-20.

The histogram data range can be changed back to the full data value display range by right clicking in the modified histogram with the mouse pointer. This is a valuable function for interactively adjusting a grid layer map display, i.e., to apply a color or histogram stretch.

Copy Settings from other layer
This option is available for all three of the layer types. Using the option is a two-step process.

First, I move the mouse pointer over the name of the layer in the Data tab area that I want to assign settings from another layer. In this example, this layer is '1MCslopeDegrees'. I press the right mouse button and choose the "Copy Settings from other layer" option on the dropdown menu. The second step is to choose a layer in the 'Select a layer to copy settings from it' window. The settings for this layer are assigned to the '1MCslopeDegrees' layer. This dialog window displays in Figure 4-21. I want to use the same settings used for the '1MCslopeRads' grid layer.

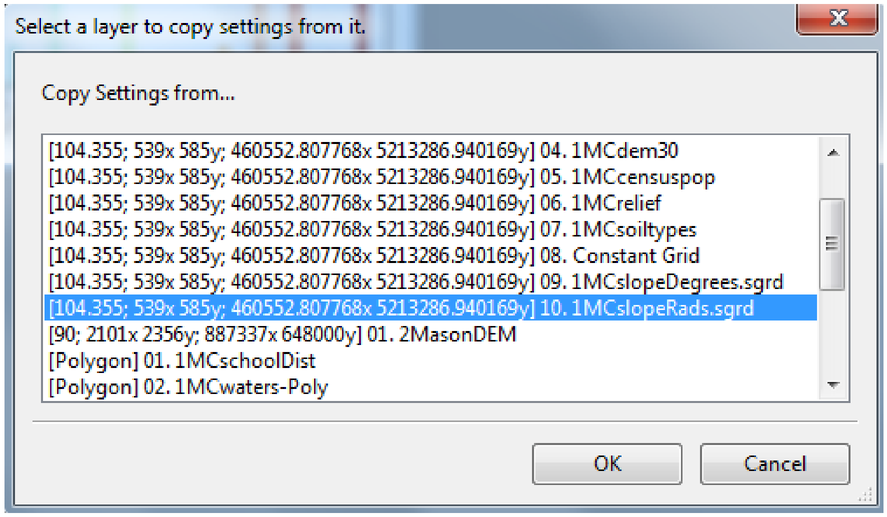


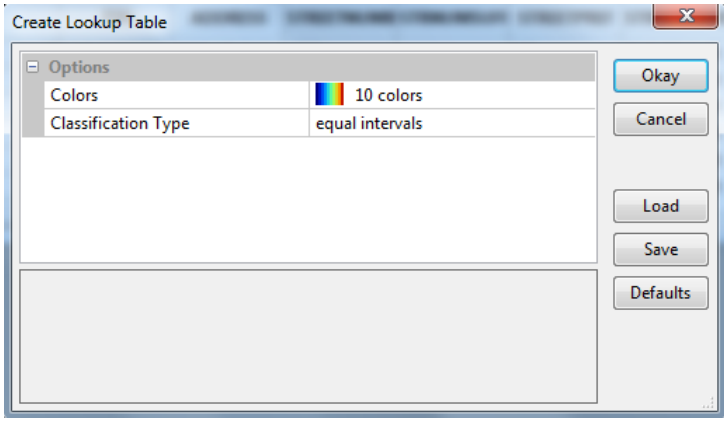
Figure 4-21. The 'Select a layer to copy settings from it' dialog window.

This same dialog window displays when the command is executed for any of the three layer types. I can see that the list includes grid and shape layers. If any point cloud layers had been loaded they would also appear in the list. I can choose any of the listed layers.

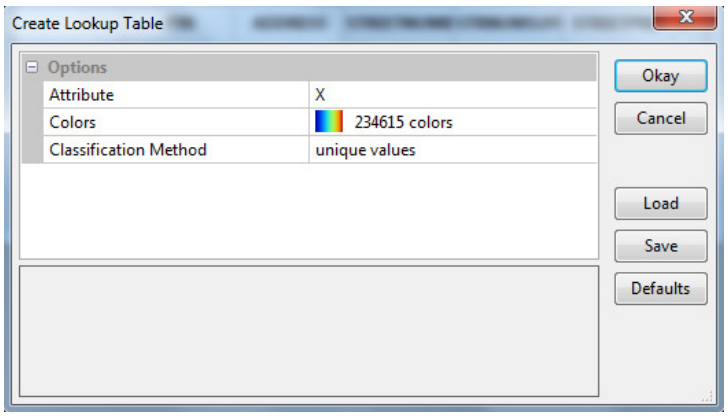
I choose the '1MCslopeRads' layer name on the list by clicking on it with the mouse pointer. After I click on the OK button at the bottom of the dialog window, the color display settings for the layer replace the color display settings for the layer the 'Copy Settings from other layer' command was opened from, in this case the '1MCslopeDegrees' layer.

The "Create Lookup Table" Option

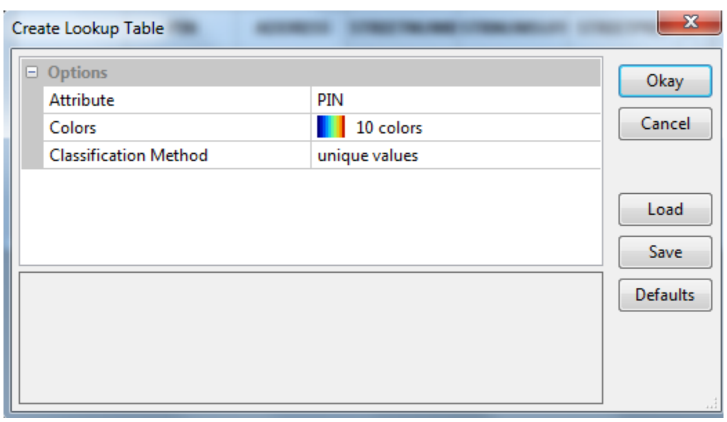
The last option that is common to all three layer types is "Create Lookup Table". I choose this option by moving my mouse pointer over the layer I want to create a lookup table for in the list of layers in the Data tab area of the Manager window. Once the mouse pointer is over the layer name I press the right mouse button and choose the "Create Lookup Table" option from the popup list of options. Depending on which of the three layer types I have chosen, one of the dialog windows in Figure 4-22 displays.



(a) 'Create Lookup Table' dialog window for a grid layer.



(b) 'Create Lookup Table' dialog window for a point cloud layer.



(c) 'Create Lookup Table' dialog window for a shape layer.

Figure 4-22. The three 'Create Lookup Table' dialog windows.

The three 'Create Lookup Table' dialog windows are quite similar. The only difference between the three is that for the point cloud and shape layers there is an attribute parameter for identifying a source of data values. Other than this difference, the windows function in the same manner. Let's briefly look at the other two parameters on the dialog window.

The 'Colors' parameter is where I choose the color palette for assigning colors to display classes in a lookup table.

I move the mouse pointer over the ellipsis in the value field to the right of the 'Colors' parameter and press the left mouse button. The 'Colors' dialog window in Figure 4-23 displays.

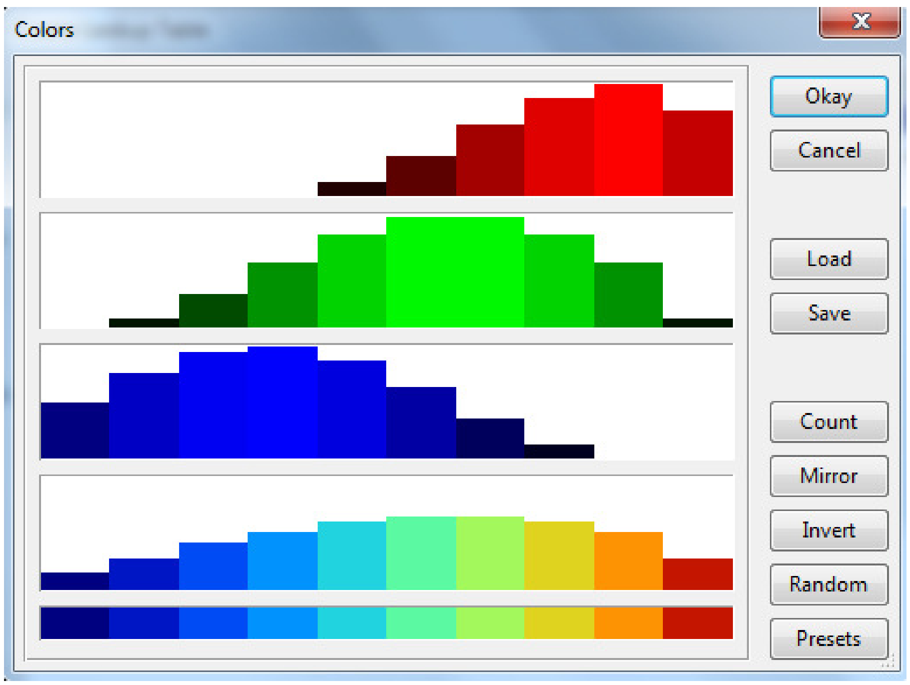


Figure 4-23. The 'Colors' dialog window.

A color palette is chosen using the Load or Presets buttons. When I click on the Presets button, a 'Preset Selection' window displays a list of palettes programmed into SAGA as a default set of options. I can scroll through the list, click on a preset palette, click on the OK button, and the 'Colors' dialog window is updated by the new palette.

Alternatively, I can use the Load button to navigate to and load a palette in my palette folder. This folder has a full range of palettes to choose. Once I select a palette from the 'Load Colors' dialog window, I click on the Open button and the 'Colors' dialog window updates with the new color palette.

There are three buttons on the 'Colors' dialog window used to change the order of the color classes in the palette. These are Mirror, Invert, and Random.

The value field to the right of the 'Colors' parameter displays a thumbnail of the color range for the chosen palette. It also includes a number for the number of color display classes. I can see in Figure 4-23 that the current number of color or data value classes that will display is 10. The Count button on the 'Colors' dialog window is access to the count parameter for identifying how many color or data value classes are to display. There is an exception to this described later.

I click on the Count button in the 'Colors' dialog window and the 'Input' dialog window in Figure 4-24 displays.

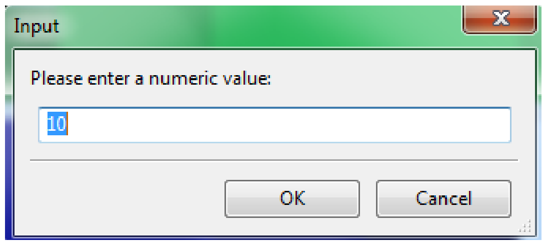


Figure 4-24. The 'Input' dialog window for the 'Count' variable.

I can enter a different number into the field. The number I enter becomes the number of color or data value display classes for use by the layer. Note that the actual data values are not changed; this process only effects how the color or data value classes display in a map view window or histogram. I move the mouse pointer into the field, click on the current number, and change it to the number of classes I want to display.

The value entered for the 'Count' parameter is a variable for two of the options available for the 'Classification Type' parameter on the 'Create Lookup Table' dialog window. The 'Classification Type' parameter has three choices: equal intervals, unique values, and quantiles. The value entered for the 'Count' parameter does not affect the output when the "unique values" option is used but it does affect the output for the "equal intervals" and "quantiles" options. The number of the 'Count' parameter is the number of color or data display classes for the two options.

The SAGA software defines classes for the "equal intervals" option by first calculating the equal class interval. This is calculated by dividing the data range by the value entered for the 'Count' parameter. For example, the data value range for my elevation grid layer is from 0 to 6379 or 6379 feet. I have entered 10 for the 'Count' parameter. The lookup table produced will contain ten data classes using a class interval of 63.79. Class 1 is from 0 to 63.79, Class 2 is from 63.79 to 127.58, etc.

The display classes for the "quantiles" option are calculated to contain approximately the same number of grid cells in each class. For example, I have a grid layer that contains 315,400 grid cells (all grid cells outside of the irregular outline of the study area contain the no data value). The number of grid cells in each class is calculated by dividing the total number of grid cells by the entry for the 'Count' parameter, 10. Thus, there will be approximately 31,540 grid cells in each of the 10 classes. The class interval for the first class is identified by locating the 31,540th grid cell along the cumulative curve of values and identifying its data value. In this case the value is around 73. The next class boundary is determined by the value of the 63,080th grid cell along the cumulative curve of values. Class 2 is from 73 to approximately 128, etc.

Here is an example. I will use a sub-scene of a Landsat satellite image, more specifically, the band 4 file named '1MCL720020922_4'. This file consists of 3,803,904 grid cells of data values. The data range is from 12 to 216. The mean data value is 75.120844 and the standard deviation is 29.026509.

I move the mouse pointer over the file name '1MCL720020922_4' in the Data tab area of the Manager and press the right mouse button. I choose the "Create Lookup Table" option from the popup list of options. The 'Create Lookup Table' dialog window that displays is in Figure 4-25.

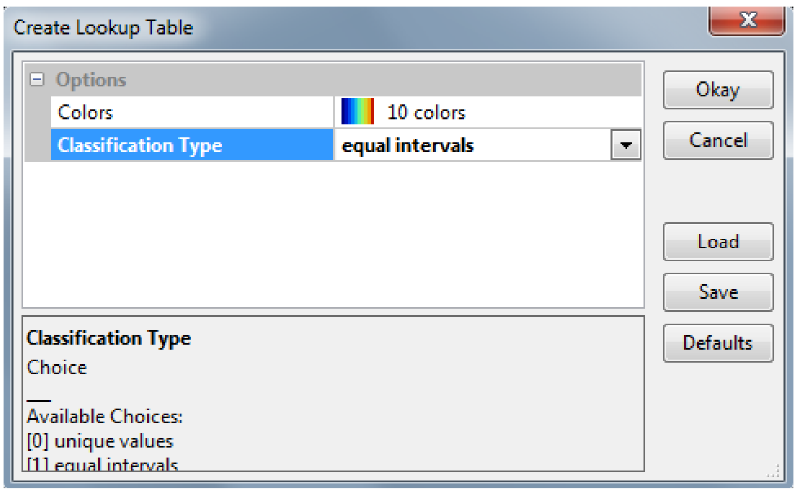
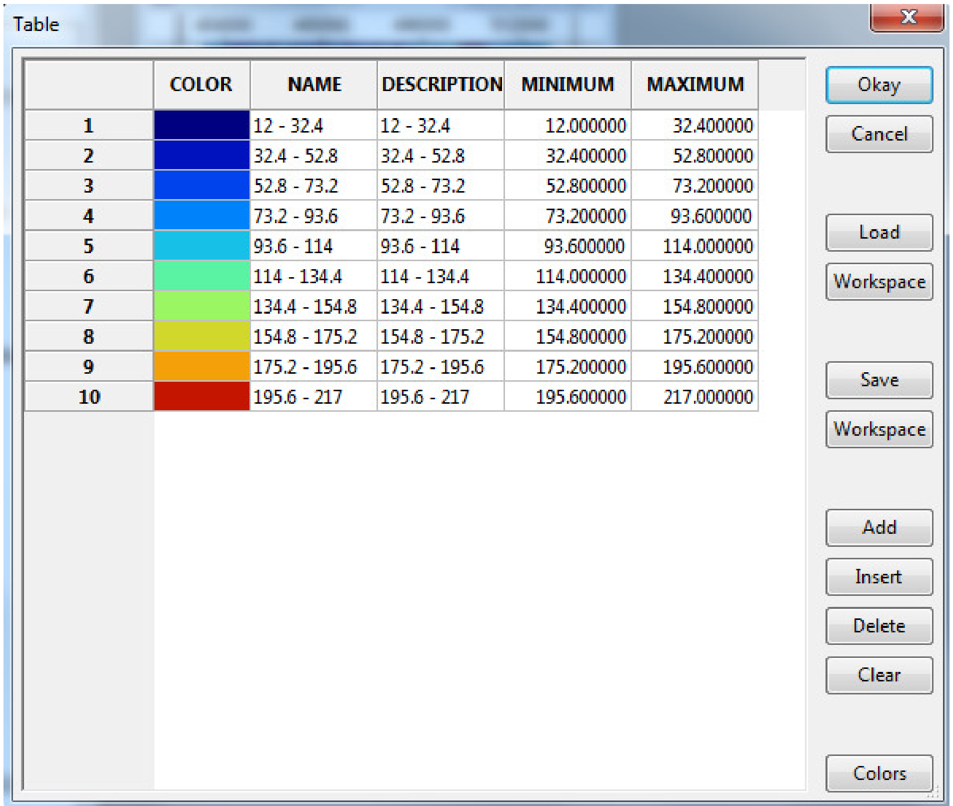


Figure 4-25. The 'Create Lookup Table' dialog window.

I access the 'Colors' dialog window from the value field to the right of the 'Colors' parameter and enter the value 10 for the 'Count' parameter (as described earlier). I have chosen the "equal intervals" option for the 'Classification Type' parameter. I click on the Okay button and a new lookup table is created. Figure 4-26 displays the new lookup table.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		12 - 32.4	12 - 32.4	12.000000	32.400000
2		32.4 - 52.8	32.4 - 52.8	32.400000	52.800000
3		52.8 - 73.2	52.8 - 73.2	52.800000	73.200000
4		73.2 - 93.6	73.2 - 93.6	73.200000	93.600000
5		93.6 - 114	93.6 - 114	93.600000	114.000000
6		114 - 134.4	114 - 134.4	114.000000	134.400000
7		134.4 - 154.8	134.4 - 154.8	134.400000	154.800000
8		154.8 - 175.2	154.8 - 175.2	154.800000	175.200000
9		175.2 - 195.6	175.2 - 195.6	175.200000	195.600000
10		195.6 - 217	195.6 - 217	195.600000	217.000000

Figure 4-26. The 10-class "equal intervals" lookup table.

The class interval is calculated by dividing the range (204) by the number of classes, 10. The class interval is 20.4. I can see from the table view in Figure 4-26, that the class interval used for the 10 classes is 20.4.

I use the "Histogram" option to look at the frequency of occurrence of grid cells for each class. Figure 4-27 displays the histogram for the grid layer when the option "equal intervals" is used with the "Lookup Table" option for the Colors: Type parameter in the Settings tab area of the Object Properties window for the grid layer.

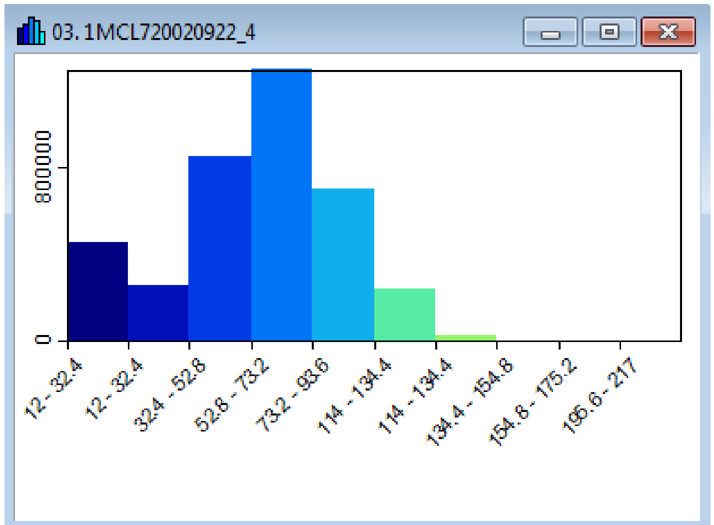


Figure 4-27. The 10-class "equal intervals" histogram.

I notice that duplicate class names are displayed in the histogram view window. This is a problem with the histogram display routine and should be fixed for the next SAGA release.

Once I display the histogram, I use the "Convert to Table" option from the Menu Bar Histogram menu to create a table of the histogram values. Figure 4-28 displays the portion of the histogram table showing the number of grid cells in each class.

01. Histogram: 1MCL720020922_4

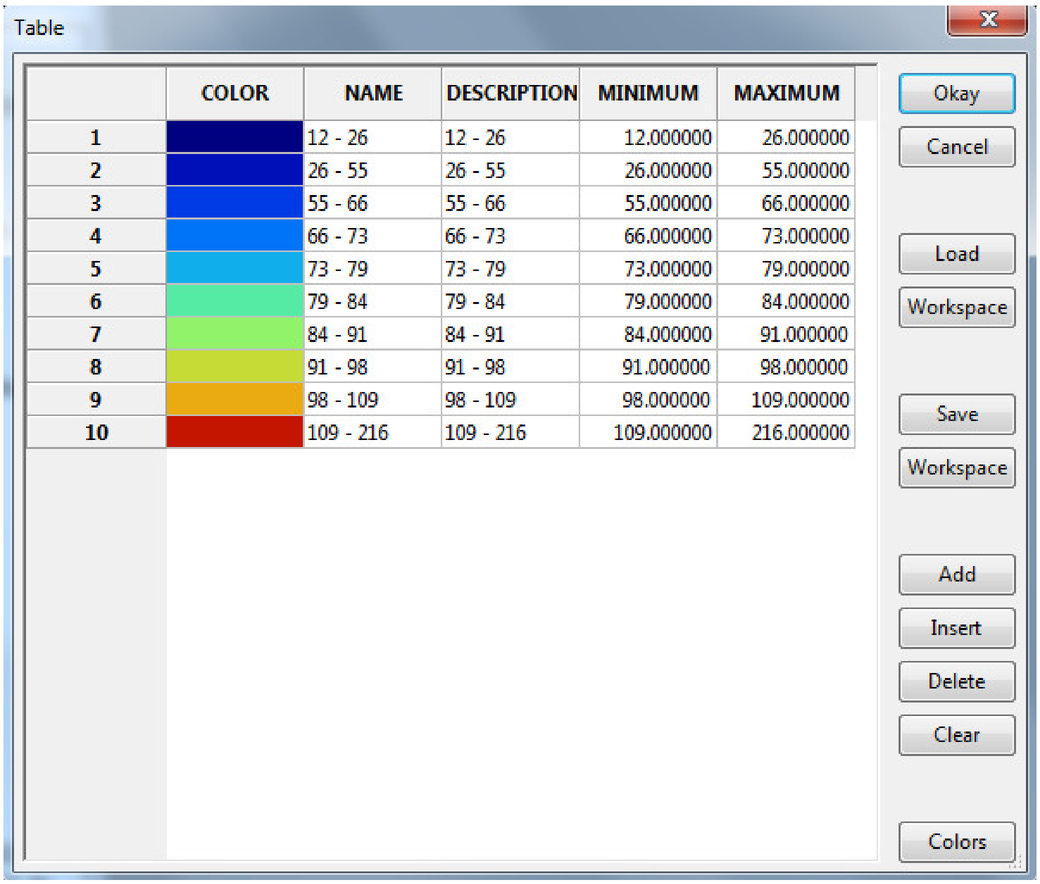
	CLASS	COUNT	CUMUL	NAME
1	1	457266	457266	12 - 32.4
2	2	261772	719038	32.4 - 52.8
3	3	849412	1568450	52.8 - 73.2
4	4	1252131	2820581	73.2 - 93.6
5	5	708158	3528739	93.6 - 114
6	6	239512	3768251	114 - 134.4
7	7	32321	3800572	134.4 - 154.8
8	8	3005	3803577	154.8 - 175.2
9	9	284	3803861	175.2 - 195.6
10	10	43	3803904	195.6 - 217

Figure 4-28. The number of grid cells in each data display class.

Notice that the "NAME" column does not include any duplicate names like the histogram view window. The histogram view incorrectly displays the names whereas the table version of the histogram displays the correct names. The names used in the lookup table in Figure 4-26 compare to the names used in Figure 4-28.

The grid cell frequency lists in the column labeled "COUNT". The mean (75.120844) for the data falls in Class 4 that also has the highest frequency of grid cells at 1,252,131. Notice how the cumulative frequency drops off starting with Class 6. The "majority" of the data falls in classes 3, 4, and 5. The standard deviation supports this observation.

Now, I will use the same grid layer ('1MCL720020922_4') with the "quantiles" option for the 'Classification Type' parameter and 10 for the 'Count' parameter. I click on the Okay button and a new lookup table is created. Figure 4-29 displays the new lookup table.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		12 - 26	12 - 26	12.000000	26.000000
2		26 - 55	26 - 55	26.000000	55.000000
3		55 - 66	55 - 66	55.000000	66.000000
4		66 - 73	66 - 73	66.000000	73.000000
5		73 - 79	73 - 79	73.000000	79.000000
6		79 - 84	79 - 84	79.000000	84.000000
7		84 - 91	84 - 91	84.000000	91.000000
8		91 - 98	91 - 98	91.000000	98.000000
9		98 - 109	98 - 109	98.000000	109.000000
10		109 - 216	109 - 216	109.000000	216.000000

Figure 4-29 . An example of a 10-class "quantiles" lookup table.

I can use the "Histogram" option to look at the frequency of occurrence of grid cells for each class. The histogram in Figure 4-30 is for a layer with a lookup table defined using the "quantiles" option. The "Lookup Table" option is chosen for the Colors: Type parameter in the Settings tab area of the Object Properties window for the grid layer.

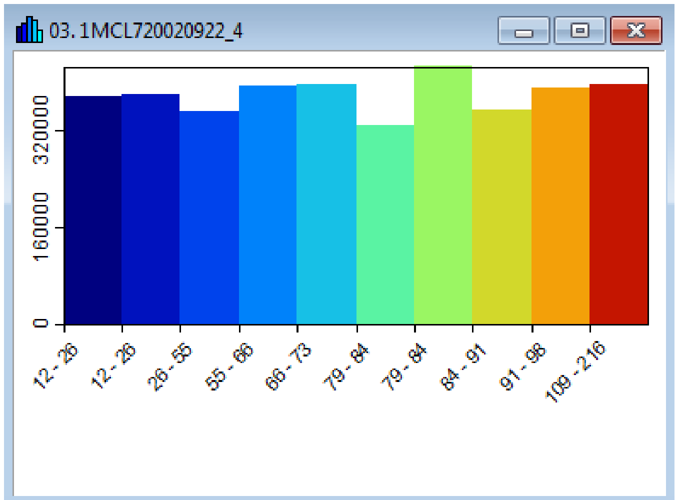


Figure 4-30. A 10-class "quantiles" histogram.

The criteria for the class interval is calculated by dividing the total number of grid cells by the number of classes, 10. Each class will include approximately 380,390 grid cells.

I can use the "Histogram" tool to look at the frequency of occurrence of grid cells for each class. Once I display the histogram, I use the "Convert to Table" option from the Menu Bar Histogram menu of options to create a table of the histogram values. I can see from the table view in Figure 4-31, that the class intervals vary from 5 to 24 to a high of 107. Figure 4-31 displays the portion of the histogram table showing the number of grid cells in each class.

02. Histogram: 1MCL720020922_4

	CLASS	COUNT	CUMUL	NAME
1	1	377945	377945	12 - 26
2	2	379695	757640	26 - 55
3	3	351781	1109421	55 - 66
4	4	394634	1504055	66 - 73
5	5	397364	1901419	73 - 79
6	6	330016	2231435	79 - 84
7	7	426400	2657835	84 - 91
8	8	355857	3013692	91 - 98
9	9	392414	3406106	98 - 109
10	10	397798	3803904	109 - 216

Figure 4-31. The number of grid cells in each data class of a "quantiles" histogram.

The important column to view is the "COUNT" column. The number of grid cells falling in each class should be around 380,390. I can see that the frequencies are relatively close.

Let's do another example, this time using a point cloud layer. A point cloud layer has some similarity to a point shape layer. The attribute table for the layer has 8 attributes including the X and Y coordinates and a Z or elevation value. Recall from earlier that with point cloud and shape layers, an additional parameter in the 'Create Lookup Table' dialog window is for 'Attribute'.

The name of my point cloud layer is '1pc3304sub'. It contains 4,361,413 points. The "Z" attribute is chosen to supply the data (elevation values) for the lookup table. The minimum value for "Z" is 47.65 and the maximum is 214.12 for a data value range of 166.47. The mean data value is 124.07 and the standard deviation for the data is 24.38.

I choose the "Create Lookup Table" command for the '1pc3304sub' layer. The 'Create Lookup Table' dialog window displays in Figure 4-32.

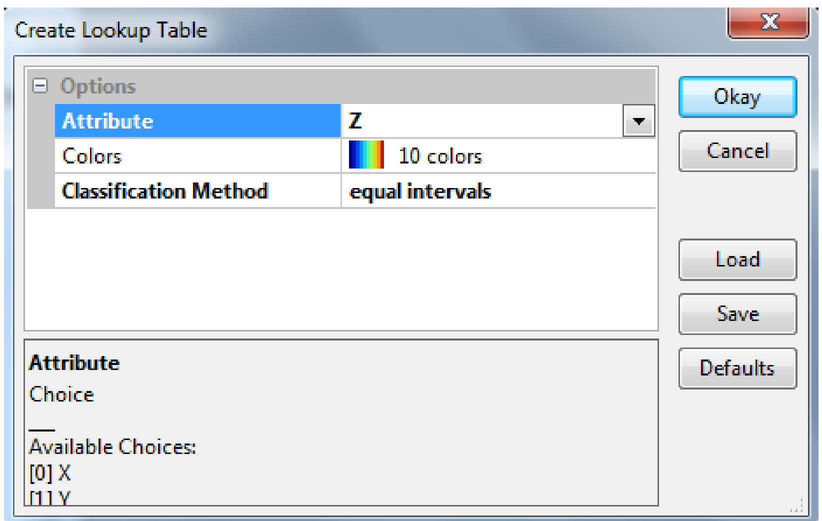
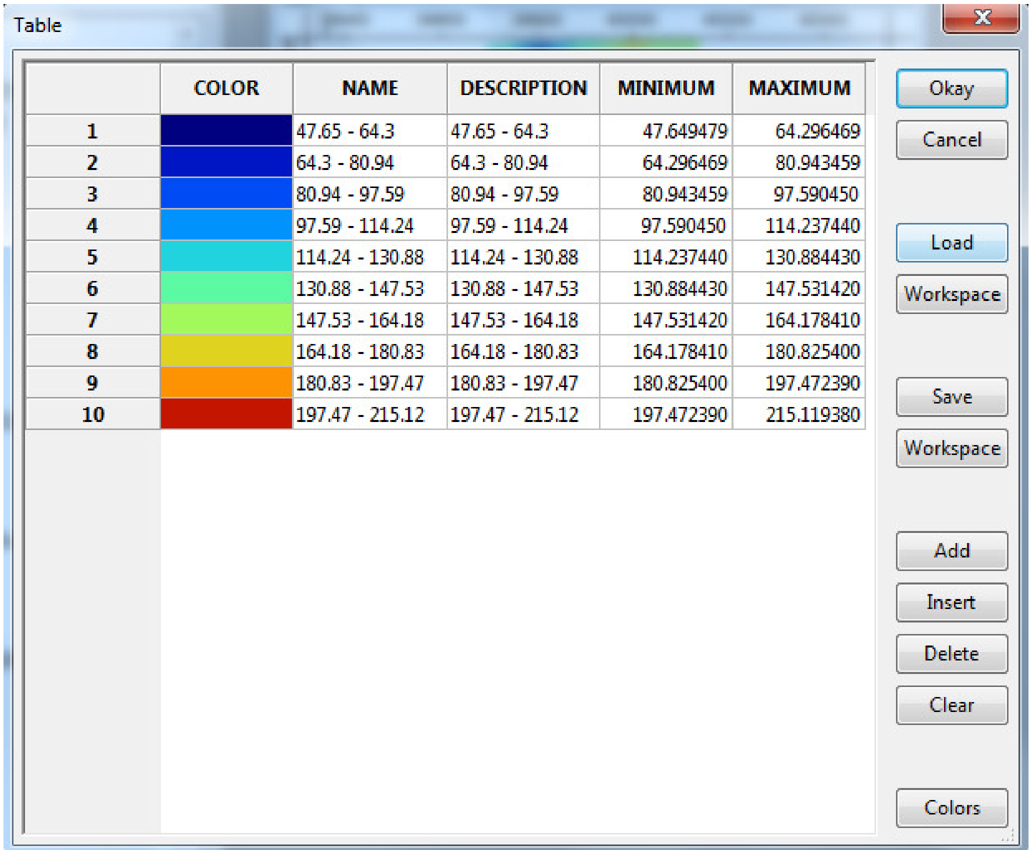


Figure 4-32. The 'Create Lookup Table' dialog window.

I move the mouse pointer into the value field to the right of the 'Attribute' parameter over the triangle and press the left mouse button. The popup attribute list has 8 attributes listed. I choose the "Z" attribute. I access the 'Colors' dialog from the value field to the right of the 'Colors' parameter and enter the value 10 for the 'Count' parameter (as described earlier). I have chosen the "equal intervals" option for the 'Classification Method' parameter. I click on the Okay button and a new lookup table is created. Figure 4-33 displays the new lookup table.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		47.65 - 64.3	47.65 - 64.3	47.649479	64.296469
2		64.3 - 80.94	64.3 - 80.94	64.296469	80.943459
3		80.94 - 97.59	80.94 - 97.59	80.943459	97.590450
4		97.59 - 114.24	97.59 - 114.24	97.590450	114.237440
5		114.24 - 130.88	114.24 - 130.88	114.237440	130.884430
6		130.88 - 147.53	130.88 - 147.53	130.884430	147.531420
7		147.53 - 164.18	147.53 - 164.18	147.531420	164.178410
8		164.18 - 180.83	164.18 - 180.83	164.178410	180.825400
9		180.83 - 197.47	180.83 - 197.47	180.825400	197.472390
10		197.47 - 215.12	197.47 - 215.12	197.472390	215.119380

Figure 4-33. The 10-class "equal intervals" lookup table.

The class interval is calculated by dividing the range (166.47) by the number of classes, 10. The class interval is 16.647. I can see from the table view in Figure 4-33, that the class interval used for the 10 classes in the table is 16.647.

I use the "Histogram" option to look at the frequency of occurrence of grid cells for each class. Figure 4-34 displays the histogram for the grid layer when the lookup table for "equal intervals" is the option for the Colors: Type parameter in the Settings tab area of the Object Properties window for the grid layer.

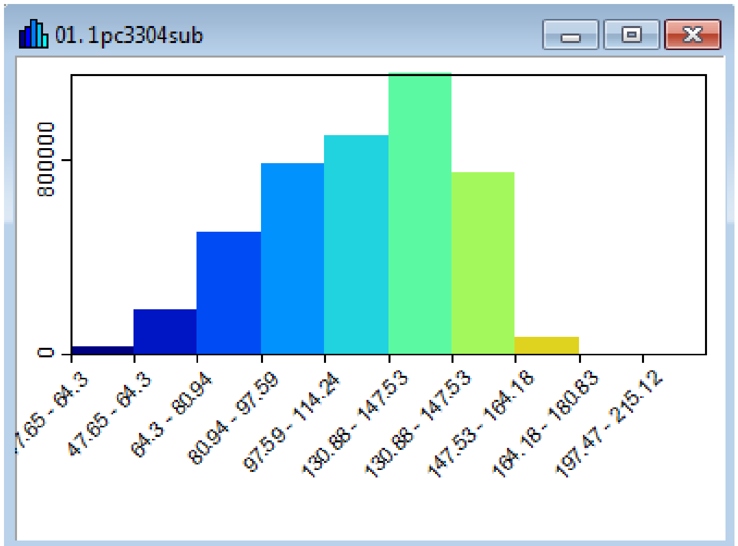


Figure 4-34. The 10-class "equal intervals" histogram.

Once the histogram displays I use the "Convert to Table" option from the Menu Bar Histogram menu to create a table of the histogram values. Figure 4-35 displays the portion of the histogram table showing the number of grid cells in each class.

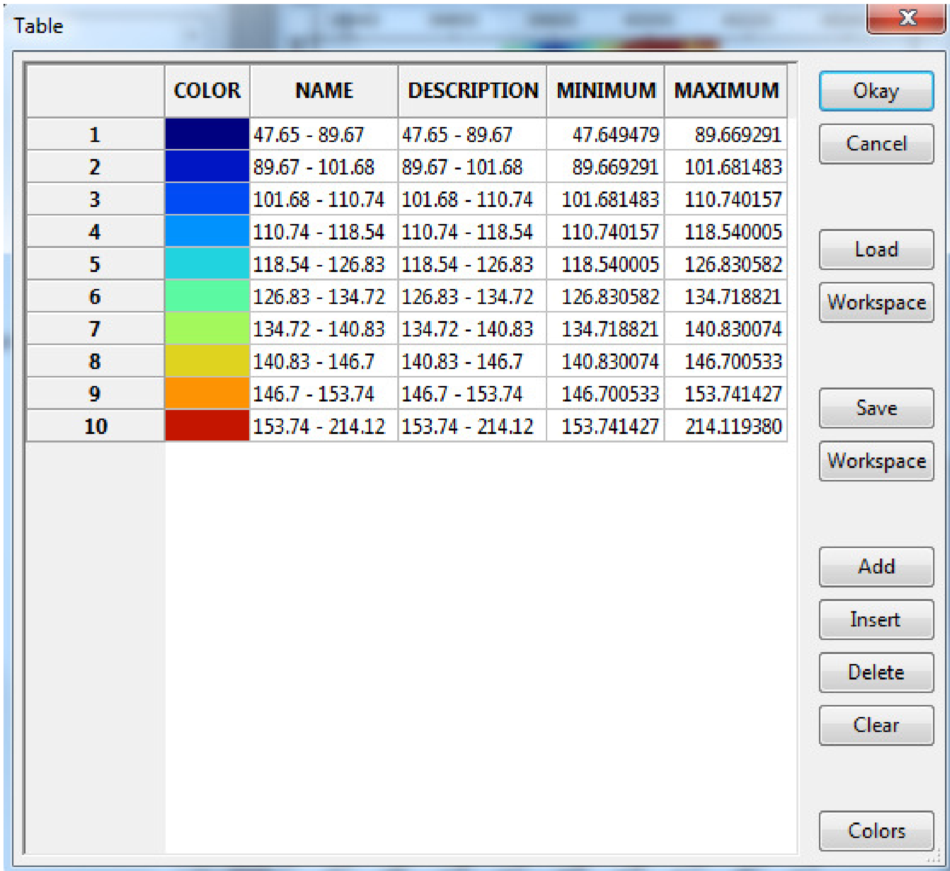
07. Histogram: 1pc3304sub

	CLASS	AREA	COUNT	CUMUL	NAME	MIN	CENTER	MAX
1	1	32353	32353	32353	47.65 - 64.3	47.6495	55.973	64.2965
2	2	183788	183788	216141	64.3 - 80.94	64.2965	72.62	80.9435
3	3	500472	500472	716613	80.94 - 97.59	80.9435	89.267	97.5904
4	4	782244	782244	1498857	97.59 - 114.24	97.5904	105.9139	114.2374
5	5	894621	894621	2393478	114.24 - 130.88	114.2374	122.5609	130.8844
6	6	1151401	1151401	3544879	130.88 - 147.53	130.8844	139.2079	147.5314
7	7	744809	744809	4289688	147.53 - 164.18	147.5314	155.8549	164.1784
8	8	74509	74509	4364197	164.18 - 180.83	164.1784	172.5019	180.8254
9	9	212	212	4364409	180.83 - 197.47	180.8254	189.1489	197.4724
10	10	204	204	4364613	197.47 - 215.12	197.4724	206.2959	215.1194

Figure 4-35. The number of grid cells in each data class.

The grid cell frequency lists in the column labeled "COUNT". The mean (124.07) for the data is in Class 5. Notice how the cumulative frequency drops off starting with Class 8. Over 90% of the data falls in classes 3, 4, 5, 6 and 7.

Now, with the same point cloud layer, I will use the "quantiles" option for the 'Classification Type' parameter and 10 for the 'Count' parameter. I click on the Okay button and a new lookup table is created. Figure 4-36 displays the new lookup table.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		47.65 - 89.67	47.65 - 89.67	47.649479	89.669291
2		89.67 - 101.68	89.67 - 101.68	89.669291	101.681483
3		101.68 - 110.74	101.68 - 110.74	101.681483	110.740157
4		110.74 - 118.54	110.74 - 118.54	110.740157	118.540005
5		118.54 - 126.83	118.54 - 126.83	118.540005	126.830582
6		126.83 - 134.72	126.83 - 134.72	126.830582	134.718821
7		134.72 - 140.83	134.72 - 140.83	134.718821	140.830074
8		140.83 - 146.7	140.83 - 146.7	140.830074	146.700533
9		146.7 - 153.74	146.7 - 153.74	146.700533	153.741427
10		153.74 - 214.12	153.74 - 214.12	153.741427	214.119380

Figure 4-36. The 10-class "quantiles" lookup table.

The class interval is calculated by dividing the total number of grid cells by the number of classes, 10. Each class will include approximately 436,461 grid cells. I can see from the table view in Figure 4-36, that the class intervals vary from a low of 6 to a high of 61 with most around 8.

I use the "Histogram" option to look at the frequency of occurrence of grid cells for each class. Figure 4-37 displays the histogram for the grid layer when the lookup table for "quantiles" is the option for the Colors: Type parameter in the Settings tab area of the Object Properties window for the grid layer.

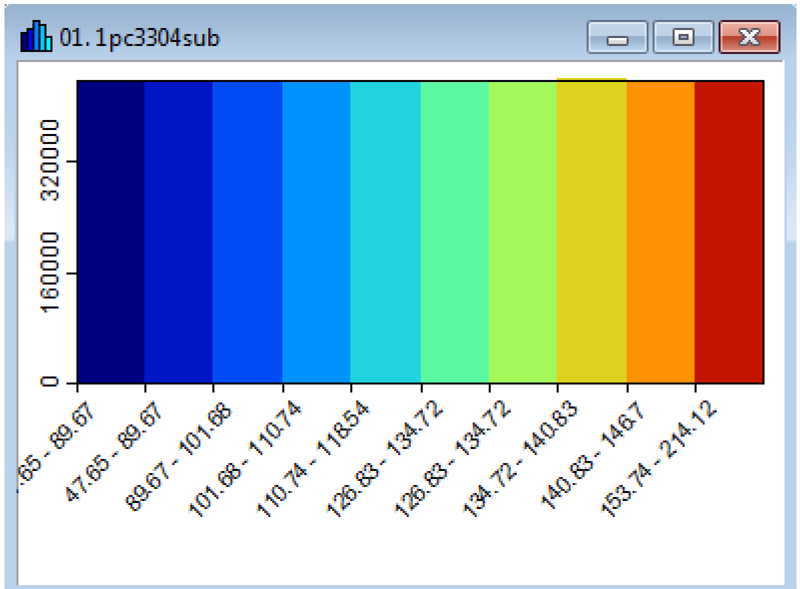


Figure 4-37. The 10-class "quantiles" histogram.

Once I display the histogram I convert it to a table using the "Convert to Table" option from the Menu Bar Histogram menu. Figure 4-38 displays the portion of the histogram table showing the number of grid cells in each class.

08. Histogram: 1pc3304sub

	CLASS	AREA	COUNT	CUMUL	NAME	MIN	CENTER	MAX
1	1	436270	436270	436270	47.65 - 89.67	47.6495	68.6594	89.6693
2	2	436588	436588	872858	89.67 - 101.68	89.6693	95.6754	101.6815
3	3	436525	436525	1309383	101.68 - 110.74	101.6815	106.2108	110.7402
4	4	436016	436016	1745399	110.74 - 118.54	110.7402	114.6401	118.54
5	5	436769	436769	2182168	118.54 - 126.83	118.54	122.6853	126.8306
6	6	436059	436059	2618227	126.83 - 134.72	126.8306	130.7747	134.7188
7	7	436105	436105	3054332	134.72 - 140.83	134.7188	137.7744	140.8301
8	8	437249	437249	3491581	140.83 - 146.7	140.8301	143.7653	146.7005
9	9	436004	436004	3927585	146.7 - 153.74	146.7005	150.221	153.7414
10	10	437028	437028	4364613	153.74 - 214.12	153.7414	183.9304	214.1194

Figure 4-38. The "COUNT" column: number of grid cells in each data class.

The important column to view is the "COUNT" column. The "COUNT" column lists the number of point objects falling in each data class. The 'pc3304sub' point cloud layer contains 4,364,613 vertices. This means that each of the 10 data classes should contain about 436,461 vertices. I can see that the frequencies are close.

Actions Only for Grid Layers
This next section is a discussion of features and functions only available for grid layers. There are three: Save As Image..., Copy to Clipboard, and Scatterplot.

Save As Image…
This option saves a grid layer as an image file. There are six image formats supported:

Windows or OS/2 Bitmap (*.bmp)
JPEG - JFIF Compliant (*.jpg)
Tagged Image File Format (*.tif)
Portable Network Graphics (*.png)
CompuServe Graphics Interchange (*.gif)
ZSoft Paingbrush (*.pcx)

The default is Portable Network Graphics (*.png).

A number of graphic and word processing programs accept an insert of an image file or display an image file.

I choose this command by moving the mouse pointer over a grid layer name in the Data tab area of the Manager window and press the right mouse button. I click on the "Save As Image..." option and the dialog window in Figure 4-39 displays.

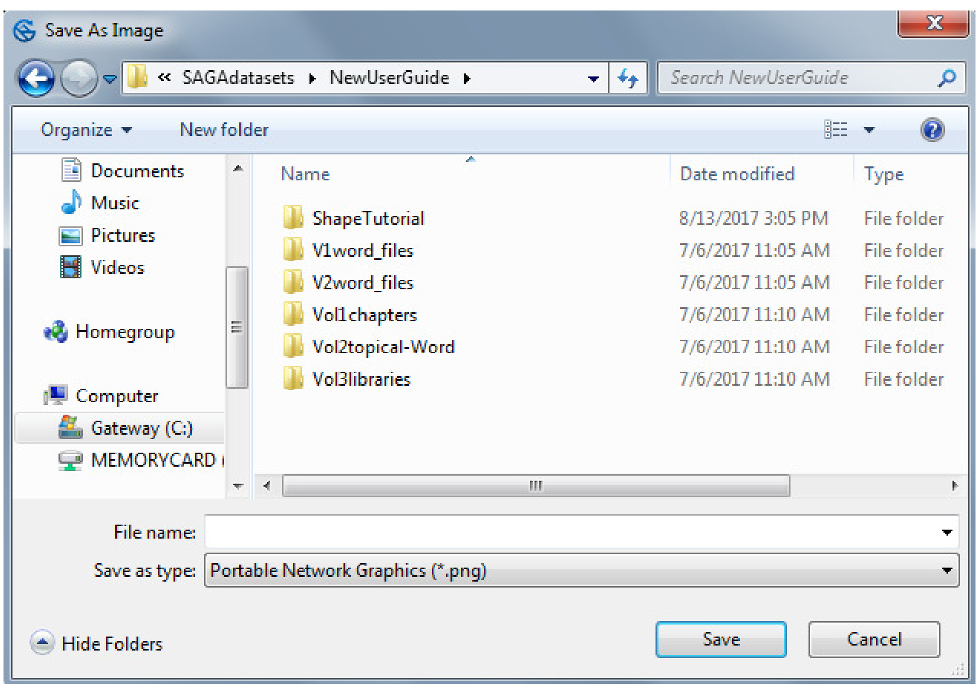


Figure 4-39. The dialog window for the grid layer "Save As Image…" option.

I can see that this window is very similar to the 'Save Grid' window in Figure 4-16. I can navigate to the location I want to save the image file and enter a name for the file in the "File name:" data field.

The "Save as type:" data field is where I choose one of the six image file formats supported. If I click on the small triangle at the far right in the data field, a list of format choices displays.

Upon browsing to where I want the image saved, identifying the image format for saving, and entering a name for the image file, when I click on the Save button, the 'Save Grid as Image...' dialog window in Figure 4-40 displays.

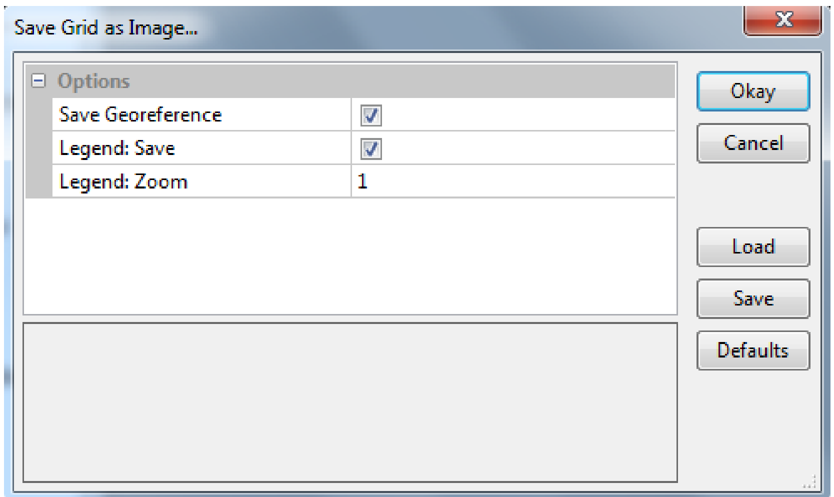


Figure 4-40. The 'Save Grid as Image…' dialog window.

The first parameter is 'Save Georeference'. The default is for the toggle check box in the value field to the right of the parameter name to contain a check mark. When the box is checked, the georeferencing for the layer, i.e., upper left corner coordinates, rotation and cell size, will be stored in a file. The format for this file conforms to the ESRI world file. The file extension for the file varies depending on the image format chosen. For example, if I choose the .jpg image format the world file format used is .jgw and if I choose the .bmp image format the world file format used is .bpw and so on. This file can provide georeferencing information for importing the image to another GIS application. If the box is un-checked, the georeferencing data for the layer is not stored.

The second parameter is Legend: Save. Again, the default is for the toggle check box in the value field to be checked. If the box contains a check, an image of the layer legend saves in an image file. I can toggle the check box to off by moving the mouse pointer into the check box and pressing the left mouse button. The check mark disappears. Now the image saves without a legend saving.

The third parameter is Legend: Zoom. This is a zoom magnification factor for the legend. The default magnification is 1.

Figure 4-41 displays an example of grid layer and legend images created using the "JPEG – JFIF Compliant (*.jpg)" option. The grid layer is the digital elevation model (DEM) for Mason County, Washington. The images in Figure 4-41 were inserted as picture files into my word processing program.

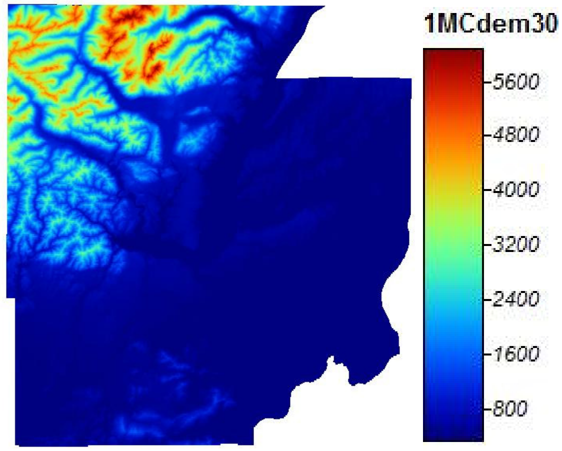


Figure 4-41. Images saved using the grid layer "Save As Image…" option.

Figure 4-42 displays an example of a ".jgw" file. This format is identical to the Environmental Systems Research Institute (ESRI) ".world" file format.

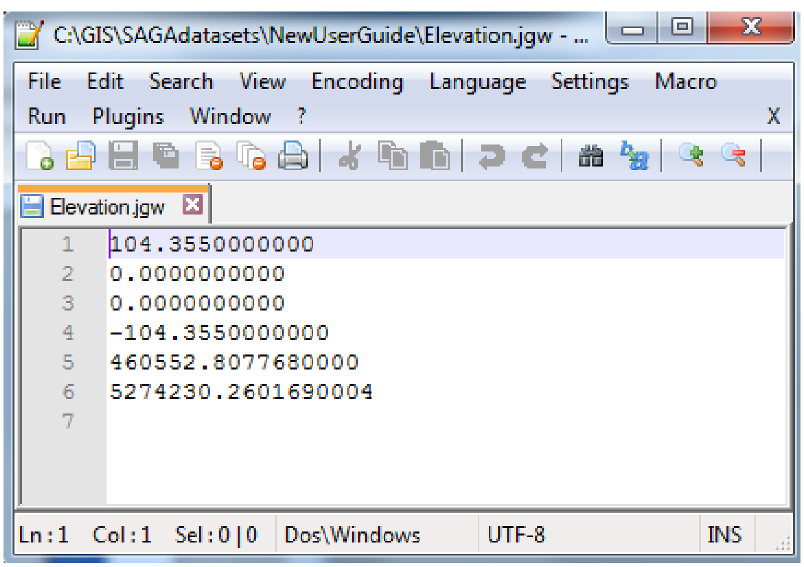


Figure 4-42. The georeference file (.jgw) content.

According to Wikipedia, a world file is a six line plain text "sidecar" file used by GIS programs to georeference raster map images. The file consists of six coefficients of an affine transformation that describes the cell size, the upper left corner coordinates, scale, and rotation of a grid map.

Copy to Clipboard
I choose this option by moving the mouse pointer over a grid layer name in the Data tab area of the Manager window and pressing the right mouse button. I choose the "Copy to Clipboard" command on the popup list of options by clicking the mouse on it. A graphic of the data layer is copied to the desktop clipboard.

The image on the clipboard can be pasted to any program on my desktop that supports the system clipboard.

Scatterplot
The Scatterplot Menu options and support parameters are described in Chapter 7. The scatter plot is described in this chapter in its role as a command or feature. There is overlap of information between these two chapters.

The "Scatterplot" command is available for grid and shape layers. The command does not appear to be operational for shape layers in SAGA Version 5.0 but it is working in SAGA Version 6.0. A scatter plot displays the correlation, graphically, between two variables. In this case, the variables are grid data layers.

The grid layer "Scatterplot" command is executed by right-clicking on a grid layer name in the Data tab area and choosing the "Scatterplot" option from the popup list of options that displays. The data layer the command is executed from, is by default, one of the two input layers (i.e., variables) for this command. The default grid data layer is the X or dependent variable. The layer data values plot on the x-axis of the output scatter plot.

When I execute the "Scatterplot" command, a ‘Scatterplot’ parameters window displays. One of the purposes of this window is to choose the second input variable for the scatter plot. The data values of this second input are plotted on the y-axis of the scatter plot and serve as the independent variable. The second input may be either a grid or a point shape data layer. The ‘Scatterplot’ parameters window displays in Figure 4-43.

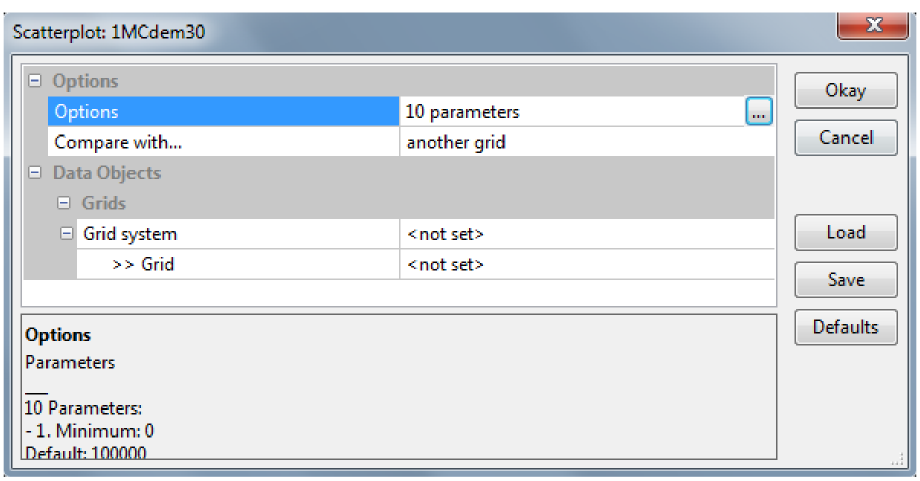


Figure 4-43. The ‘Scatterplot: MCdem30’ parameter settings window.

The window title bar includes the name of the grid layer serving as the default dependent variable, i.e., the grid layer the command was executed on. In this example, I can see that the ‘1MCdem30’ grid layer lists in the window title bar. This is a digital elevation model (DEM). The second input for the scatter plot can be another grid layer or it can be a point shape layer.

The "Options" section has two option parameters. One of these is ‘Compare with…’. This option has two choices, “another grid” or “points”. The default is "another grid". This choice identifies the type of layer for the second input. Thus, if the second input is another grid layer, I choose "another grid" for the 'Compare with...' parameter and use the "Grids" portion of the 'Scatterplot' parameters window for choosing the grid layer. If the second input is a point shape layer I would choose "points" for the 'Compare with...' parameter. The "Grids" portion of the dialog window is replaced with the "Shapes" portion of the 'Scatterplot' parameters window for choosing the shape layer and a specific numeric attribute of the layer.

This example will develop a scatter plot graphing the behavior of the ‘1MCdem30’ grid layer versus the ‘1MCslopeDegrees’ grid layer. Intuitively, I think the scatter plot should show a high correlation between low slope angles and low elevation and between high slope angles and high elevation. The data values of the second input grid layer are average slope in degrees for each grid cell. I choose "another grid" for the 'Compare with...' parameter.

I choose the ‘Grid system’ parameter by clicking with the mouse pointer in the value field to the right of the ‘Grid system’ label. It is important that I choose the grid system that the input grid layer, ‘1MCslopeDegrees’, is a part.

Next, for the ‘>> Grid’ parameter, I click with the mouse pointer in the value field to the right of the ‘>> Grid’ label. A list of the grid layers available in the work session that are part of the chosen grid system displays. In this example, I choose the ‘1MCslopeDegrees’ grid layer name from the list of available layers.

A number of parameters that determine various display and method characteristics for the scatter plot are available using the value field to the right of the 'Options' parameter name. I move the mouse pointer into the value field over the ellipsis and press the left mouse button. The 'Options' parameters window in Figure 4-44 displays.

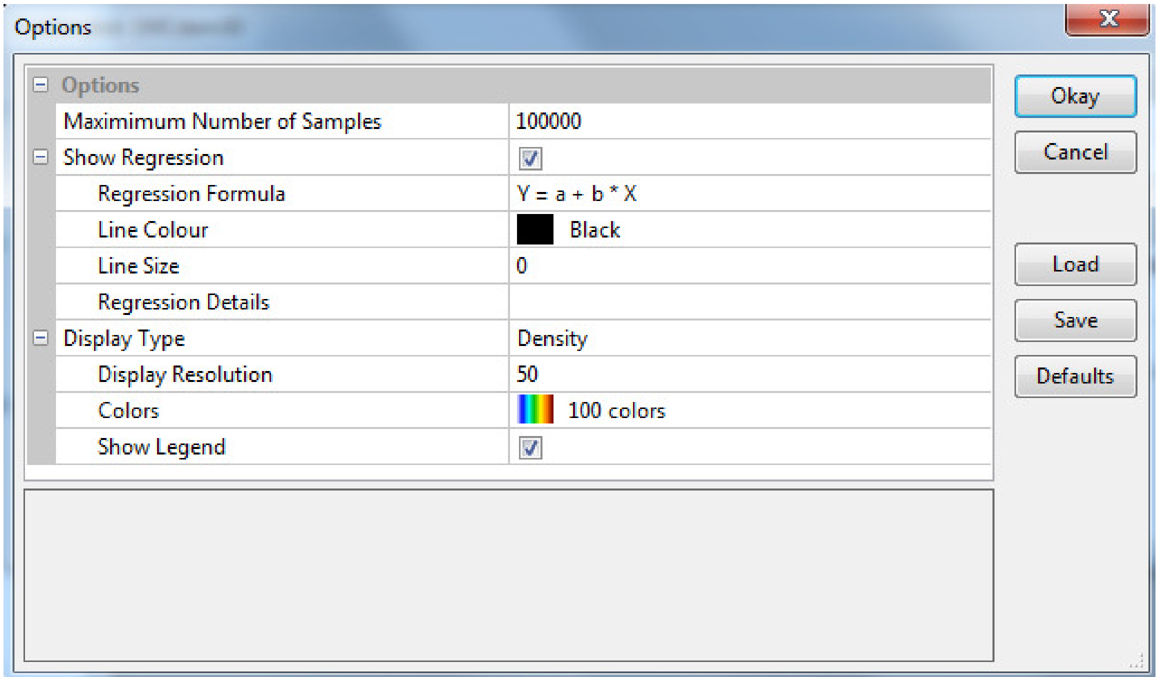


Figure 4-44. The scatter plot 'Options' parameters window.

The default for the 'Maximum Number of Samples' parameter is 100000. This is the most number of samples to be considered in the scatter plot. This does not mean that 100000 samples exist for the two input grid layers. I believe the theoretical maximum number of samples is the number of grid cells common between the two layers when none of the layer grid cell values contain the no data value. Using a smaller maximum number of samples could shorten the time to create a scatter plot.

The 'Show Regression' parameter is a toggle check box parameter. The default is for a check mark to appear in the box indicating the option is on. The scatter plot will display a regression formula for the relationship between the two data sources. The data values of the first input serve as the X or dependent variable and the data values of the second input as the Y or independent variable.

The 'Regression Formula' parameter has six options. I can choose the regression formula I think best represents the expected correlation between the two variables. I move the mouse pointer into the value field to the right of the 'Regression Formula' label and press the left mouse button. A dropdown list of the six options displays.

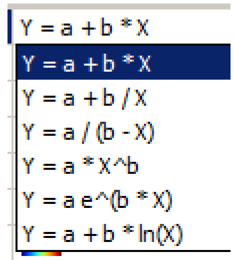


Figure 4-45. Linear Regression formulae options.

The default is "Y = a + b * X".

The 'Line Colour' parameter is used to select the color for the regression line displayed in the scatter plot. The default entry for 'Line Size' is 0. I can change this as needed.

The 'Regression Details' parameter is actually an information parameter. Until the function is executed, there will not be any details to view. The information displayed will be statistics describing the relationship between the two variables, the dependent and independent variables.

There are two options for the 'Display Type' parameter: Density and Points. Figure 4-46 displays a comparison of two scatter plots, the difference being using the "Density" option on the left and the "Points" option on the right. There is not a legend display for point density when the "Points" option is used. I can see that the difference is that individual points (coordinate pairs) are displayed with the "Points" option while color is used to display density of points with the "Density" option. The legend to the right for the "Density" display type is for point density.

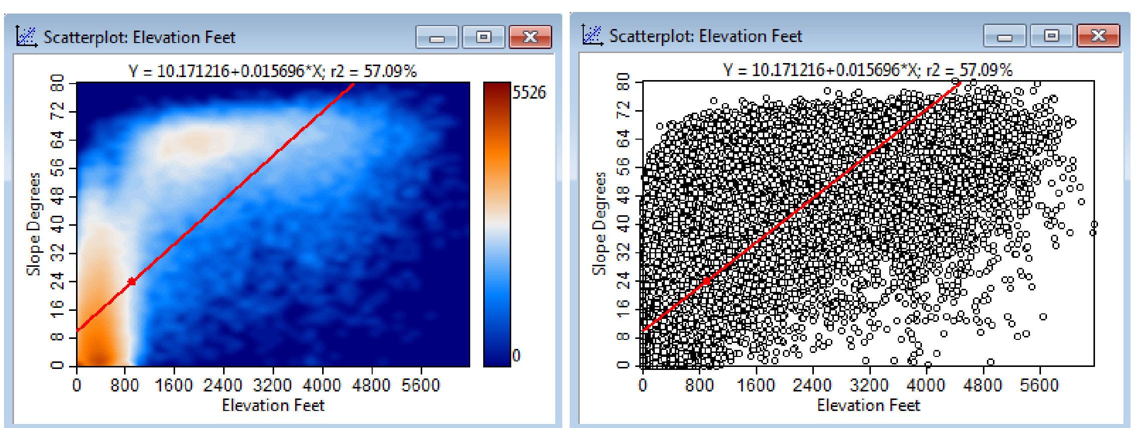


Figure 4-46. Comparing the "Density" and "Points" options.

Figure 4-47 displays two density scatter plots using the same parameter entries except the one on the left uses 20 for the 'Display Resolution' parameter and the one on the right uses 40 for the same parameter.

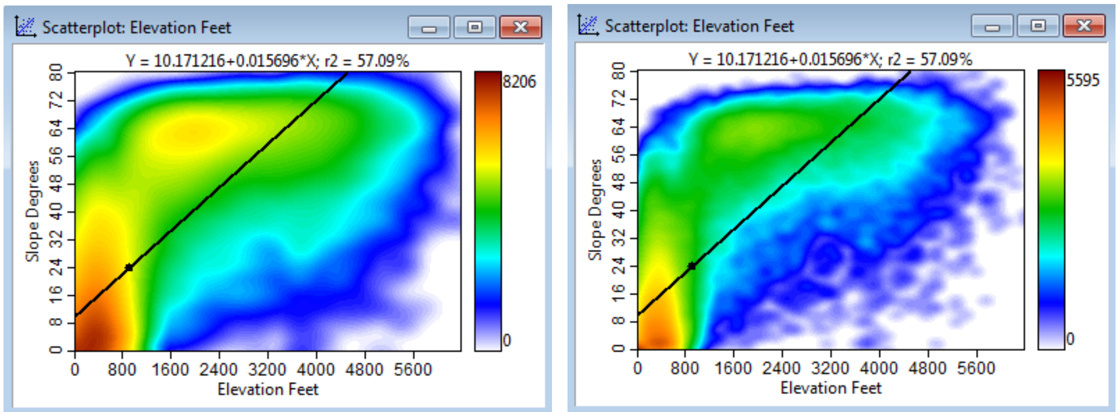


Figure 4-47. Comparing the 'Display Resolution' parameter entries 20 and 40.

The entry for 'Display Resolution' is in dots per inch. The lower the number the lower the resolution. The higher the number the more detailed the diagram information.

The 'Colors' parameter is where I can select a color palette. This option uses the 'Color' dialog window described elsewhere in this Guide.

The 'Show Legend' parameter is a toggle check box parameter. It works with scatter plots of the "Density" type. When I move my mouse pointer into the toggle check box and press the right mouse button the status will toggle to off, and the check mark disappears.

I click on the Okay button and return to the 'Scatterplot: 1MCdem30' parameters window. Any changes made to the parameters take affect when I click on the Okay button.

This same 'Options' window is available from the Scatterplot menu on the Menu Bar. When a scatter plot is the active window in the work area, the Scatterplot menu appears on the Menu Bar. The 'Options' window is found using the "Properties" choice on the Scatterplot menu dropdown.

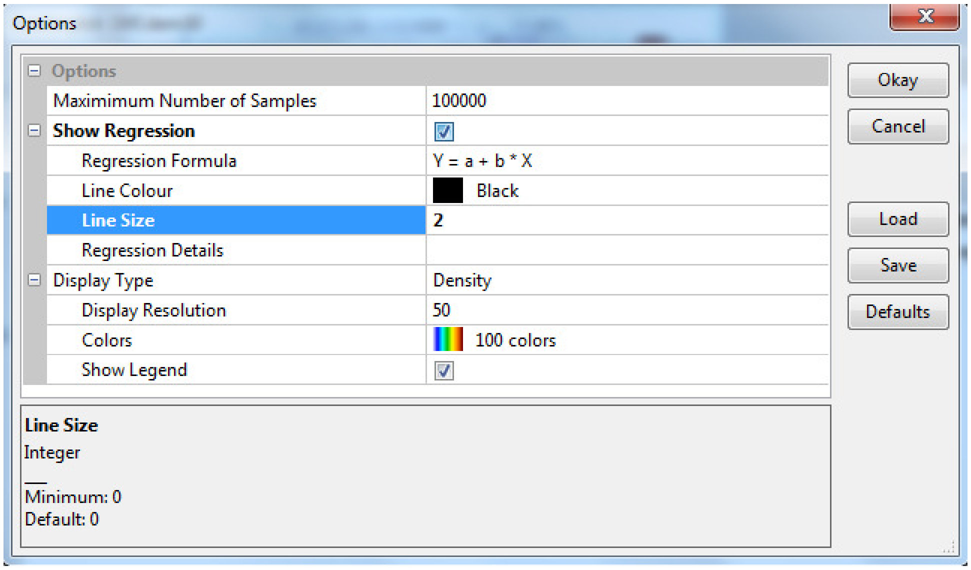


Figure 4-48. The 'Options' parameters used for the example scatter plot.

The 'Options' parameter settings (Figure 4-48) and the 'Scatterplot: 1MCdem30' parameter window (Figure 4-49) are used to create the scatter plot in Figure 4-50.

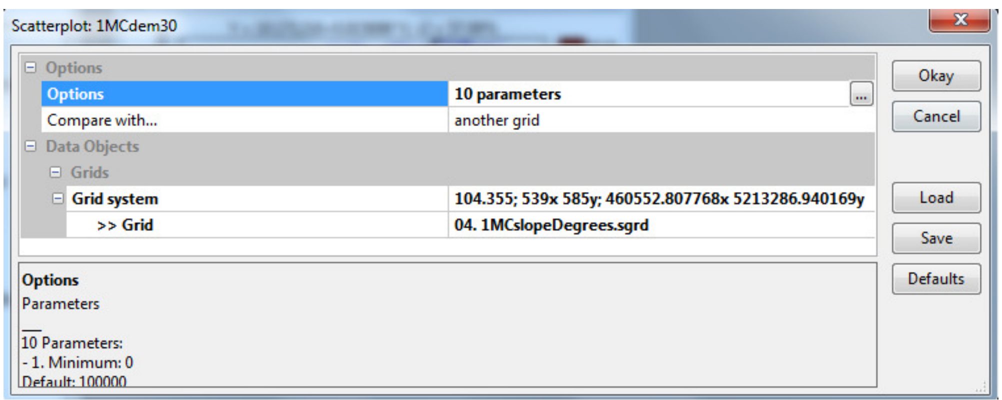


Figure 4-49. The 'Scatterplot: 1MCdem30' parameter settings window using the '1MCslopeDegrees' grid layer.

The scatter plot window displays the linear regression formula for the relationship between the two variables. The R^2 or coefficient of determination calculation displays above the graph area following the regression formula.

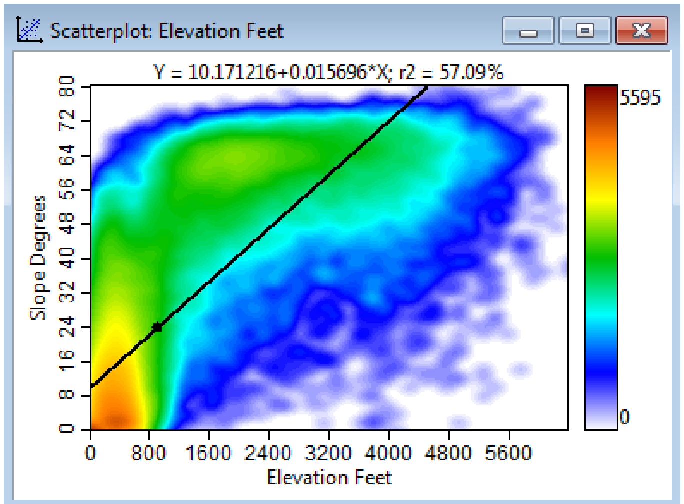
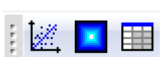


Figure 4-50. The '1MCdem30' versus '1MCslopeDegrees' scatter plot.

Default labels are used for the x- and y-axes of the scatter plot in a scatter plot view window. These labels are the entries used for the 'Name' parameter in the Settings tab area of the Object Properties window for the input variable layers. You may have noticed that I edited the entry for the two input grid layers I used in the scatter plot examples. I entered "Elevation Feet" for the 'Name' parameter for the '1MCdem30' layer and "Slope Degrees" for the '1MCslopedegrees' layer.

When the scatter plot view window displays, the Scatterplot menu is added to the Menu Bar. When I click on the new menu, the dropdown list of options lists Properties, Update Data and Convert To Table. In addition, several new icons appear on the toolbar:



These icons correspond to the options Properties, Update Data, Convert To Table on the dropdown menu.

The 'Scatterplot: 1MCdem' dialog window displayed in Figure 4-49 displays when I click on the "Properties" option in the Scatterplot Menu Bar menu. I can look at the 'Options' parameters and edit the parameters if desired. Most of these parameters were discussed earlier. The only one we did not look at was 'Regression Details' as a scatter plot example did not yet exist. Now that I have created a scatter plot, I can look at the detail available for this information parameter. Figure 4-51 displays the content of the 'Regression Detail' information parameter.

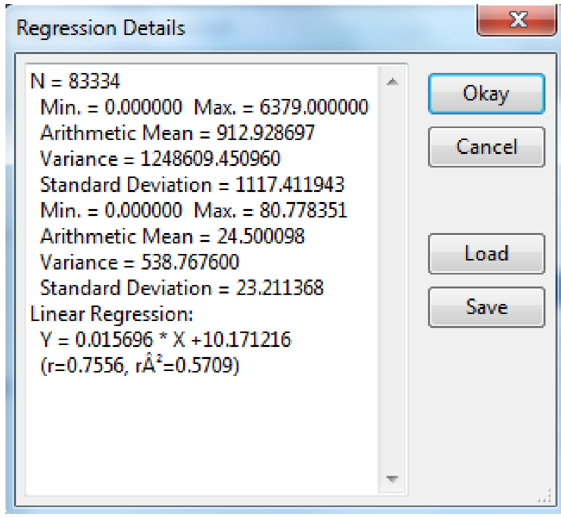


Figure 4-51. An example of 'Regression Detail' information.

Actions Only for Shape Layers
There are two categories of options available for shape layers and not available for other layer types. One category is for "Attributes". The options for this category are Show, Diagram, Scatterplot, and Save Attributes As. The "Scatterplot" option is available but it is not operational. The second category is "Edit". These edit options support the creation of new shape objects and the edit of existing objects. SAGA edit options make it easy to manage the spatial definition of shape objects.

Attribute: Show
This function is available in the Data tab area of the Manager window. I move the mouse pointer over a shape layer name and press the right mouse button. I move the mouse pointer down over the black triangle to the right of the "Attributes" option on the dropdown list of options. I click on the "Show" option on the new dropdown list of options. The attribute table for the shape layer I clicked the mouse pointer on displays in the work area in a table view window.

The Attributes: Show option allows me to view a shape layer attribute table directly from the layer name rather than using the "Load Table" option to load the attribute table from its' storage location.

Attribute: Diagram
This function is available in the Data tab area of the Manager window. I move the mouse pointer over a shape layer name ('1MCschoolDist2') and press the right mouse button. I move the mouse pointer down over the black triangle to the right of the "Attributes" option on the dropdown list of options. I click on the "Diagram" option on the new dropdown list of options. The 'Properties' window in Figure 4-52 displays.

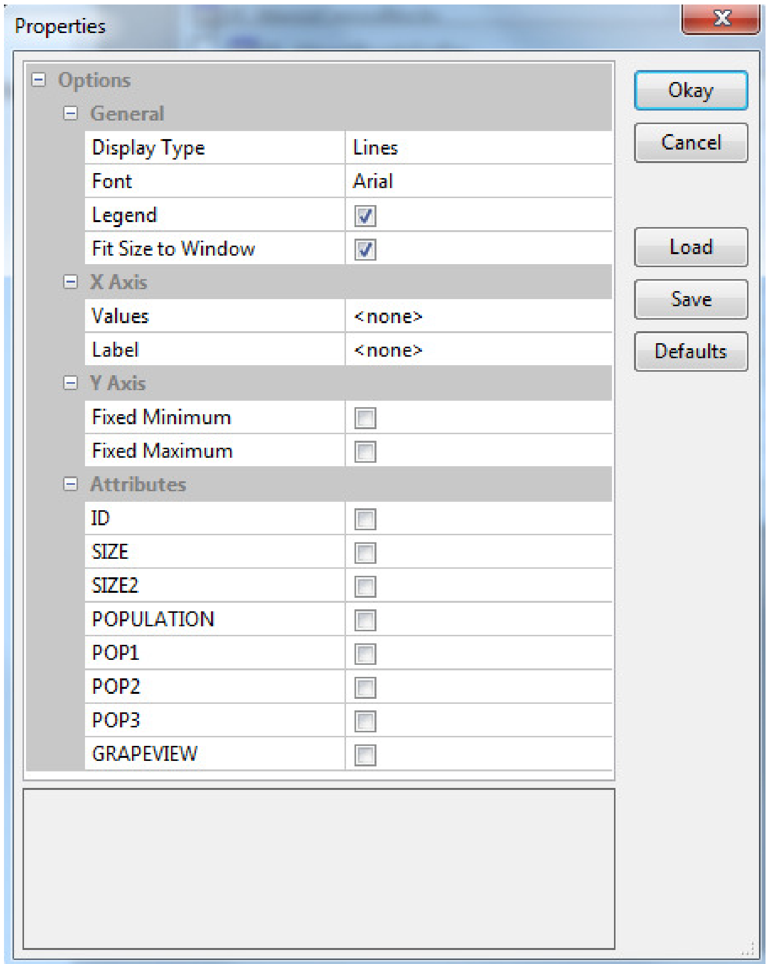


Figure 4-52. The Diagram 'Properties' window.

In this case, the "Diagram" option is chosen for the ‘1MCschoolDist2’ polygon shape layer.

The attribute table linked to the ‘1MCschoolDist2’ polygon shape layer has eleven attributes describing the layers' polygon objects. Eight of the attributes are numeric. The eight attributes containing numeric data values are listed in the "Attributes" section in the diagram ‘Properties’ window in Figure 4-52. A toggle check box appears in the value field to the right of the attribute names. I can choose to plot an attribute's data values in the diagram by clicking in the corresponding toggle box. A check mark appears in the box when the attribute is in chosen status.

Just below each of the chosen attributes, a color parameter for the attribute plot line appears. I can click on the color swatch to view a list of colors. If I want to chose a different color I use the mouse to click on the color swatch I want to use.

The remaining sections in the ‘Property’ window deal with how the diagram appears. The options are easy to explore on your own.

Here is an example using the ‘1MCschoolDist2’ polygon shape layer.

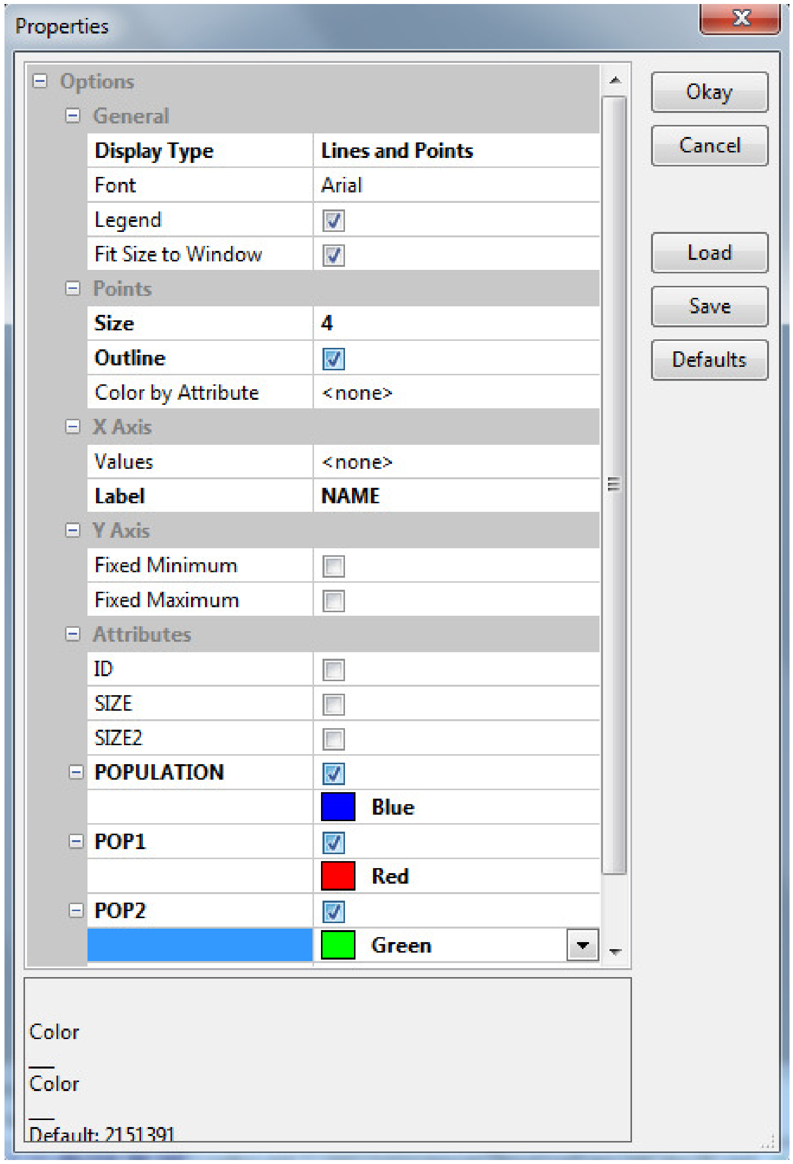


Figure 4-53. ‘Properties’ settings for the ‘MCschoolDist’ diagram example.

Three of the numeric attributes are chosen to plot in the diagram. These are: POPULATION, POP1, and POP2. The plot colors chosen are blue, red, and lime green. The “Lines and Points” option is chosen for the ‘Display Type’ parameter. The other choices for ‘Display Type’ are Bars, Lines, and Points. The ‘Size’ parameter for points was increased to 4.

The eight polygon objects making up the ‘MCschoolDist2’ layer represent the eight school districts in Mason County. The "NAME" attribute is chosen to provide labels on the x-axis of the diagram. The diagram output from these properties displays in Figure 4-54.

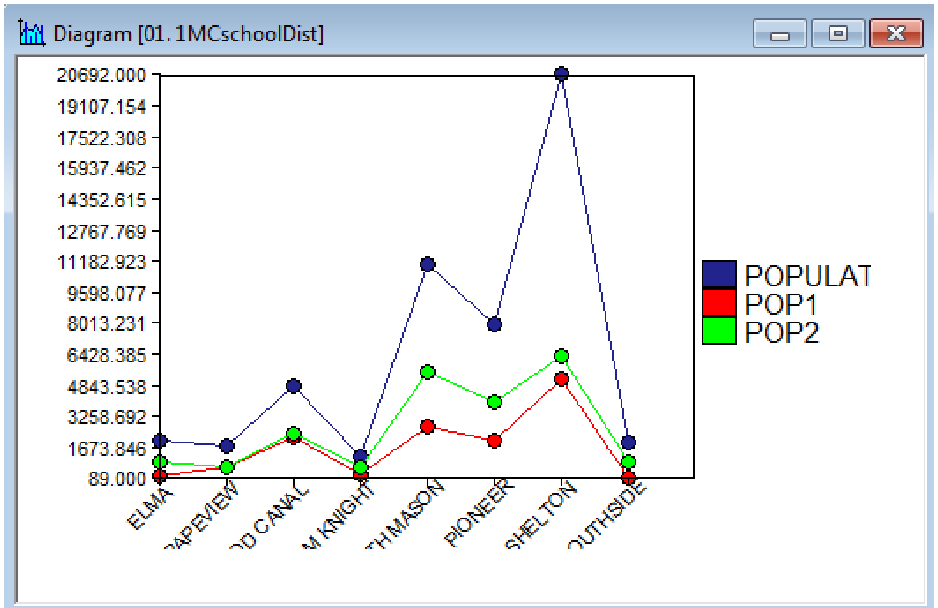


Figure 4-54. A diagram view window for school district population.

When the "Diagram" option is chosen, the Diagram menu appears on the Menu Bar. When I click on it, the dropdown in Figure 4-55 appears.

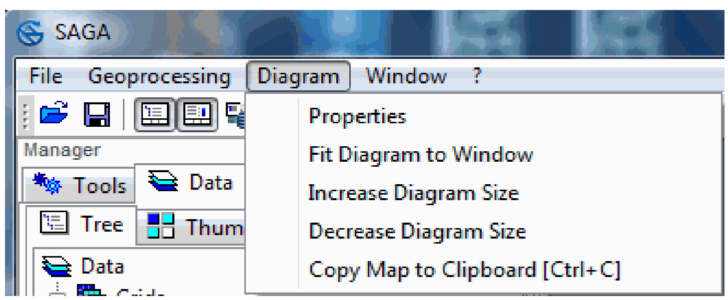
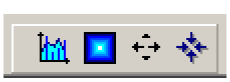


Figure 4-55. The Menu Bar Diagram dropdown menu.

In addition, four of the five options on the dropdown menu appear on the toolbar:



The "Copy Map to Clipboard [Ctrl+C]" option is only available from the Menu Bar.

Attribute: Scatterplot
This option is not operational and causes the SAGA program to crash.

Attribute: Save Attributes as...
There may be reasons to save an attribute table independent of its role as a linked attribute table to a shape layer. For example, I might want to analyze numeric attributes

of an attribute table using a spreadsheet program outside of SAGA. An attribute table containing an unusually large number of attributes might be better managed splitting it into a set of smaller tables each with a smaller numbers of attributes. Or, a copy of the attribute table may serve a role in associating attributes or column data between two tables. Whatever the reason, this command is used to save an attribute table using the same or different name, in a different format, and/or in a different storage location.

I am going to save a copy of the attribute table linked to the '1MasonParcelsVal' polygon shape layer so it can be prepared for a spreadsheet analysis of land parcel assessed values.

I move the mouse pointer over the shape layer name '1MasonParcelsVal' in the Data tab area and press the left mouse button. This highlights the layer name. I press the right mouse button and a dropdown list of available options displays. I move the mouse pointer down over the black triangle to the right of the "Attributes" option on the dropdown list of options. I click on the "Save Attributes as..." option on the new dropdown list of options. The 'Save Table' dialog window displays in the work area (Figure 4-56).

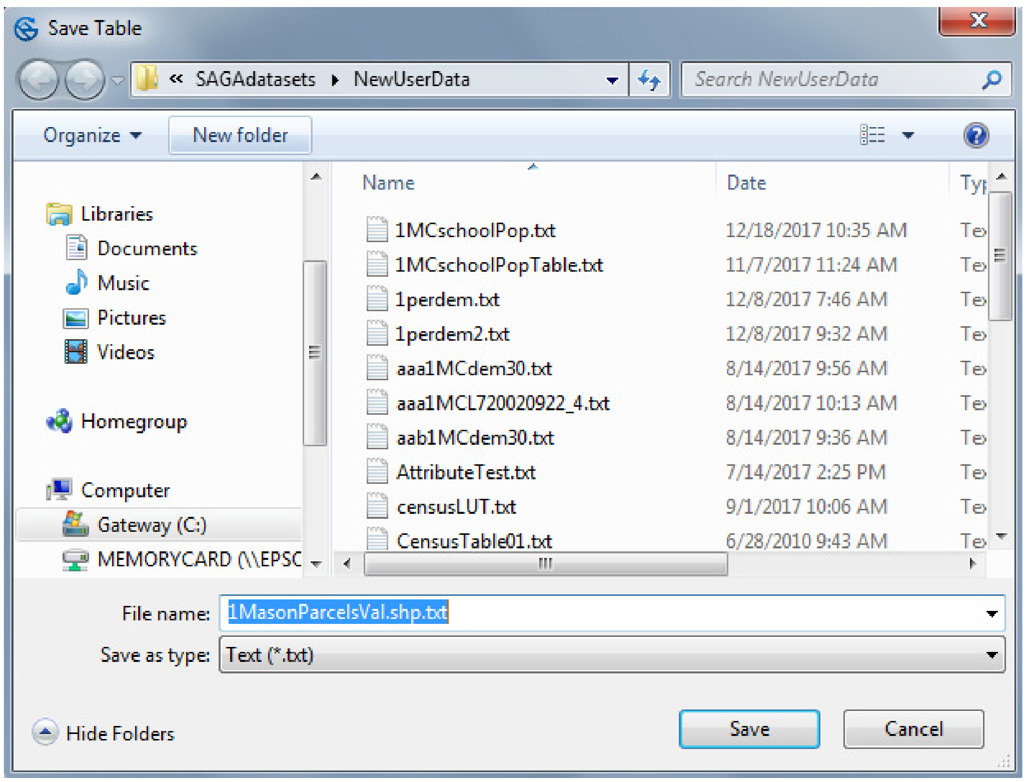


Figure 4-56. The 'Save Table' dialog window.

This dialog window works in a similar manner to other "Save" dialog windows we have discussed. The "Save as type:" data field supports three table formats: Text (*.txt), Comma Separated Values (*.csv), and DBase (*.dbf). The default is "Text (*.txt)". The "Comma Separated Values (*.csv)" option is a variation of the text format. The .dbf format is the format generally used for storing attribute tables linked to shape layers. I can use the operating system functions to navigate to a different storage location and enter a different file name in the "File Name:" data field.

I want to make sure that I don't use the same name or if I use the same name I save in a different storage location than the one for the shape layer the table is linked. I do not want to create a conflict between shape layer objects and the linked attribute table.

Map Edit Options for Shape Layers

This section of the chapter explores the shape layer "Edit" options. Referring to these options as "Edit" features is a little misleading. These options support what is called heads-up screen or on-screen digitizing to create new shape objects as well as to edit existing shape objects.

It is convenient for explanation to view the on-screen digitizing process as supporting four general on-screen digitizing situations.

A first situation is the set of options available for a layer when no object is in selection status. The edit options available are minimal with only two of five not grayed out. The grayed out options cannot be selected. I will refer to this mode as "Edit Options Available When No Objects Are Selected".

A second situation is the set of options available when one or more objects of a shape layer are in selection status. This means that, possibly from using the Action tool on the toolbar, one or more objects of a shape layer have been selected and are highlighted with the color specified for the Selection: Color parameter in the Settings tab area of the Object Properties window for the shape layer. This situation I will call "Edit Options Available for Objects in Selection Status".

A third situation is the set of edit options available if an object has been selected and is actively being edited. In this case, the geometry of a selected object is being edited. In the case of point objects, a single point represents a point object. It can be deleted, it's location can be changed, or a new point can be created. A vertex of a line or polygon object definition, can be deleted, added to, or moved. This situation I will call "Edit Options Available for Objects in Edit Status ".

A fourth situation is when a new object is being added to an existing shape layer or new objects are being added to a brand new shape layer. This mode I call "Adding a Shape Edit Options".

These four situations are all facets of on-screen digitizing. During the on-screen digitizing process, the Action tool of the toolbar is used to select shape layer objects, to move the location of object vertices, to create new vertices for an object, and to create new objects.

A point object is a simple single vertex. The Action tool cursor is moved to where a point location is to be defined and the left mouse button pressed. The single point is located.

A line object has a beginning and ending vertex. A straight line connects the two vertices defining a line object or a line segment or edge of a line object. Changes to the angle of the line object are defined by vertices. Thus, a line object is made up of a series of vertices defining edges or line segments of the line object.

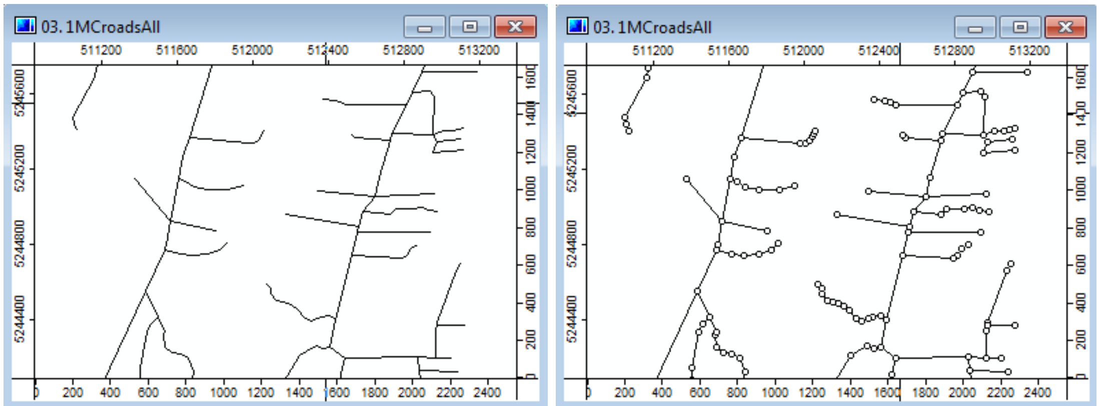
In its' simplest view, a polygon object is a line object (enclosing an area) where the beginning and ending vertices coincide. As with a line object, a series of vertices define connecting edges for the polygon object boundary.

On-screen digitizing in SAGA enables a feature called "snap to ...". An important aspect of using the Action tool to digitize vertices for an object is the ability to have a new vertex coincide with or snap to an existing point, line or polygon object of the current layer or of a different layer when it falls within a specified distance criterion.

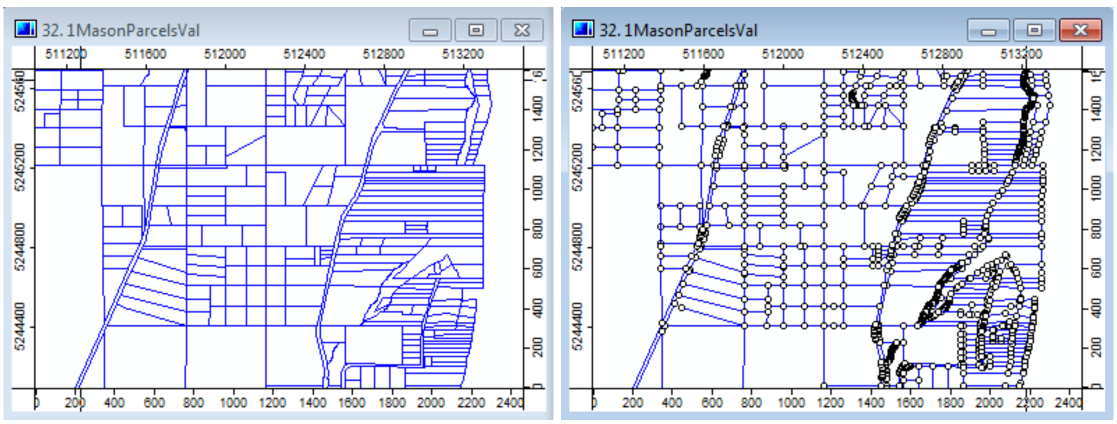
The way SAGA supports the capability to snap a point object to existing line and polygon objects is different from how SAGA supports snapping a line vertex or polygon vertex to existing line and polygon objects.

Briefly, a vertex being digitized as a point object can be snapped to an existing point object, a line vertex, or a polygon vertex but not to a line or edge connecting line and polygon vertices. However, a vertex being digitized as part of a line or polygon object can be snapped to any vertex or edge that is part of a line or polygon object.

What does this mean? Figure 4-57 compares two views of the line shape layer '1MCroadsAll' and the polygon shape layer '1MasonParcelsVal'. The map view windows on the left in the figure display each of the layers. The map view windows on the right display the same layers with the 'Show Vertices' parameters for the two layers toggled to on status.



a. The '1MCroadsAll' line shape layer



b. The '1MasonParcelsVal' polygon shape layer

Figure 4-57. Comparing map view windows of the '1MCroadsAll' and '1MasonParcelsVal' layers.

A line or polygon object is defined by digitizing points locating straight lines or edges that form the object. These points become the vertices for the objects. Usually with line objects, the tendency is to digitize a point at the beginning and ending of a straight line segment or edge and digitize many points along a curving line segment or edge. Clearly this is illustrated in the top two map view windows. I can see that in general a road that is a straight line has two points; a beginning point or vertex and an ending point or vertex. I can see that when a road is curved rather than having two vertices, it will have multiple points compared to a straight line road of the same length.

The lower two map view windows display polygon objects representing land parcels. Again, the tendency is to digitize straight lines of a polygon object with beginning and ending vertices. If the property boundary is a curved line multiple vertices define the curvature of the line. A rectangular shaped parcel, formed by only straight lines has four vertices. A parcel corner of an adjoining smaller parcel probably requires a midpoint vertex to be defined for its' larger neighbor. The longer straight line boundary of the larger parcel uses 3 vertices rather than 2.

Locating a point object is digitizing a single point. The snap capability supports snapping the point location (if within a specified snap distance) to any line or polygon vertex but not to the straight lines or edges connecting the vertices. Locating a point that becomes a vertex of a line or polygon object can be snapped to any vertex or any line or edge between two vertices of a line or polygon object either on the active layer or one chosen for the 'Snap to...' parameter.

Let's briefly look at how this snap process works in SAGA.

The purpose is to "snap" the location of a new point to a vertex or edge of an existing object of the current layer or of another layer available in the work session. For example, I am on-screen digitizing the location of a new road, a line object. I want the beginning point of the new road to fall on an existing road line object. I move my Action tool pointer to the area of the existing road I want the beginning point of the new road to be located. The pointer gets within a specified distance (the snap distance) of the existing road, I press the left mouse button, and my beginning point snaps to a location on the existing road that becomes the beginning point for the new road.

Two parameters in the Settings tab area of any shape layer support the snapping process. These are '>> Snap to...' and 'Snap Distance'. The entries for these parameters display in the Settings tab area of the Object Properties window of any shape layer. The entries can be changed in that window.

The '>> Snap to...' parameter is for identifying one or more shape layers whose objects or parts of objects will be the snap to objects. These layers can include the layer being edited. In the example above for adding a new road, the same layer contains the objects that a new road should snap to, i.e., existing road line objects. Another example is the edit of a commissioner administrative boundary. Part of the administrative boundary should coincide with a portion of the county boundary. In this instance, the selection for the '>> Snap to...' parameter is the county boundary polygon shape layer. As needed, points of the commissioner administrative boundary are selected, moved, and snapped to the county boundary polygon.

A layer is identified for the '>> Snap to...' parameter by moving the mouse pointer into the value field to the right of the parameter over the ellipsis and pressing the left mouse button. The 'Snap to...' window displays in the work area (See Figure 4-58).

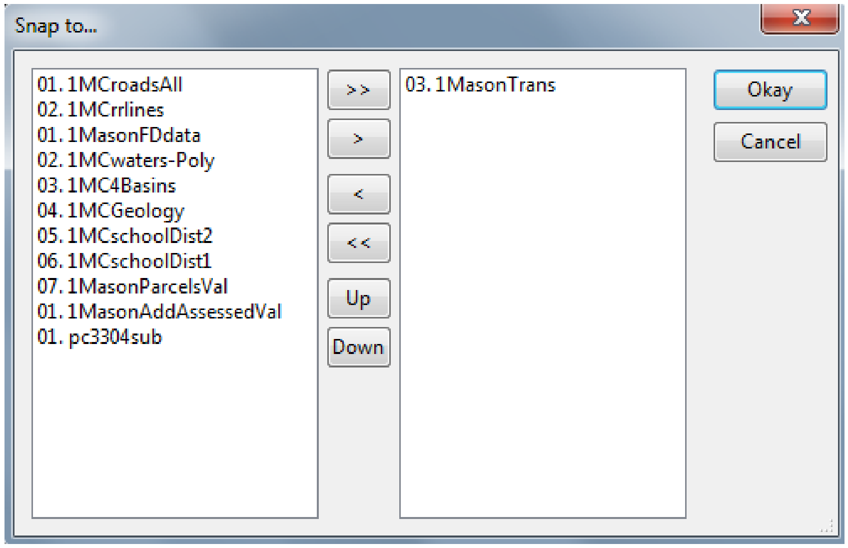


Figure 4-58. The 'Snap to...' window.

I move the mouse pointer over the shape layer in the list in the left panel that contains the objects I want to "snap to" related to the layer I am editing.

In this example, I am editing the road line shape layer '1MasonTrans' but I also want to snap to the line objects of the layer. Once the mouse pointer is over the layer I want to choose, I press the left mouse button and the layer name on the list becomes highlighted. I move the highlighted layer name to the right panel by clicking with the mouse on the 

button in the middle of the window. Then I click on the Okay button. This layer is now listed in the value field to the right of the 'Snap to...' parameter name. Notice that one or more shape layers can be chosen to serve this role. If a layer has been chosen for the 'Snap to...' parameter, this activates a graphic representation of the snap distance in the map view window.

The second parameter involved is 'Snap Distance'. The default entry is 10. This value represents screen units or pixels. A graphic display of the snap distance appears in the upper left corner of a map view window during an on-screen digitizing process.

I can use the snap capability as needed. It is easy to turn off and on. I might only have one situation where I have an object that I want to partially coincide with an object on another layer. After locating this particular object I don't want the snap capability to be active so I can move the 'Snap to...' layer from the right side panel to the left side panel (see Figure 4-58). Thus, there is not any layer identified for the snap capability.

Edit Options Available When No Objects Are Selected

An on-screen digitizing process is starting up using the '1MasonTrans' line shape layer. This is the road network for Mason County, Washington. I click on the Data tab in the Manager window, move the mouse pointer over the '1MasonTrans' layer name in the

"Shapes: Line" section of the data list. I double-click on the layer name and display the layer in a new map view window in the work area.

Using the "Zoom" option on the toolbar, I zoom in on the area of interest in the map view window. I click on the Action tool ( ) on the toolbar and move the mouse pointer into the map view window. The cursor converts to . I want to see a list of edit options available so I press the right mouse button. The popup list of options in Figure 4-59 displays.

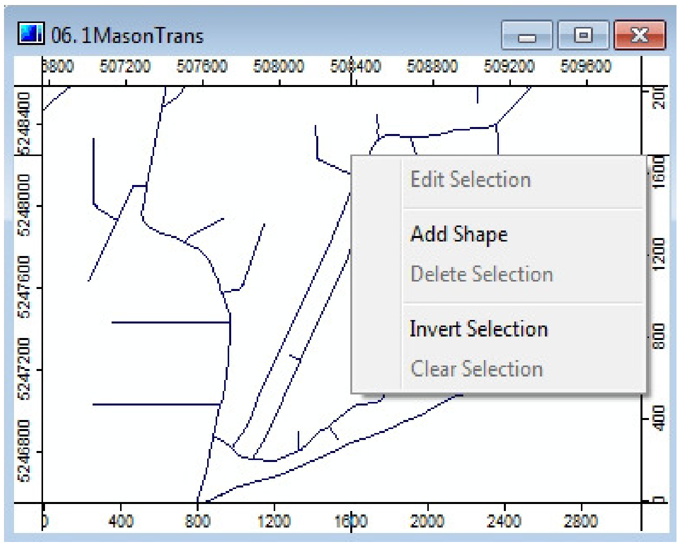


Figure 4-59. The popup list of edit options.

These are the options available when I start an on-screen digitizing process. The "Edit Selection", "Delete Selection", and "Clear Selection" options are not available, they are grayed out because I have not selected one or more objects of the layer. The two options available are "Add Shape" and "Invert Selection".

If my purpose is to add a new object or shape to the layer, I can choose the "Add Shape" option and proceed to digitize points for a new road or line object. The "Invert Selection" option is a little different. Since no object is selected, if I choose this option all objects become selected. The color for displaying the objects would change to the color specified for the Selection: Color parameter for the layer.

Edit Options Available for Objects in Selection Status

I display the Mason County road network layer '1MasonTrans' in a map view window in the work area. I choose the Action tool on the toolbar and move the Action tool pointer into the map view window. As noted above, when the tool pointer enters the map view window the pointer converts to . I am going to select a road object that is near the center of the map view window. I have checked to see what the color is for the Selection: Color parameter for the layer and it is red. When I select the road or line object of interest it will turn from blue to red. I move the Action pointer to the left of the line object, depress the left mouse button, and drag it to the right crossing the line object and let up on the left mouse button. The result is that the line object is selected and displays in red.

I want to see which edit options are available so I press the right mouse button and a popup list of edit options displays (Figure 4-60).

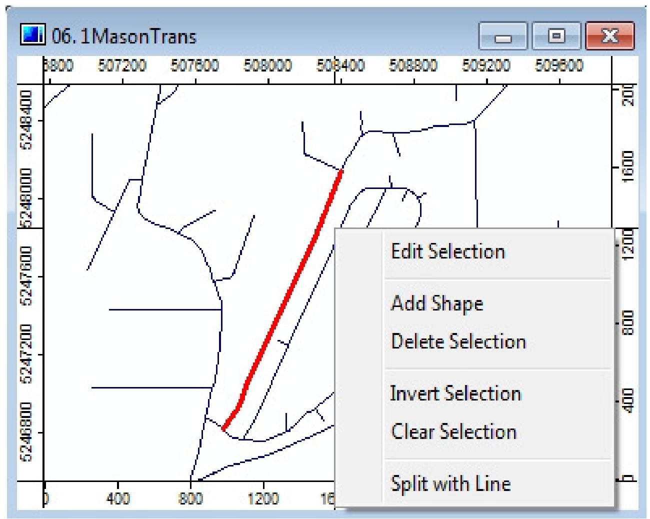


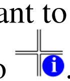
Figure 4-60. A popup list of available edit options for a selected object.

The top two options initiate different processes. The "Edit Selection" process is described in the following section and the "Add Shape" option in the last section.

The "Delete Selection", "Invert Selection", "Clear Selection" and "Split with Line" options can be used with the selected line object. I can see that the line object near the center of the map view window is selected as it displays in the selection color red.

I would choose the "Delete Selection" option if I want to delete the line object. The deletion would be temporary unless I specifically save the layer before exiting from the work session. A "save" makes it a permanent deletion. The "Clear Selection" option clears any current selections, i.e., it is de-selects any selected objects.

I introduced the "Invert Selection" in the previous section. In this case, I have a single line object selected. If I choose the "Invert Selection" option, all objects not selected become selected and any selected objects go into non-selected status.

The "Split with Line" option is a way to split a line object into two or more new line objects. Here is how it works. I choose the Action tool on the toolbar and move the Action tool pointer into the map view window to the left of where I want to define two new line objects from a single one. The Action tool pointer converts to . I dpress the left mouse button, drag the pointer across the selected line at the point I want to split it, and press the left mouse button again. The place where the mouse pointer crossed the selected line object defines an end point for each of the two new line objects.

Edit Options Available for Objects in Edit Status

There are a number of edit options supporting the actual edit of a shape object. Let's start with the edit options displayed in Figure 4-60, and, more specifically I want to choose the first one in the list "Edit Selection". Remember I have selected a line object and it is displayed in red. Immediately after I select the "Edit Selection" option, the appearance of the selected line object changes. Figure 4-61 displays the updated map view window.

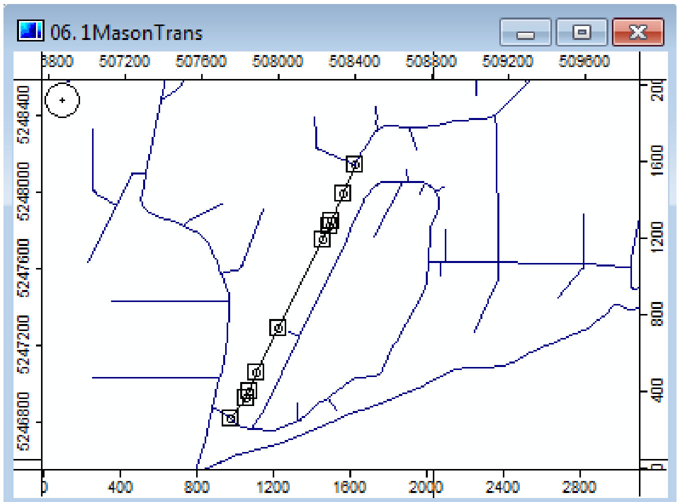


Figure 4-61. The "Edit Selection" updates the appearance of a selected line object.

The line color is no longer red. The individual vertices that define the line segments or edges making up the line object display as small circles with surrounding boxes. I notice that this display change is only for the line object that is in selection status.

Something else appears in the map view window that was not there previously. Look in the upper left hand corner and you see a circle with a dot at its center. The radius of this circle is the same as the entry for the 'Snap Distance' parameter discussed earlier.

In addition to these display differences there are also changes in the edit options. I move the Action tool pointer into the map view window and press the right mouse button. The popup list of edit options in Figure 4-62 displays.

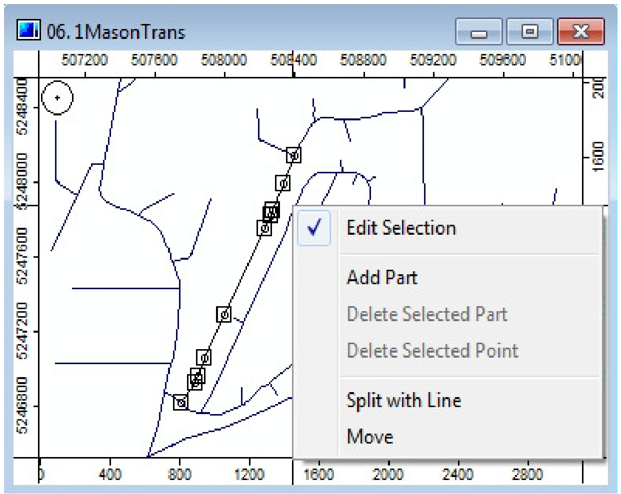


Figure 4-62. Edit options for a selected line object.

A check mark displays to the left of the "Edit Selection" option. There are five options. The "Add Part", "Split with Line", and "Move" options are available. The "Delete Selected Part" and "Delete Selected Point" options are grayed out because I have not selected a line object vertex. Once I select a line object vertex those two options become available.

The "Add Part" option is used when I want to add additional line to the existing line object. Additional line can either connect to the line object or not. Logically I would expect a road part to connect either to an end-point or to some other point along the existing object. I will add a part that connects to the middle of the object. I move the Action tool pointer about half way along the long line segment in the middle. As the pointer nears the line I press the left mouse button and define a vertex on the existing line. Next I define three vertices moving in a northerly direction.

I press the right mouse button when finished with the four vertices definition of a part. The popup list of edit options displays. I want to save this new part as part of the line object so I click on the "Edit Selection" option at the top of the list. The 'Edit Shapes' dialog window in Figure 4-63 displays.

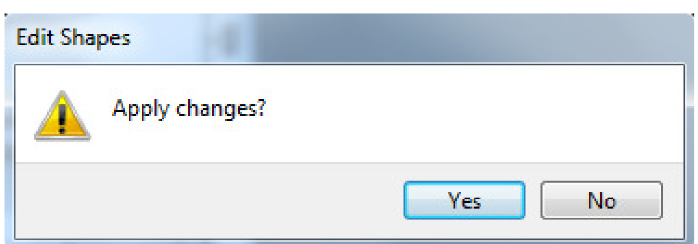
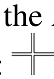


Figure 4-63. The 'Apply Changes' dialog window.

I click with the Action tool pointer on the Yes button and the new line part becomes a temporary part of the layer. It becomes a permanent part if I save the new version of the layer.

I discussed the "Split with Line" edit option earlier. I have not discussed the "Move" edit option. I will use Figure 4-62 to explain how this option works.

I make sure that the Action tool is selected. The "Move" option is used to move the line object a specific distance and direction. For example, I want to move the selected line in Figure 4-62 to a position halfway between its current location and the loop road to the west. I click on the "Move" option and move the Action tool pointer to a position on the line object. I depress the left mouse button and drag toward the line object to the west. As I move the pointer a line is drawn from the pointer location leaving a track. At the halfway mark I let go of the mouse button and the line object has been re-positioned. The line did not change its orientation or form, only its' location. I exit this edit option by pressing the right mouse button and choosing the "Edit Selection" option. Again, the 'Edit Shapes' dialog window displays with the question "Apply Changes?"

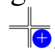
The two edit options grayed out in the popup list displayed in Figure 4-62 are available if I select a vertex using the Action tool pointer. Let's select a vertex. The Action tool pointer looks like this: . When I move the Action tool pointer within the bounding box of a line vertex, the tool pointer converts to . When I have positioned the tool pointer in the bounding box of a vertex I want to delete or move I press the left mouse button and the point becomes selected. Added to the bounding box is a red outline indicating the selection status of the vertex.

I press the right mouse button and the popup list of edit options displays. This time, since I have a point in selection status, the two options "Delete Selected Part" and "Delete Selected Point" are available.

Recall that I added a part to a line object. The vertex I just selected is the second vertex of the road part that I added. I can choose the "Delete Selected Part" and the road part I added is deleted. Selecting a point of a line object part is the same as selecting the entire part related to how the "Delete Selected Part" option works.

The "Delete Selected Point" option operates only on the single selected vertex. It will be deleted.

There are a couple edit options available that are not in the edit list. One can be applied to a selected vertex. I can drag a selected vertex to a new location. With the Action tool pointer positioned in the bounding box of the vertex I want to move, I depress the left mouse button, drag the vertex to a new location, and let up on the mouse button. Notice that the line segments connected to the two adjacent vertices stretch or contract as the vertex moves.

I can insert a new vertex into a line object. I move the Action tool pointer near a line segment (the line connecting two adjacent points). When the tool pointer gets near the line the pointer converts to . I press the left mouse button and a new vertex is defined on the line object.

I de-select a selected vertex by moving the Action tool pointer somewhere else in the map view window and press the left mouse button.

Adding a Shape Edit Options
The edit options supporting adding a new shape or object to a layer display in Figure 4-60. This is a relatively easy process.

I choose the "Add Shape" edit option. I can digitize a new object for the current shape layer.

Point objects are created one at a time. I create point objects by moving the Action tool pointer to the location I want to define a point object and press the left mouse button. I can move the pointer to a different location and press the left mouse button again if I am not okay with the first location. If I am okay with the location, I press the right mouse button twice. A small window displays the edit option "Edit Selection" with a check mark in front of it. I click on the window and the 'Edit Shapes' dialog window with the question "Apply changes?" appears. I can accept the new point object by clicking on the Yes button or reject it by clicking on the No button. A short-cut for saving a new object is to press the Enter key rather than press the right mouse button a second time when completing the digitizing of an object. This bypasses the "Edit Selection" step (a "Yes" is assumed).

A line object is defined by a series of vertices defining the line segments or edges that make up a line or line object. I move the Action tool pointer to the beginning location of the new line and press the left mouse button. I move it to the next location along the line for a second vertex. Normally I define vertices at the beginning and ending of straight line segments and define multiple vertices along a curving line segment. I notice as I move the Action pointer from digitizing a vertex that a straight line links two adjacent vertices. As I move the pointer from the most recent vertex, a line is drawn from the recent vertex to the mouse pointer as I move it to the next location for a vertex. When I reach the end vertex of the line object, I press the right mouse button. This stops the digitizing process. Pressing it a second time causes the popup list of edit options in Figure 4-62 to display.

I click on the "Edit Selection" option (it has a check mark displayed to its' left) and the dialog window with the question "Apply changes?" appears. I can accept the new line object by clicking on the Yes button or reject it by clicking on the No button.

A polygon object is like a line object having a beginning point at the same location as an ending point enclosing an area. I move the Action tool pointer to a starting vertex of a polygon. I click the left mouse button and a vertex defines the starting point. As I move the Action tool pointer to the next vertex along the polygon boundary a line is drawn from the first vertex to the pointer. When I am at the second place and I want to define a vertex I click the left mouse button. As I move from the second vertex a line is drawn from the first vertex to the mouse pointer. When I am at the third place and I want to define a vertex I click the left mouse button. As I move the mouse pointer around the area I can see where the boundary of the polygon is located. At the last point of the polygon boundary, after pressing the left mouse button to capture the last point, I press the right mouse button. The digitizing process stops. I press the right mouse button a second time and the popup list of edit options displays.

I click on the "Edit Selection" option (it has a check mark displayed to its' left) and the dialog window with the question "Apply changes?" appears. I can accept the new line object by clicking on the Yes button or reject it by clicking on the No button.

This is a quick summary of how to use the edit options to digitize point, line, and polygon objects and save the results.

There is another process that complements the capture of shape object definitions. This process relates to adding attributes for the new objects. Once I have displayed the map view window that includes the necessary shape layers to support defining new objects, regardless of the type of object, I make the Attributes tab active in the Object Properties window for the layer I am adding new objects or editing existing objects.

Immediately after defining a new object, I click on the Yes button in answer to the question "Apply changes?" The attributes for the new object are displayed in the Attributes tab area of the Object Properties window. The "ID" attribute has the value 0 entered. Any other attributes will have blank entries. I am able to enter numeric and text values, depending on the type of attribute, by clicking the mouse pointer in the attribute field, and keying in an entry. When I have finished making my entries, I click on the Apply key at the bottom of the window and the entries are saved. This is a temporary save and made permanent when I save the layer before exiting the SAGA work session.

Another strategy for adding attributes for shape objects is to use a unique label for a single attribute. These data values or unique labels would correspond to the data values for an attribute in an existing .dbf table. The *Table - Tools/Join Attributes from a Table (Shapes)* tool can be used to build the shape layer attribute table from the existing .dbf table. This process is described in Chapter 8.

The Donut Issue

This is not really an issue if the program supports the definition of a polygon that includes a fully surrounded area that is not part of the polygon definition.

The "Add Part" option is used to define an area of a polygon that fully lies within the polygon boundary that is not part of the larger polygons definition. A donut is an internal area of a polygon that does not belong to the polygon. An island in a lake is a good example where the lake is a water polygon. The island is a land area that is not part of the water area of the lake.

The map view window in Figure 4-64 displays a salt-water lagoon body of water.

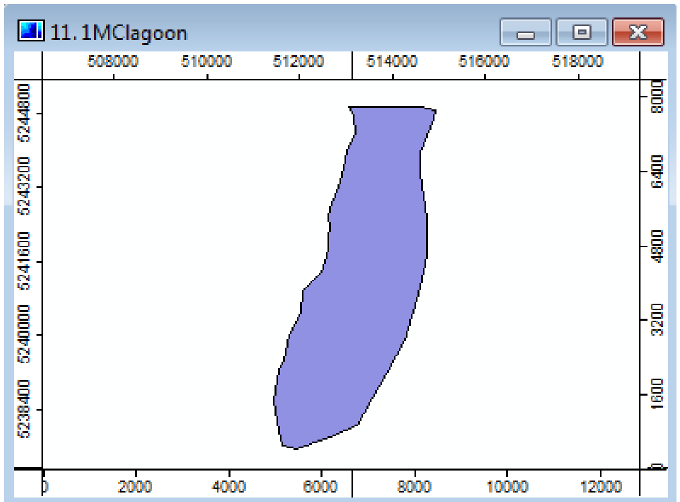


Figure 4-64. A salt-water lagoon body of water.

A polygon shape layer named '1MClagoon' exists. There is a single polygon object defining a salt-water lagoon body of water. However, within the lagoon exists two small islands just off the western shoreline. They are clearly visible on a satellite image. The land area of these two islands needs to be removed or subtracted from the lagoon object. This is done using the "Add Part" option described earlier.

First I display the '1MClagoon' layer in a map view window using the satellite image as a backdrop. I use the "Transparency" option for the 'Fill Style' parameter to display the '1MClagoon' layer. This allows for the satellite backdrop to be seen. The two islands are clearly visible on the satellite backdrop as is the salt-water lagoon.

I move the Action tool pointer into the map view window over the lagoon polygon and press the left mouse button. This chooses the polygon object. Then I press the right mouse button and choose the "Edit Selection" option on the popup list of options that displays. I press the right mouse button a second time and choose the "Add Part" option from the second popup list of options.

I proceed to on-screen digitize one of the two islands following the island outline on the satellite image. I press the right mouse button when I finish digitizing the island. I click with the mouse cursor on the "Edit Selection" option at the top of the popup menu. When asked if I want to save the changes I click on the Yes button.

I repeat these steps to on-screen digitize the second island. Figure 4-65 displays the results of adding these polygon object parts.

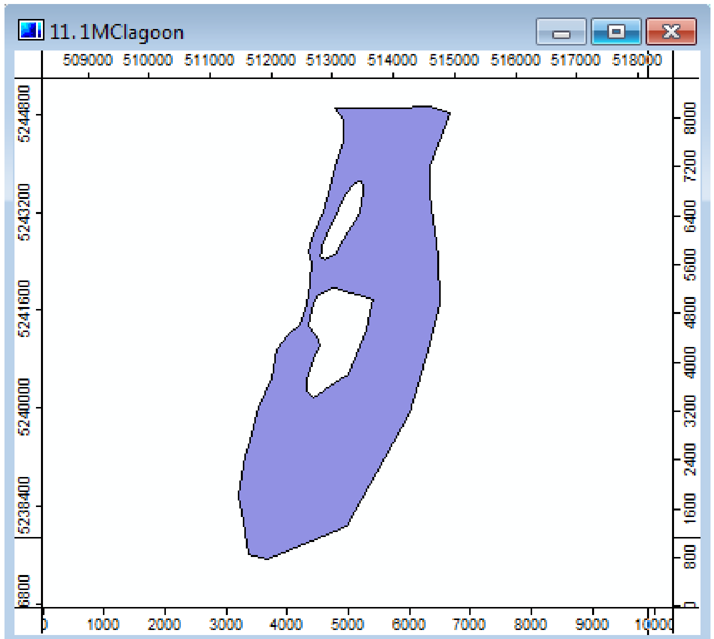


Figure 4-65. The salt water lagoon body of water less the two islands.

A Point Object Example
A new point shape layer named '1FireHydrants' has four attributes in the linked attribute table. The first attribute in the table is a default attribute named "ID". The second attribute is named "REF#". This entry identifies the fire hydrant according to a fire district code. The third attribute is for the address number ("ADDRESS#") of the parcel the hydrant is located. The fourth is the street name, "ADDRESS-STREET", of the hosting parcel.

It happens that fire hydrants for this hamlet are always located on a property line nearest a road. And, they are positioned on the approximate mid-point of the property boundary. The parcel boundaries are the polygon objects of the '1TICCparcels' polygon shape layer.

1. The first step is to display the '1TICCparcels' polygon shape layer in a map view window in the work area. This is the parcels layer.
2. Display the '1FireHydrants' layer in the same map view window as the '1TICCparcelswsp' layer. The '1FireHydrants' layer does not yet contain any point objects since it is a new layer. The map view window will not change when the layer is added.
3. The '1FireHydrants' layer should be the active, highlighted layer in the Data tab area of the Manager window.
4. Choose the "Zoom" option on the toolbar and zoom in on the parcel that is hosting the first fire hydrant location.
5. Select the Action tool on the toolbar by clicking on it with the mouse pointer.
6. Move the Action tool pointer into the map view window and press the right mouse button.
7. Choose the "Add Shape" option on the popup list of edit options.

8. Move the Action tool pointer to the location of the first fire hydrant. Press the left mouse button.
9. Press the right mouse button once to exit the digitizing process and press the right mouse button a second time. Click on the "Edit Selection" window that displays.
10. I want to save the new point so I click on the Yes button on the 'Edit Shapes' dialog window responding to the question "Apply changes?"
11. The blank attributes for the new point object display in the Attributes tab area of the Object Properties window for the layer. I enter "03001" for the attribute REF#, 220 for the attribute ADDRESS#, and "E. Treasure Island Dr" for the ADDRESS-STREET attribute. Then I click the Apply button at the bottom of the window for the new data be temporarily retained. The layer needs to be saved in order for new data and edits to be retained for future use.

Figure 4-66 displays the new fire hydrant location and its' associated attribute data.

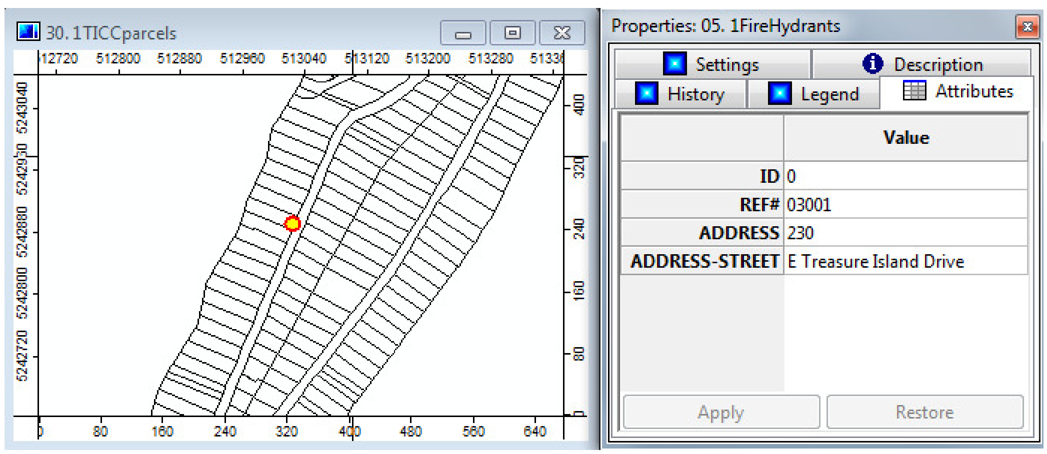


Figure 4-66. The location of fire hydrant 03001.

The snapping capability of SAGA was not used in this example. This is because a point object can only be snapped to a vertex of a line or polygon object and not to an edge. Most of the property boundaries I can see that are adjacent to the road are straight lines. This means they probably will not have any vertices other than at their intersection with a neighbor parcel. Unlike line and polygon objects that can snap to vertices and connecting lines of vertices, point objects can only snap to vertices of line and polygon objects. I located the point object for fire hydrant 03001 by zooming in and clicking the Action pointer as near to the parcel line as possible.

A Line Object Example

I created a new line shape layer for named '1NewRoads' having three attributes in the linked attribute table. The first attribute in the table is a default attribute named "ID". The second attribute is named "ROADNUM". This entry is a unique number assigned to Stretch Island roads for road maintenance. The third attribute, "ROADNAME", is for the name of the road. This new line shape layer for new roads on Stretch Island is eventually used to update the existing road line shape layer named '1StretchRoads'. The attribute table for the '1NewRoads' is the same structure, same attributes, as the attribute table linked to the '1StretchRoads' layer.

This example involves the on-screen digitizing of a new road that starts at the current end of East View, follows a couple property lines, and connects to Vineyard Crest. The name for this new road extension is "East View". It will have an "ID" of 21 and a road maintenance code of 1300 for the "ROADNUM" attribute.

I will display three layers in a map view window. These layers are the new line shape layer '1NewRoads', the existing line shape layer for Stretch Island Roads, '1StretchRoads', and a land parcel polygon shape layer named '1MasonParcelsVal'.

I will specify two shape layers for the 'Snap to...' parameter for the '1NewRoads' layer: '1StretchRoads' and '1MasonParcelsVal'.

Figure 4-67 displays the Stretch Island road network on the left and a zoomed in view of the East View and Vineyard Crest roads. The new extension of East View road displays in red dots.

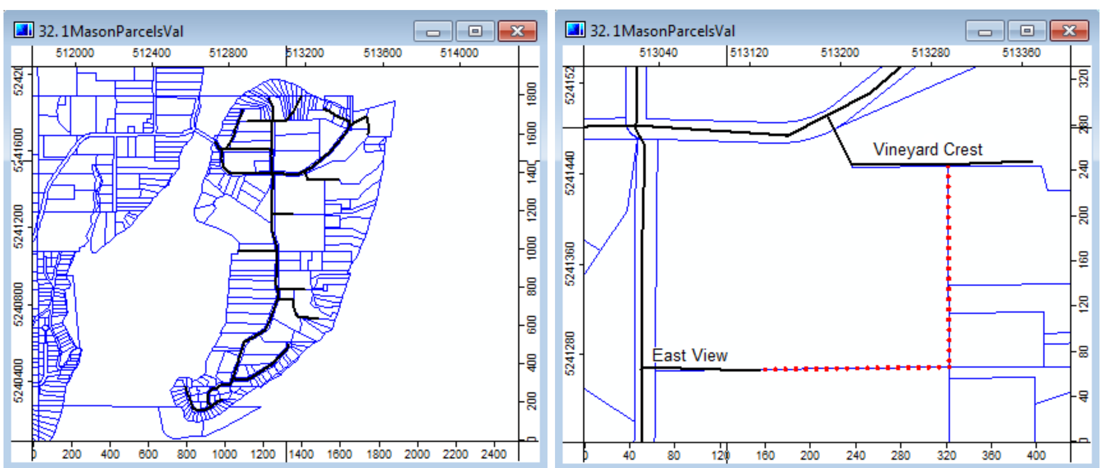


Figure 4-67. The new East View road extension.

Here are the steps I follow to create the new road extension for East View.

1. The first step is to display the two shape layers '1StretchRoads' and '1MasonParcelsVal' in the same map view window in the work area.
2. Identify the '1StretchRoads' and '1MasonParcelsVal' layers for the 'Snap to...' parameter for the '1NewRoads' layer.
3. Display the '1NewRoads' layer in the same map view window as the '1StretchRoads' and '1MasonParcelsVal' layers. The '1NewRoads' layer does not yet contain any line objects since it is a new layer. The map view window will not change when the layer is added.
4. The '1NewRoads' layer should be the active, highlighted layer in the Data tab area of the Manager window.

5. Choose the "Zoom" option on the toolbar and zoom in on location of the East View and Vineyard Crest roads.
6. Select the Action tool on the toolbar by clicking on it with the mouse pointer.
7. Move the Action tool pointer into the map view window.
8. Choose the "Add Shape" option on the popup list of edit options.
9. Move the Action tool pointer near the end of the East View road. Press the left mouse button and press the left mouse button. This locates the beginning point for the extension of the East View road. I see the point snap to the end point of the existing East View line object on the '1StretchRoads' layer.
10. I move the Action tool pointer along the property boundary to the next property lines intersection. I press the left mouse button to define another vertex for the new line object.
11. I will on-screen digitize the end point for the new line object. The end-point intersects at the end of a property line that Vineyard Crest is located. I move the Action tool pointer to Vineyard Crest and the parcel intersection and press the left mouse button.
12. Press the right mouse button once to exit the digitizing process and press the right mouse button a second time. Click on the "Edit Selection" window that displays.
13. I want to save the new line object so I click on the Yes button on the 'Edit Shapes' dialog window responding to the question "Apply changes?"
14. The blank attributes for the new point object display in the Attributes tab area of the Object Properties window for the layer. I enter "22" for the attribute ID, 1300 for the attribute ROADNUM, and "East View" for the ROADNAME attribute. Then I click the Apply button at the bottom of the window for the new data to be temporarily retained. The layer needs to be saved in order for new data and edits to be permanently saved.

Figure 4-68 displays the new line object and its' associated attribute data.

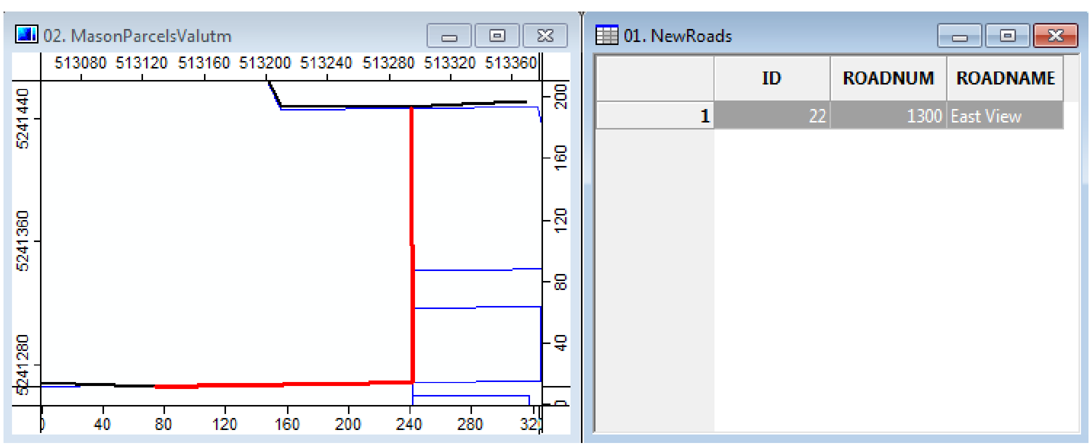


Figure 4-68. New road on Stretch Island.

The snapping capability of SAGA was used in this example. I notice how easy this works even when two layers are identified for the 'Snap to...' parameter. The new line object displays in selection status in Figure 4-68.

A Polygon Object Example
I created a new polygon shape layer named '1Clearcuts' having four attributes in the linked attribute table. The first attribute in the table is a default attribute named "ID". The second attribute is named "AGE". This entry is an estimate on the age of the clear-cut polygon. The third attribute, "TIMBERSALE", is for the name of the timber sale the clear-cut is a part. The timber sale name may or may not be known. A fourth attribute is AREA. This attribute is added using the *Shapes - Polygons/Polygon Properties* tool. The on-screen digitizing of clear-cuts is supported using a false color infrared composite image of a Landsat satellite scene.

This new polygon shape layer for clear-cuts eventually will become part of the environmental planning process.

This example involves the on-screen digitizing of the first polygon object for the layer for an existing clear-cut. The clear-cut is located on the Olympic Peninsula of Washington State. The entry for the ID attribute is 1. The clear-cut is estimated to be 2 years old. The name of the timber sale is "Chatterbox Creek".

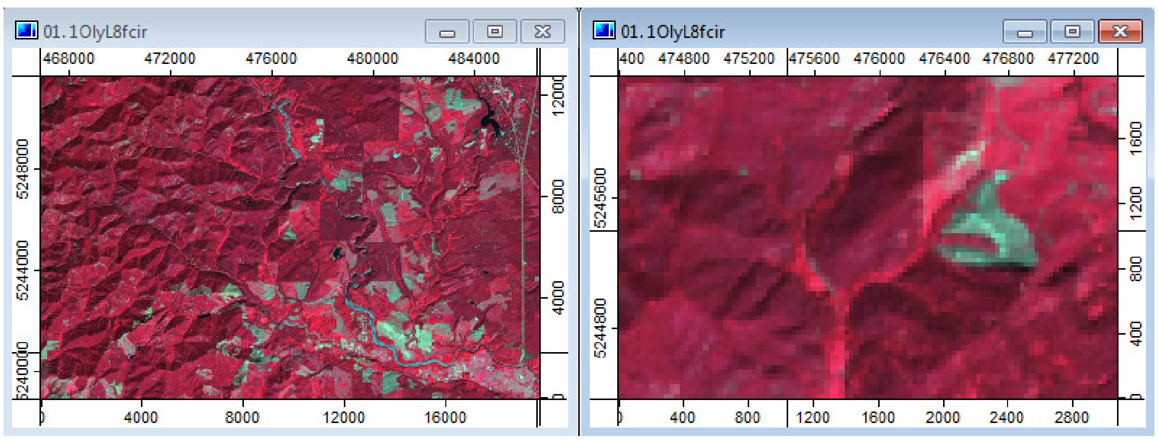


Figure 4-69. The Chatterbox Creek clear-cut.

The clear-cut is at the center of the zoomed in view on the left in Figure 4-69. The zoomed in view on the right shows more detail.

Here are the steps I follow to create the new road extension for East View.

1. The first step is to display the '1OlyL8fcir' grid layer in a map view window in the work area. This is the Landsat false color infrared satellite image.
2. Display the '1Clearcuts' layer in the same map view window as the '1OlyL8fcir' grid layer. The '1Clearcuts' polygon shape layer does not yet contain any polygon objects since it is a new layer. The map view window does not change when the layer is added.
3. The '1Clearcuts' layer should be the active, highlighted layer in the Data tab area of the Manager window.
4. Choose the "Zoom" option on the toolbar and zoom in on the location of the clearcut to on-screen digitize.

5. Select the Action tool on the toolbar by clicking on it with the mouse pointer.
6. Move the Action tool pointer into the map view window.
7. Choose the "Add Shape" option on the popup list of edit options.
8. I move the Action tool pointer to a location for the beginning point for the polygon boundary.
9. I press the left mouse button to define the first vertex for the new polygon object.
10. I continue pressing the left mouse button where I want to locate points to define the boundary of the clear-cut.
11. When I digitize the last point for the boundary, I press the right mouse button once to exit the digitizing process and press the right mouse button a second time. Click on the "Edit Selection" window that displays.
12. I want to save the new line object so I click on the Yes button on the 'Edit Shapes' dialog window responding to the question "Apply changes?"
13. The blank attributes for the new point object display in the Attributes tab area of the Object Properties window for the layer. I enter 1 for the attribute ID, 2 for the attribute AGE, and "Chatterbox Creek" for the TIMBERSALE attribute. Then I click the Apply button at the bottom of the window for the new data to be temporarily retained. The layer needs to be saved in order for new data and edits to be available for future use.
14. Apply the *Shapes - Polygons/Polygon Properties* tool to calculate the area of the clear-cut as an attribute in the attribute table linked to the layer.

Figure 4-70 displays the digitized polygon object just before I exited the digitizing process.

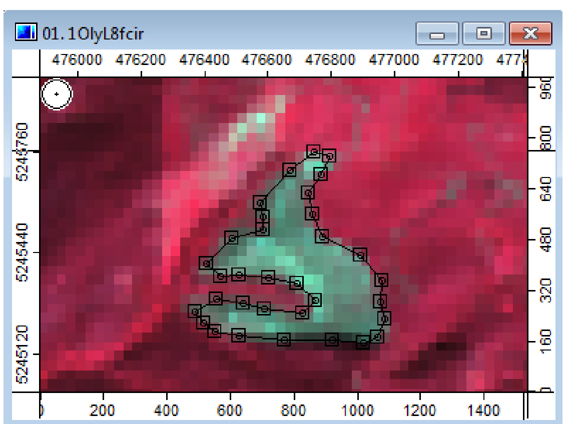


Figure 4-70. The polygon object boundary points.

The digitized points display as small circles enclosed by a box boundary. The final polygon object and the attributes for the object display in Figure 4-71.

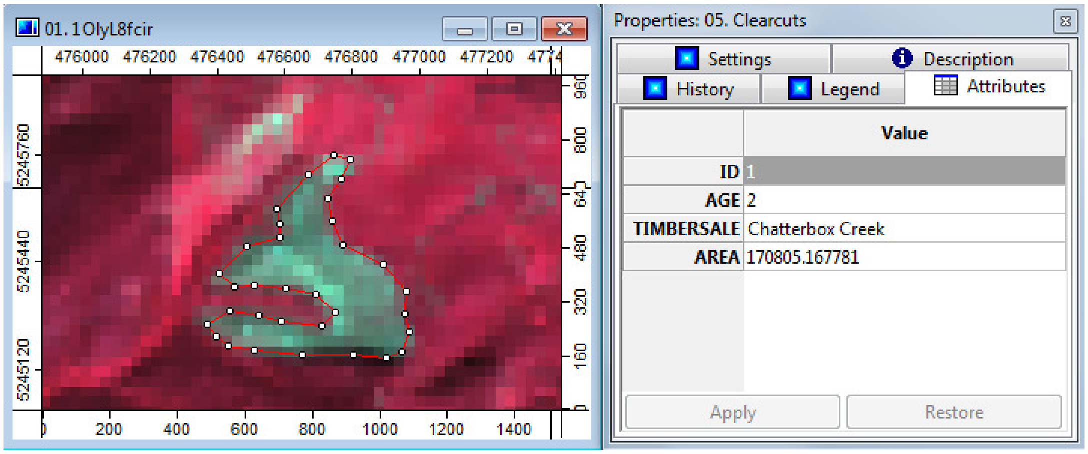


Figure 4-71. The new polygon object and its' associated attribute data.

The digitized boundary vertices display as small white filled circles and a red line connects the vertices defining the object boundary. The 'Show Vertices' parameter in the Settings tab area of the Object Properties window for the '1Clearcuts' layer is in on status. This is how the vertices display in Figure 4-71. Otherwise, I would see a solid black or red line for the polygon object boundary (not selected or selected) because the "Transparent" option is used for the 'Fill Style' parameter for the layer.

Actions Only Available for Point Clouds

The "Classification" function for point clouds has three options: Set Range to Minimum/Maximum, Set Range to Standard Deviation (1.5), and Set Range to Standard Deviation (2.0). The second function for point clouds is specific to displaying the attribute table built-in to the point cloud format.

The Classification Options

The "Classification" title that displays when I right-click on a point cloud layer name in the Data tab area of the Manager, offers three options (see Figure 4-72).

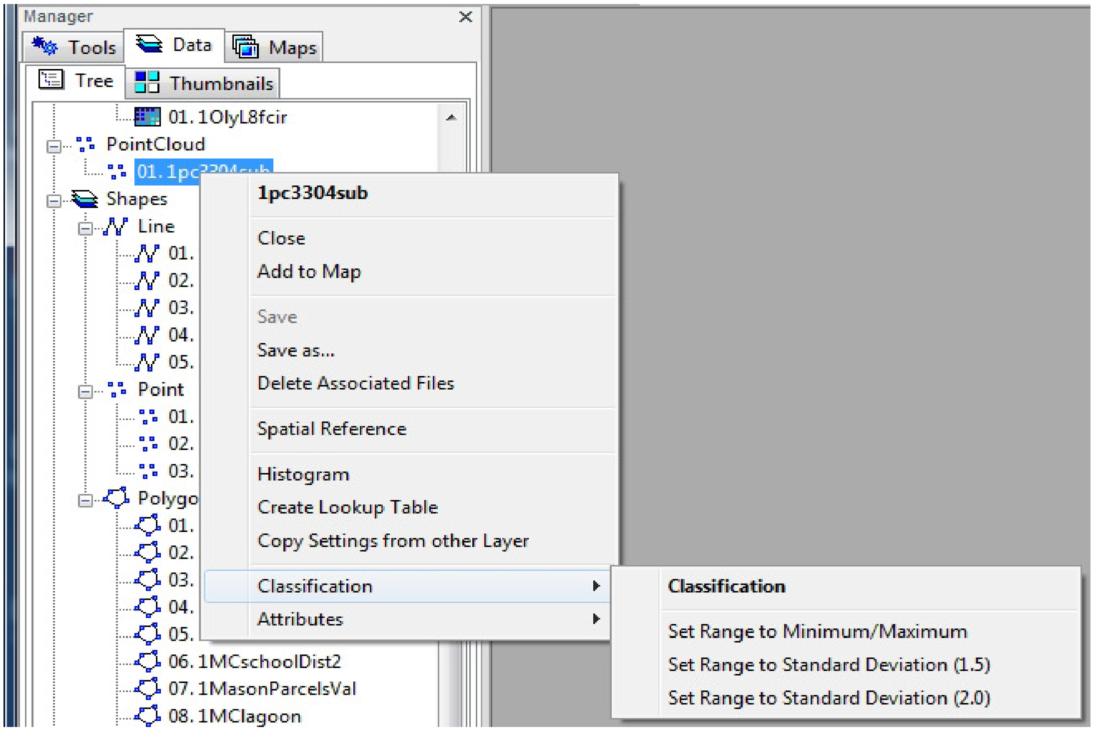


Figure 4-72. The "Classification" list of options.

The three classification options are described below. These options do not change data values, rather, they determine the data value range that will display for a point cloud layer attribute.

The data values displayed will be for the attribute chosen for the Colors: Scaling: Attribute parameter for the point cloud layer. There are 9 attributes that are part of this point cloud layer. They are the X and Y coordinates and the Z values (elevations). Additional attributes include gps-time, intensity, number of the return, classification, number of returns of given pulse, and FEET. The FEET attribute was added. The data values for the Z attribute are meters and the data values for FEET are feet. The option chosen for the "Classification" function is applied to the data values for the attribute chosen for the 'Attribute' parameter.

Set Range to Minimum/Maximum

This option sets the data range for display to the minimum and maximum data values for the attribute chosen for the Colors: Scaling: Attribute parameter. The data range is set in the ‘Value Range’ parameter in the Settings tab area of the Object Properties window for the layer. There will not be any dialog window displayed. One way I can verify that the option worked correctly is by comparing the minimum and maximum values for the ‘Value Range’ parameter to the minimum and maximum data values displayed in the Description tab area of the Object Properties window for the layer.

Set Range to Standard Deviation (1.5), Set Range to Standard Deviation (2.0)
These two options set minimum and maximum values for the ‘Value Range’ parameter in the Settings tab area of the Object Properties window using the mean and standard deviation for the data. The standard deviation is multiplied by 1.5 or 2.0. This number is subtracted from the arithmetic mean to set a new minimum and added to the mean to set a new maximum value for the ‘Value Range’ parameter.

There will not be any dialog window displayed. I can verify that the option worked by manually calculating the expected values and comparing my calculation results with the new values for the ‘Value Range’ parameter displayed in the Description tab area of the Object Properties window for the layer.

As an example, let’s look at the '1pc3304sub' point cloud layer using the "Z" or elevation attribute. The data range is from 47.65 meters to 214.12 meters. The arithmetic mean for the data is 124.07 meters and the standard deviation is 24.38 meters. Multiplying the standard deviation by 1.5 results with a value of 36.57. Using this value I estimate that the display value range calculated using the ‘Set Range to Standard Deviation (1.5)’ will be from 87.5 to 160.64 for a maximum. These values match to the values the option calculated.

Using the standard deviation approaches can be valuable if the data has outlier values that distort visual interpretation.

The Attributes Option
The "Attributes" title that displays when I right-click on a point cloud layer name in the Data tab area of the Manager, offers one option (see Figure 4-73).

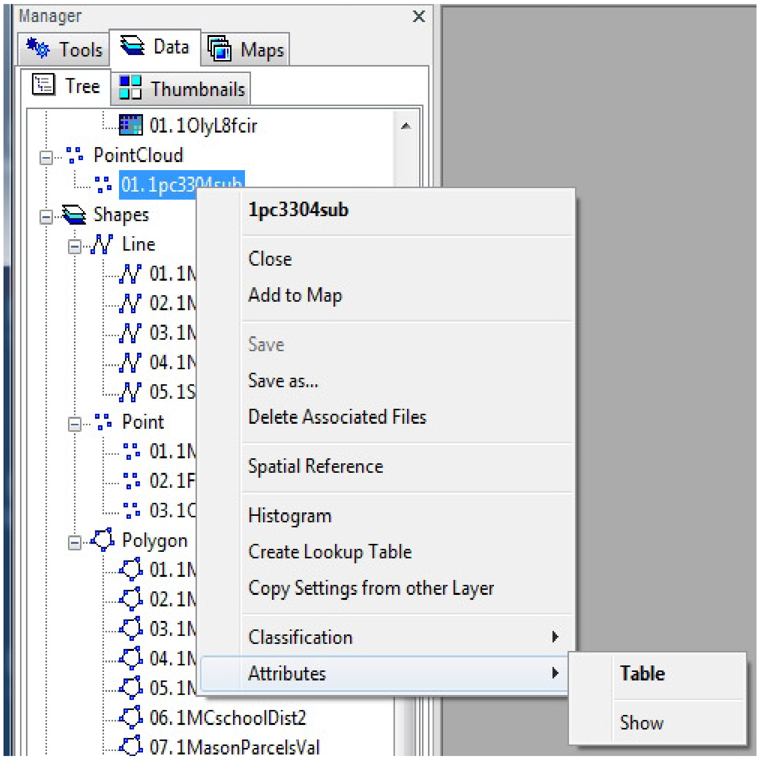


Figure 4-73. The Attributes menu option "Show".

This option displays the attribute table that is part of a point cloud layer. For example, Figure 4-74 displays a portion of the table for the '1pc3304sub' point cloud layer. In this case, attributes for 11 of the 4,364,613 vertices for the '1pc3304sub' point cloud layer display in the figure.

01.1pc3304sub

	X	Y	Z	gps-time	ntensit	:r of the	lassificatio	eturns o	FEET
1	399719.822481	267242.914249	105.189738	252528.545459	0	3	2	3	345.106506
2	399719.434907	267241.569872	111.858776	252528.547998	26	2	1	2	366.986267
3	399719.422396	267241.289018	111.819152	252528.548008	37	2	1	2	366.856262
4	399719.404657	267240.980562	111.910592	252528.548017	47	2	1	2	367.156281
5	399719.533223	267237.472738	119.241046	252528.563895	147	1	1	1	391.206024
6	399719.554582	267237.763016	119.250191	252528.563905	149	1	1	1	391.236023
7	399719.525988	267237.993803	119.618999	252528.563914	166	1	1	1	392.446014
8	399719.530032	267238.253052	119.750064	252528.563924	123	1	1	1	392.876007
9	399719.538922	267238.552084	119.7714	252528.563934	92	1	1	3	392.946014

Figure 4-74. The attribute table linked to the '1pc3304sub' point cloud layer.

The first two columns display the X and Y coordinates for each point of the point cloud layer. The third column displays the Z or elevation value for the point.

Chapter 5 – The Menu Bar Map Menu and Manager Maps Tab Parameters

The SAGA Manager window includes three areas accessed by tabs at the top of the window. These areas are: Tools, Data and Maps. Chapters 3 and 4 explored parameters related to the Tools and Data tab areas. This chapter explores map and map view window parameters available in the Maps tab area of the Manager. Chapter 6 describes options on the Menu Bar Map menu. The parameters described in this chapter support the features and functions available on the Map menu.

There are two places we find map related parameters. Both locations are accessed from the Maps tab area of the Manager. If I move the mouse pointer over the "Maps" title at the top of the Maps tab area of the Manager and press the right mouse button, a list of parameters displays in the Settings tab area of the Object Properties window. Some of these parameters are defaults for new map view windows and some are related to how a map view window display appears. There is also a set of parameters supporting a specific map view window. These parameters are viewed by clicking with the on a map view window name in the Maps tab area.

Figure 5-1 displays the Maps tab area of the Manager using both viewing modes, Tree and Thumbnails. In Figure 5-1, three maps or map view windows exist for the current work session.

Briefly, the default name for a map or map view window is the name of the layer that initiated the map view window. Included in the map name is the order of the layer in the list of layers in the Data tab area. For example, for the first map view window listed in Figure 5-1, the second map in the layer stack is named "11. 1MCcountyBdry". I check in the Data tab area and I see that the '1MCcountyBdry' polygon shape layer is layer number 11 listed in the shape polygon section of the Data tab area. It lists first in the stack of layers for the map view window. A second layer was added named '1MCGeology'. This layer is the fourth layer listed in the shape polygon section of the Data area. The order of the layers in the stack can be easily changed as you will see later in this chapter.

In Figure 5-1, there are three map view windows or maps available in the work area. The second one was just described. The other two maps are named "01. 1MCroadsAll" and "08. 1MCstnDistance". I can see that the layer stacks for the first and third map view windows each have two layers listed.

In the Tree view on the left in Figure 5-1, I have moved the mouse pointer over the map view window named "11. 1MCcountyBdry" and pressed the left mouse button. The map name in the list of map definitions is highlighted. Switching to the Thumbnail view on the right I see the layer icon for the "11. 1MCcountyBdry" map surrounded by a red frame.

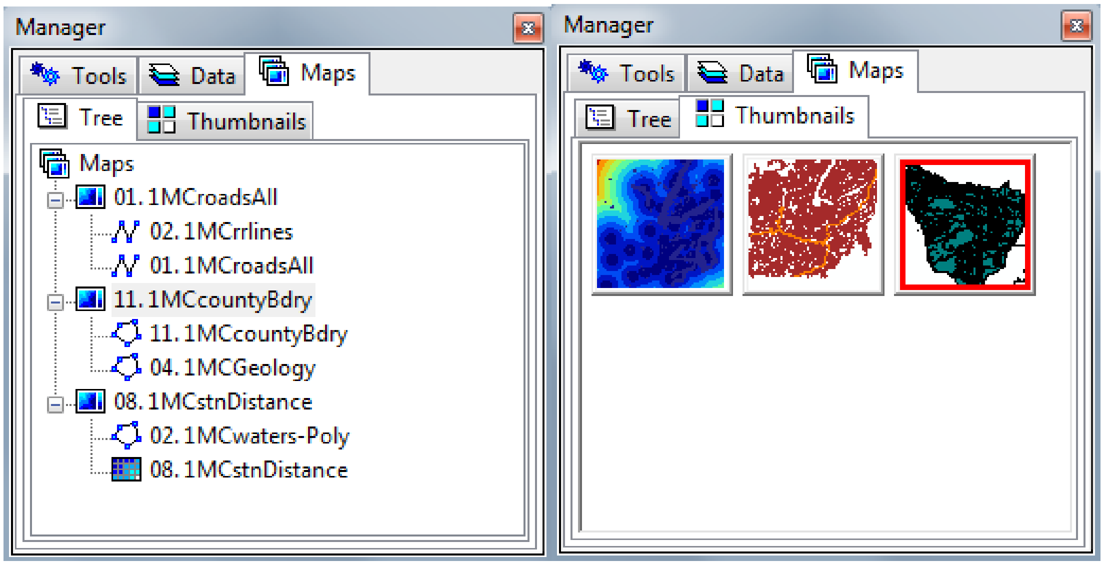


Figure 5-1. List of layers in the Data tab area of the Workspace.

Before taking a look at the Maps tab and map view window related parameters, we will look at map view windows in general.

Introduction to the Map View Window Environment

The primary source for functions and features related to map and map view windows is the Menu Bar Map menu. After the first map view window is created for a work session, the optional Map menu appears on the Menu Bar. If I click on the Map menu, a dropdown list of options displays (Figure 5-2).

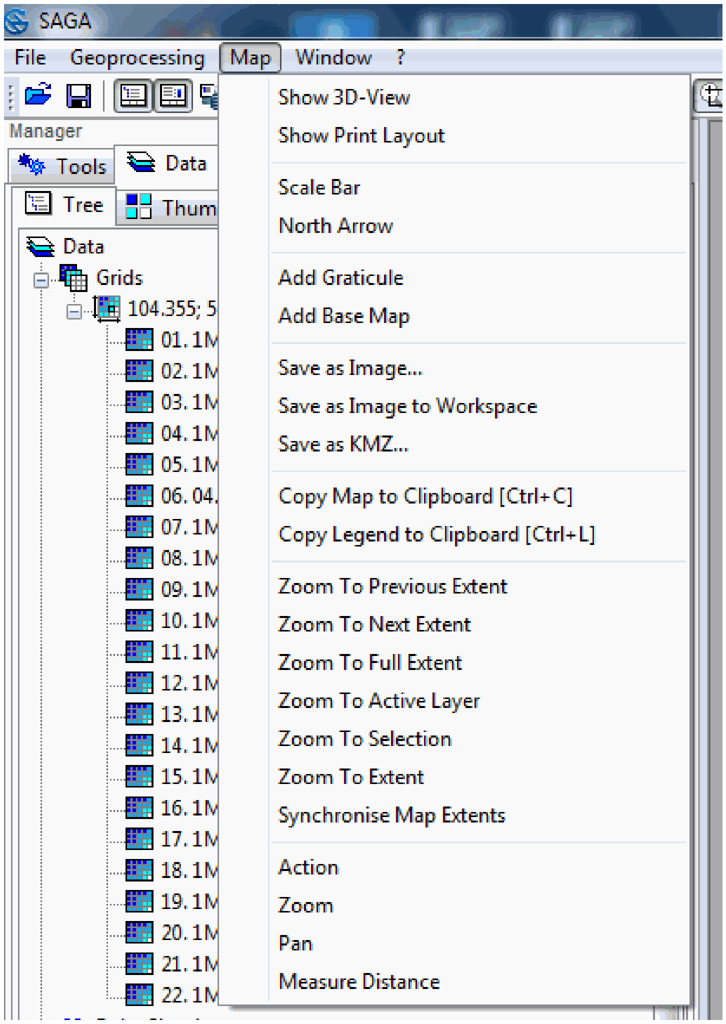


Figure 5-2. Menu Bar Map dropdown options.

Parameters related to many of the functions and features available on the Map menu are accessible from two places in the Maps tab area of the Manager. I move the mouse pointer over the "Maps" text at the top of the Maps tab area and press the left mouse button. A list of map related parameters displays in the Settings tab area of the Object Properties window (Figure 5-3).

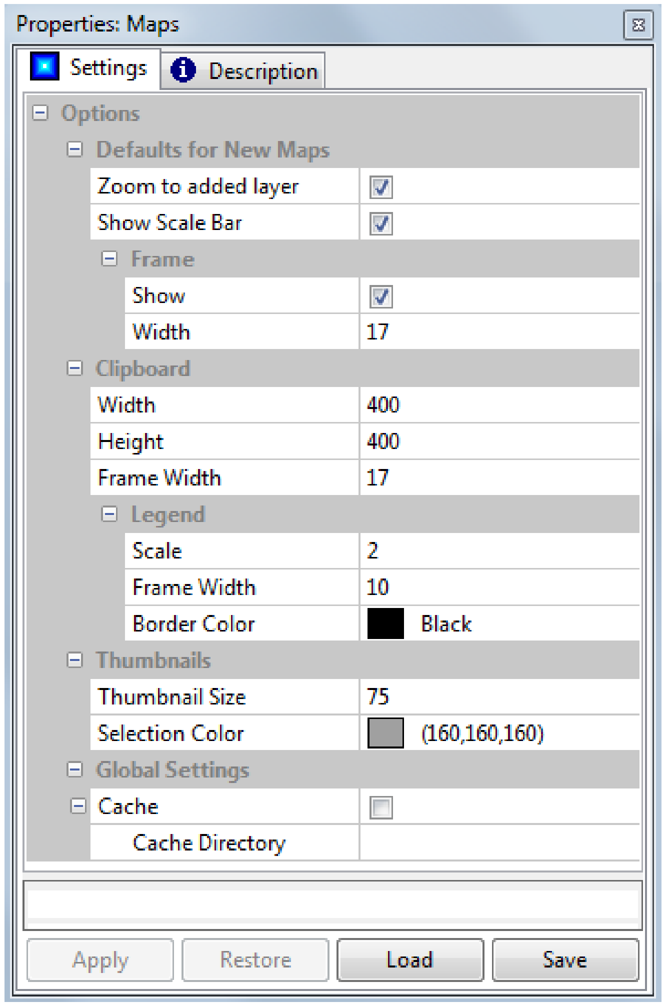


Figure 5-3. Options available from the "Maps" title in the Maps tab area.

Many of the parameters available from the "Maps" title, at the top of the Maps tab area in the Manager, relate to how new map view windows appear. Several relate to how features will display on new maps, i.e., color, size, etc. These parameters appear to be more global in nature compared to the parameters available from a map view window.

A second set of map related parameters is viewed from an individual map view window. I move the mouse pointer over the name of an existing map view window and press the left mouse button. The Settings tab area of the Object Parameters window updates with map parameter settings (Figure 5-4).

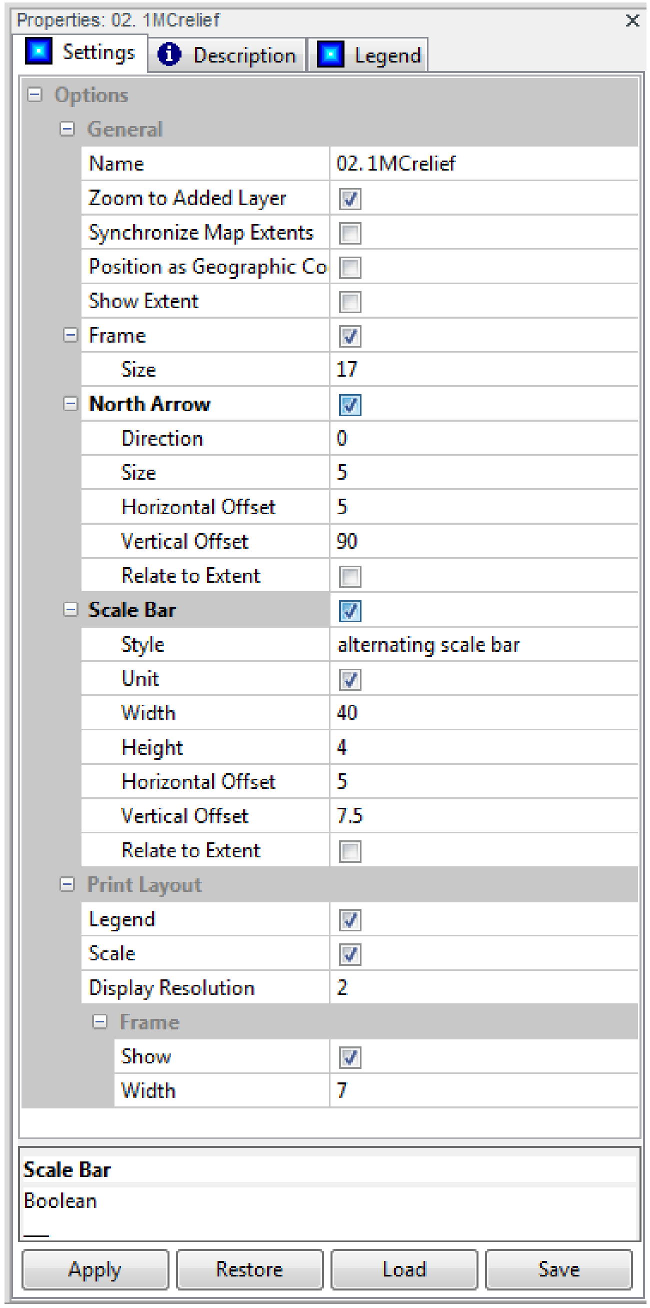


Figure 5-4. Map view window parameters list.

The parameters in Figure 5-4 relate to an individual map view window. I can see that most of these parameters are for customizing how an individual map view window displays. I can add a north arrow and scale bar. I can identify whether a print layout view window will include a legend and scale. One parameter allows me to display the mouse pointer location using geographic coordinates.

A map view window is used to display one or more layers. The layers do not have to be of the same type, they can be a mixture of grid, point cloud or shape. The only requirement is that layers in a map view window use the same coordinate reference system. Actually, this is not really a requirement. Layers involving different coordinate reference systems can display in the same map view window. However, if they cover the same geographic area, they will not display in an integrated fashion as intended if each uses a different coordinate reference system. The layers must use the same coordinate reference system in order to meet the goal of integrating geographic information. A requirement? Yes, if you want to achieve analysis objectives. SAGA includes tools for converting from one coordinate reference system to another.

A new map view window is created by double-clicking on any grid, point cloud or shape layer listed in the Data tab area of the Manager.

Here is an example to display a shaded relief grid layer. I double-click with the mouse on the shaded relief grid layer named '1MCrelief' in the Data tab area list of grid layers. Because three map view windows already exist, a dialog window displays (Figure 5-5). If a map view windows did not exit, the dialog window would not display.

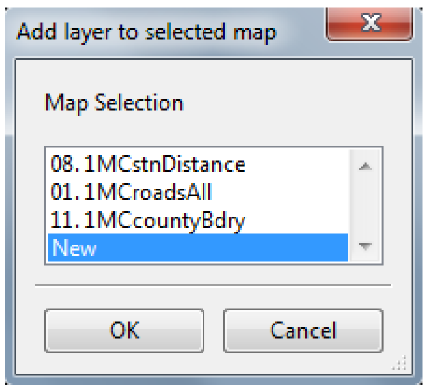


Figure 5-5. The 'Add layer to selected map' dialog.

There are two possible options for what I can do with the '1MCrelief' layer. Either I can add it to an existing map view window (one of the three on the list) or I can create a new map view window (by selecting the "New" option). I choose the "New" option and create the map view window in Figure 5-6.

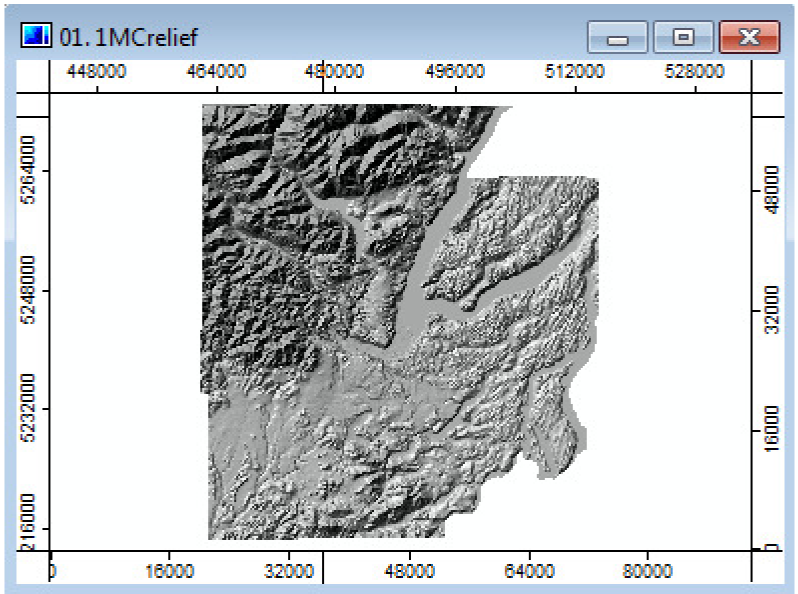


Figure 5-6. A new map view window for displaying the '1MCrelief' grid layer.

Let's look at the information available in a map view window.

In the map view window title bar in Figure 5-6 is the text "01. 1MCrelief". This text is the name SAGA assigned to the map view window. It is the name of the first layer in the map view window; the one that initiated the view window. The name relates to the layer list in the Data tab area of the Manager. The "01" means that the first layer (a grid layer) is the first one in the Data tab area list of grid layers available for the grid system "104.355; 539x 585y; 460552.897768x 5213286.940169y". The text "1MCrelief" appears for the 'Name' parameter in the Settings tab area of the Object Properties window of the layer. This text is how SAGA refers to the layer.

Here is how the Maps tab area of the Manager window and the work area appear after creating this new window (Figure 5-7).

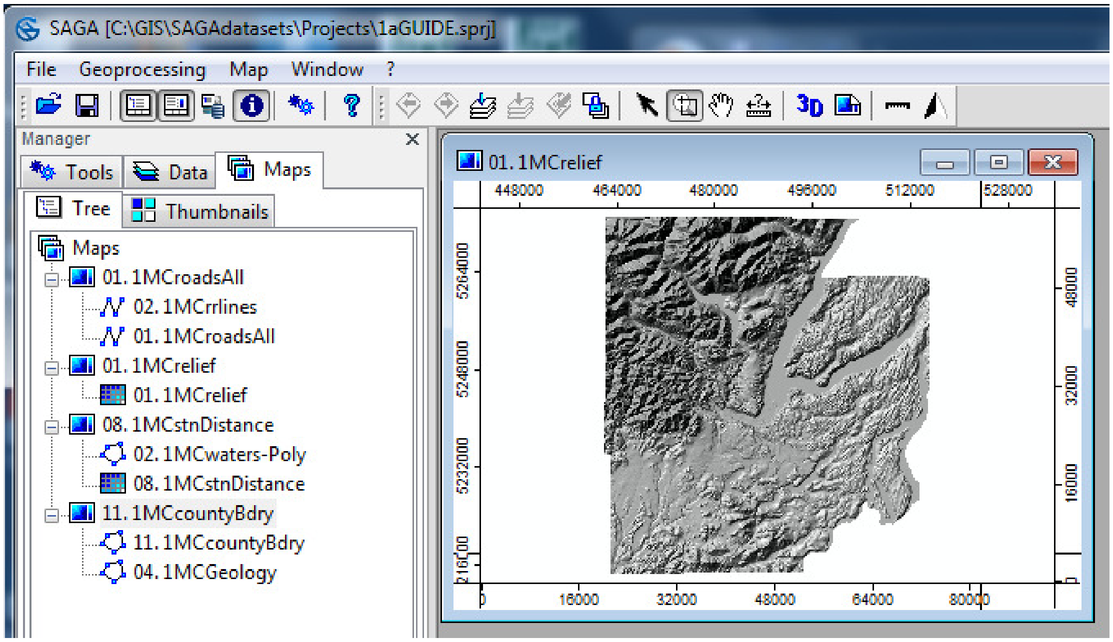


Figure 5-7. The Maps tab area and a portion of the workspace.

I click on the Maps tab to view map view window definitions. Comparing to the list of maps in Figure 5-1, I see the new one I just created is the second one in the list: 01. 1MCrelief. Below the name of the map view window is the name of the layer displayed in the map view window and its number in the list of layers in the Data tab area of the Manager window.

Let's continue looking at basic features of a map view window (Figure 5-5). Surrounding the map display is a frame. In the frame, along the top and left sides are ticks labeled with Universal Transverse Mercator (UTM) coordinate values. The values for the ticks in the top area of the frame are X coordinates and the values for ticks on the left side of the frame are Y coordinates. The UTM Zone 10 is the coordinate reference system for this grid layer and map view window.

As I move the mouse pointer around inside the map window I notice several dynamic outputs in the map view window and at the bottom of the work area. The position of the mouse pointer is tracked in the four sides of the map frame by four bars (one on each side) in the frame width in the map view window. These bars move, following the location of the mouse pointer.

The UTM coordinate pair (X, Y) of the mouse pointer position displays in the X and Y display fields at the bottom of the work area. A third display field labeled "Z" shows the data value for the pointer position. Data values displayed are for the grid or shape layer that is in the most recent active status in the Data or Maps tab areas of the Manager.

I have selected the '1MCrelief' grid layer on the list. The data values displayed in the "Z" display field are data values for shaded relief. In this case, the values are for the angle of light striking the earth's surface, in radians. It is important to know that the data values displayed are for the grid or shape layer that is active in the Data tab list even if this layer is not part of the map view window. This can be a source of confusion. It is important to keep track of which layer is the active layer.

When the "Scale Bar" option is chosen (on the toolbar, from the Menu Bar Map list, or from the Maps tab area) to display in a map view window, the ticks labeled in the map view window frame on the right and bottom sides will also be for the coordinate reference system. If the scale bar is not displayed in the map window (like in Figure 5-7), the numbered tick marks on the right and bottom sides of the map view frame represent distance in map units. Remember, the position of the mouse pointer in the window is tracked by bars in the map view window frame. By looking at the position of the bars I can get a good idea of relative distances and geographic location.

I can have more than one map view window displayed in the work area at a time. Only one is active but inactive ones are still visible. Figure 5-8 shows two visible map view windows, '04. 1MCchannelNet' and '09. 1MCrelief'. The '1MCchannelNet' grid layer is for streams. On the '1MCchannelNet' grid layer, grid cells containing a stream contain a data value while grid cells that do not contain a stream contain the no data value -99999. I notice that in the Maps tab area of the Manager is displayed the definitions of the two maps. Map 04 is active as its name is highlighted in the list of maps.

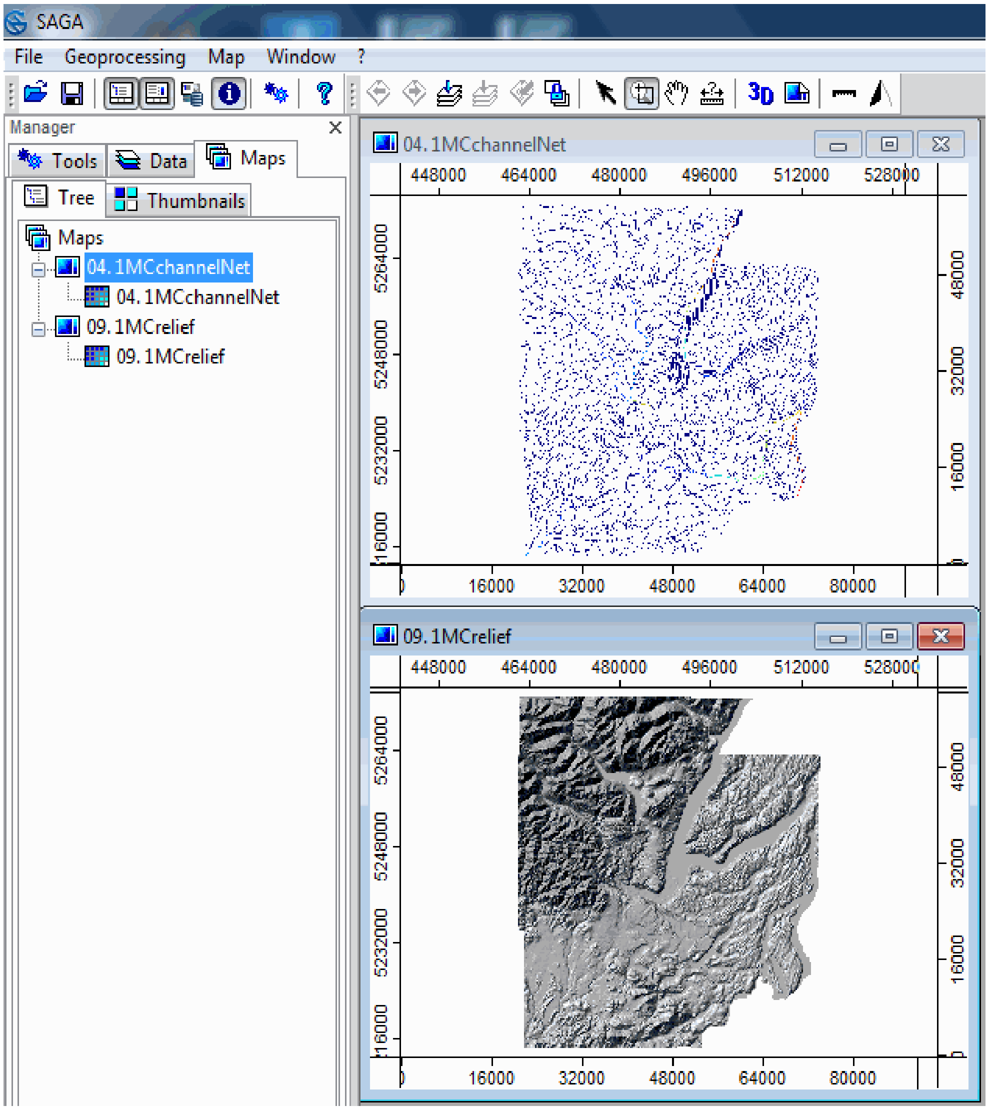


Figure 5-8. Two map view windows display in the work area.

I want to add water bodies to the map view window that already includes the shaded relief grid layer ('1MCrelief'). I double-click with the mouse on the water bodies polygon shape layer, '1MCwaters-Poly', in the Data tab area of the Manager. When the ‘Add layer to selected map’ dialog window displays I choose ‘09. 1MCrelief’. This is the existing map view window I want to add the polygon shape layer for water bodies, '1MCwaters-Poly'. Figure 5-9 shows the result.

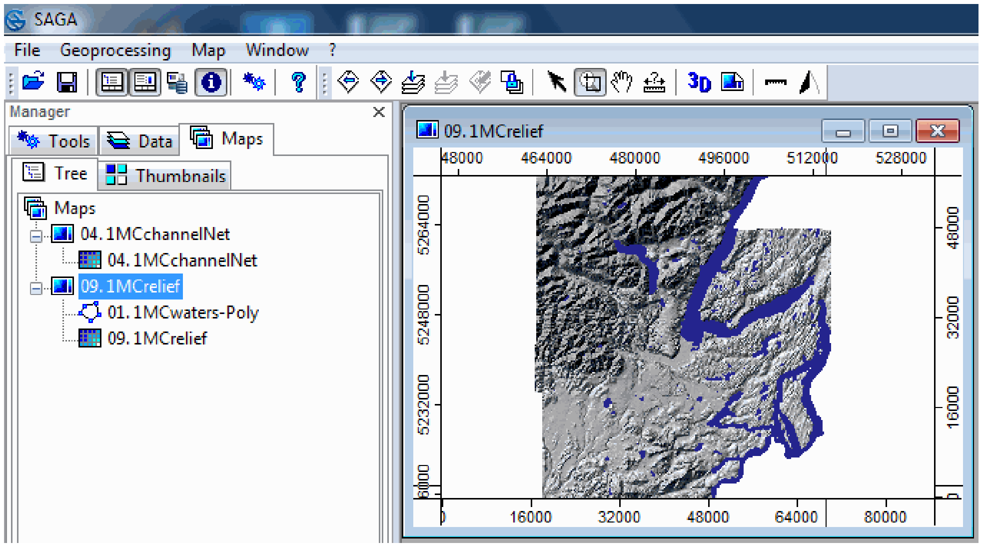


Figure 5-9. "08. 1MCrelief" with two layers displayed.

The information in the Maps tab area shows that the '1MCwaters-Poly' shape layer is added to the map view window '09. 1MCrelief'. I can add any grid, point cloud or shape layer to a map view window. Any layer added to the map view window should be using the same coordinate reference system used by other layers in the window.

This next example involves a map view window named "02. 1MasonParcels". There are three layers in the layer stack for the map view window. I click with the mouse on the Maps tab of the Manager window and move the mouse pointer over the name of the first layer in the stack of layers: '1MCrelief'. I press the left mouse button. The layer name becomes highlighted. I then press the right mouse button. A popup menu appears (Figure 5-10).

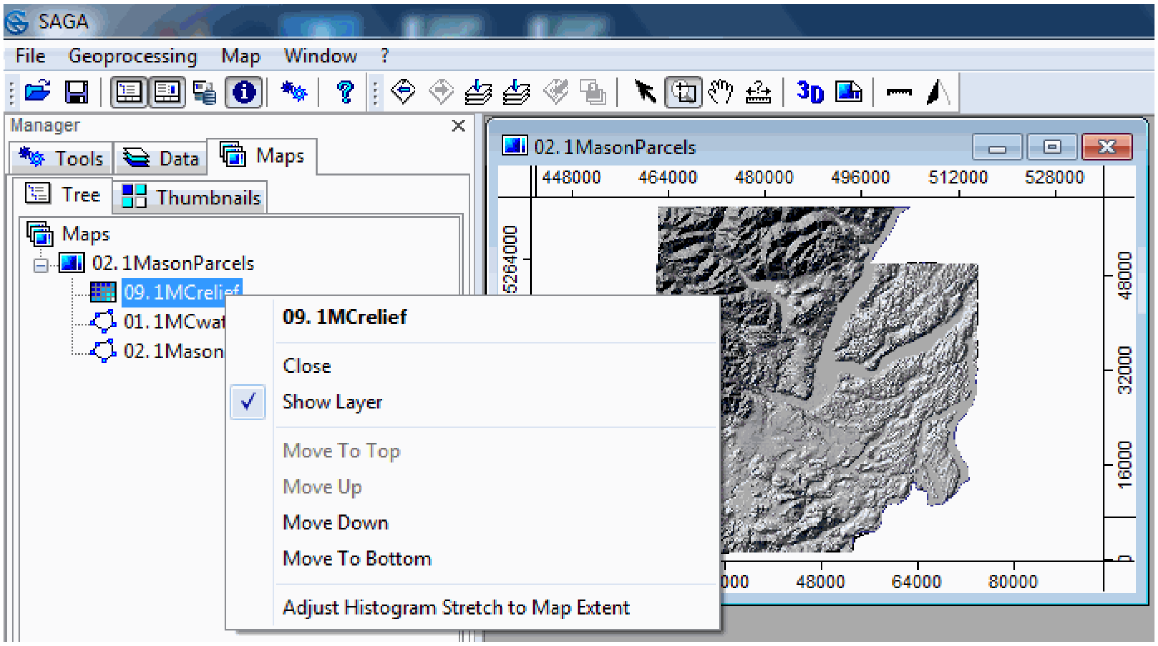


Figure 5-10. Menu options available from a map layer.

The popup menu options are for the '1MCrelief' layer.

The options available in the popup menu include Close, Show Layer, Move to Top, Move Up, Move Down, Move to Bottom, and Adjust Histogram Stretch to Map Extent.

If I choose the "Close" option, a dialog displays with the question "Do you want to delete the selection?" and includes two buttons Yes and No. If I choose Yes, the layer is removed from the layer stack for the map view window. It remains in the list of layers in the Data tab area of the Manager but no longer displays in the "02. 1MasonParcels" map view window.

A check mark to the left of the "Show Layer" option indicates the layer displays in the map view window. Clicking on the option when the check mark is visible turns off the display of the layer in the map view window. The layer remains in the layer stack for the map view window and its' name in the list is enclosed in brackets indicating its' off status. The status can be changed back to display by choosing the "Show Layer" option. A shortcut is to move the mouse pointer over the layer name and press the left mouse button twice. This results in the layer name enclosed by brackets.

The four "move" options are for adjusting the position of a layer in the stack of layers for the map. Let's look at Figure 5-10. The map view window (partially blocked by the popup list of options) is displaying the shaded relief grid layer '1MCrelief'. I see in the Maps tab area, in the layer stack, for map "02. 1MasonParcels", that there are three layers displayed in this map view window. Only the first one in the stack, '1MCrelief', is visible. This is because it is blocking the view of the two layers below it in the stack. The intent is for the shaded relief to provide a backdrop display in the map view window. The Display:

Fill Style parameter for the polygon shape layer is set to "Transparent" so that parcel lines are visible and the parcel polygons are not filled, i.e., they are transparent. The same parameter for the water bodies layer '1MCwaters-Poly' is set to "Opaque". The water body polygons display with a color fill of blue. The layers for land parcels and water bodies should be in positions 1 and 2 allowing the shaded relief grid layer, in position 3, to display as background where it is not blocked by upper layers in the stack.

I need to move the top layer in the list, '1MCrelief', to the bottom of the list. I move the mouse pointer over the '1MCrelief' layer in the Maps tab area and press the right mouse button. The popup list of options displays (see Figure 5-10). I click on the "Move to Bottom" option with the mouse. Figure 5-11 displays a zoomed in area of the revised map view window.

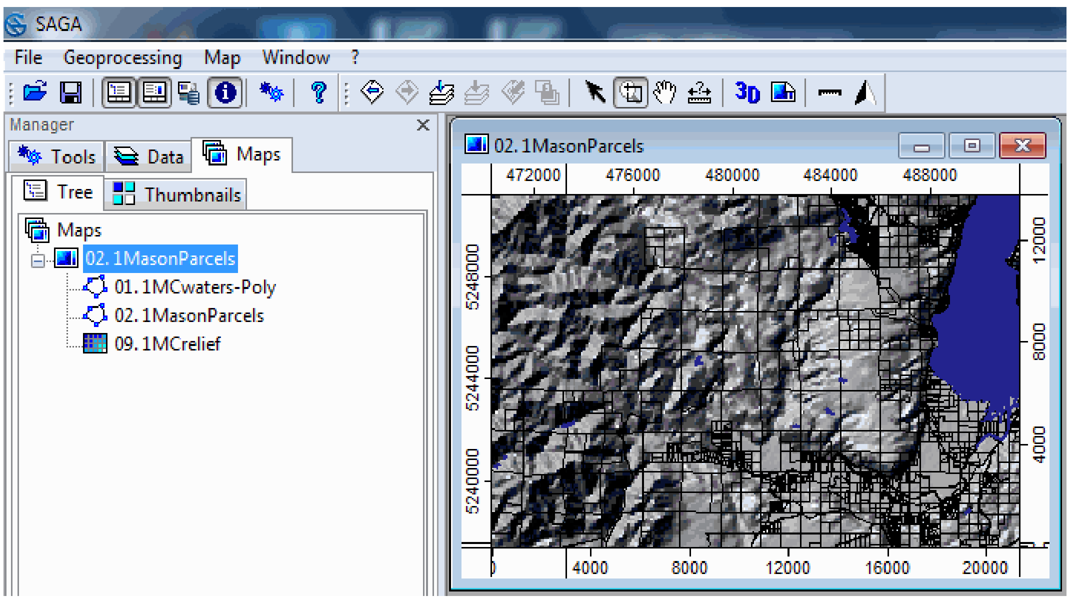


Figure 5-11. A zoomed in view in the '1MasonParcels' map view window.

A short-cut to the four "move" commands is to use the mouse to drag a layer from one position to a new position in the stack.

The last option in this popup menu is "Adjust Histogram Stretch to Map Extent".

Normally, default parameters are set so that when a shape, grid or point cloud layer is first displayed in a map view window, the map extent of the map view window zooms to the full extent of the new layer. The full extent definition of a shape, grid or point cloud layer is displayed in the Description tab area for the layer in the Object Properties window in the West, East, South, and North information fields. The coordinates in these fields define a bounding box that fully encloses the layer objects, vertices or grid cells. In the case of a point cloud or grid layer, the full range of data values is available for display. Data values for shape objects depend on several shape parameters including the Colors: Type: Scaling: Attribute parameter.

A zoomed in or zoomed out view of a map view window establishes a new map extent, one either spatially smaller (zoomed in) or spatially larger (zoomed out). If zoomed out from the full extent of a map, the data range display does not change. If zoomed in from the full extent of a map, the data range may change to a narrower data range for the new map extent.

For example, maybe the data range for the full extent of the layer was from 23 to 7400 but for a zoomed in map extent it decreases to a shorter range from 2150 to 6290. In this case, the data range is 4140 as compared to 7377 for the full extent of the layer. The color assignments used for the full extent are applied to the zoomed in view just as if the data range had not changed in the view. If I use the "Adjust Histogram Stretch to Map Extent" option for the layer, the color assignments will adjust to the narrower data range of the map extent. Rather than the color gradient displaying the data values from 23 to 7400, the color gradient adjusts to the narrower data range 2150 to 6290.

Figure 5-12 shows an example using the DEM grid layer for Mason County ('1MCdem30').

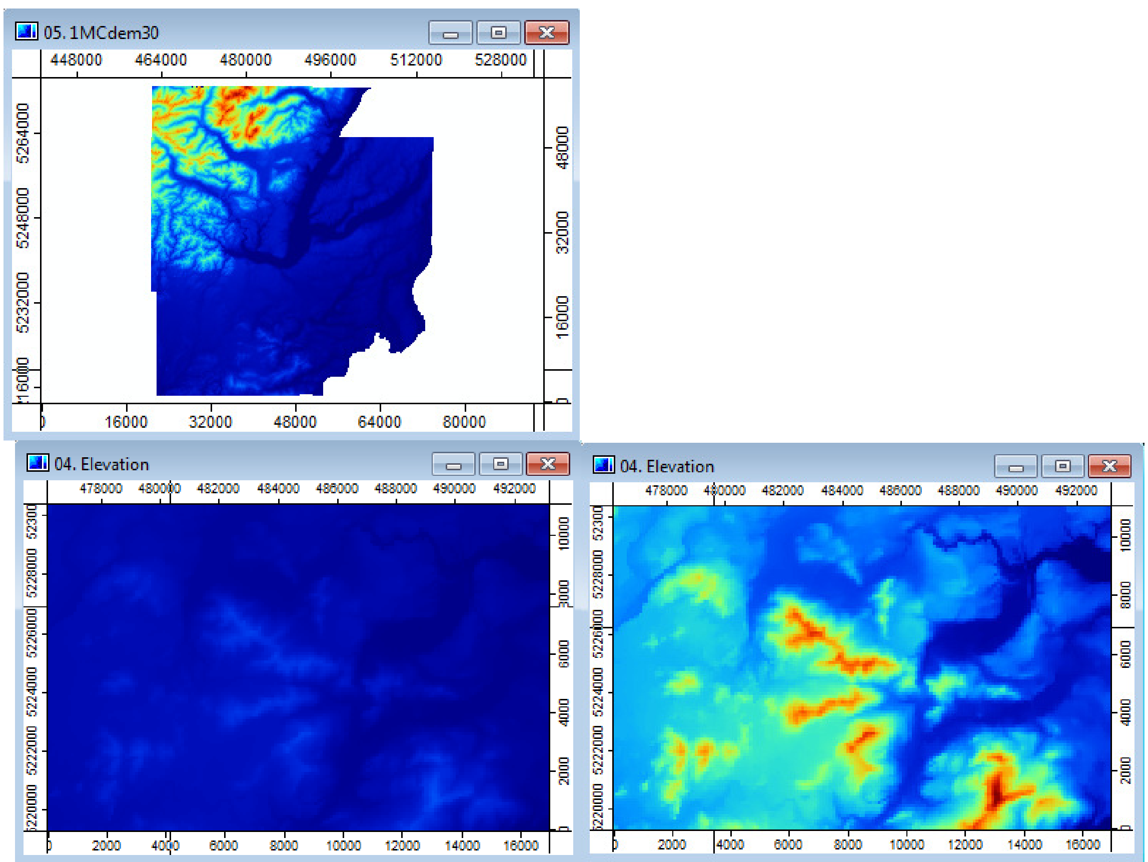


Figure 5-12. Example of using 'Adjust Histogram Stretch to Map Extent'.

The upper map view window displays the full extent for the elevation grid layer '1MCdem30'. The data range is from 0 to 6379. The map view window on the lower left is a zoomed in area of low relief on the '1MCdem30' layer prior to choosing the "Adjust Histogram Stretch to Map Extent" option. The zoomed in area has a data range from 25 to 1187. I can see this zoomed in area at the bottom center of the full extent view. The lower right map view window displays the zoomed in area after choosing the "Adjust Histogram Stretch to Map Extent" option. It is easier to interpret elevation differences. I also notice that the 'Value Range' parameter in the Settings tab for the layer now displays the new data range for the zoomed in area.

Using this option enhanced the interpretation of a low relief area of the elevation grid layer. When I apply the "Adjust Histogram Stretch to Map Extent" option to a layer in a map, the change in appearance will affect any map view window that happens to include the layer in its layer stack.

The "Maps" Title Parameters

Parameters related to many of the functions and features available on the Map menu are accessible from two places in the Maps tab area of the Manager. I move the mouse pointer over the "Maps" title at the top of the Maps tab area and press the left mouse button. A list of map related parameters displays in the Settings tab area of the Object Properties window.

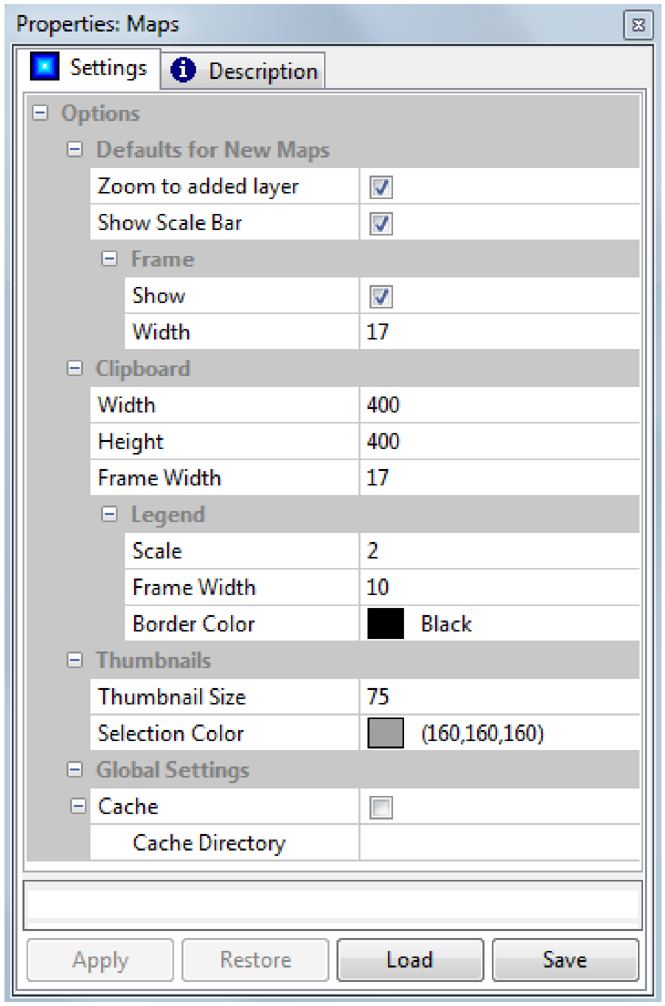


Figure 5-13. The "Maps" title set of parameters.

I can see that some of the parameters available from the "Maps" title serve as defaults for new map view windows. Several relate to what features will display on new maps, i.e., color, size, etc. These parameters appear to be more global in nature compared to the parameters available from a map view window.

Default Parameter Settings for New Map View Windows

There are four default parameters for new map view windows. The rest of the parameters relate to the size of the clipboard, thumbnail icon size, and the cache directory.

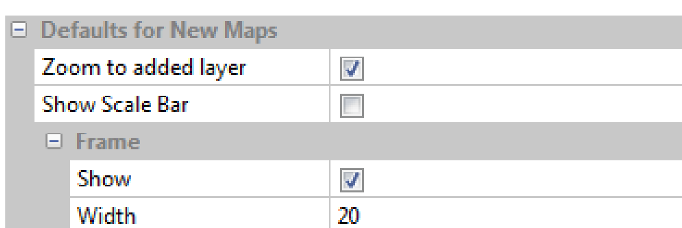


Figure 5-14. The default parameters for a new map view window.

Defaults for New Maps: Zoom to added layer
The 'Zoom to added layer' parameter is a toggle check box parameter. A check mark displayed in the box indicates the option is on. If this parameter is in on status, when a new map view window is created or when another layer is added to an existing map view window, the map view window extent changes by zooming in or out to the new maps map extent. When this parameter is in off status, when another layer is added to the existing map view window, the map view window extent does not change.

Here is an example. First, I toggle the parameter to off status. I move the mouse pointer into the Data tab area of the Manager window. I click on the '1MasonParcels' polygon shape layer. A new map view window displays in the work space. I click with the mouse on the 'Fill Style' parameter for the '1MasonParcels' layer and choose the "Transparent" option.

I add the '1MCfd3' polygon shape layer. This layer contains a single polygon for the boundary of fire protection district 3. This single polygon displays with a red fill. The single polygon shape layer is added to the map view window on the left in Figure 5-15. The map extent of the map view window did not change in scale or viewing content.

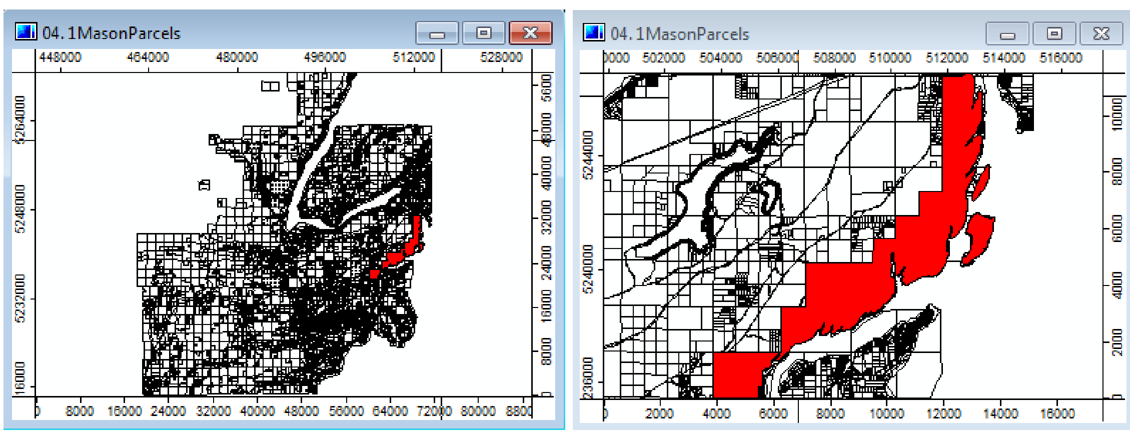


Figure 5-15. Looking at the 'Zoom to added layer' parameter.

I change the status of the 'Zoom to added layer' parameter to on. Whenever I change a status, the last step is to click on the Apply button at the bottom of the Object Properties window so that the change can take effect.

I click on the '1MasonParcels' polygon shape layer. I choose to display it in a new map view window. Now I add the '1MCfd3' layer to the new map view window. This time the view in the map view window zooms in to the map extent of the added layer. The map view window on the right in Figure 5-15 shows the change in the map extent for the window.

Defaults for New Maps: Show Scale Bar
This is a toggle check box parameter. A check mark in the box indicates on status. When a new map view window displays in the work area, a scale bar appears in the window. If I toggle the check box so the check mark does not appear, it is in off status. When a new map view window displays in the work area it will not include a scale bar. Whenever I change the status, the last step is to click on the Apply button at the bottom of the Object Properties window so that the change can take effect.

The presence or absence of a scale bar will affect the display of the tick marks on the bottom and right sides of the frame. If a scale bar appears in the map view window, the numbers for the tick marks in map view window frame represent the coordinate reference system for the layers. If a scale bar does not appear in the map view window, the numbers for the tick marks in the bottom and right sides of the map view window frame indicate distance in map units rather than spatial coordinates.

Defaults for New Maps: Frame: Show
This is a toggle check box parameter. The default for this parameter is to be in on status. A check mark displays in the check box. When a new map view window is displayed in the work area it will include a surrounding frame. If this parameter is in off status a new map view window will not include a frame. Figure 5-16 displays two map view windows, one without a frame (on the left), one with on the right.

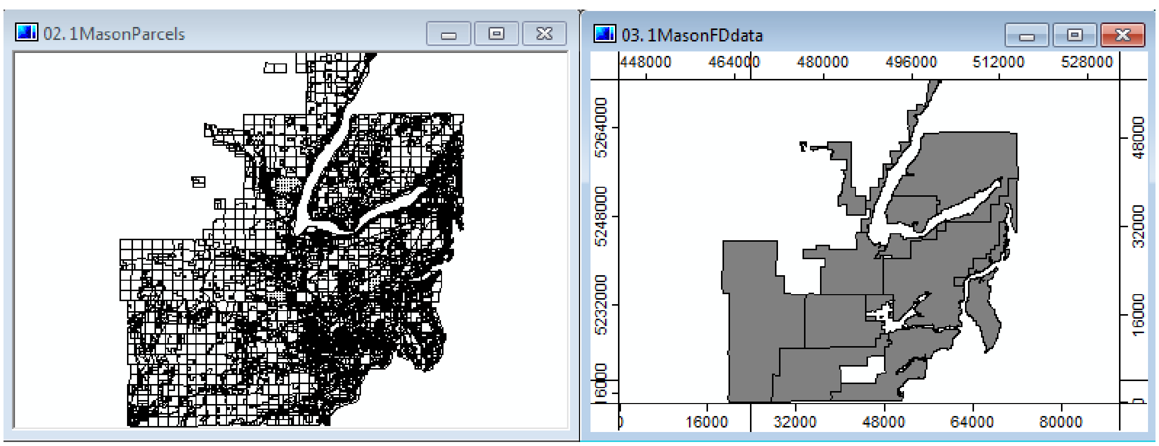


Figure 5-16. Comparing a map view window with a frame and one without.

Defaults for New Maps: Frame: Width
The value entered for this parameter determines the frame width for a new map view window. The default entry is 17. The units are screen pixels. The value is entered in the value field to the right of the parameter name. When I change this entry, the last step is to click on the Apply button at the bottom of the Object Properties window so that the change can take effect. Two examples appear in Figure 5-17.

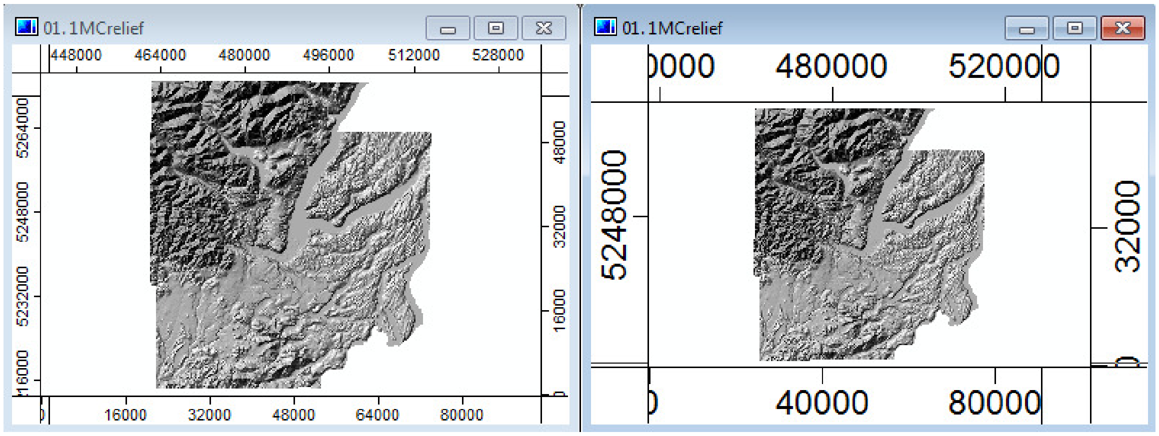


Figure 5-17. Comparing map view window frame widths 20 and 40.

The map view window frame on the left is created with an entry of 20 for the 'Width' parameter and the frame on the right using an entry of 40. The frame width on the right is about double the width of the frame on the left.

Clipboard: Width, Clipboard: Height, Clipboard: Frame Width
The "Copy Map to Clipboard" is one of the functions available as an option on the Menu Bar Map menu and also available from the Maps tab area of the Manager.

The Clipboard: Width Clipboard: Height, and Clipboard: Frame Width parameters support the "Copy Map to Clipboard" function. The Clipboard: Width and Clipboard: Height set the pixel width and height for a map view window that is copied to the clipboard by the function. The default entry for the 'Width' and 'Height' parameters is 400 pixels.

I can paste the clipboard content into a number of graphic programs, e.g., Adobe Photoshop. Using the default settings of 400 for both the 'Width' and 'Height' parameters, results with an image 440 pixels by 440 pixels. The frame is 20 pixels on a side so the actual size is 400 +40 for 440 pixels. This is 6.11 inches by 6.11 inches.

I can double the entries to 800 pixels, leave the frame width at 20. This result with an image 840 pixels by 840 pixels, about 12.22 inches by 12.22 inches.

Clipboard: Legend: Scale, Clipboard: Legend: Frame Width, Clipboard: Legend: Border Color
The "Copy Legend to Clipboard" is another function available as an option on the Menu Bar Map menu and in the Maps tab area of the Manager.

The Clipboard: Legend: Scale, Clipboard: Legend: Frame Width, Clipboard: Legend: Border Color parameters support the "Copy Legend to Clipboard" function. It appears that the width of the legend is determined by the length of the longest name for a layer displayed in the map view window. Recall that the name is the entry for the 'Name' parameter in the Settings tab area of the Object Properties window for a layer. The 'Scale' parameter is applied to this default width. A scaler of 2 doubles the default width; a scaler of 3 triples the width and so on.

The frame width is in pixels. An entry of 20 adds 40 pixels to the width of the legend copied to the clipboard. This is not like the frame used for a map view window. This frame has an outer border (using the color for the 'Border Color' parameter) and an invisible inner border. The invisible inner border on the left marks the point where legend text starts. On the right-side the invisible inner border starts at the end of the longest legend text to the visible border.

The exterior border of the frame displays in the color chosen for the 'Border Color' parameter.

Thumbnails: Thumbnail Size

This parameter controls the size of the thumbnails displayed when the Thumbnails viewing tab is used as the viewing mode for the Maps tab of the Manager window. The entry values are pixels. The default entry is 75. This parameter does not affect the display of thumbnails in the Data tab area of the Manager.

Figure 5-18 displays thumbnails on the left using an entry of 50 for this parameter. An entry of 100 is used for the thumbnail size on the right.

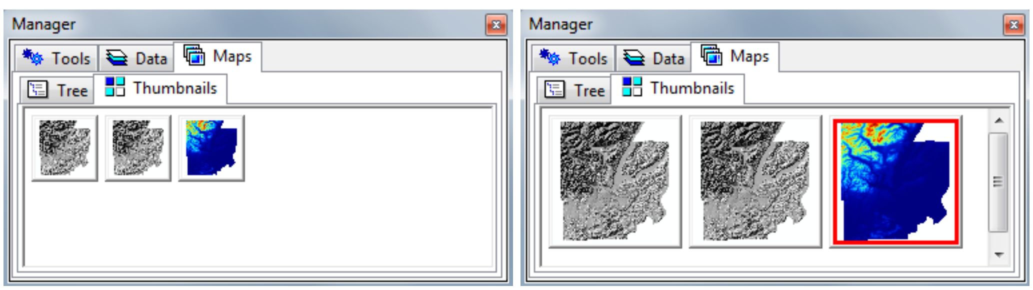


Figure 5-18. Comparing two different sizes for the 'Thumbnail Size' parameter.

Thumbnails: Selection Color

A selected thumbnail has a color outline surrounding it. This parameter identifies the color used for the outline of a selected thumbnail. I select a thumbnail by moving the mouse pointer over the thumbnail and pressing the left mouse button. I can see in Figure 5-18 that the far right thumbnail is selected. The selection color is red and a red outline surrounds the thumbnail.

I can change the selection color. I move the mouse pointer into the value field to the right of the 'Selection Color' parameter and press the left mouse button. Then I move the pointer onto the triangle on the right side and press the left mouse button again. A dropdown display of labeled color swatches appears. I choose the color I want to use with the mouse. The last step is to click on the Apply button at the bottom of the Object Properties window so that the change can take effect.

Global Settings: Cache
File caching involves the swapping of data between storage and memory as needed for computations. In particular, this process supports operations involving large amounts of data. Overall performance may be degraded. For example, computation time may be extended because of the ongoing data swapping.

The default is for this parameter to be in off status. This is a toggle check box parameter and is in on status if a check mark displays in the check box and is off if a check mark is absent. I can toggle between on and off by clicking with the mouse in the toggle check box.

Global Settings: Cache: Cache Directory
This parameter identifies a directory path and folder for the storage of temporary cache files. I click with the mouse pointer in the value field to the right. An ellipsis appears and I click on it. A 'Choose Directory' dialog window displays. I can navigate or browse to the storage location I want to specify for temporary cache file storage. When the path and folder name display, I click on it and the path and folder name are copied into the value field to the right of the 'Temporary files' parameter. I click on the Apply button at the bottom of the Object Properties window and the change takes effect.

As noted earlier, only a few of the parameters on the parameters page in Figure 5-3 were defaults for new map view windows. This next set of parameters are specific to existing map view windows.

Parameter Settings for Map View Windows
Maps or map view windows have parameters similar to layers. The parameters for a specific map view window are viewed from the Maps tab area of the Manager window. I move the mouse pointer into the Maps tab area and click on the map name. The parameters for the map view window display in the Settings tab area of the Object Properties window. There are two areas of parameters: General and Print Layout.

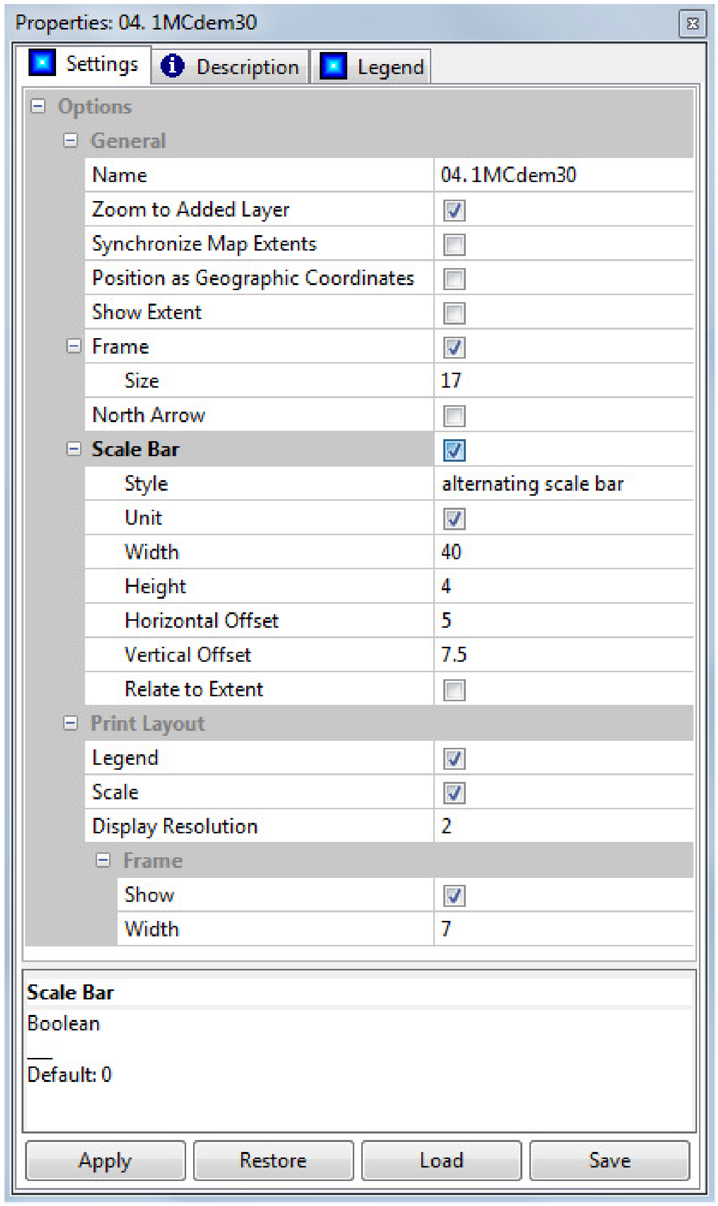


Figure 5-19. A map view window parameters list.

The parameters in Figure 5-19 are for a map view window named "04. 1MCdem30". The several parameters in the "General" section deal with how the map window reacts to the addition of a new layer, affects other map windows, and the coordinate display. Additional parameters support a north arrow, scale bar, and print layout display.

Maps are not stored in files like layers. Similar to layers, parameters related to map view windows listed in the Maps tab area, are saved as part of the configuration file (.cfg) upon exiting SAGA and in project files (.sprj) created during a work session. The parameters for a single map view window can be saved to a .sprm file using the Save button at the bottom of the Object Properties window. This is the same function available for saving the parameter settings for a single layer.

General: Name
This parameter is the name that SAGA uses for the map definition. The default is for the name to be the number (the order of the layer in the Data tab area list of layers) and layer name of the first layer that defines the map.

Here is an example map view window named ‘01. 1MCrelief’ in the Maps area of the Manager. The ‘1MCrelief’ grid layer was the first layer for the map view window. This grid layer in the Data tab data list area is the first one listed for its’ grid system. When I add a second layer, the polygon shape layer '1MCwaters-Poly', the text for General: Name does not change. The added layer lists in the layer stack in the first position as "02. 1MCwaters-Poly" and "1MCrelief" moves down in the list. The 'MCwaters-Poly' layer is the second one in the polygon shape area of the Data tab area of the Manager.

If I click on the value field to the right of the General: Name parameter, in the Settings tab area of the Object Properties window, with my mouse and highlight the text, I can enter a new name or edit the existing one. Figure 5-20 displays the map settings in the Object Properties window for the ‘01. 1MCrelief’ map.

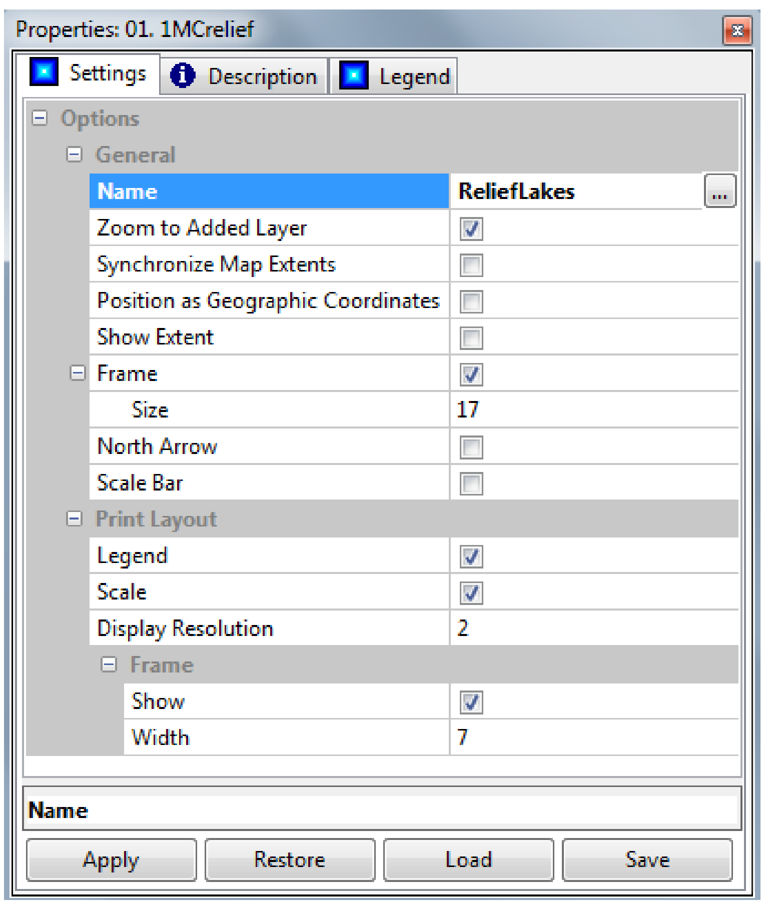


Figure 5-20. The map parameters settings for the ’01. 1MCrelief’ map.

I have entered new text in the ‘Name’ parameter value field. Notice that the Apply button is available at the bottom of the Object Properties window. When I click on the Apply button, the name I have entered will replace the default name ‘01. 1MCrelief’.

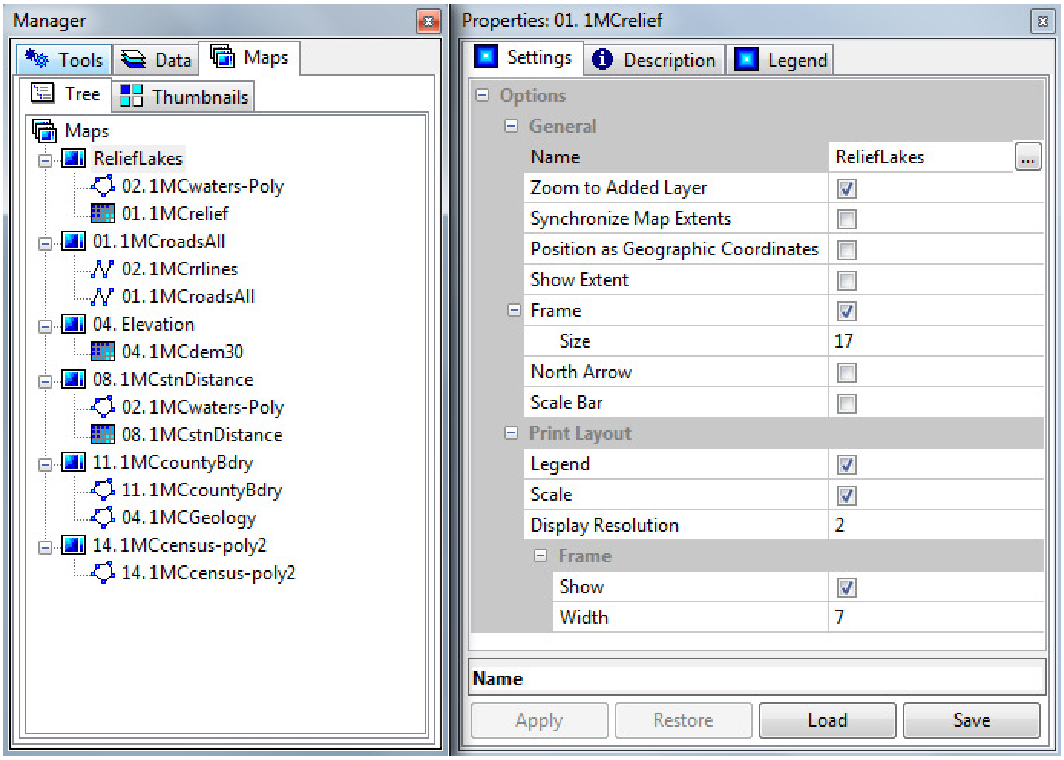


Figure 5-21. The Maps tab area of the Manager and Settings tab area of the Object Properties window after changing the ‘Name’ parameter.

The map definitions in the Maps tab area have been updated. The first map in the list is the one previously named ‘01. 1MCrelief’. Its’ name is now ‘ReliefLakes’. The map name parameter does not affect any text used with the map legend display. The map legend content is controlled by the layer parameters.

General: Zoom to added layer

This parameter affects whether the map extent of a map view window adjusts to the map extent of a layer added to it or not. This is a toggle check box parameter. The default setting is for the box to be on with a check visible in the box. If the parameter is on, when another layer is added to the map view window, the map view window extent will change to the map extent of the added layer, regardless of whether the need is to zoom in or zoom out. The status of the parameter can be toggled between on and off by clicking with the mouse in the checked box. When this parameter is off the map extent of the map view window will not change with the addition of a new layer. Whenever a change is made to a parameter, the Apply button must be clicked on for the change take effect.

Figure 5-22 displays an example of this parameter.

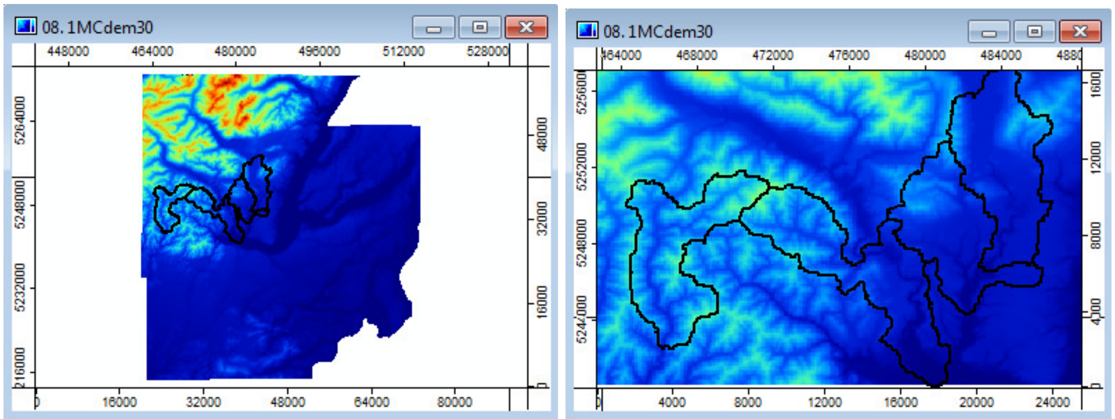


Figure 5-22. An example of using the ‘Zoom to added layer’ parameter.

While this parameter is off (i.e., no check in the check box), I add a polygon shape layer for four contiguous watersheds to the map view window on the left. I can see the watersheds outlines displayed in black.

I turned the parameter back on by clicking in the box. After removing the polygon shape layer for the four watersheds, I added it back. Instantly the map view window adjusted the view to the map extent of the added layer. I can see in the map view window on the right that the view is a zoomed in view using the watershed layer extent to limit the zoom.

General: Synchronize Map Extents

This is a very valuable display mode. I use it when I want the map extents of several map view windows in the work area to be coordinated.

For example, I have four map view windows in the display area. One of the map view windows includes a polygon shape layer for four contiguous watersheds. I want to zoom in on each of the watersheds and see the same zoomed in view for three other map view windows; one for roads, one for relief, and one for water bodies. With the map view window for the four watersheds active, the quick way is to turn the ‘Synchronize Map Extents’ parameter on for the map window. When I zoom in on one of the watershed polygons, the map extents for the other three map view windows will change to display the same zoomed in area. Whenever I change the zoom area for the watersheds map, the map extents for the other three map view windows adjust.

If I make the ‘Synchronize Map Extents’ parameter active for each of the maps, I can move from map to map and map extents would all adjust. I can disable the ‘Synchronize Map Extents’ parameter by clicking with the mouse in the toggle check box. The check mark will disappear indicating the parameter is off.

General: Position as Geographic Coordinates

The map view window must have a coordinate reference system definition for this parameter to perform. The map view window will have this definition if any layer in the map view window layer stack has a coordinate reference system or a ".prj" or georeference file.

The 'Position as Geographic Coordinates' parameter is a toggle box parameter. The default is for this parameter to be off. There is not a check mark displayed in the check box when this parameter is off. I can toggle the parameter on by clicking with the mouse in the check box with the mouse. A check mark appears in the box.

As the mouse pointer moves within the map view window, the coordinates displayed in the "X" and "Y" information fields at the bottom of the work space will be longitude for the "X" information field and latitude for the "Y" information field. The "Z" field is not affected by this parameter nor is any other map view window.

General: Show Extent
This extent is related to the spatial display of the map view window. The extent is defined by map coordinates for the top, bottom, left and right sides of the extent (a rectangular shaped box). This is a toggle check box parameter. When I turn this parameter to on status, the current extent for the map view displays as shadow bars on the left and right sides or the top and bottom sides.

I can use the "Zoom to Extent" option, on the Menu Bar Map menu, to view the coordinate definition of the map view extent. This option displays the 'Map Extent' dialog window. This window has four parameters: West, East, South, North.

The display of the north arrow and scale bar can be related to either the map view window or to the map extent (see Figure 5-25).

General: Frame
This is a toggle check box parameter. The default is for this parameter to be in on status with a check displayed in the box. A frame surrounding the map view window displays when this parameter is in on status. I can toggle the parameter to off status by clicking in the box with the mouse. I click on the Apply button at the bottom of the Object Properties window status for changes to take effect. The frame surrounding the map view window then disappears.

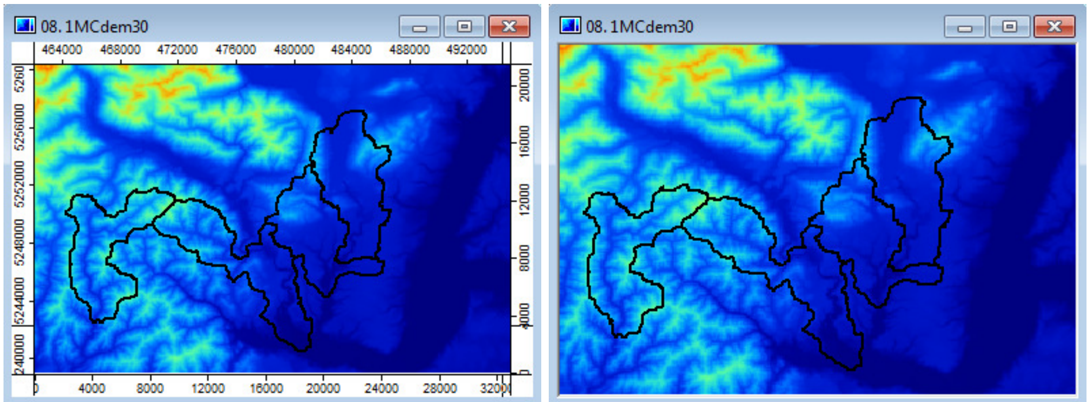


Figure 5-23. Displaying the map view window frame.

The map view window on the left, in Figure 5-23, displays with a surrounding frame. This is the default condition for this parameter. When I do not want the frame displayed, I click in the check box with the mouse, press the Enter key and click on the Apply button. When I click with the mouse on the Apply button, the map view window is updated as shown on the right in Figure 5-23.

General: Frame: Size

This numeric parameter sets the width of the frame for a map view window. The units for this entry are pixels. The default is 17. I can change this value by clicking the mouse pointer in the value field to the right of the parameter name. If I double-click in the field, the current entry is selected and highlighted. I key in a new number from the keyboard. After entering a new number I must press the Enter key on the keyboard and then click on the Apply button for the new number to take effect.

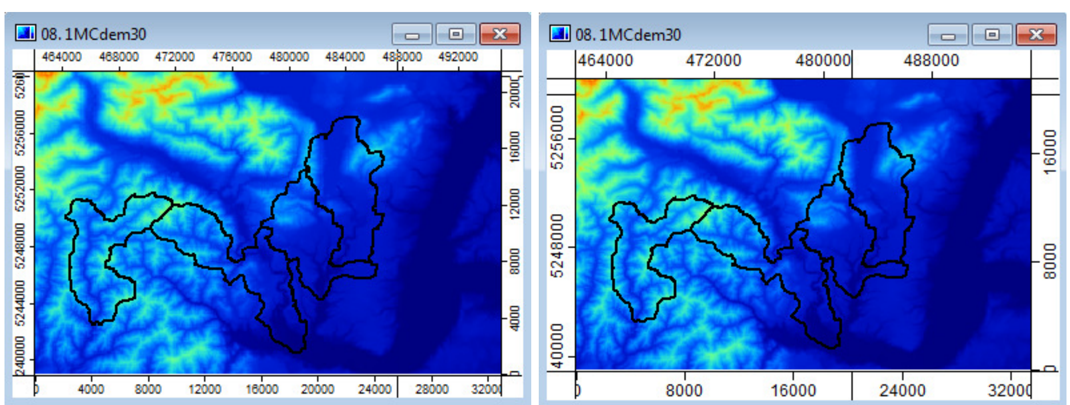


Figure 5-24. Comparing two frame widths, 17 and 22.

The map view window on the left in Figure 5-24 uses the default ‘Width’ parameter of 17. The window on the right uses a new value of 22.

General: North Arrow
The General: North Arrow parameter is a toggle check box parameter. If I want a north arrow displayed in a selected map view window, I toggle this parameter to on status by clicking in the toggle box. A check mark displays in the toggle box when the parameter is in on status. This parameter is in off status if a check mark is not displayed in the check box.

Five additional support parameters become available when the 'North Arrow' parameter is in on status.

General: North Arrow: Direction
Traditionally, a "North Arrow" is an indicator for the direction of north on a map. The entry for the 'Direction' parameter is in degrees and sets the direction the "North Arrow" will point. The default entry is 0 for north. An entry of 90 points the "North Arrow" to the east. Any numeric value between 0 and 360 can be entered.

General: North Arrow: Size
The size is entered as a percentage of map size. The default entry for the 'Size' parameter is 5. Entering a value of 10 results in a north arrow 4 times the size of one using 5.

General: North Arrow: Horizontal Offset, General: North Arrow: Vertical Offset
The numeric entries for these two parameters position the north arrow in the map view window. Entries are between 1 and 100 and represent percentage of map size. An entry of 1 for the 'Horizontal Offset' parameter places the north arrow on the western edge of the map view window. An entry of 100 places it on the eastern edge of the window. An entry of 10 places the north arrow about 10% of the distance from the western edge of the map view window.

An entry of 1 for the 'Vertical Offset' parameter places the north arrow on the south edge of the map view window. An entry of 100 places it on the north edge of the window. Entries between 1 and 100 place the arrow accordingly from south to north. An entry of 50 places the north arrow about half way between the north and south edges of the window.

General: North Arrow: Relate to Extent
It is probably easiest to understand 'Extent' to recognize that a map view window relates to two extents. One extent is the spatial coverage of the map view window. The other extent is for the map itself. The map view window extent changes when the scale is changed either by zooming in or out or by changing the physical size of the actual map view window.

The 'Extent' this parameter relates to is for the map. When this parameter is in off status, the percentage of map size measurements will relate to the map view window extent. When this parameter is in on status, the percentage of map size measurements will relate to the map extent rather than to the extent of the map view window. If you have a doubt as to what the map extent is, the 'Show Extent' parameter is used to display it in the map view window.

Figure 5-25 compares two map view windows and the use of the 'Relate to Extent' parameters for the north arrow and the scale bar.

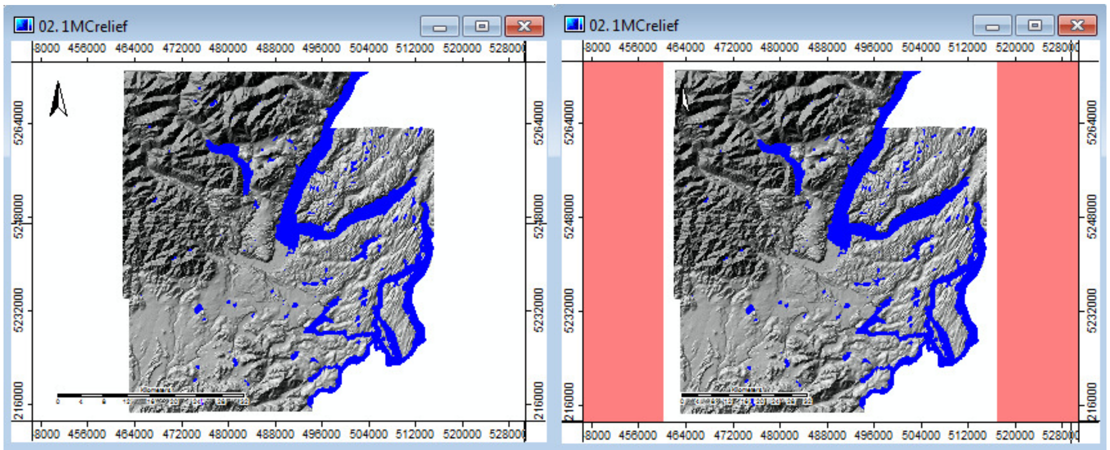


Figure 5-25. Comparing map view window extent and map extent.

Both map view window display the '1MCrelief' and '1MCwaters-Poly' layers. Both map view windows also include a north arrow and a scale bar. The north arrow and scale bar 'Relate to Extent' parameters are in off status in the map view window on the left. I can see that the entries for the 'Horizontal Offset' parameters, for the two features, relate to the left side of the map view window. I am displaying the map extent using the 'Show Extent' parameter in the right map view window. This makes it easy to see that the 'Horizontal Offset' parameters now relate to the map extent and not to the map view window sides.

General: Scale Bar

The General: Scale Bar parameter is a toggle check box parameter. If I want a scale bar displayed in a selected map view window, I toggle this parameter to on status by clicking with the mouse in the toggle box. A check mark displays in the toggle box when the parameter is in on status. This parameter is in off status if a check mark is not displayed in the check box. Following a change to the check box status I click on the Apply button at the bottom of the Object Properties window for the change to take effect.

Figure 5-26 displays an example of the use of a scale bar. The parameter settings are displayed to the right of the map view window.

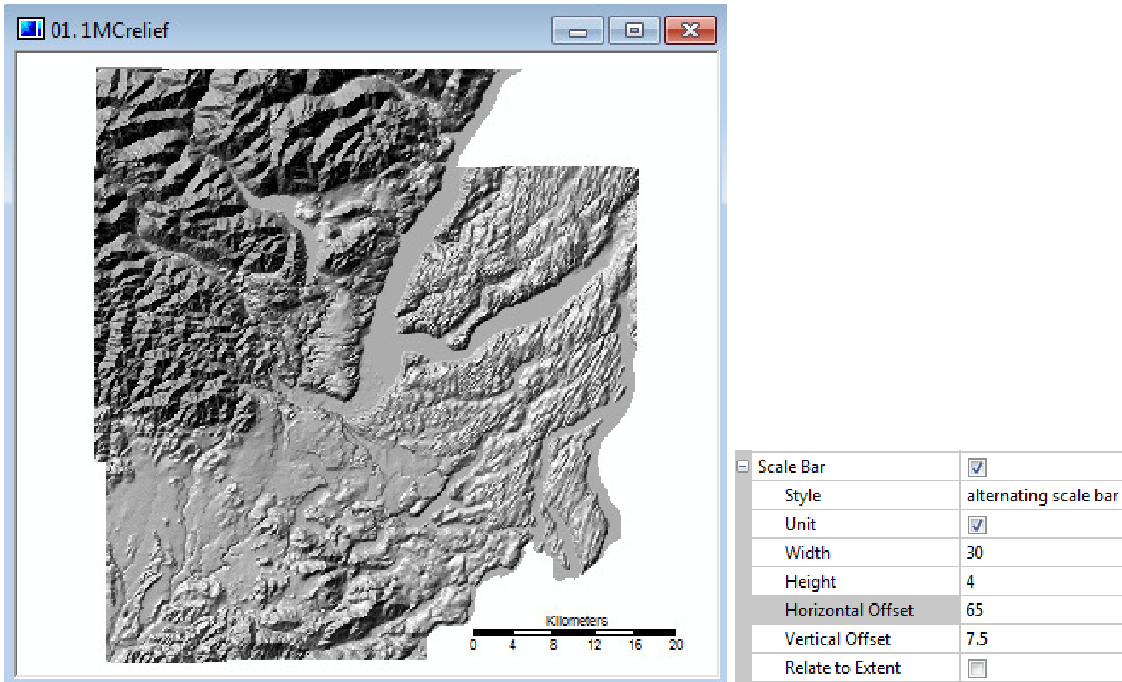


Figure 5-26. An example of using the "Scale Bar".

Seven support parameters become available when the Scale Bar' parameter is in on status.

There may be a problem with how SAGA calculates the map scale for the map extent. The scale bar scale displayed without the extent displayed is accurate and matches to the map distance units. When the scale bar is related to the extent, the scale appears to be in error.

General: Scale Bar: Style

Two options are available for the General: Scale Bar: Style parameter. They are alternating scale bar and scale line. The "alternating scale bar" is the default entry for the parameter. An example of the "alternating scale bar" option is in Figure 5-26 and an example for "scale line" is in Figure 5-27.

General: Scale Bar: Unit

This is a toggle check box parameter. When this parameter is in on status, the units of measurement for the map view window display above the scale bar, e.g., "Kilometers" as in Figures 5-26 and 5-27. The units of measurement do not display if this parameter is in off status.

General: Scale Bar: Width

The width of the scale bar, as a percentage of map size, is entered for this parameter. This value is between 1 and 100. The entry for this parameter is a factor in calculating an entry for the 'Horizontal Offset' parameter. The entries for the 'Width' and 'Horizontal Offset' parameters cannot total more than 100. The scale bar displayed in Figure 5-26 uses an entry of 30 for this parameter.

General: Scale Bar: Height
The numeric entry for this parameter is percentage of map size. In Figure 5-26 I used an entry of 4 for this parameter; in Figure 5-27 I used an entry of 8.

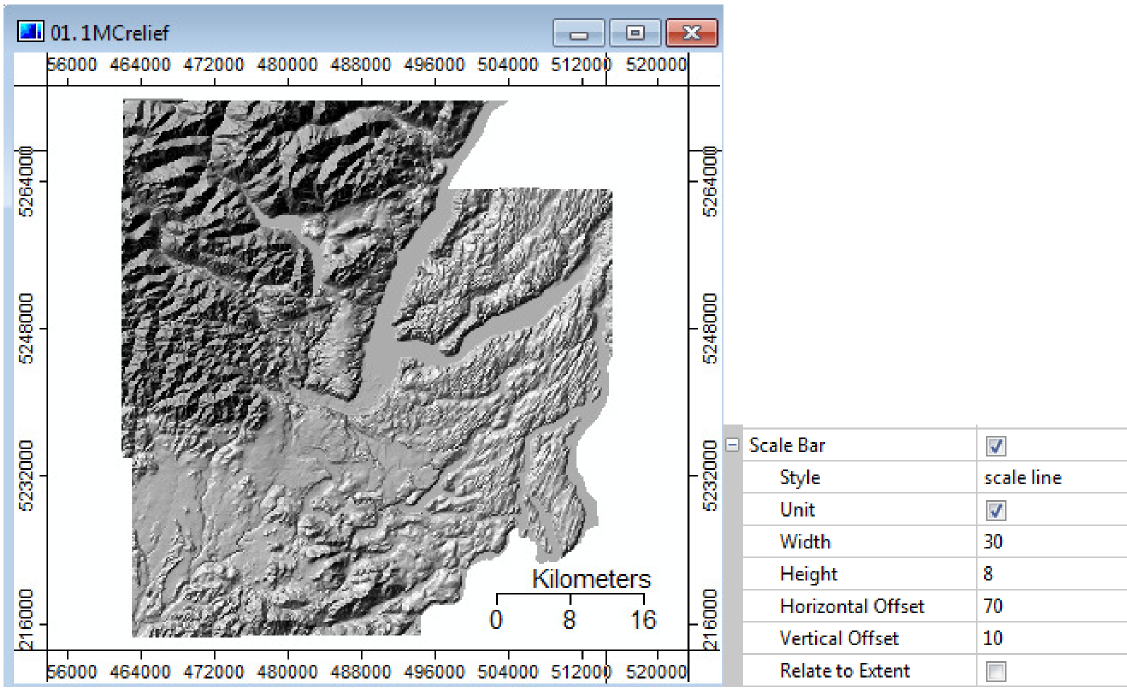


Figure 5-27. An example of using a "scale line" scale bar.

General: Scale Bar: Horizontal Offset, General: Scale Bar: Vertical Offset
The numeric entries for these two parameters position the scale bar in the map view window. Entries are between 1 and 100 and represent percentage of map size. The entry for the 'Width' parameter is a factor when entering a value for the 'Horizontal Offset' parameter. The units used for the 'Width' and 'Horizontal Offset' parameters are the same, percentage of map size.

The entry for the 'Horizontal Offset' is from the left side of the scale bar. This means that the width of the scale bar plus the entry for the 'Horizontal Offset' cannot exceed 100. For example, if I enter 50 for the width of the scale bar, I must enter a value less than 50 for the 'Horizontal Offset' parameter. Otherwise, if the value is, e.g., 60, 10% of the scale bar will extend past the right side of the map view window.

An entry of 1 for the 'Vertical Offset' parameter places the scale bar on the south edge of the map view window. An entry of 100 places it on the north edge of the window. Entries between 1 and 100 place the scale bar accordingly from south to north.

I included the parameters and their entries for the scale bar display in Figure 5-26 and Figure 5-27.

General: Scale Bar: Relate to Extent
The 'Extent' this parameter relates to is the spatial coverage of the map. When this parameter is in off status, the percentage of map size measurements will relate to the map view window extent. When this parameter is in on status, the percentage of map size measurements will relate to the map extent rather than to the extent of the map view window. If you have a doubt as to what the map extent is, the 'Show Extent' parameter is used to display it in the map view window. Figure 5-25 displays two map view windows related to how the 'Relate to Extent' parameter work.

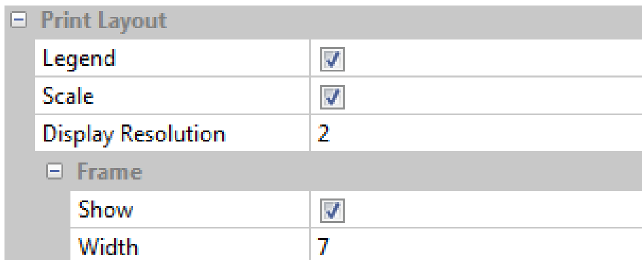


Figure 5-28. The "Print Layout" category of parameters.

The "Print Layout" section includes five parameters. These parameters affect how a print layout window displays in the work area.

Print Layout: Legend
This toggle check box parameter is in on status when a check mark displays in the check box. I can toggle this parameter to off status by clicking with the mouse pointer in the check box removing the check mark.

I display a print layout window by choosing the "Show Print Layout" option from the Menu Bar Map menu or by right-clicking on the map name in the Maps tab area and choosing the "Show Print Layout" option from the popup list of options. When the 'Show Legend' parameter is in on status for the map view window, a map legend for the maps displays. The legend information for all of the layers in the stack of layers displays. The exception is if the 'Show Legend' parameter for a layer is in off status, the legend for the layer is excluded.

Print Layout: Scale
A map scale (representative fraction) for the map layout window displays below the frame on the left side of the print layout window. The check box in the value field to the right of the ‘Scale’ parameter controls whether the scale displays. The default is for a check to appear in the toggle check box. I can turn off display of the scale by moving the mouse pointer into the box, and pressing the left mouse button. This removes the check mark from the check box. I click on the Apply button at the bottom of the Object Properties window for the change to take effect.

Print Layout: Display Resolution
This setting is used to improve the display resolution for a print layout window. The default is 2. The lowest resolution setting is 1. Numbers greater than 1 result with a

higher resolution display for a print layout window for both visual display and printing hardcopy.

Print Layout: Frame: Show
This parameter is similar to the one with the same name discussed earlier related to map view windows. Here, this parameter is used to control whether the frame for a print layout window displays or not.

Print Layout: Frame: Width
The entry for this parameter sets the width of the frame display within a print layout window. The units are pixels.

Introduction to the "Add Graticule" and "Add Base Map" Options
The "Add Graticule" and "Add Base Map" options are accessed from the Menu Bar Map menu and from a map view window name in the Maps tab area of the Manager. They do not have parameters in the Object Properties window until they display as a layer in the layer stack of a map view window. The user can select the 'Graticule' or 'Base Map' layer name in the layer stack for a map and the parameters for the layer display in the Settings tab area of the Object Properties window.

Map: Add Graticule, Map view window: Add Graticule
Graticules are lines showing parallels of latitude and meridians of longitude for a map. A graticule can be added to a map view window as a layer if the map view window has a coordinate reference system. The information for the coordinate reference system is used to determine latitude and longitude coordinates.

When the "Add Graticule" option is chosen, a new layer named 'Graticule' is added at the top of the layer stack for the map view window. I can click on the name 'Graticule' and view a set of supporting parameters in the Settings tab area of the Object Properties window. There are three categories of parameters: General, Display and Label.

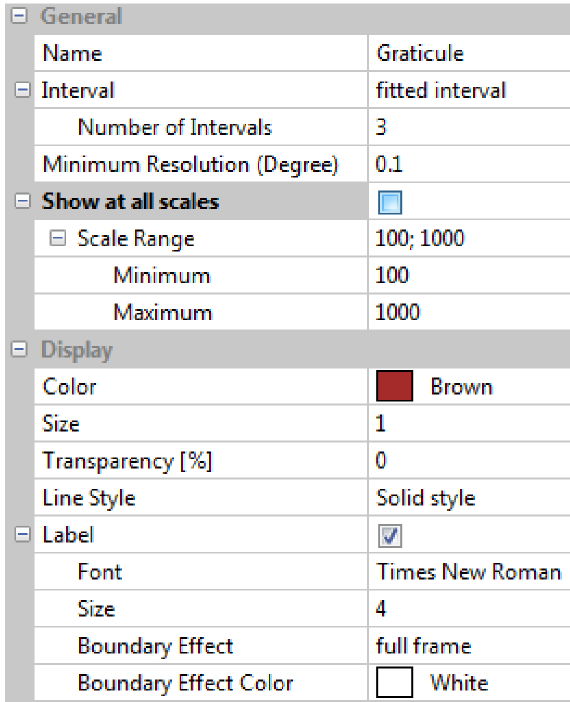


Figure 5-29. The parameters for the 'Graticule' layer.

There are four parameters in the "General" section of the parameters supporting the 'Graticule' layer in the Settings tab area of the Object Properties window. The "Display" section includes four parameters and the "Label" section includes another four parameters. All of these parameters support the display of graticules in a map view window.

The graticule layer is added to the layer stack for the map as the top layer in the stack.

Graticule: General: Name

The 'Name' parameter functions the same as it does for other layers. The default entry is "Graticule". This text can be edited. This name appears in the map view window definition in the Maps tab area of the Manager. This is the name the SAGA software references for the layer.

Graticule: General: Interval

This parameter has two options related to the degree interval displayed for the latitude and longitude coordinates. The two options are fitted interval and fixed interval. The default entry is "fitted interval".

Using the "fitted interval" option, the entry for the 'Number of Intervals' parameter determines the interval spacing for parallels and meridians for the current zoom level of the map view window. When the map view window is zoomed in or zoomed out the number of parallels and meridians does not change.
The "fixed interval" option uses the entry for the 'Fixed Interval (Degree)' parameter to identify the degree interval for parallels and meridians display. An entry of 5 means a

graticule every 5 degrees (north-south, east-west). An entry of 1 sets the interval spacing to 1 degree intervals for displaying graticules. The interval spacing does not change for a zoomed in or zoomed out map view window but the number of parallels and meridians that display will adjust accordingly.

Graticule: General: Fixed Interval (Degree)
This parameter supports the "fixed interval" option for the 'Interval' parameter. See the description for the Graticule: General: Interval parameter. The default entry for this parameter is 5.

Graticule: General: Number of Intervals
This parameter supports the "fitted interval" option for the 'Interval' parameter. See the description for the Graticule: General: Interval parameter. The default entry is 5.

Graticule: General: Minimum Resolution (Degree)
I explored different entries for this parameter but could not discern any change in output.

Graticule: General: Show at all scales
This is a toggle check box type parameter. The default is for this parameter to be in on status. The graticule layer displays at any scale when this parameter is on (has a check in the box). I can change this parameter to off status by moving the mouse pointer into the box and pressing the left mouse button. The check mark in the box disappears and three additional parameters display just below the 'Show at all scales' parameter.

Graticule: General: Show at all scales: Scale Range, Minimum, Maximum
One of the three additional parameters is 'Scale Range'. Supporting 'Scale Range' are parameters for setting a minimum for scale range ('Minimum') and a maximum for scale range ('Maximum'). The values entered for the 'Minimum' and 'Maximum' parameters define the scale range (the minimum map scale and the maximum map scale) for a map view window within which the graticule layer displays. Graticules do not display if the scale of the map view window is outside the defined scale range.

The values entered for these parameters are in map units. If the scale bar available on the tool bar is not active in the map view window, the bottom and right sides of a map view window display map unit tics. Graticules will display in the map view window if the range for either the bottom or right scales (whichever one is the least) is greater than the minimum and less than the maximum.

For example, I have a map view window displaying a grid layer. The map distance range for the bottom side of the window is 72000; the range for the right side is 62000. The map distance range of 62000 is the lesser of the two. I enter 15000 for the 'Minimum' and 70000 for the 'Maximum'. I zoom out changing the map distance range to over 89000. The Graticule does not display in the window. I choose the "Zoom to Previous Map Extent" option. Now I zoom in. When the map distance range reaches less than 15000, the Graticule should not display. I have zoomed in a couple times, the current map distance range is 18000. I zoom in one more time, the range changes to 8800, less than 15000. The Graticule does not display in the window.

Graticule: Display: Color
The color for the graticule parallels and meridians display is chosen with this parameter. I move the mouse pointer over the color swatch displayed in the value field to the right of the 'Color' parameter (or anywhere in the value field) and press the left mouse button. A dropdown list of color swatches/names displays. I move the mouse pointer over the color I want to use and press the left mouse button. The color is chosen. I click the mouse pointer over the Apply button at the bottom of the Object Properties window and graticule line color in the map view window changes to the color I chose.

Graticule: Display: Size
The size or thickness for the graticule parallels and meridians display is chosen with this parameter. The default entry is 0. An entry of 0 defaults to 1. I click the mouse pointer twice in the value field to the right of the 'Size' parameter. The current entry in the value field is highlighted. I key in a new value from the keyboard. I press the enter key on the keyboard and click the mouse pointer on the Apply button at the bottom of the Object Properties window. The graticule line thickness in the map view window changes to the entry value.

Graticule: Display: Transparency [%]
The default entry for this parameter is 0. Using 0 means that the graticule lines are fully opaque. That is, they block any map view window content they cross. The line can be set to various levels of transparency by entering a percent number between 1 and 100 in the value field to the right of the 'Transparency [%]' parameter. A value of 100 means 100 percent transparency effectively causing the lines to disappear. A value of 50% results with a balance between the line opaqueness and being able to see map view window content the graticules overlay.

Graticule: Display: Line Style
This parameter sets the line style used for displaying the graticules. The default is the "Dot and dash style". There is a solid style as well as variations for dot and dash and there are a set of diagonal cross-hatch styles.

Line style is chosen in a similar manner as color and size is chosen for the 'Color' and 'Size' parameters above.

I click the mouse pointer in the value field to the right of the 'Line Style' parameter. A dropdown list of line style options displays. I move the mouse pointer over the style I want to use and press the left mouse button. I click the mouse pointer on the Apply button at the bottom of the Object Properties window. The graticule line style in the map view window changes to the new one I chose.

Graticule: Label: Font
The default entry in the value field to the right of the 'Font' parameter is "Arial". I click on the ellipsis symbol that displays in the value field and a 'Font' dialog window displays. This window allows me to choose a new font type, font style, and a number of other font characteristics related to display. There is an option in this window for choosing font size but the entry for this option is ignored and the entry for Graticule: Lable: Size is used.

Graticule: Label: Size
The default entry for this parameter is 2. This value represents "as percentage of map size". The minimum accepted value is 0 and the maximum accepted value is 10. Once I enter a value I must click on the Apply button for the change to take effect in the map view window. Remember that the entry for this parameter determines the label size and the font size entered in the 'Font' dialog window discussed above is ignored.

Graticule: Label: Boundary Effect
There are 10 options available for the 'Boundary Effect' parameter. A boundary effect is directional or from all directions. Essentially, it is an enhancement of the edges of the graticule label numbers either from a specific direction or from all directions. The default entry for this parameter is "none". In addition to the "full frame" option, there are options for top and bottom and right and left around the label.

Graticule: Label: Boundary Effect Color
The edge enhancement of labels can also include color. I move the mouse pointer over the color swatch displayed in the value field to the right of the 'Boundary Effect Color' parameter (or anywhere in the value field) and press the left mouse button. A dropdown list of color swatches/names displays. I move the mouse pointer over the color I want to use and press the left mouse button. The color is chosen. I click the mouse pointer over the Apply button at the bottom of the Object Properties window and the edges of graticule labels, in the map view window, change to the color I chose. The type of effect depends on the option for the 'Boundary Effect' parameter.

Map: Add Base Map, Map view window: Add Base Map
A base map can be added to a map view window as a layer if the map view window has a coordinate reference system. The coordinate reference system and the map view window map extent are used to query a map tile from a Tile Map Server (TMS). In general, TMS is a protocol for serving maps as tiles based on map extent inputs.

The SAGA support team emphasizes the user should read and understand the usage agreements or terms of service before using one of the server options of the 'Server' parameter.

I choose the "Add Base Map" option, from either location, the 'BASEMAP' dialog window in Figure 5-30 displays.

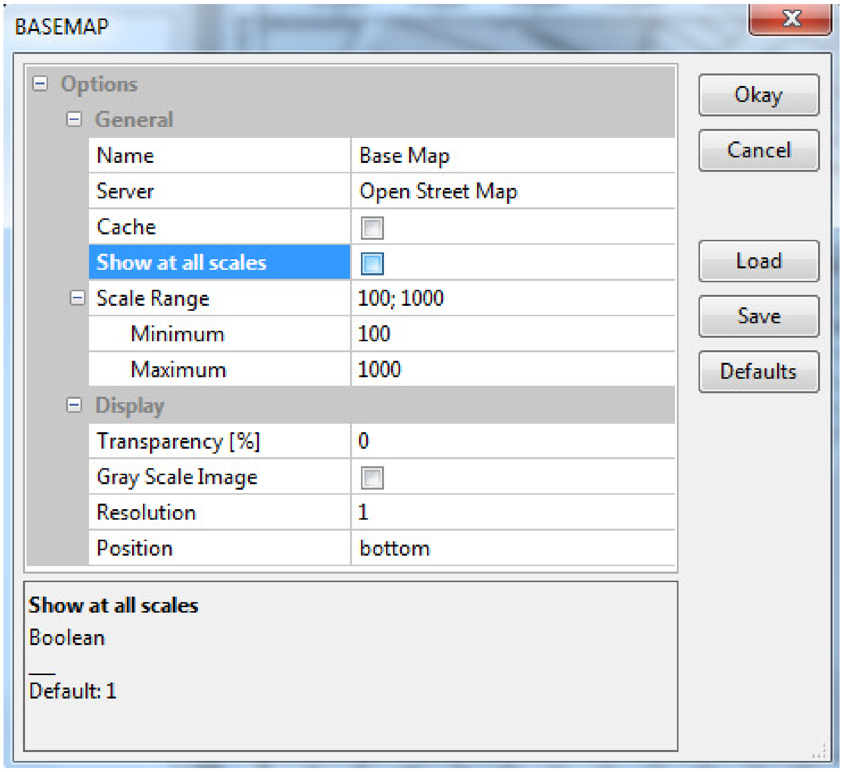


Figure 5-30. The 'BASEMAP' dialog window.

Base Map: General: Name
The 'Name' parameter is used for giving a name to a base map layer that becomes part of the layer stack for the map view window. I notice an ellipsis on the right side of the value field to the right of the 'Name' parameter. I can access a 'Name' data entry window by clicking with the mouse on the ellipsis. It serves the same purpose as entering a name (or other text) directly into the value field without using the 'Name' data entry window.

Base Map: General: Server
The default entry for the 'Server' parameter is "Open Street Map". Other options include:

Google Map
Google Satellite
Google Hybrid
Google Terrain
Google Terrain, Streets and Water
ArcGIS MapServer Tiles
user defined

The "Open Street Map" option accesses the Open Street map of the world. It is available under an open-content license. The map is free and has largely been created through volunteer efforts. The other options are from Google and ESRI.

Base Map: General: Cache
This is a toggle check box parameter. The default is for it to be in off status. The box will be empty in off status and will have a check in it when in on status. I can toggle the box from off to on by clicking the mouse pointer in the box. A check mark will then appear in the box.

What is file caching? File caching involves the swapping of data between storage and memory as needed for computations. Operations involving large amounts of data can continue. The performance may be degraded, for example, computation time may be extended because of the ongoing data swapping.

Parameters supporting file caching are accessed in the Data tab area of the Manager. These parameters are discussed in Chapter 8 of this User Guide.

Base Map: Cache: Cache Directory
This parameter supports the 'Cache' parameter. This parameter identifies a directory path and folder for the storage of temporary cache files. I click with the mouse pointer in the value field to the right. An ellipsis appears and I click on it. A 'Choose Directory' dialog window displays. I can navigate or browse to the storage location I want to specify for temporary cache file storage. When the path and folder name display, I click on it and the path and folder name are copied into the value field to the right of the 'Temporary files' parameter. I click on the Apply button at the bottom of the Object Properties window and the change takes effect.

Base Map: General: Show at all scales
This is a toggle check box type parameter. The default is for this parameter to be in on status. The 'Base Map' layer displays at any scale when this parameter is on (has a check in the box). I can change this parameter to off status by moving the mouse pointer into the box and pressing the left mouse button. The check mark in the box disappears and three additional parameters display just below the 'Show at all scales' parameter.

Base Map: General: Show at all scales: Scale Range, Minimum, Maximum
One of the three additional parameters is 'Scale Range'. Supporting 'Scale Range' are parameters for setting a minimum for scale range ('Minimum') and a maximum for scale range ('Maximum'). The values entered for the 'Minimum' and 'Maximum' parameters define the scale range (the minimum map scale and the maximum map scale) for a map view window within which the 'Base Map' layer displays. The 'Base Map' does not display if the scale of the map view window is outside the defined scale range.

The values entered for these parameters are in map units. If the scale bar available on the tool bar is not active in the map view window, the bottom and right sides of a map view window display map unit tics. The 'Base Map' will display in the map view window if the range for either the bottom or right scales (whichever one is the least) is greater than the minimum and less than the maximum.

For example, I have a map view window displaying a grid layer. The map distance range for the bottom side of the window is 72000; the range for the right side is 62000. The map distance range of 62000 is the lesser of the two. I enter 15000 for the 'Minimum' and 70000 for the 'Maximum'. I zoom out changing the map distance range to over 89000. The 'Base Map' does not display in the window. I choose the "Zoom to Previous Map Extent" option. Now I zoom in. When the map distance range reaches less than 15000, the 'Base Map' should not display. I have zoomed in a couple times, the current map distance range is 18000. I zoom in one more time, the range changes to 8800, less than 15000. The 'Base Map' does not display in the window.

Base Map: Display: Transparency [%]
The default entry for this parameter is 0. Using 0 means that the 'Base Map' layer is fully opaque. A value of 100 for this parameter means the layer is fully transparent and actually appears invisible. Note that the default position for the 'Base Map' layer, when first displayed in the map view window, is at the bottom of the layer stack.

If the entry for the parameter is 0, a layer below the 'Base Map' in the layer stack for the map view window is blocked from view. It would be logical for the 'Base Map' to be the bottom layer of the layer stack. If not, and there is a layer below the 'Base Map' in the layer stack and I want it to be partially visible, I can enter a value between 1 and 100 to give the 'Base Map' an acceptable level of transparency. This allows the other layer to be somewhat visible as well as for the 'Base Map' to be somewhat visible. A good balance is to enter 50 for this parameter.

Base Map: Display: Gray Scale Image
This is a toggle check box parameter. A check mark in the box means the parameter is on and the 'Base Map' layer will display in the map view window as a gray scale map or image. If a check mark does not appear in the box, the parameter is off and the 'Base Map' displays using its available display color (which could be gray scale if displaying relief).

Base Map: Display: Resolution
Screen resolution is measured in screen pixels or picture elements. The default (and the minimum value) is 1. A number larger than 1 has the effect of generalizing the resolution, i.e., the resolution is lower. The highest level of resolution is the default entry of 1. The purpose of this parameter is to improve the screen display.

Base Map: Display: Position
The "Add Base Map" option on the Menu Bar Map title includes the parameter named 'Position'. The "Add Base Map" option accessed in the Maps tab area of the Manager does not include this option.

The 'Position' parameter has two options: top or bottom. The "top" option is used when you want the 'Base Map' to be the topmost layer in the layer stack and the "bottom" option us used when you want the layer to be the one at the bottom of the stack. Regardless of how I use this option (or don't use it if I access "Add Base Map" from the

Maps tab) I can use the standard "move" commands for moving a layer up in the layer stack or down in the layer stack if I need to re-arrange its position.

Chapter 6 – The Menu Bar Map Menu

When I first execute SAGA, a work session starts up. How a new workspace appears depends on parameter settings and how the previous SAGA work session was exited. If I start up SAGA and choose the "[empty]" option on the 'Select Startup Project' dialog window, no layers are loaded and it is an empty work session. The menus on the Menu Bar are File, Geoprocessing, and Window.

Menu Bar: Map

I proceed to load a few layers and they appear in the list in the Data tab area of the Manager. I decide I want to display one of the layers in the work area. I double-click on the layer and a map view window appears in the work area. I also notice that a new menu appears on the Menu Bar named Map (see Figure 6-1). This menu displays on the Menu Bar when there is an active map view window in the work area. It is also the default additional menu when the work area is empty but a map view window previously existed.

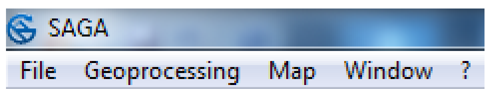


Figure 6-1. The Menu Bar Map menu.

This chapter focuses on the various functions and features related to new and existing map view windows. All of these functions and features have parameters that influence how they are used and how they display. These parameters are explored in Chapter 5 of this Guide. There is some overlap between this chapter and Chapter 5.

Figure 6-2 displays a list of functions and features available in the Menu Bar Map dropdown list of options. A similar list of functions and features available for map view windows defined in the Maps tab area displays in Figure 6-3. There are functions and features shared by both lists but each list also includes unique options.

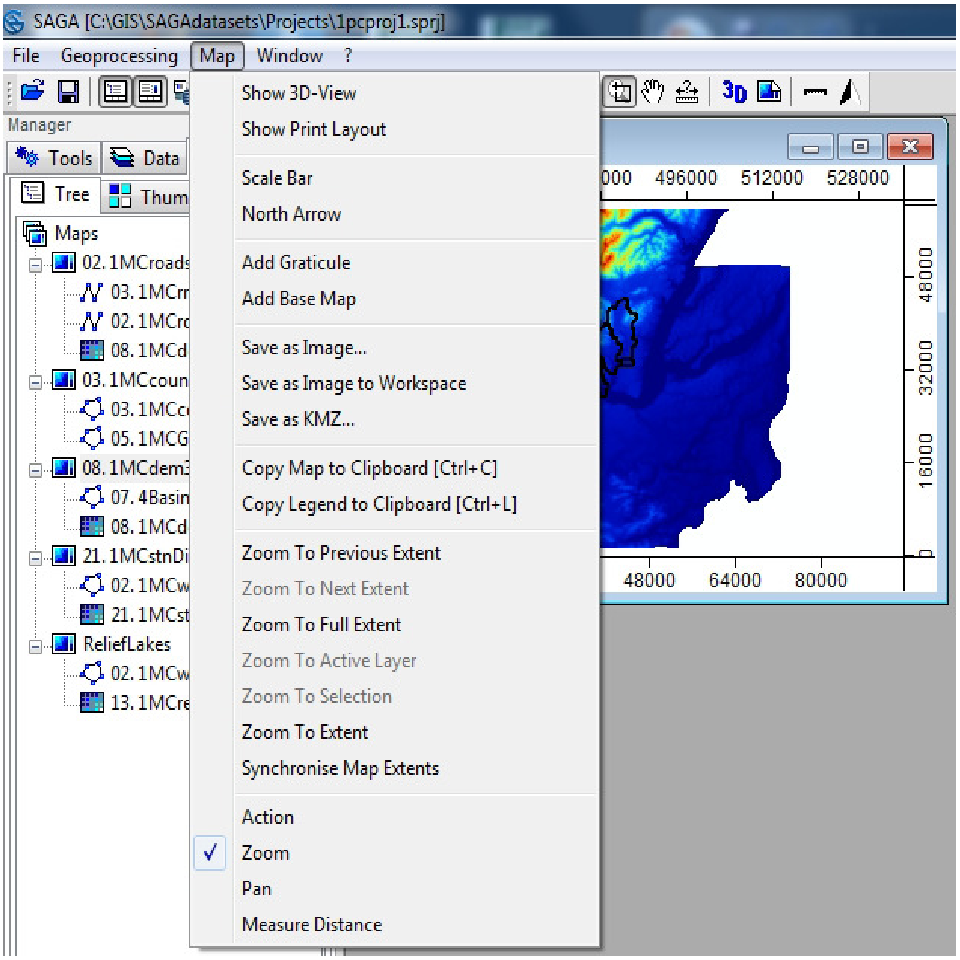


Figure 6-2. The Map menu dropdown list of options.

Maps Tab

Figure 6-3 displays the list of functions and features available from map view window definitions in the Maps tab area of the Manager.

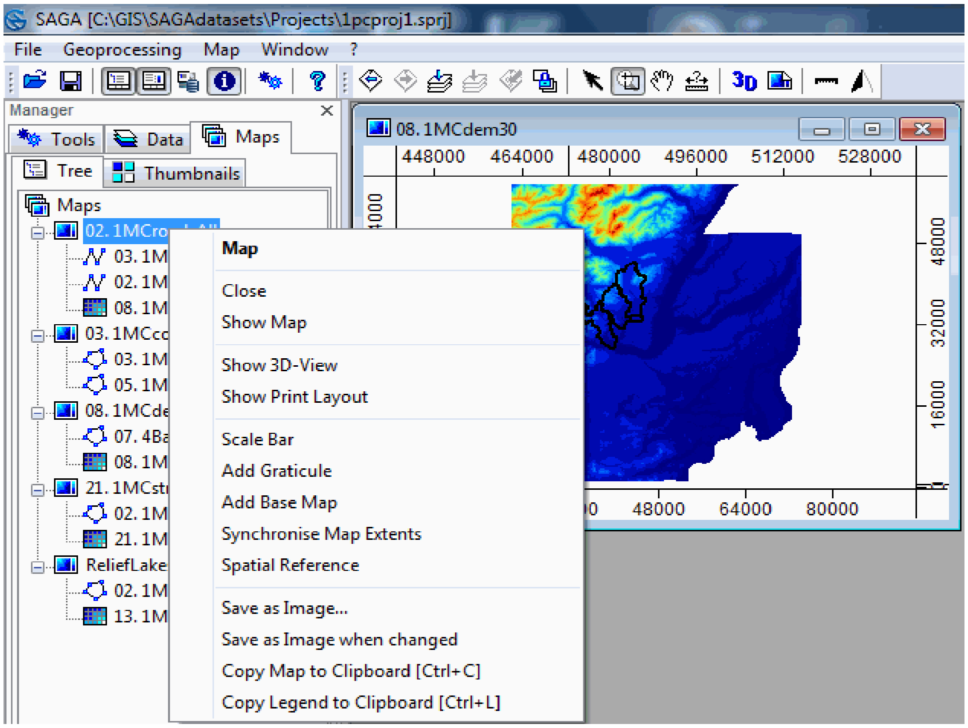


Figure 6-3. Map view window options list.

There are nine functions common to both option lists. I will describe these first. They are: Show 3D-View, Show Print Layout, Scale Bar, Add Graticule, Add Base Map, Save as Image..., Copy Map to Clipboard, Copy Legend to Clipboard and Synchronize Map Extents. Following this section, the unique features are described for the Map menu followed by a similar description of the unique features in the Maps tab list.

When the Map menu is added to the Menu Bar, a topical set of icons updates the toolbar (Figure 6-4).

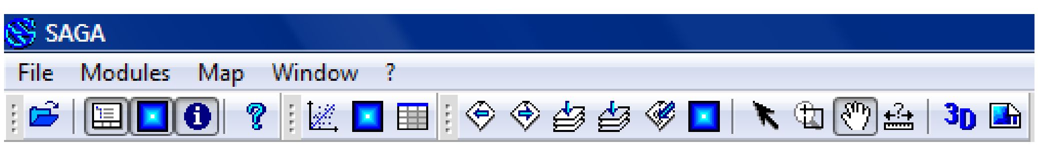


Figure 6-4. Map menu option icons added to the toolbar.

Here is a cross-reference between these new icons and Menu Bar options described in this chapter.

Zoom to Previous Extent

Zoom to Next Extent

Zoom to Full Extent

Zoom to Active Layer

Zoom to Selection

Synchronize Map Extents

Action

Zoom

Pan

Measure Distance

3D-View

Show Print Layout

Scale Bar

North Arrow

Let's begin the discussion of the nine common features for the two lists of options.

Map: Show 3D-View, Maps Tab: Show 3D-View
A map view window displays a two-dimensional view of one or more layers. This view is a flat or plan view with various color display options portraying data values and features. This is the normal SAGA viewing mode for a layer or layers as a map.

The three-dimensional view of a map is a perspective view of the layer or layers, normally created using an elevation grid layer as the basis of a 3D model. The elevations provide the perspective data of the view or topography. The layers of the map view window are overlain on the 3D model and provide the color part representing non-elevation data.

It is important to understand that the elevation grid layer does not have to be one of the layers in the map view window. If it is not one of the layers in the stack of layers for the map view window, the 3D view window may not include a visible topographic reference. The layers in the map view window will be draped over a topographic model, but the model itself "appears" invisible. Let's look at an example.

In Figure 6-5, the 3D view window on the left is for a map view window that does not include the elevation layer in the layer stack while the 3D view window on the right does include the elevation layer in the layer stack.

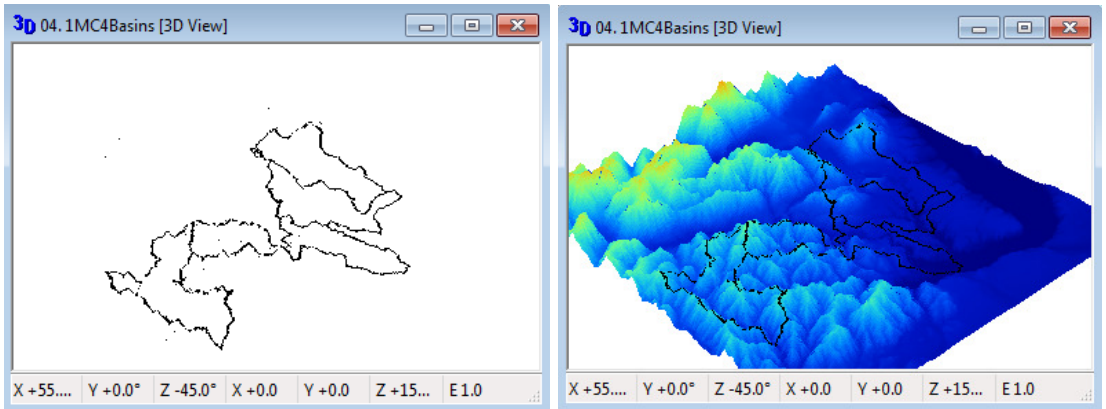


Figure 6-5. Comparing 3D views with and without displaying the elevation layer.

Both 3D views in Figure 6-5 use the '1MCdem30' grid layer as the basis of a 3D model. The parameters for the 3D perspective are the same for both windows. The black lines are watershed boundaries. I can see that the perspective portrayal of the watershed boundaries is identical for both views. Including the elevation layer in the map view window provides a better visual interpretation of the perspective.

When using the "Show 3D-View" option on the Menu Bar Map menu, a map view window must appear in the work area. If more than one map view window displays in the work area, the active window is the subject of the 3D view. The "Show 3D-View" option in the Maps tab area is chosen with the name of an existing map view window. It is not necessary that the map view window display in the work area although it is convenient using the map view window displayed for zooming in and out on corresponding areas of the 3D view window.

When I click on the "Show 3D-View" option, the '3D-View' properties window displays. This window is used to identify the grid layer that provides elevation data values and to set display parameters for the three-dimensional view. The 3D view capability is explained in detail in Chapter 7.

Map: Show Print Layout, Maps Tab: Show Print Layout

There are three ways to display a print layout view of a map view window. The "Show Print Layout" icon () on the toolbar can be selected with the mouse. The "Show Print Layout" option on the Menu Bar Map list of options can be chosen. The "Show Print Layout" option available in the Maps tab area of the Manager can be chosen by right-clicking with the mouse on a map view window name and choosing the function from the popup list of options.

Using one of the three ways described above, a layout view window displays in the work area. A new menu name, Layout, appears on the Menu Bar (see Figure 6-6).

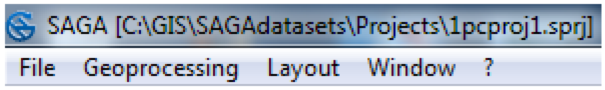


Figure 6-6. The Layout menu on the Menu Bar.

The Layout menu displays on the Menu Bar whenever a layout window is the active window for the work area.

Map: Add Scale Bar, Maps Tab: Add Scale Bar

This option adds a scale bar to a map view window. The scale bar style, location, and other characteristics are determined by how the scale bar parameters are set. Figure 6-7 displays an example of a scale bar for a slope grid layer. The scale bar parameter settings are displayed on the right in the same figure.

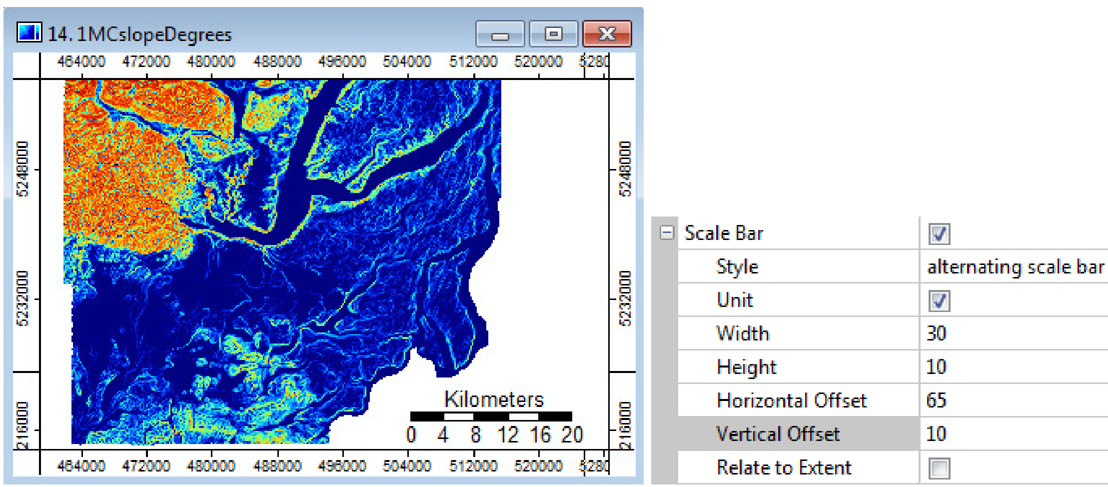


Figure 6-7. Using a scale bar with a slope grid layer.

There are two options for the 'Style' parameter: alternating scale bar (the style used in Figure 6-7) and scale line. The 'Unit' toggle check box parameter controls whether the units displays above the scale bar or do not display. In this example, the units are "Kilometers". The parameter is in on status (a check mark displays in the check box) and "Kilometers" displays above the scale bar.

The entries for the 'Width', 'Height', and offset parameters are percentage of map size. The width of the scale bar is 30 percent of map width distance. The entry for the 'Horizontal Offset' parameter is 65 percent. The scale bar is located starting at 65 percent of the map width distance. The scale bar itself is 30 percent of the map width distance. This is a total of 95 percent. There is a 5 percent space left following the right side of the scale bar. Vertically, from south to north, the scale bar displays at 10 percent of the map height distance. Any value less than 10 percent and the scale bar numbers would start to fall below the inner map frame.

Map: Add Graticule, Maps Tab: Add Graticule

Graticules are lines showing parallels of latitude and meridians of longitude for a map. A graticule can be added to a map view window as a layer if the map view window (or any layer in the map view window) has a coordinate reference system. The information for the coordinate reference system is used to determine latitude and longitude coordinates. A graticule layer has been added to the shaded relief grid layer '1MCrelief' map view window in Figure 6-8.

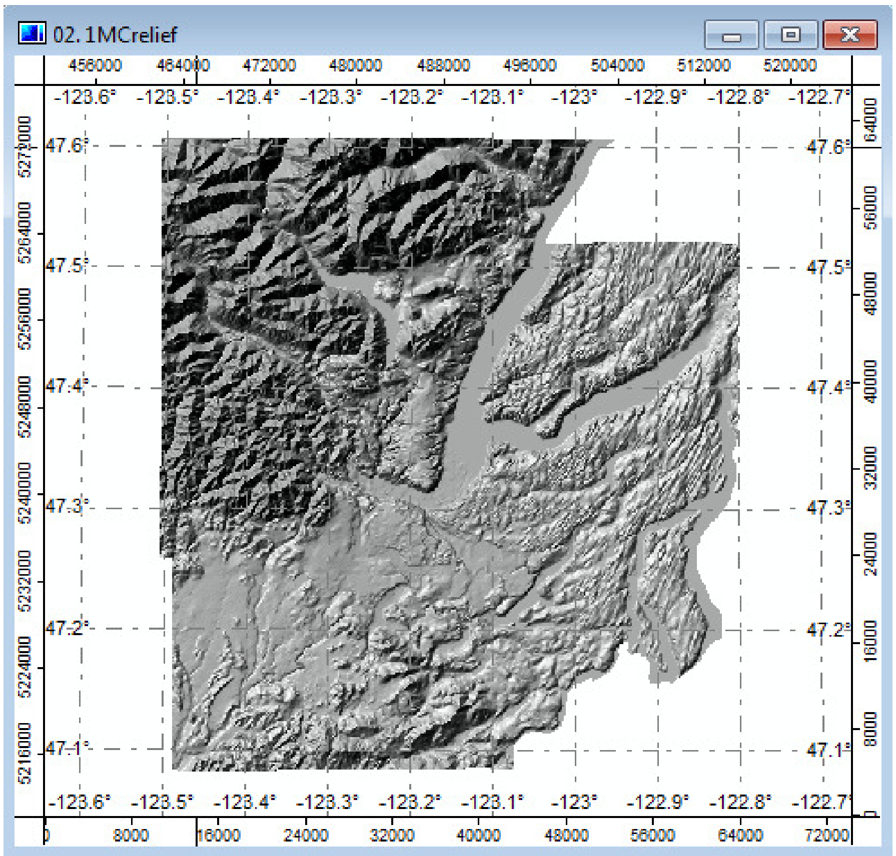


Figure 6-8. Using a graticule layer with the shaded relief map view window.

When the "Add Graticule" option is chosen, a new layer named 'Graticule' is added at the top of the layer stack for the map view window. I can click on the name 'Graticule' and view a set of supporting parameters in the Settings tab area of the Object Properties window (Figure 6-9).

General	
Name	Graticule
Interval	fitted interval
Number of Intervals	5
Minimum Resolution (Degree)	0.5
Show at all scales	☑
Display	
Color	Gray
Size	0
Transparency [%]	0
Line Style	Dot and dash style
Label	☑
Font	Arial
Size	2
Boundary Effect	full frame
Boundary Effect Color	White

Figure 6-9. The Graticule layer parameters.

The graticule layer parameters listed in Figure 6-9 are described in Chapter 5. The entries for the parameters displayed in Figure 6-9 produced the graticule display in Figure 6-8.

The entry for the 'Interval' parameter is "fitted interval". A degree of latitude and a degree of longitude has five intervals (the 'Number of Intervals' parameter is set to 5. The longitude spacing goes from -123 degrees, to -123.2 to -123.4 and so on. The same interval pattern is apparent for latitudes.

Map: Add Base Map, Maps Tab: Add Base Map
A base map layer can be added to a map view window if the map view window (or any layer in the map view window) has a coordinate reference system. Information for the map view window coordinate reference system and map extent are used to query a map tile from a Tile Map Server (TMS). In general, TMS is a protocol for serving maps as tiles based on map extent inputs.

Figure 6-10 displays the shaded relief grid layer '1MCrelief' map view window including a base map.

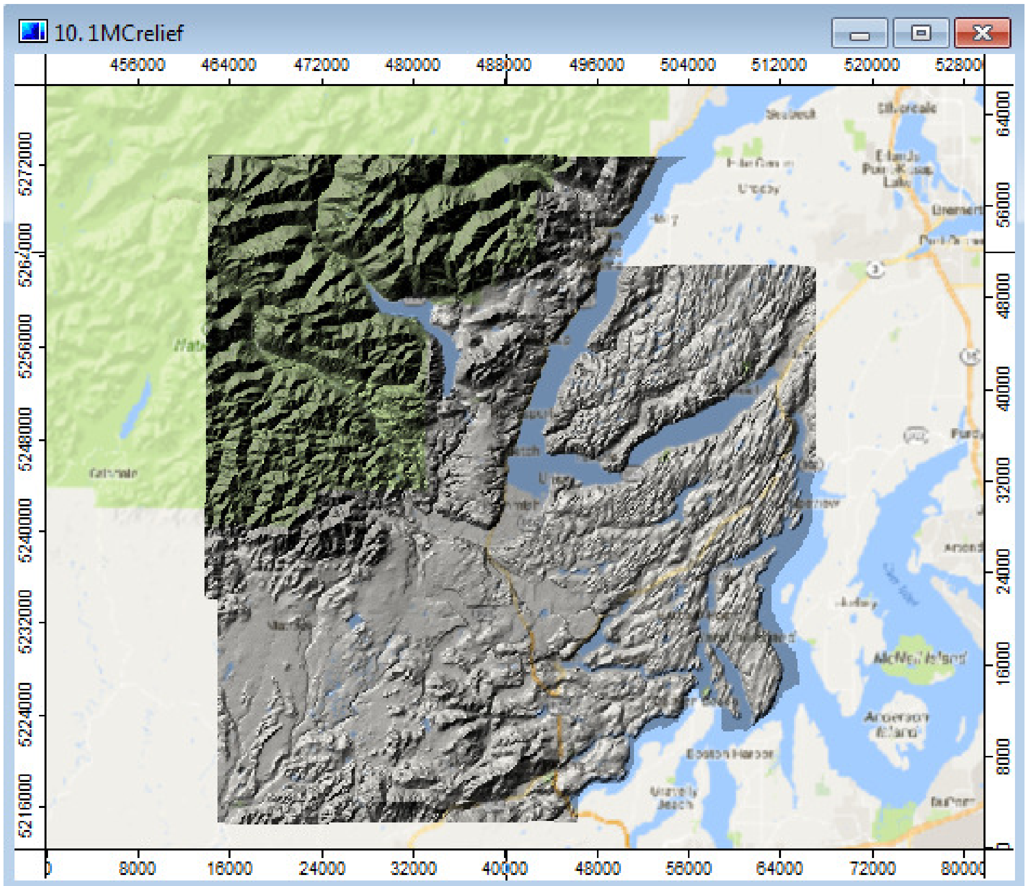


Figure 6-10. A base map displayed with the shaded relief grid layer '1MCrelief' map view window.

Figure 6-11 displays the parameters that support the display of a base map.

General	
Name	Base Map
Server	Google Map
Cache	☐
Show at all scales	☑
Display	
Transparency [%]	0
Gray Scale Image	☐
Resolution	1

Figure 6-11. The base map layer parameters.

There are a number of options for the 'Server' parameter. These include the default entry "Open Street Map". Other options are: Google Map, Google Satellite, Google Hybrid , Google Terrain, Google Terrain, Streets and Water, ArcGIS MapServer Tiles and user defined.

The "Open Street Map" option for the 'Server' parameter accesses the Open Street map of the world. It is available under an open-content license. The map is free and has largely been created by volunteer efforts. The other options are from Google and ESRI.

The SAGA support team emphasizes the user should read and understand the usage agreements or terms of service before using one of the server options of the 'Server' parameter.

The supporting parameters for the base map layer are described in Chapter 5.

Map: Save as Image..., Maps Tab: Save as Image...
This option saves a map as an image file. I can choose the option on the Menu Bar Map dropdown list of options or I can right-click on a map name in the Maps tab area of the Manager and choose the option from the dropdown list of options. When I choose the option, a 'Save As Image' dialog displays (Figure 6-12).

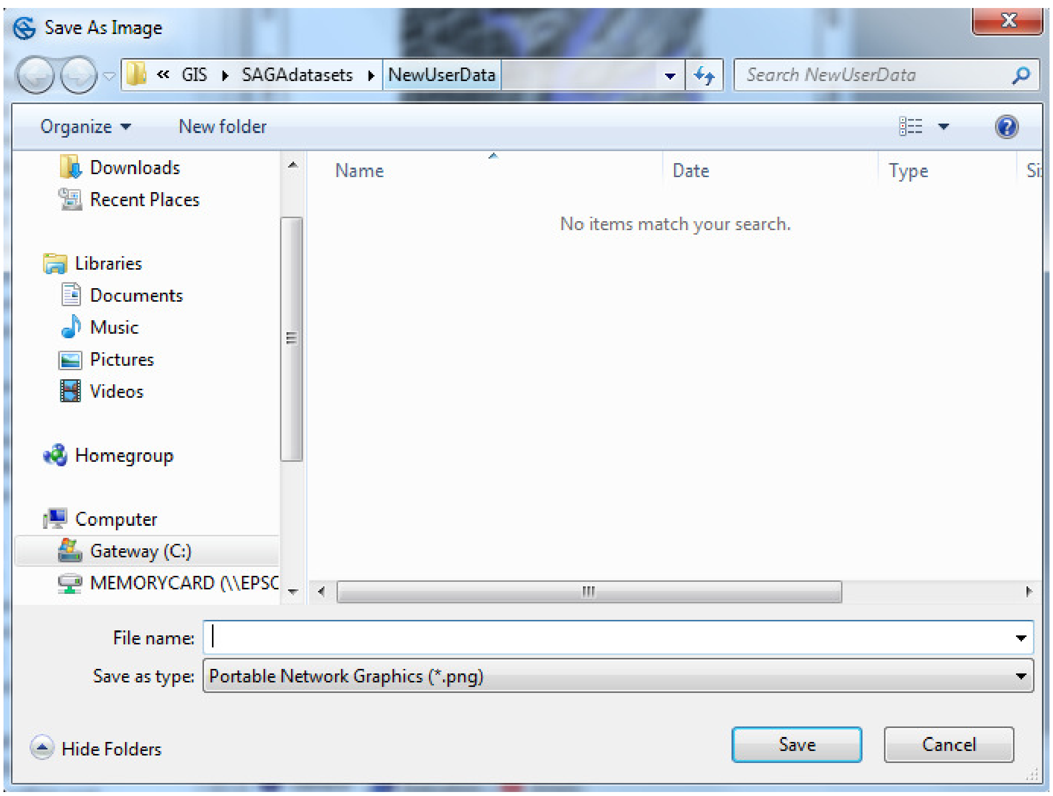


Figure 6-12. The 'Save As Image' dialog window.

I can browse to a different folder if the default path is not where I want to save the image.

There are several file formats supported. The default is the "Portable Network Graphics" format (.png). Other choices include:

Windows or OS/2 Bitmap (*.bmp)
JPEG - JFIF Compliant (*.jpg)
Tagged Image File Format (*.tif)
CompuServe Graphics Interchange (*.gif)
Zsoft Paintbrush (*.pcx)

I am going to save an image of the layers displayed in a map view window as a .jpg. After entering a file name for the image file I click on the Save button. A parameters page, 'Save Map as Image...', is displayed (Figure 6-13).

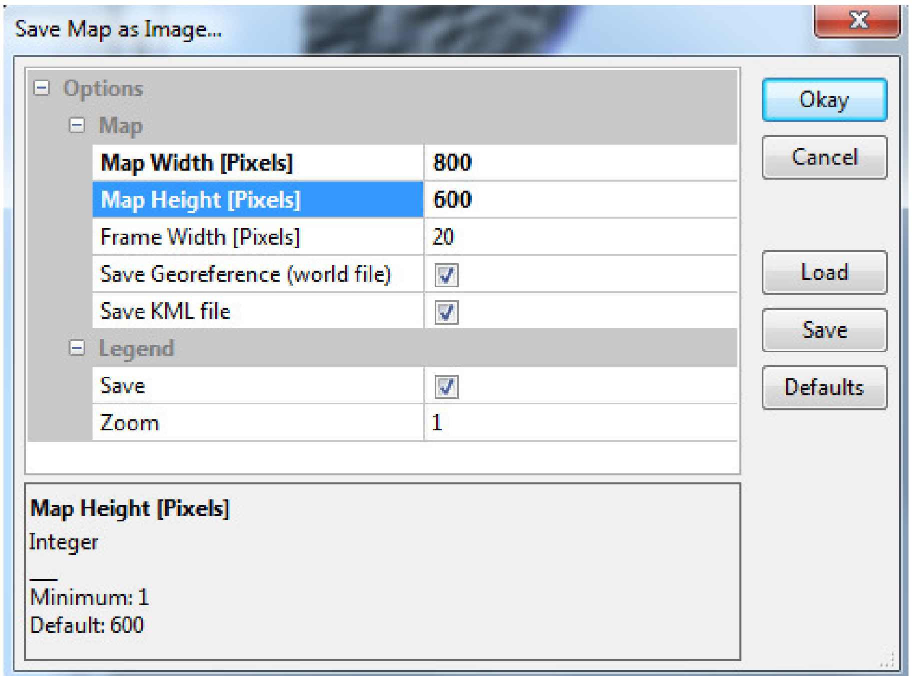


Figure 6-13. The 'Save Map as Image ...' parameters page.

The parameters 'Map Width [Pixels]' and 'Map Height [Pixels]' define the number of pixels in the X and Y directions for the saved map. Increasing these values above the defaults saves an image with a higher resolution and improved display quality. Pixel stands for picture elements.

The frame width is the area surrounding the map where the coordinate information displays. The 'Frame Width [Pixels]' parameter specifies the width in pixels for this area. The number of pixels for the frame width adds to the number for the width and height for the total size of the image. Thus, using the defaults, the image width (X direction) will be 840 pixels and the height (Y direction) will be 640.

The 'Save Georeference (world file)' parameter is a toggle check box parameter. When a check mark displays in the check box the parameter is on and georeferencing information is saved in a world file. This is a .jgw file format and specific to providing real world coordinate information related to a corresponding .jpg file. The information is used to correctly position the .jpg file on a map or in a mapping system. I can change the status to off by moving the mouse pointer into the check box and pressing the left mouse button. The check mark disappears and the parameter is off.

A KML file is a .kml file extension, a "Keyhole Markup Language" file. It is a placemark file used in Earth browsers like Google Earth.

The "Legend" section of the parameters page has two parameters: Save and Zoom. The ‘Save’ parameter value field has a check box. The default is for it to be checked. When it is checked, a legend image file automatically saves. I can un-check the box by clicking on it with my mouse. The 'zoom’ parameter allows me to specify whether to reduce or enlarge the size of the legend.

Figure 6-14 displays the JPEG files I created.

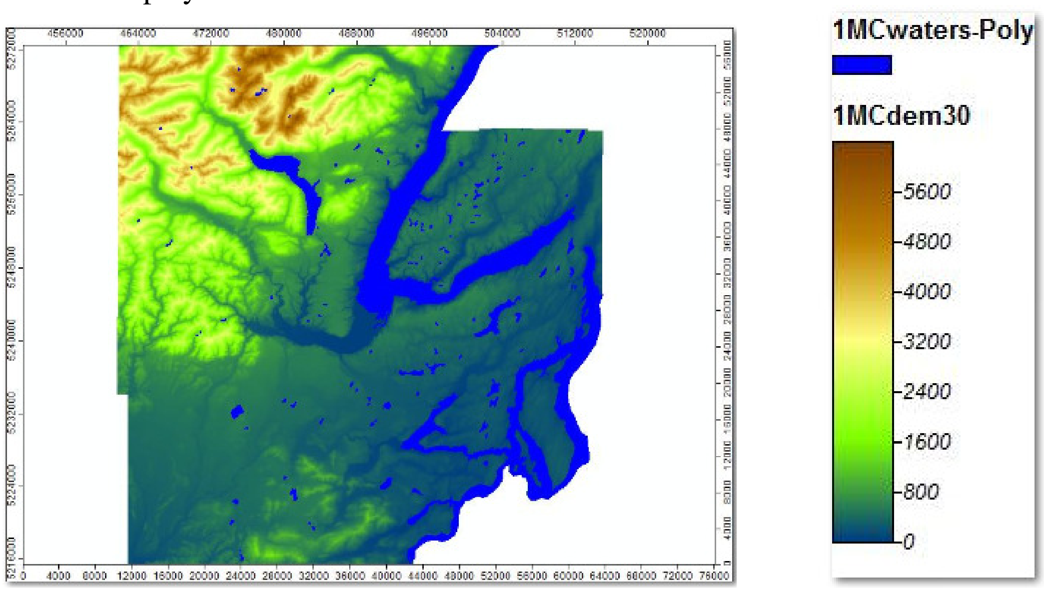


Figure 6-14. A map and legend saved as JPEG files.

The legend displayed on the right in Figure 6-14 is saved as a separate image file. The map consists of two grid layers: ‘1MCdem30’ and ‘1MCwaters-Poly’. Notice that a legend for each layer is created.

Figure 6-15 displays the world file (the file format is .jgw).

```
95.2882410848
0.0000000000
0.0000000000
-95.2882410848
449366.6339138633
5274446.7679937640

```

Figure 6-15. The world file (.jpw) created by the "Save as Image" option.

The KML or keyhole markup language file that was saved is displayed in Figure 6-16.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Folder>
    <name>Maps exported from SAGA</name>
    <description>System for Automated Geoscientific Analyses - www.saga-gis.org</description>
    <GroundOverlay>
      <name>08. 1MCdem30</name>
      <description><h4>Map</h4><table border="0"><tr><td valign="top"><b>Name</b></td><td valign="top">08. 1MCdem30</td></tr><tr><td valign="top"><b>Layers</b></td><td valign="top">2</td></tr><tr><td valign="top"><b>Coordinate System</b></td><td valign="top">
      Projected Coordinate System:
Transverse_Mercator
[+proj=utm +zone=10 +datum=WGS84 +units=m +no_defs ]</td></tr></table></description>
      <Icon>
        <href>TopoWater.jpg</href>
      </Icon>
      <LatLonBox>
        <north>5274446.767994</north>
        <south>5213462.293700</south>
        <east>529408.756425</east>
        <west>449366.633914</west>
        <rotation>0.0</rotation>
      </LatLonBox>
    </GroundOverlay>
  </Folder>
</kml>
```

Figure 6-16. The KML file.

Map: Copy to Clipboard [Ctrl + C], Maps Tab: Copy to Clipboard [Ctrl + C]

This option makes a copy of the active map view window, including the frame with the coordinate and distance references, and places it on the system clipboard. The contents of the clipboard can be pasted into any program supporting the “paste” from clipboard function.

Map: Copy Legend to Clipboard [Ctrl + L], Maps Tab: Copy Legend to Clipboard [Ctrl + L]

This option makes a copy of the active maps layer legends and places then as a single graphic in the system clipboard. The content of the clipboard can be pasted into any program supporting the “paste” from clipboard function.

Map: Synchronise Map Extents, Maps Tab: Synchronise Map Extents

This can be a very valuable display mode when I am displaying a set of map view windows and I want each window to display the same map extent. For example, I have four map view windows in the workspace and they all include some coverage of Lake Cushman. I zoom in on Lake Cushman in the water bodies map view window. I want to see what the other three maps display for the Lake Cushman area. With the water bodies map view window active, the quick way is to choose the ‘Synchronise Map Extents’ mode (either from the Menu Bar Map title or the toolbar icon). The map extents of the other three map view windows will adjust to match the map extent for the water bodies map view window. In this mode, whenever I change the zoom area for the water bodies map, the map extents for the other three map view windows will have corresponding changes.

I can disable the ‘Synchronize Map Extents’ mode by clicking on the "Synchronize Map Extents" option on the Map dropdown menu a second time or choosing the  icon on the toolbar a second time.

Options Unique to the Menu Bar Map Title

There are options available only on the Menu Bar Map Menu. These include North Arrow, Save as Image to Workspace, Save as KMZ.... There are six related to zoom capabilities. They include Zoom to Previous Extent, Zoom to Next Extent, Zoom to Full Extent, Zoom to Active Layer, Zoom to Selection, and Zoom to Extent. The last four are the Action function, Zoom, Pan, and Measure Distance.

Map: North Arrow

This option adds a north arrow to the active map view window in the work area. Five parameters support the size and display location of the north arrow. These parameters are described in Chapter 5 of this Guide.

The map view window in Figure 6-17 includes a north arrow for a shaded relief, water bodies map.

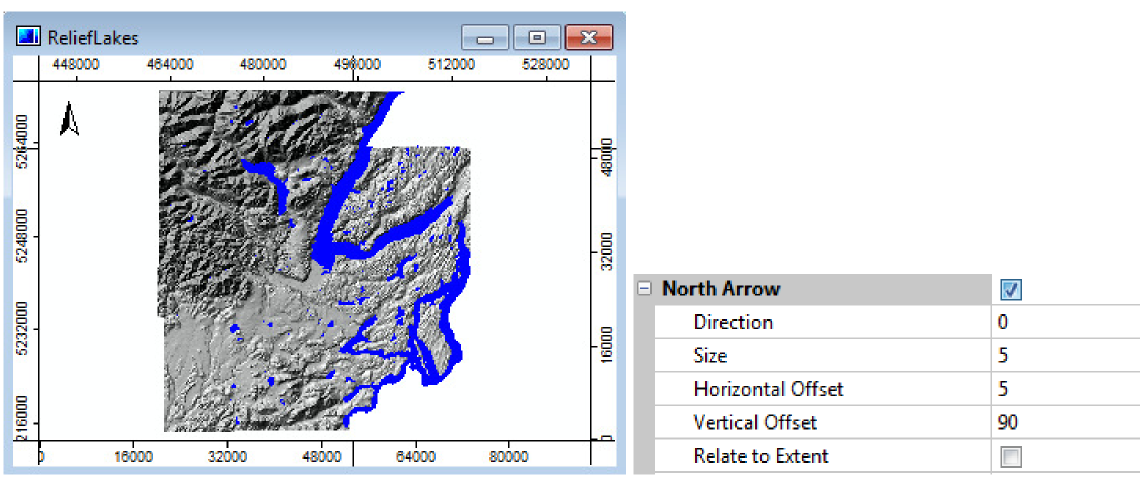


Figure 6-17. A north arrow example.

The parameter settings for the north arrow are shown on the right in the figure.

The SAGA north arrow might be unique in that it can be displayed as a non-north arrow using the 'Direction' parameter. Entering 0 or 360 displays the north arrow as a true north arrow. However, I can enter other values if I want the arrow to point toward 90 degrees or some other compass direction. If the north arrow is pointed a different compass direction, this could be quite confusing.

The numeric entries for the 'Size' and offset parameters relate to percent of map size. The entry of 5 for the 'Size' parameter means that the north arrow is 5 percent of the map distance size. The entry for the 'Horizontal Offset' parameter means that the symbol is located 5 percent of the distance from the west side of the map view window. The 90 percent entry for 'Vertical Offset' locates the symbol 90 percent of the distance from the south side of the map view window.

Map: Save as Image to Workspace
This option applies to the map view window that is active when the option is chosen. When the option is chosen, the 'Save To Memory Grid' dialog window displays. This window has one option: Cellsize. A default entry for the option appears. I click with the mouse on the Okay button.

I check in the Data tab area of the Manager. A new grid system based on the entry for the 'cellsize' option has been created. A grid layer named after the map view window is created in the new grid system. The grid layer data values are RGB codes, i.e., they are RGB numbers for colors and not the data values on the source map view window.

Map: Save as KMZ...
A KMZ file, file extension.kmz, is a compressed version of the KML file, a "Keyhole Markup Language" file. It is a placemark file used in Earth browsers like Google Earth. I was able to use this option to create a .kmz file but have not explored how to use it.

Map: Zoom To Previous Extent
This option is for changing the current map view window extent to the immediately previous map extent. It is convenient to execute it using the icon on the toolbar. The option is available on the toolbar and Map dropdown menu on the Menu Bar.

Map: Zoom To Next Extent
This option changes the current map view window map extent to the next one (providing there is a next one). This option is useful for moving around in a set of existing map extents for a map view window. It is convenient to execute this option using the "Zoom to Next Extent" icon on the toolbar. The option can be chosen on the toolbar and on the Map dropdown menu on the Menu Bar.

Map: Zoom To Full Extent
When I first open a layer in a map view window, the view will be what is referred to as full extent. A full extent view is the geographic coverage of the layer scaled to fit within the map view window. If I have zoomed in or out from the full extent view, I can update

a map view window to full extent using the "Zoom to Full Extent" icon on the toolbar or the option on the Map dropdown menu on the Menu Bar.

A map view window can display 1 or more layers. The full extent for a map view window is a rectangle that fully encloses the extents of all layers in the map view window. The full extent can change if a layer is added to the map view window that includes spatial coverage outside of the previous full extent area. The rectangle for the map view window will adjust in size to include any additional spatial area related to the newly added layer.

Figure 6-18 displays two map view windows. The one on the left displays a slope aspect grid layer for Mason County, Washington. A geology shapes layer is added to the same map view window. The geographic coverage of the geology layer is Olympic Peninsula, Washington, a much larger area, that includes a portion of Mason County. The new, re-sized, map view window displays on the right, using the new full extent rectangle. I can see that the geology shapes layer covers the western part of Mason County but extends to coverage of the Olympic Peninsula.

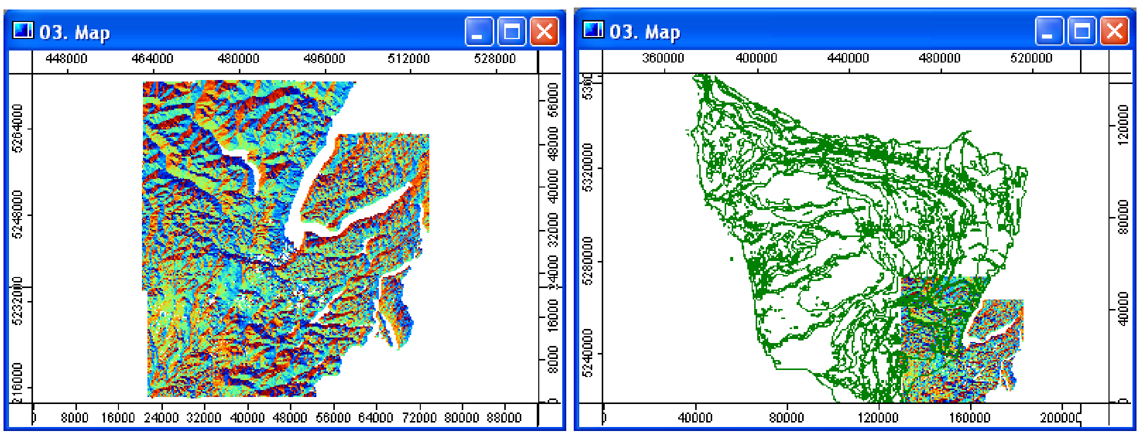


Figure 6-18. Comparing “Full Extent” map view windows.

After I have zoomed in to enlarge an area, I can always return to the full extent view by selecting the "Zoom to Full Extent" option from the Menu Bar Map dropdown list of options (Map: Zoom to Full Extent).

Map: Zoom To Active Layer

A map view window will often include more than one layer. In Figure 6-18 I can see that a geology shapes layer, having a large map extent, displays with a grid layer for slope aspect, having a much smaller map extent.

Choosing a layer name on the list of layers in the Data tab area of the Manager window or selecting a layer name listed as part of a map view window definition in the Maps tab area of the Manager, makes the chosen layer the active layer. It is not necessary that the active layer be in the layer stack for a map view window. The selection to active status can be made in either the Data or the Maps tab areas.

Once a layer is active, when I choose the "Zoom To Active Layer" option from the toolbar or the Map dropdown menu, the current map view window map extent is defined based on the map extent of the active layer. The active layer does not have to be part of the map definition or be in a current map view window in the work area. The map extent of the current active map view window will change to match the map extent of the active layer.

It does make sense that the main benefit of using the "Zoom To Active Layer" be related to a map and to the current map view window. The "Zoom To Active Layer" option could be used to quickly move from a zoomed in map extent out to whichever layer is active. On the other hand, it can also be used to zoom in on a layer that has only partial coverage of a larger study area.

Map: Zoom To Selection

This option is used with shapes layers. Figure 6-19 illustrates how this option is used. First, an object of a shapes layer displayed in a map view window is selected with the Action tool. When the object is selected, it will display with a yellow fill. The yellow fill is used because the Selection: Fill parameter for the shapes layer is set to yellow. I choose the "Zoom To Selection" option on the Map dropdown menu on the Menu Bar or use the () icon on the toolbar. SAGA adjusts the map view window so that the map extent of the selected object defines the map extent for the map view window.

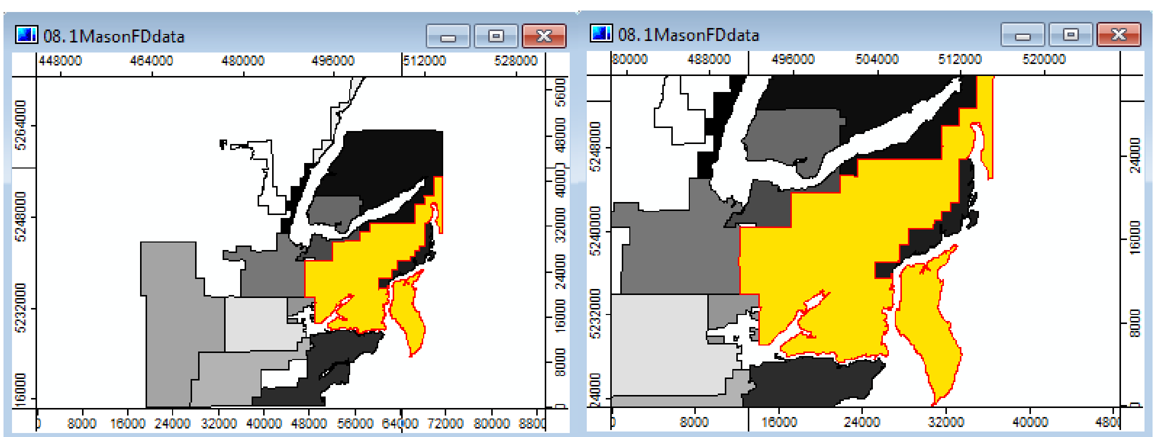


Figure 6-19. Using the "Zoom To Selection" option.

Fire Protection District 5, on the county fire district shapes layer, is selected in the map view window on the left in Figure 6-19. The map view window on the right results from choosing the "Zoom To Selection" option. The map extent of the selected object defines the map extent of the map view window.

Map: Zoom To Extent

This option is used to view the coordinates defining the map extent of the map view window. If you have chosen the 'Zoom to Full Extent' option, the map view window displays data for all grid cells, objects, and points that are part of the layers in the map view window definition. In this case, the coordinates define an envelope that fully encloses all data in the window. If you have zoomed in on an area of a map view window and the map view window displays a much smaller area of the larger map area, this smaller area is now the map extent of the map view window. In this case, the coordinates define the boundaries of what is viewed in the zoomed in map view window. Both of these examples define an extent for the map view window.

The "Zoom To Extent" option displays a dialog window that includes parameters with entries for the West, East, South, and North sides of the current extent for the map view window. Thus, every map view window has an extent definition.

When I choose the "Zoom To Extent" option on the Map dropdown menu (this option is not available on the toolbar), a ‘Map Extent’ properties window displays (Figure 6-20).

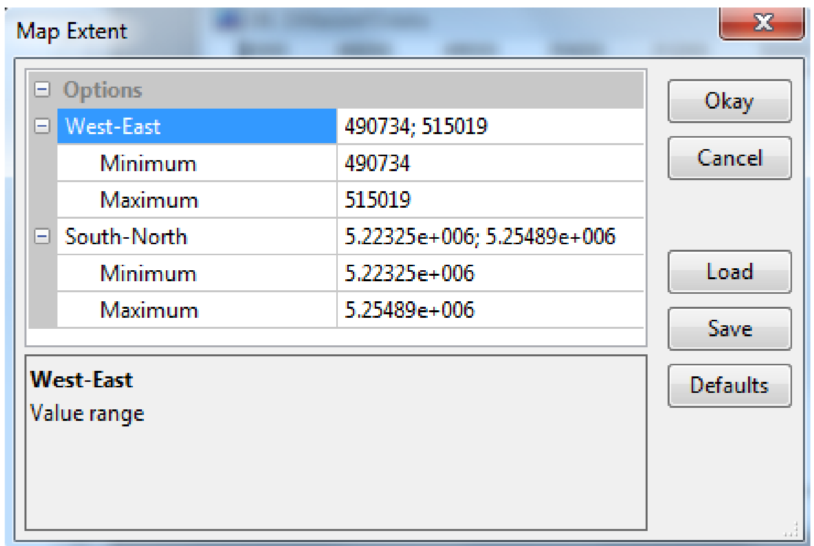


Figure 6-20. A ‘Map Extent’ properties window.

The ‘Map Extent’ properties window in Figure 6-20 has four options. The first two identify the left and right or the ‘West-East’ coordinate boundaries and the next two, the ‘South-North’ coordinate boundaries.

On the right side I see four buttons: Okay, Cancel, Load, and Save.

I can customize the map view window extent using this dialog. There are three ways of entering or changing the coordinates for the ‘West-East’ and ‘South-North’ 'Minimum' and 'Maximum' parameters. If I already know the coordinate values that I want to use, I can key the values into the value fields to the right of the parameter labels.

A second approach is to use the "Zoom" and "Pan" options to adjust the map extent of the map view window before executing the "Zoom To Extent" option. The coordinates for the map view window are the default values entered into the value fields for the ‘West-

East' and 'South-North' options. Regardless of how I enter the coordinates, once the coordinate values are what I want, I click on the Okay button. If the coordinate values were changed, the active map view window extent adjusts to match the change values.

The third way is to re-load a previously saved set of values for the West-East, South-North 'Minimum' and 'Maximum' parameters. I can save an extent using the Save button on the right side of the window. When I click on the Save button, the dialog window in Figure 6-21 displays.

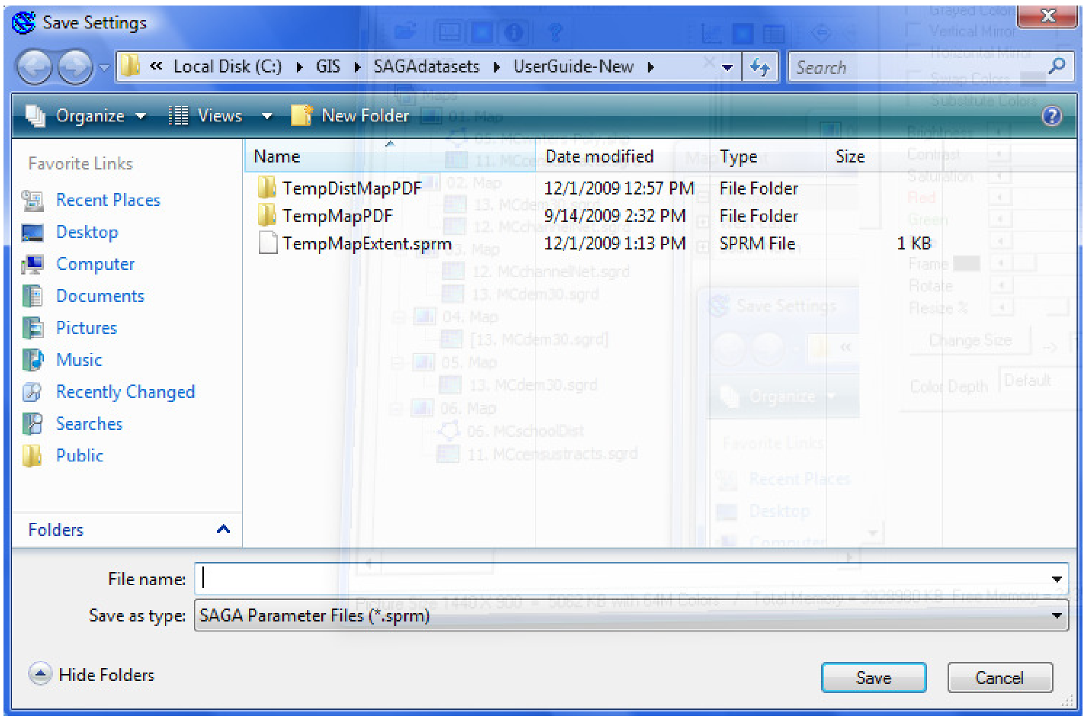


Figure 6-21. The 'Save Settings' dialog window.

Once I save the extent settings in a file, the next time I want to use the same map extent, after choosing the "Zoom To Extent" option from the Map dropdown menu, I click on the Load button on the 'Map Extent' parameters page and re-load the saved file. When I click on the Okay button, my "custom" map extent defines the map extent of the active map view window.

Map: Action

When the Action tool is active, if I move the mouse pointer over cells of a grid layer containing data values or over objects on a shapes layer, the pointer will turn into a large plus with an X across the center intersection and a lower-case 'i' displayed. The lower-case 'i' stands for "information". However, any information or "action" related to it is for whichever grid or shapes layer is active in the Data tab area of the Manager.

The Action tool appears to serve several major roles in SAGA. First, it is used to identify grid cells or objects for the display of data values as it is moved across a map view window. The data values will always be for either the active layer in the Data tab area or the active layer in the Maps tab area.

The Action tool can be used to query a grid layer for data values. First, in the Data tab area of the Manager I click on the grid layer I want to query for data values. The parameter values for the chosen grid layer update the Object Properties window. I choose the Attribute tab for the Object Properties window. When I position the Action pointer over a grid cell and press the left mouse button, the data value for the grid cell displays in the Attribute tab area of the Object Properties window. The same approach is used to display attribute values for a selected object on a shapes layer or a selected point on a point cloud layer. The data values displayed in the Attribute tab area can be edited, changed, followed by clicking on the Apply button in order for the change to take effect.

Second, the Action tool can be used to edit grid or shapes layers. For example, the Action tool can be used to choose an object or a part of an object on a shapes layer. Once selected, the object or part of an object is highlighted in red (or whatever color is chosen in the layer parameter settings for the Selection: Color parameter). At that point, SAGA vector edit tools are used.

On grid layers, especially within several SAGA interactive tools, the Action tool is used to choose a grid cell to change its value or maybe to define a pour point. The *Change Cell Values [Interactive]* and *Change Grid Values –Flood Fill [Interactive]* are a couple of the tools that use the Action tool for this kind of input.

Figure 6-22 shows a zoomed in area of a map view window that displays a slope aspect grid layer. I have zoomed in on an area so that the actual data values stored in the grid cells display. The 'Show Cell Values' parameter for the layer is in on status so the cell values display.

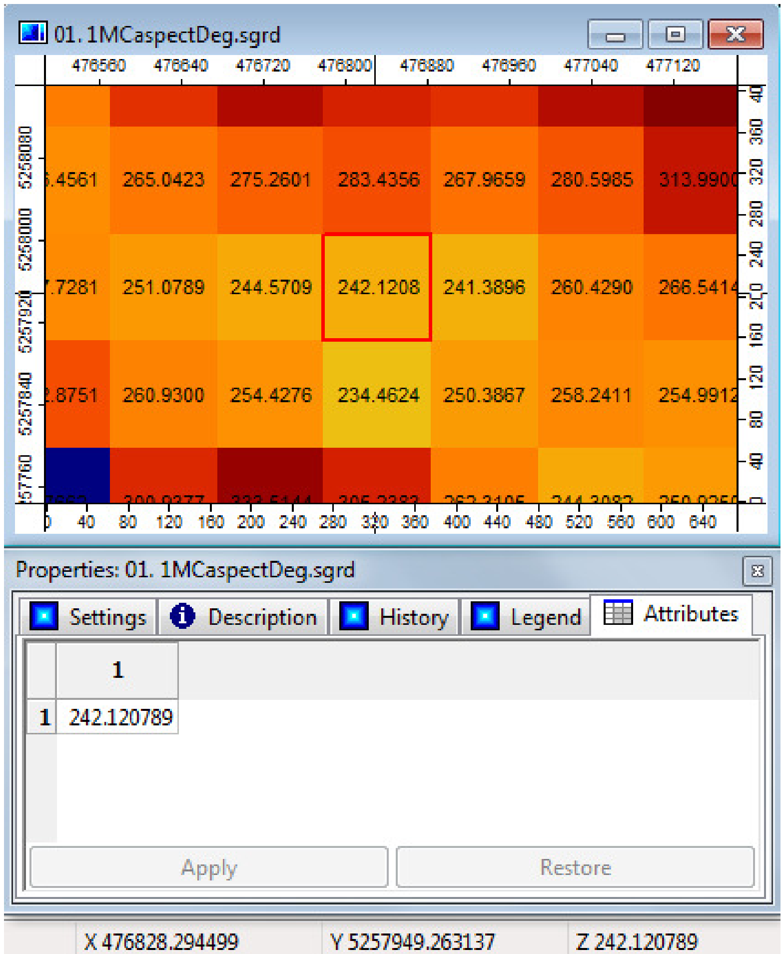


Figure 6-22. Using the Action tool with a grid layer.

I moved the Action tool pointer over the grid cell near the center of the zoomed in area in the map view window and pressed the left mouse button. I see that SAGA outlined the grid cell I clicked on in red. The slope aspect grid layer name is chosen on the list of layers in the Data section of the Manager window. The Attributes tab at the top of the Object Properties window is active. The value displayed in the grid cell in the map view window is 242.1208. The Attributes tab area of the Object Properties window is displaying the full data value (242.120789) as is the field labeled ‘Z’ at the bottom of the display.

The school district shapes layer displays in a map view window in the work area (see Figure 6-23). The layer name ('1MCschoolDist') is chosen on the list of layers in the Data tab area of the Manager window. The information that displays in the Object Properties window is for the '1MCschoolDist' layer.

I click with the Action tool on one of the school district polygon objects. I can see that the boundary of the polygon now displays in red and the polygon object is filled in yellow.

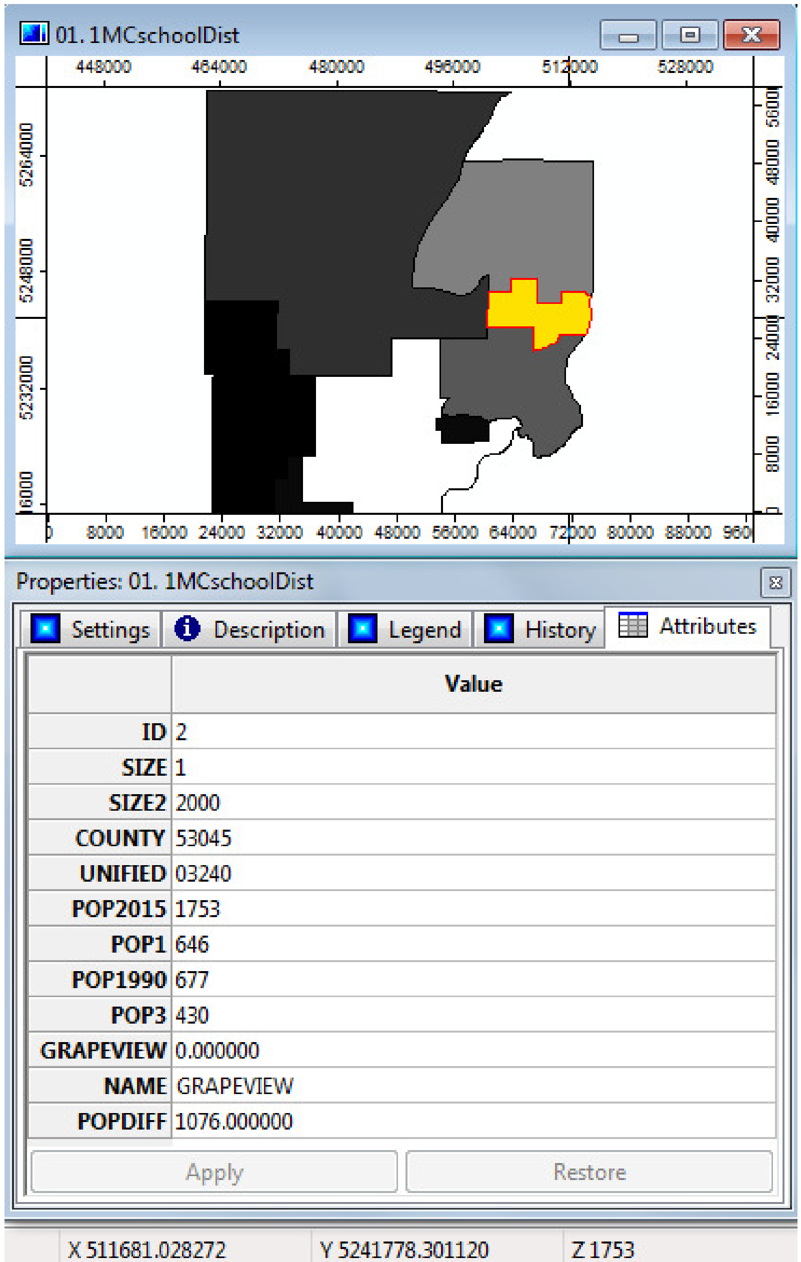


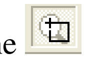
Figure 6-23. Selecting a shape layer object with the Action tool.

I click on the Attributes tab at the top of the Object Properties window. The attribute values for the selected polygon object have updated the Attributes tab area of the Object Properties window.

In the grid layer example, in Figure 6-22, I observed a single data value for the grid cell. This is because grid layers are single theme layers. Shapes layers are multi-attribute layers. In Figure 6-23 the information for twelve attributes displays. Each object in the school district shapes layer is described by twelve attributes.

There will be a check mark to the left of the Action option in the Map dropdown menu when the Action tool is active. On the toolbar, the  icon is selected when the Action tool is active.

Map: Zoom

The "Zoom" option enlarges or reduces the map extent of a map view window. This effectively makes the map scale larger (zoom-in) or smaller (zoom-out). After choosing the "Zoom" option from the Map dropdown menu on the Menu Bar or using the  icon on the toolbar, I click the mouse pointer on one of the corners of an area I want to enlarge, and, holding the mouse button down, drag to the opposite diagonal corner and release the button. This defines a specific area that enlarges. Another, less exacting way to enlarge a map view window area, using a default zoom factor, is to click once with the left mouse button while positioning the mouse pointer in the approximate center of the area I want to enlarge. I can keep clicking the left mouse button until I reach the desired magnification or map extent.

In addition to using the "Zoom" option to magnify or enlarge a portion of a map view window, I can use it to reduce magnification. I can zoom out by clicking in the map view window using the right mouse button. Each time I press the right mouse button, the map view window zooms out one step. I can quickly return to the full extent map view window by clicking on the "Zoom to Full Extent" option in the Map dropdown menu or its icon () on the toolbar. There is a check mark to the left of the "Zoom" option in the Map dropdown menu when the "Zoom" option is active. On the toolbar, the  icon is selected when the "Zoom" option is active.

Map: Pan

The "Pan" option lets me reposition a map display. I choose the "Pan" option and move the mouse pointer within a map view window. The mouse pointer turns into a hand. I depress the left mouse button and drag. As I drag, the map display repositions based on the location of the mouse hand. The map display can move entirely outside of the map view window.

It is handy to use the "Pan" option when zoomed in on an area of a map view window. The "Pan" option can be used to move the enlarged view to other areas of the map view window without losing the current magnification. The size of the “window” for the layer will not change; only the spatial area of the layer being viewed changes.

There will be a check mark to the left of the "Pan" option in the Map dropdown menu when the "Pan" option is active. On the toolbar, the  icon will be selected when the "Pan" option is active.

Map: Measure Distance
The measuring option measures distances in a map view window. When the "Measure Distance" option is chosen, the mouse pointer turns into a large plus symbol when positioned within a map view window.

I locate the pointer at a location from which I want to start to measure a linear distance. I click the left mouse button and move the pointer. As I move the mouse pointer, a thin line plots connecting the starting point with the mouse pointer location on the screen. Simultaneously, the X and Y coordinates of the mouse pointer location display in the “X” and “Y” labeled information fields at the bottom of the SAGA display window.

The distance the mouse pointer moves from the first clicked point to its current position displays in the field labeled as “D” just after the “Y” information field. When I click a second time, the second point defines the end point of a line segment and the beginning point of a new segment to be measured. The line from the first point to the second point turns to bold. The measuring option is still active.

As I move the mouse pointer away from the second point, a thin line plots on the screen connecting the most recently entered point to the mouse pointer location. The accumulative distance from the first point and continuing past the second point to the pointer displays in the “D” field. I terminate the measuring option by clicking on the right-button of the mouse. The distance units depend on the coordinate system used by the grid system or shapes layer.

There will be a check mark to the left of the "Measure Distance" option in the Map dropdown menu when the "Measure Distance" option is active. On the toolbar, the  icon is selected when the "Measure Distance" option is active.

Options Unique to the Maps Tab
This final section covers five options unique to the Maps tab list of options. These options are Close, Show Map, Spatial Reference, and Save as Image when Changed.

Maps Tab: Close
This "Close" option is available from a map view definition in the Maps tab area of the Manager. If I choose this option, a 'Delete' dialog displays with the text "Do you want to delete the selection?" There are two buttons for Yes or No at the bottom of the delete window. I click on the Yes button to delete the map view window. The map view window disappears from the work area and no longer has a definition in the Maps tab area of the Manager. Layers in the layer stack remain available in the Data tab area of the Manager and in any other already existing map view windows.

Maps Tab: Show Map
The quick way to display an existing map view window is to double-click with the mouse on the map view window definition (the name) in the Maps tab area of the Manager. A second way is to move the mouse pointer over a map view window name in the Maps tab area of the Manager. Then press the right mouse button and the list of options in Figure

6-3 displays. I choose the "Show Map" option and the map view window appears in the work area. A check mark now displays to the left of the "Show Map" option the next time I view the options list for the map view window. If I click on the "Show Map" option while the check mark appears, the map view window is removed from the work area. The definition remains in the Maps tab area of the Manager.

Maps Tab: Show Layer

A "Show Layer" option exists for layers in the layer stack for a map view window. If I right-click with the mouse on the name of a layer in the layer stack for a map view window, a check mark appears to the left of the "Show Layer" option when the layer is visible in the map view window. If a check mark does not appear to the left of the layer name, it means its display in the window is turned off. The turned off status is also indicated by a pair of brackets enclosing the number and name of the layer in the map view window definition. I can move the mouse pointer over the layer name and press the left mouse button. The pair of brackets are removed, the layer now displays in the map view window, and a check mark appears to the left of the "Show Layer" option.

A shortcut to applying the "Show Layer" option to a layer is to double-click with the mouse on the layer name in the map view window layer stack. In the case where the layer displays in the map view window, there will be a check mark to the left of the layer name in the list. I can turn off the display of the layer by clicking with the mouse twice on the layer name in the list. A pair of brackets appear around the layer name and the check mark to the left disappears. I can turn the display of the layer in the map view window back on by double-clicking with the mouse on the layer name enclosed by brackets.

Maps Tab: Spatial Reference

This is an information related parameter. It does not change the coordinates used in a map view window. The purpose of this option is to assign or pick the name for the Coordinate Reference System used in a map view window.

This command is identical to the tool *Projection - Proj4/Coordinate Reference System Picker* except it applies to a map view window rather than a layer. The option is used to pick the appropriate Coordinate Reference System (CRS) for a map view window. Since a CRS is not already identified for the map view window, it means that none of the layers in the map view window have a CRS identified, either. This option can also be used if an incorrect CRS has been chosen that needs corrected.

The Description tab in the Object Properties window for a map view window includes coordinate reference system information if a CRS is identified for any layer in the map view window. If CRS information is listed in the Description tab as "Undefined Coordinate System" it means that a .prj file does not exist for any map view window layer and various parameters related to the coordinate system, projection, datum are undefined. Without this information it is not possible to convert from one coordinate reference system to another; for example, converting from the Universal Transverse Mercator Zone 10 to the Washington State Plane Coordinate System South Zone. Nor is it possible to create a graticule or base map layer for the map view window.

Figure 6-24 displays the 'Coordinate Reference System Picker' parameters window that displays when "Spatial Reference" option is chosen.

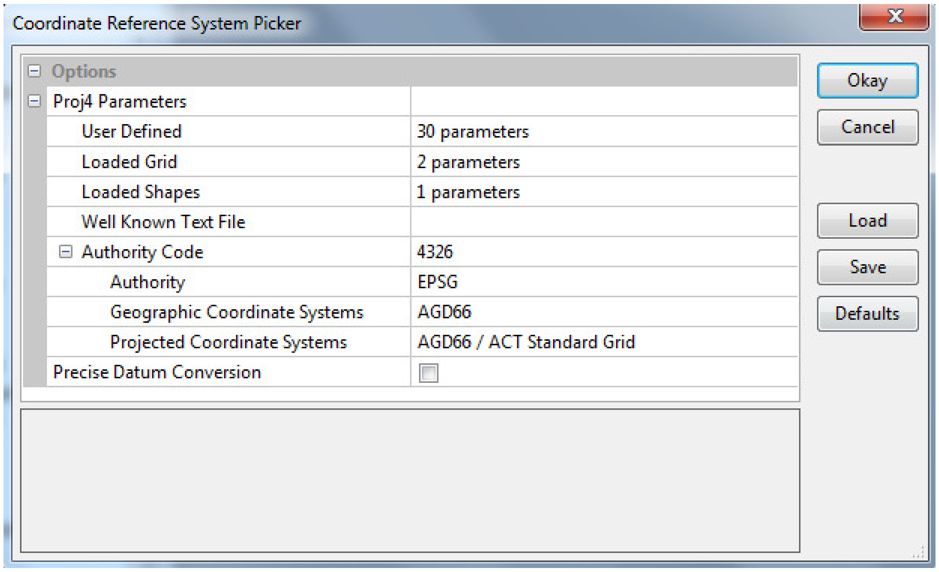


Figure 6-24. The 'Coordinate Reference System Picker' parameters window.

The "Spatial Reference" command, and other georeferencing tools in SAGA, are based on projection routines in the Proj. 4 Cartographic Projection Library developed by Gerald Evenden of the U.S. Department of Interior, Geological Survey.

The information required for the 'Coordinate Reference System Picker' parameters window normally is available as part of the documentation accompanying a layer from its source. Sometimes this information is included in a text or read-me file or a html file. It is also possible it is included in a special projection or georeferencing file.

Maps Tab: Save as Image when Changed
This option causes an image of a map view window to save whenever certain changes occur to the content of the map view window. Some of the actions that cause an image save include changing an attribute value, selecting or de-selecting an object, and changing the color palette. Some actions that do not cause an image save include adding or removing a layer from the map view window and adding or removing a north arrow or scale bar.

There is some similarity between this option and the "Save as Image" option discussed earlier in this chapter.

When I choose the option, a 'Save As Image' dialog window displays (Figure 6-25).

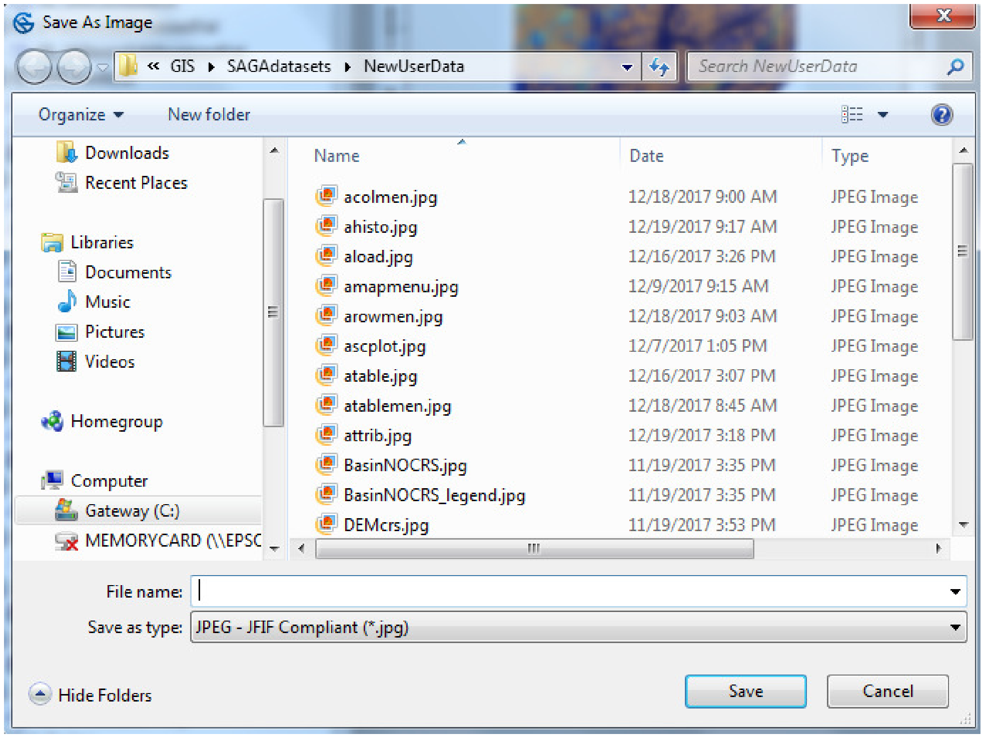


Figure 6-25. The 'Save As Image' dialog window.

I can browse to a different folder if the default path is not where I want to store the change images. There will be between one and four images saved every time a change occurs. Three of the files are optional. The three optional files are an image file for the legend, a world file, and a KML file.

There are several file formats supported for the map view window image and legend. The default is the “Portable Network Graphics” format (.png). Other choices include:

Windows or OS/2 Bitmap (*.bmp)
JPEG - JFIF Compliant (*.jpg)
Tagged Image File Format (*.tif)
CompuServe Graphics Interchange (*.gif)
Zsoft Paintbrush (*.pcx)

I am going to save images in the.jpg format. I enter a file name. The first set of change files save with "001" appended to the file names. The second set of change files have "002" appended and so on.

Once I have selected a path and file name, I click on the Save button.

The 'Save Map as Image' parameters page displays (Figure 6-26).

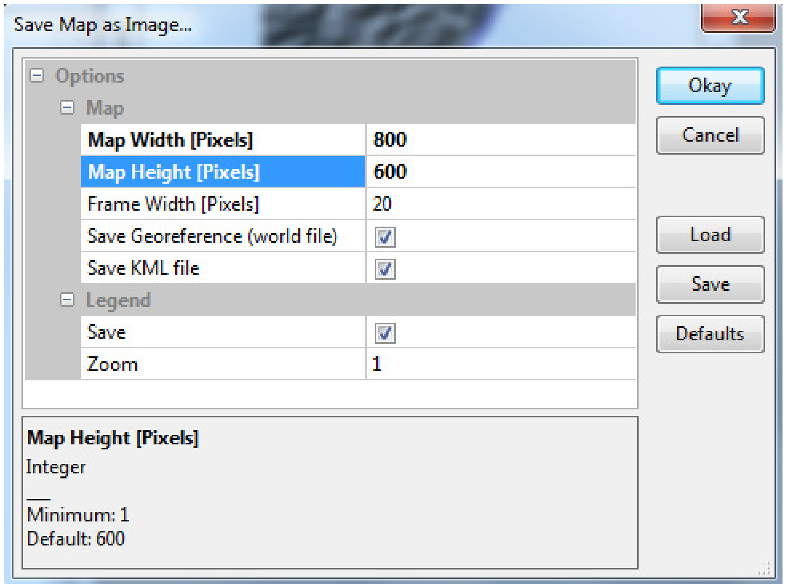


Figure 6-26. The 'Save Map as Image ...' parameters page.

The parameters 'Map Width [Pixels]' and 'Map Height [Pixels]' define the number of pixels in the X and Y directions for the saved map. Increasing these values from the defaults saves an image with a higher resolution and improved display quality.

The frame width is the area around the map where the coordinate information displays. The 'Frame Width [Pixels]' parameter specifies the width in pixels for this area. The number of pixels for the frame width is added to the number for the width and height for the total size of the image. Thus, using the defaults, the image width (X direction) will be 840 pixels and the height (Y direction) will be 640.

The 'Save Georeference (world file)' parameter is a toggle check box parameter. When a check mark displays in the check box the parameter is on and georeferencing information is saved in a world file. This is a .jgw file format and specific to providing real world coordinate information related to a corresponding .jpg file. The information is used to correctly position the .jpg file on a map or in a mapping system. I can change the status to off by moving the mouse pointer into the check box and pressing the left mouse button. The check mark disappears and the parameter is off.

The 'Save KML file' parameter is a toggle check box parameter. A KML file is a .kml file extension, a "Keyhole Markup Language" file. It is a placemark file used in Earth browsers like Google Earth. A check mark in the box indicates the parameter is in on status. I can change the status from on to off by moving the mouse pointer into the check box and pressing the left mouse button. The check mark disappears and the parameter is off.

The "Legend" section of the parameters page has two parameters: Save and Zoom. The 'Save' parameter value field has a check box. The default is for the parameter to be in on status with a check mark in the check box. I can un-check the box by clicking on it with my mouse. The ‘Zoom’ parameter allows me to specify whether to reduce or enlarge the size of the legend.

Figure 6-27 displays the JPEG files created for the '1MCRoadsAll' map view window. In this case the image is saved because a rail line object is selected. I can see the selected rail line object displayed in red in the middle of the image. The second JPEG file is for the map view window legend.

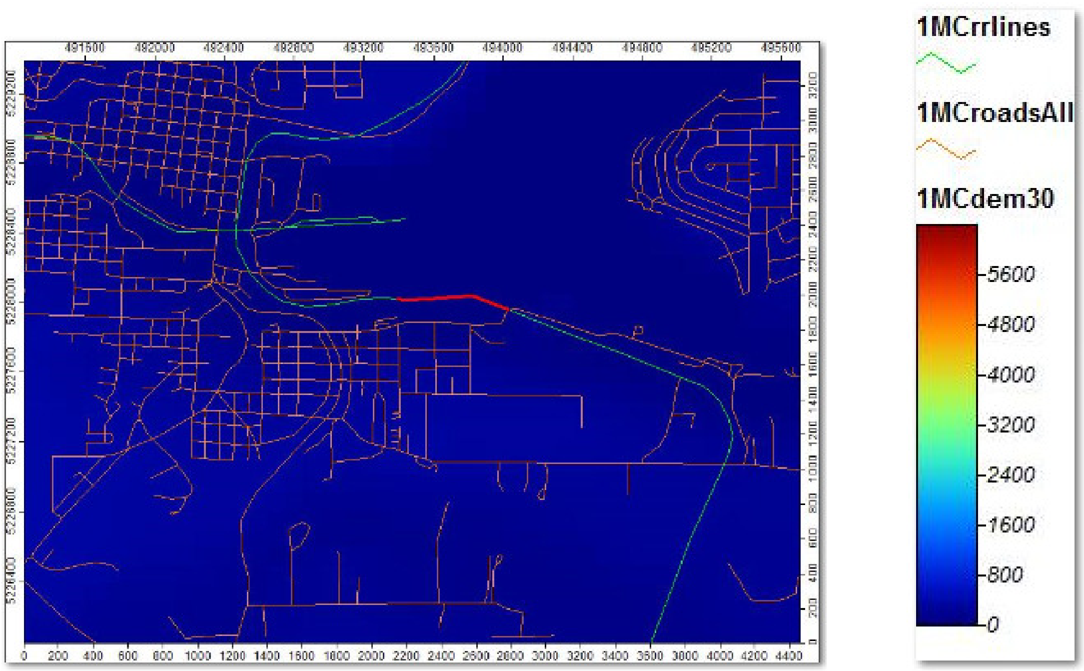


Figure 6-27. A map and map legend saved as JPEG files.

The legend displayed on the right in Figure 6-27 is saved as a separate image file. There are three layers in the view window: 1MCrrline, 1MCroadsAll, and 1MCdem30. Notice that a legend for each layer of the map is produced.

Figure 6-28 displays the world file (the file format is .jgw).

```
RoadsAllChanges_001.jgw
1  5.5781866776
2  0.0000000000
3  0.0000000000
4  -5.5781866776
5  491133.8995953896
6  5229501.9293760629
7
```

Figure 6-28. The world file (.jgw) created by the "Save as Image" option.

The KML or keyhole markup language file that was saved is displayed in Figure 6-29.

RoadsAllChanges_001.kml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Folder>
    <name>Maps exported from SAGA</name>
    <description>System for Automated Geoscientific Analyses - www.saga-gis.org</description>
    <GroundOverlay>
      <name>02. 1MCroadsAll</name>
      <description><h4>Map</h4><table border="0"><tr><td valign="top"><b>Name</b></td><td valign="top">02. 1MCroadsAll</td></tr><tr><td valign="top"><b>Layers</b></td><td valign="top">3</td></tr><tr><td valign="top"><b>Coordinate System</b></td><td valign="top">Projected Coordinate System:
Transverse_Mercator
[+proj=utm +zone=10 +datum=WGS84 +units=m +no_defs ]</td></tr></table></description>
      <Icon>
        <href>RoadsAllChanges_001.jpg</href>
      </Icon>
      <LatLonBox>
        <north>5229501.929376</north>
        <south>5225931.889902</south>
        <east>495819.576405</east>
        <west>491133.899595</west>
        <rotation>0.0</rotation>
      </LatLonBox>
    </GroundOverlay>
  </Folder>
</kml>
```

Figure 6-29. The KML file.

Each change results in up to four files saved if all of the parameters of the 'Save Map as Image' parameters page are in on status. The two .jpg files are an image of the map view window and an image of the legend for the map view window. The two other files are a world file, a .jwg file format, and a KML or .kml file. I could save storage space if I do not need all of these files. I could change these parameters to off status in the 'Save Map as Image' dialog window.

Chapter 7 – The Menu Bar "Other" Menus

The Menu Bar is dynamic. The standard Menu Bar that displays when SAGA opens with an empty work space, i.e., no map view windows displayed in the work space nor defined in the Maps tab area, displays in Figure 7-1.

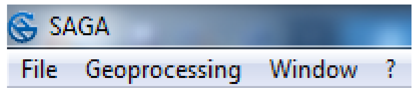


Figure 7-1. The standard Menu Bar display.

As I apply SAGA tools, functions, and commands with various mixes of layers (grid, shapes, point cloud), additional Menu Bar titles appear in the Menu Bar. These menus do not appear randomly but result from an action such as displaying a map view window, displaying a 3D view window, displaying a scatterplot, etc., in the work area. The additional menus are: Map, 3D View, Layout, Histogram, Scatterplot, Diagram, and Table. They appear on the Menu Bar between the Geoprocessing and Window menu titles.

The Map and Table menus are explored in Chapters 6 and 8. The other menus are the subjects of this chapter.

What are the actions causing the "other" menus to display on the Menu Bar? Let's summarize these actions.

Menu Bar: Map
When I first execute SAGA, a work session starts up. The appearance of the work area depends on parameter settings and the environment of the previous SAGA work session. If I start up SAGA and choose the "[empty]" option on the 'Select Startup Project' dialog window, no layers are loaded and I have an empty work session. The standard menus on the Menu Bar are File, Geoprocessing, and Window as displayed in Figure 7-1.

I decide to load a few layers into the work session and they appear in the list in the Data tab area of the Manager. Further, I decide I want to display one of the layers in the work area in a map view window. I double-click on the layer name and a map view window appears in the work area. I notice that a new menu appears on the Menu Bar named Map (see Figure 7-2). The map menu is active on the Menu Bar whenever a map view window is the active window in the work area. It is also the default other menu for the duration of the work session whenever another type of window is not displayed in the work area.

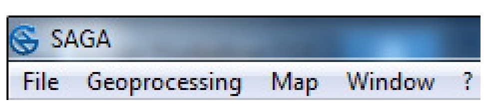


Figure 7-2. The Map menu on the Menu Bar.

Another way to reveal the Map menu is by clicking with the mouse on a layer name in the Data tab area of the Manager and choosing the "Add to Map" option on the dropdown list of options. If a map view window is not already defined for the work session, this action causes the Map menu to appear on the Menu Bar.

Menu Bar: 3D View
A map view window is a 2-dimensional view of one or more layers. This view is a flat or plan view using various color display options portraying data values and features of one or more layers. This is the normal SAGA viewing mode for a layer or layers as a map.

The 3-dimensional view of a map is a perspective view of the layer or layers, normally created using a digital elevation grid layer as the basis of a 3-dimensional model. Elevations provide the perspective part of the view or topography while layers of the map view window are draped on the 3-D model and provide the color part representing non-elevation data. It is not necessary that the digital elevation grid layer be in the layer stack for the map view window. It is necessary that the elevation grid layer be available in the Data tab area of the Manager.

There are three ways to display a 3-dimensional view of a map view window. I can click the mouse on the 3D icon ( ) on the toolbar and select it. The "Show 3D-View" option on the Menu Bar: Map menu can be chosen. The "Show 3D-View" function available in the Maps tab area of the Manager can be chosen by right-clicking with the mouse on a map view window name and choosing the function from the popup list of options.

Using one of the three ways described above, when the 3D view window appears in the work area, I notice that the 3D View menu appears on the Menu Bar (see Figure 7-3).

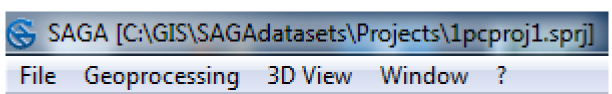


Figure 7-3. The 3D View menu on the Menu Bar.

This will be the additional menu whenever a 3D view window is the active window for the work area.

Menu Bar: Layout
This title includes options for preparing a ready-to-print map design. There are three ways to display a print layout view of a map view window. The 'Show Print Layout' icon ( ) on the toolbar or the Menu Bar: Map menu can be selected with the mouse. The "Show Print Layout" option available in the Maps tab area of the Manager can be chosen by right-clicking with the mouse on a map view window name and choosing the function from the popup list of options.

Using one of the three ways described above, a Layout view window displays in the work area. The new title Layout appears on the Menu Bar (see Figure 7-4).

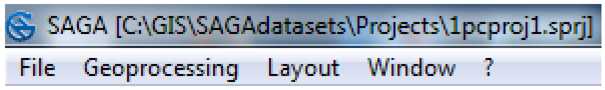


Figure 7-4. The Layout menu on the Menu Bar.

This will be the new menu whenever a layout window is the active window for the work area.

Menu Bar: Histogram
The histogram function is available as an option in the Data tab area of the Manager. It is an option for any grid, shape or point cloud layer in the list of layers in the tab area. I move the mouse pointer over a layer name and press the right mouse button. The histogram function appears in the popup list of options. I move the mouse pointer over the "Histogram" option and press the left mouse button, selecting the option. I notice the Histogram menu appears on the Menu Bar (see Figure 7-5).

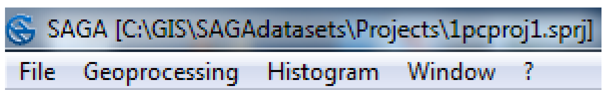


Figure 7-5. The Histogram menu on the Menu Bar.

This title remains on the Menu Bar while the histogram view window is the active window in the work area. This will be a Menu Bar menu whenever a histogram window is the active window for the work area.

Menu Bar: Scatterplot
The scatter plot option is also available in the Data tab area of the Manager. It is an option for any grid layer listed in the tab area. This option is available for shape layers but does not appear to be operational. It is working in SAGA Version 6.0.

I move the mouse pointer over a grid layer name and press the right mouse button. The scatter plot function appears in the popup list of options. I move the mouse pointer over the "Scatterplot" option and press the left mouse button, selecting the option. After the scatter plot view window appears in the work area, I notice the new menu Scatterplot appears on the Menu Bar (see Figure 7-6).

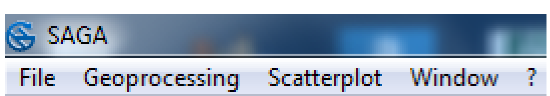


Figure 7-6. The Scatterplot menu on the Menu Bar.

This menu remains on the Menu Bar while the scatter plot window is the active window in the work area. This will be the menu whenever a scatter plot window is the active window for the work area.

Menu Bar: Diagram
The diagram function is available in the Data tab area of the Manager for any shape layer. I move the mouse pointer over a shape layer name and press the right mouse button. I move the mouse pointer to the "Attribute" option on the dropdown list of options, and choose the "Diagram" option on the popup list of options. I notice that after a diagram view window displays in the work area the new menu Diagram appears on the Menu Bar (see Figure 7-7).

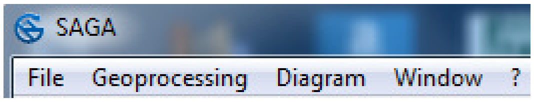


Figure 7-7. The Diagram menu on the Menu Bar.

This menu remains on the Menu Bar while the diagram view window is the active window in the work area. This will be the menu whenever a Diagram view window is the active window for the work area.

Menu Bar: Table
Anytime a table view window is active in the work area, the Table menu displays on the Menu Bar (see Figure 7-8).

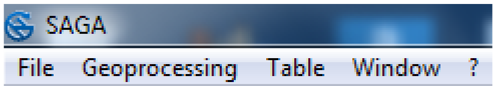


Figure 7-8. The Table menu on the Menu Bar.

Every shape layer includes an attribute table. The attribute table contains a record for each object of the layer. Attributes are data values describing the objects. Attribute tables can be viewed from the Data tab area of the Manager. I click the mouse (right mouse button) on a shape layer name. I move the mouse pointer to the "Attribute" option on the dropdown list of options, and choose the "Show" option on the popup list of options. The attribute table for the layer displays in the work area.

I notice that after a table view window displays in the work area the new menu Table appears on the Menu Bar (see Figure 7-8). This menu remains on the Menu Bar while the table window is the active window in the work area. This will be the additional menu whenever a Table window is the active window for the work area.

The "Show" command is used to display other tables that are not attribute tables loaded for the work session. A list of available tables appears in the Data tab area of the Manager at the bottom of the list of layers. I move the mouse pointer over a table name and press the right mouse button. I move the mouse pointer to the "Attribute" option on the dropdown list of options, and choose the "Show" option on the popup list of options. The attribute table displays in the work area.

The above serves as a brief overview of the rest of this chapter. The Map menu options are discussed in Chapter 6 and the Table menu options discussed in Chapter 8. The options for the remaining five menus are the subject of this chapter.

Introduction to 3D View

A 2-dimensional view of a map, i.e., a map view window, is a flat or plan view with various color display options portraying data values and feature boundaries. A map view window is how to view a layer or a set of layers as a map.

The 3-dimensional perspective view of a map view window is created using a digital elevation grid layer. The elevation layer provides the perspective part of the view or topography while the data for the one or more layers of the map view window is draped over the 3-dimensional model providing the color part representing non-elevation data.

The map view window that is active when I choose the 3D view option is the one whose layers drape on the 3-dimensional model created with the elevation grid layer identified for the elevation input. It is not unusual to develop a perspective view of just a digital elevation grid layer. An example of a 3-dimensional or perspective view of a digital elevation grid layer is in Figure 7-9.

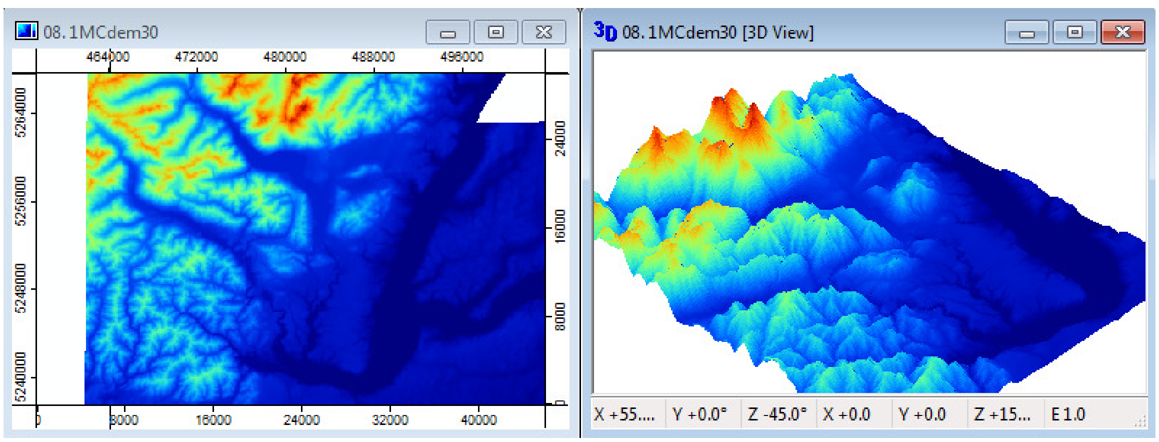


Figure 7-9. A three-dimensional or perspective view of a digital elevation grid layer.

The map view window on the left in Figure 7-9 is a zoomed in area of a 2-dimensional map view window for the elevation grid layer, '1MCdem30'. The window on the right is a 3D view window showing a 3-dimensional or perspective view window for the same zoomed in area on the left. The left side of the digital elevation model in the map view window is oriented north-south with north being up. The diagonal lower left side of the digital elevation perspective is oriented north-south.

In Figure 7-10, the 2-dimensional map view window on the left displays water bodies and four watershed basins on a topographic relief backdrop. The water bodies polygon shape layer is '1MCwaters-Poly', the watershed basins polygon shape layer is '1MC4Basins' and the topographic relief grid layer is '1MCrelief'. Water body polygons are filled in blue and the watershed basins are filled in aqua, blue, orange and red. The display of the watershed basins is set at 50% transparency (using the 'Transparency [%]' parameter).

The zoomed in view for the map view window on the left is the same area in the 3-dimensional view window on the right. In the perspective view I see how the water bodies and watershed basin polygons are draped over the perspective view of the topography. The shaded relief adds to the perspective view.

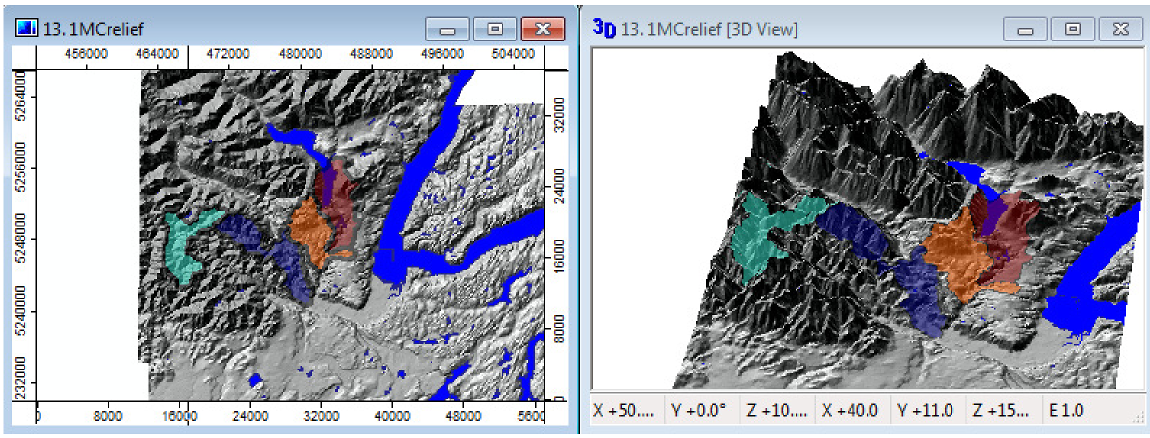


Figure 7-10. Draping layers over a three dimensional display of elevation.

There are three ways to display a 3-dimensional view of a map view window. The 3D icon () on the toolbar can be selected with the mouse. The "Show 3D-View" option on the Menu Bar: Map menu dropdown list of options is a second way. The "Show 3D-View" function available in the Maps tab area of the Manager is used by moving the mouse pointer over a map view window name and pressing the right mouse button. I can choose the "Show 3D-View" option on the popup list of options.

When a 3D view window displays in the work area, the 3D View menu is added to the Menu Bar. Figure 7-11 displays the dropdown list of options for the menu.

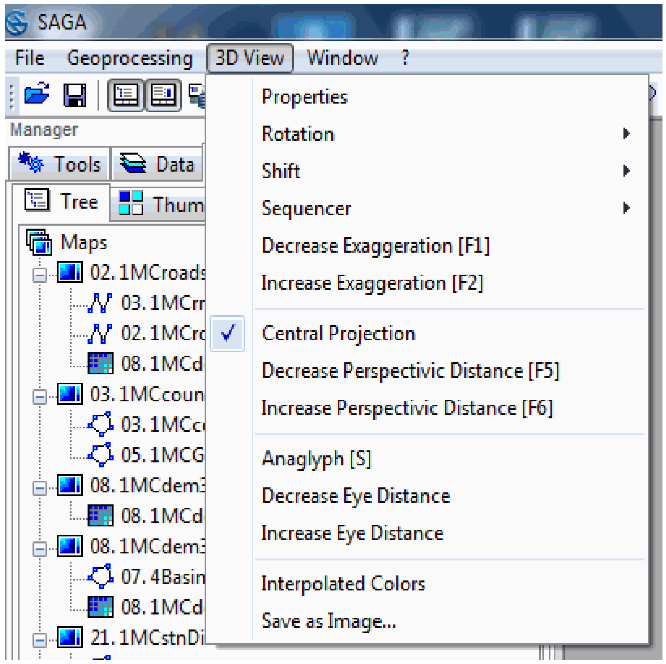


Figure 7-11. The dropdown list of options for the 3D View Menu Bar title.

Let's explore these options.

3D-View: Properties

The "Properties" option on the 3D View menu is a list of properties or parameters related to the 3-dimensional display of a map view window. There is some overlap between the properties or functions available as "Properties" versus the options available on the 3D View menu dropdown list of options. For example, the rotation and shift functions on the 3D View list of options are also available on the "Properties" page. It is also the case that exaggeration, perspectivic distance, and projection are available in similar fashion in both locations. This overlap presents some confusion in explaining these features.

I am choosing to use the "Properties" page as the structure for the first part of explaining properties and parameters. I will cross-reference between the two locations where overlap exists. Options unique to the 3D View list of options are covered in the second part of this section. I hope this will lessen any confusion due to overlap and lead to a clearer understanding of the 3D View capabilities.

Two inputs are required for creating a 3-dimensional perspective. The first is a map whose data I want to view draped on a perspective model. The active map view window in the work area when I choose the "3D-View" option is that map. When I choose "Show 3D-View", a '3D-View' properties window displays (see Figure 7-12).

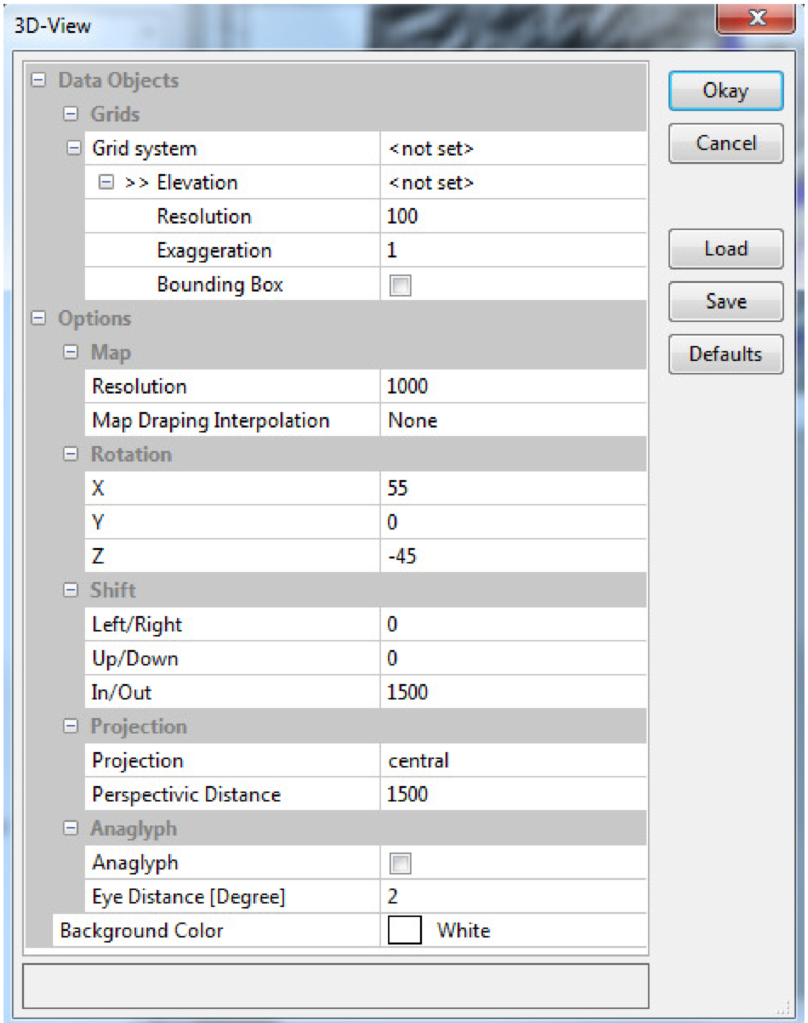


Figure 7-12. The '3D-View' properties window.

The second required input is to choose a grid layer for the '>> Elevation' parameter. This actually involves two related inputs. The map extent of the elevation grid layer must include overlap of the map view window being overlain.

The majority of the parameter settings in the properties window relate to how the perspective view is oriented in the 3D view window. The first two are for choosing the layer that is the source of elevation information for the perspective model.

When I save or re-save a project, the 3D view windows and properties are not saved as part of the project environment like layer, map and table view window properties. When I click on the Save button on the ‘3D-View’ properties window, a ‘Save Settings’ dialog displays. The opportunity is provided to choose a storage location and file name for the current properties. The current properties are saved in a .sprm file format. I can re-load the ‘3D-View’ properties using the Load button. The layer files necessary to support replication of the 3-dimensional view that the properties define must be loaded for the work session.

3D View: Properties: Grids: Grid system
This property is to identify the grid system for the elevation grid layer that will be selected for the '>> Elevation' parameter. The grid system must be one listed in the Data tab area of the Manager.

3D View: Properties: Grids: >> Elevation
This parameter is for choosing the grid layer that provides the elevation data values for the 3-dimensional perspective model. If the layer name does not appear in the list of layers in the Data tab area of the Manager, the Menu Bar File: Grid: Load command can be used to load it into the work session.

After providing inputs for the ‘Grid System’ and ‘>> Elevation’ property parameters I click on the Okay button. The 3D view window in Figure 7-13 on the right side displays. On the left side is the map view window with the digital elevation model (DEM) grid layer (‘1MCdem30’) displayed.

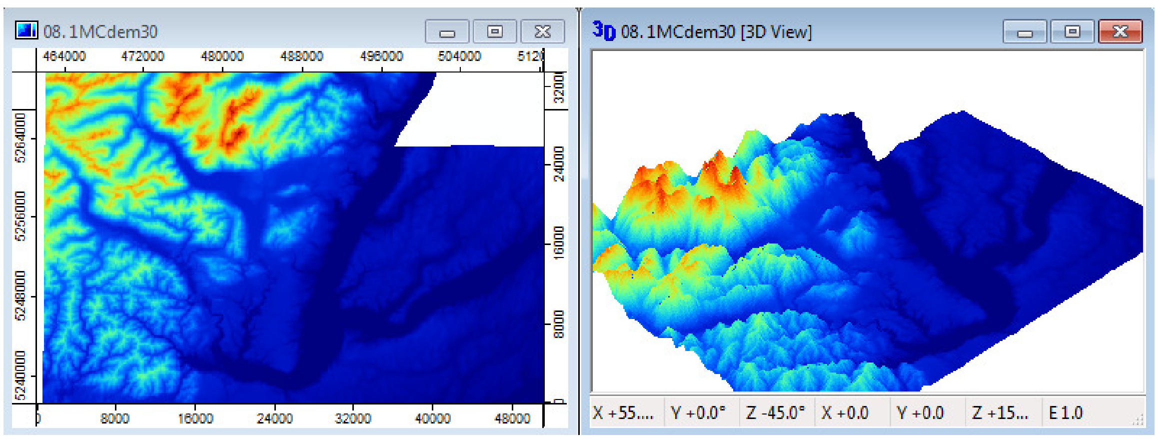


Figure 7-13. The 3D view window.

Using the mouse, I can click and drag within the 3D view window and interactively change many of the rotation parameters that control the orientation of the 3D display.

In addition to the 3D View Menu Bar menu, a topical set of icons is added to the toolbar. Figure 7-14 displays the updated toolbar.

Figure 7-14. Adding 3D view options to the toolbar.

Table 7-1 is a cross-reference between these new icons and the 3D view parameters described in this chapter.

Table 7-1. 3D View Menu Options

3D View Options	Toolbar Icons	3D View Options	Toolbar Icons
Properties		Decrease Exaggeration [F1]	
Rotation: Up		Increase Exaggeration [F2]	
Rotation: Down		Central Projection	none
Rotation: Left		Decrease Perspectivic Distance	
Rotation: Right		Increase Perspectivic Distance	
Shift: Left		Interpolated Colors	
Shift: Right		Anaglyph [S]	
Shift: Down		Decrease Eye Distance [F5]	none
Shift: Up		Increase Eye Distance [F6]	none
Shift: Forward		Save As Image…	none
Shift: Backward		Sequencer	none

3D View: Properties: Grids: Resolution

The default entry for the 'Resolution' parameter is 100. Figure 7-15 compares two 3D view windows using different entries for the 'Resolution' parameter.

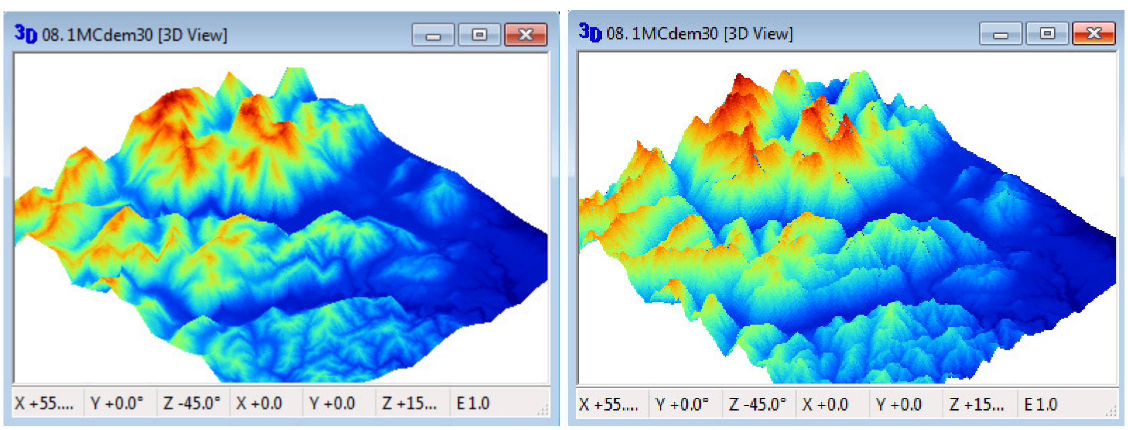


Figure 7-15. Comparing 'Resolution' values of "20" and "100".

The two zoomed in areas in Figure 7-15 are for the same 3-dimenional perspective. The view window on the left uses a resolution value of 20, the one on the right a value of 100 (the default value). Notice the difference in smoothness between the two. The visual result, i.e., the smoothness, is similar to the result of enabling interpolation. The higher the number entered for resolution, the more visually detailed the results. It may also be the case that the higher the value the longer it takes to display a 3D view window.

3D View: Properties: Grids: Exaggeration, 3D View: Decrease Exaggeration [F1], 3D View: Increase Exaggeration [F2]

This is one of the parameters on the 'Properties' page that is replicated in the list of options for the Menu Bar 3D View menu. In the case of the 3D View menu, there are two options: Decrease Exaggeration and Increase Exaggeration.

The exaggeration factor applies to the ratio between the horizontal and vertical scales. The default entry for the 'Exaggeration' property parameter is 1 or no exaggeration. In Figure 7-16, near the bottom right portion of the window frame, there is an information field labeled E. This is where the exaggeration value for the perspective model displays.

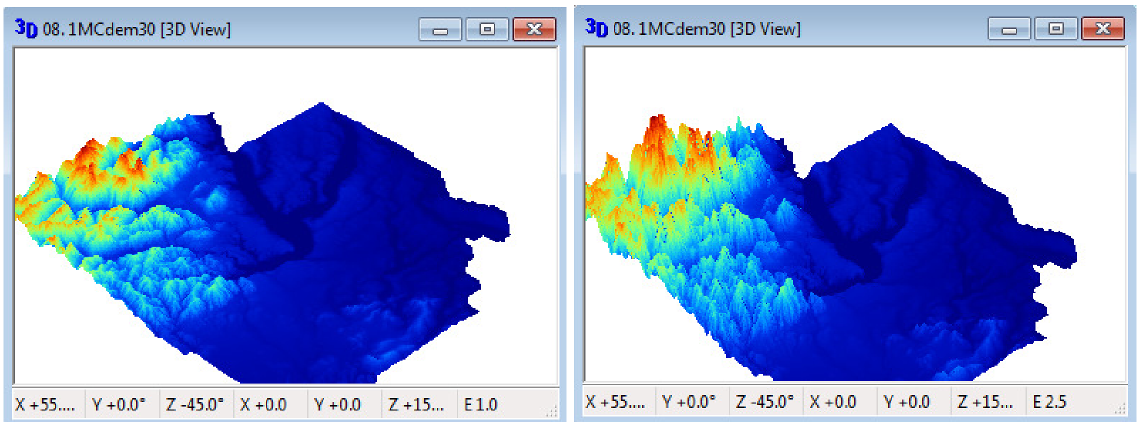


Figure 7-16. The effect of the exaggeration factor.

The 3D view window on the left in Figure 7-16 uses the default exaggeration factor of 1 which means no exaggeration. The graphic on the right in Figure 7-16 shows the perspective using an exaggeration factor of 2.5. Comparing the two view windows it is easy to visually perceive the effect of a 2.5 exaggeration factor.

The "Decrease Exaggeration" and "Increase Exaggeration" 3D View menu options also change the exaggeration factor. Each time I click the mouse on the "Decrease Exaggeration" option the ratio decrements by .5 while a click on the "Increase Exaggeration" increments the ratio by .5.

3D View: Properties: Grids: Bounding Box

This is a toggle check box parameter. The default is for it to be in off status, with no check mark displayed in the check box. If I toggle this parameter to on status by moving the mouse pointer into the check box and pressing the left mouse button, a transparent bounding box encloses the 3-dimensional perspective display.

A comparison between two 3-dimensional displays appears in Figure 7-17.

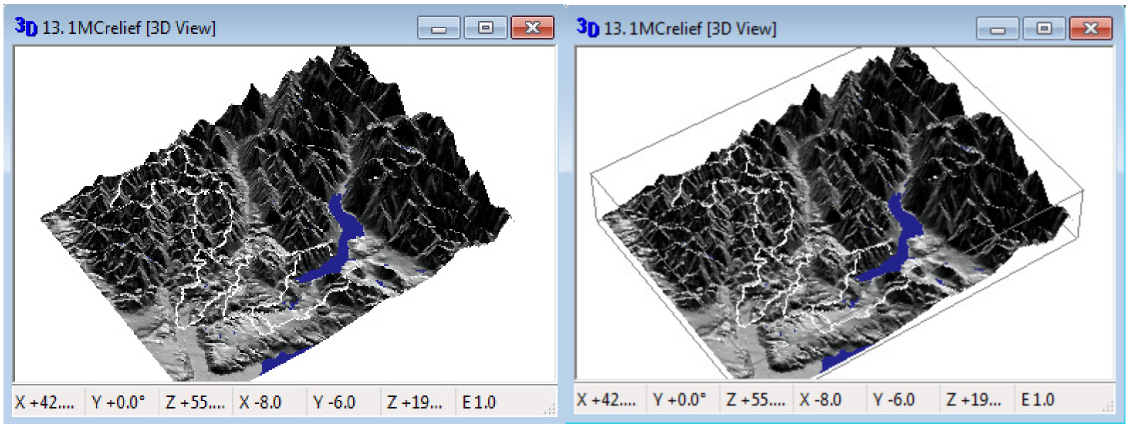


Figure 7-17. The bounding box option.

The perspective model on the left is without a bounding box and the one on the right includes a bounding box. I can see that the bounding box encloses the perspective model.

3D View: Properties: Map: Resolution
This parameter and the 3D View: Properties: Map Draping Interpolation parameter work together to improve the overall visual display quality of a draped layer on a 3D model. The larger the value entered for the 'Resolution' parameter, the more detailed the draped layer appears.

3D View: Properties: Map: Map Draping Interpolation
This parameter is used to choose an interpolation technique to use with the entry for the 'Resolution' entry above. The default entry is none. The other choices are: Bilinear, Inverse Distance, Bicubic Spline, and B-Spline. In general, Bicubic Spline and B-Spline seem to produce smoother results compared to Bilinear and Inverse Distance.

3D View: The X, Y, and Z Axes
The perspective model has three axes. The axes are X, Y, and Z. Figure 7-18 displays a simple graphic depicting the three axes. The Z-axis is normal or perpendicular to the plane of the grid and the Y-axis normal to the plane of your monitor.

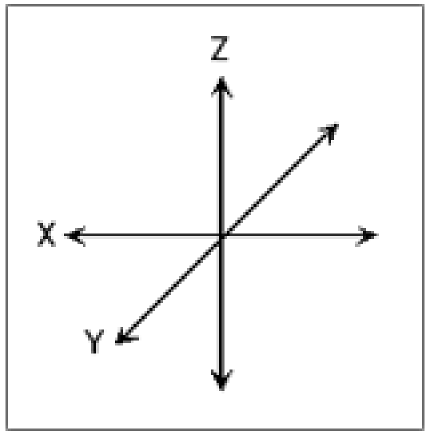


Figure 7-18. The perspective axes.

This figure is used as a reference in several of the following descriptions.

3D View: Properties: X, 3D View: Properties: Y, 3D View: Properties: Z
These three properties parameters control rotation of the perspective model around the three axes X, Y, and Z. A numeric entry, in degrees, is entered for the amount of rotation for each axis. These can be exact positive or negative values for the amount. The default entry for the X axis is 55, for the Y axis it is 0, and for the Z axis it is -45.

The values in effect for the axes rotations display in information fields at the bottom left of the 3D view window. These fields are labeled X, Y, and Z followed by a number. The number represents degrees of rotation.

An easy way to change the rotation of the model is to use the mouse in an interactive fashion. Using the mouse to freely change the rotation parameters is described in the following sections.

Let's look at an example involving rotation around the Y-axis. As noted above, the default entry in the value field to the right of the ‘Y’ parameter is 0. Figure 7-19 shows the effect on the perspective graphic when I enter a value of 30 in the value field.

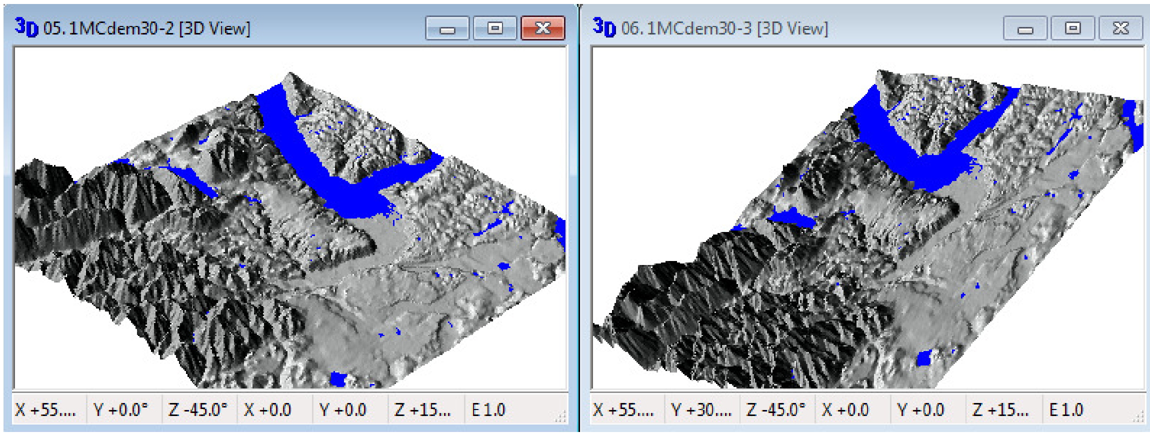


Figure 7-19. Using the ‘Y’ parameter on the ‘3D-View’ properties page.

The [F3] function key can be used to decrease the angle of rotation about the Y-axis and [F4] to increase the angle. When I press these function keys I see the value in the Y information field update.

3D View: Rotation: Up, 3D View: Rotation: Down
The Rotation "Up" and "Down" options adjust rotation of the perspective model around the X or horizontal axis. Figure 7-20 displays a 3D view window (on the left) using the default settings when I first execute the 3D view mode.

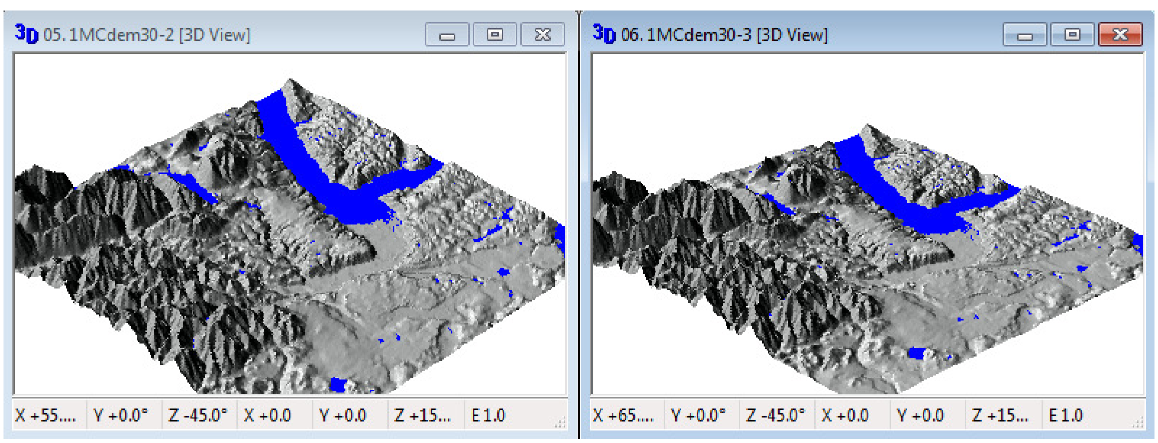


Figure 7-20. Using the "Up" rotation command.

The graphic on the right shows the same 3D view window with a change using the "Up" command on the toolbar to change the rotation around the X axis from +55 degrees to +65 degrees.

In addition to the options available on the 3D view menu on the Menu Bar and on the toolbar, the ‘3D-View’ properties window ‘Rotation: X’ parameter can be used to enter a specific positive or negative value for the rotation of the perspective about the X axis.

Adjusting the rotation of the perspective about the X or horizontal axis is much easier but not as precise using the mouse. When I hold down the left mouse button and move the mouse away from me, this is the same as Rotation "Up". I will see the value for X on the 3D view window increase. Holding the left mouse button and moving the mouse toward me is the same as using the Rotation "Down" tool. This causes the angle displayed in the X field to decrease value. Because of the difficulty of moving the mouse perfectly perpendicular to a horizontal line (i.e., in a perfectly straight path), when I move the mouse away or toward me, not only will I see the X value change but I will probably see the Z value change also. Generally, you should see the perspective appear to rotate around the X axis of the perspective plane. Rotation around the Z axis is described next.

3D View: Rotation: Left, 3D-View: Rotation: Right
The Rotation "Left" and "Right" tools control rotation of the perspective view around the Z axis. Figure 7-21 displays a 3D view window with all of the 3D view parameters set to their defaults. The graphic on the right shows the same 3D view window with the only change being using the "Right" option on the toolbar to increase the rotation around the Z axis from -45 degrees to -75 degrees.

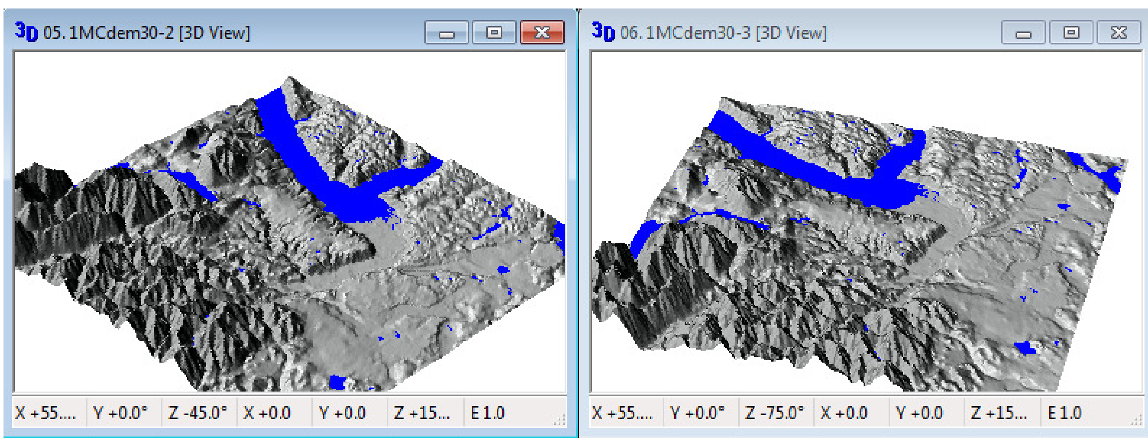


Figure 7-21. Using the "Right" rotation option.

As with the Rotation "Up" and "Down" options, the Rotation "Left" and "Right" options can be executed using the mouse. When I hold down the left mouse button and move the mouse to the right, this is the same as Rotation "Right" described above. I see the value for Z on the 3D view window increase. Holding the left mouse button, moving the mouse to the left, is the same as using the Rotation "Left" tool. This causes the angle displayed in the Z field to decrease value. Because of the difficulty of moving the mouse in a perfect straight line, when mouse deviates off a straight line to the left or right, not only will I see the Z value change but I will probably see the X value change as well. However, the perspective appears to rotate around a central point that is the point where the Z axis is perpendicular to the plane of the perspective.

As I experiment with using the mouse to interactively adjust the rotation of the perspective around the X and Z axes, I can see how easy it is to adjust the rotation by freely moving the mouse, changing simultaneously both the X and Z rotation angles.

3D View: Shift
The perspective graphic can be shifted or moved along the three axes X, Y, and Z (Figure 7-18).

The 3D View: Properties: Shift: Left/Right parameter moves the perspective model along the X axis. The 'Shift: Up/Down' parameter moves it up and down the Y axis. The 'Shift: In/Out' parameter moves the perspective along the Z axis.

The values in effect for the position of the perspective relative to the three axes are displayed in information fields to the right of the axes rotation information fields (described above) in the 3D view window. They also are labeled X, Y, Z followed by a number. The number represents distance units from the intersection of the three axes at (0,0,1500).

Options on the Menu Bar 3D View list of options also shift the perspective model along the three axes. These options are Shift: Left, Shift: Right for moving along the X axis, Shift: Down and Shift: Up for moving along the Y axis, and Shift: Forward and Shift: Backward for moving along the Z axis.

The mouse can be used to adjust the shift of the perspective model along the X axis or Y axis. When I hold down the right mouse button and drag the mouse to the left or right, this is the same as Shift "Left" or Shift "Right". I will see the perspective appear to move left or right along the X axis and the distance value for X changes with the movement. Dragging the mouse up or down is the same as using the Shift "Up" or Shift "Down". I will see the perspective appear to move up or down along the Y axis and the distance value for Y changes with the amount of movement. Because of the difficulty of moving the mouse in a perfectly straight line, when I move the mouse to the left or right or up or down, not only will I see the X distance value change but I will probably see the Y value change, too.

3D View: Properties: Shift Left/Right, 3D View: Shift: Left, 3D View: Shift: Right
The Shift "Left" and "Right" options control the position of the perspective view along the X or horizontal axis. Figure 7-22 displays a 3D view window using the default settings for the 3-D view. The graphic on the right shows the same 3D view window after the "Left" option on the toolbar is used to move the perspective left on the X axis a distance value of -75 from the default of 0.

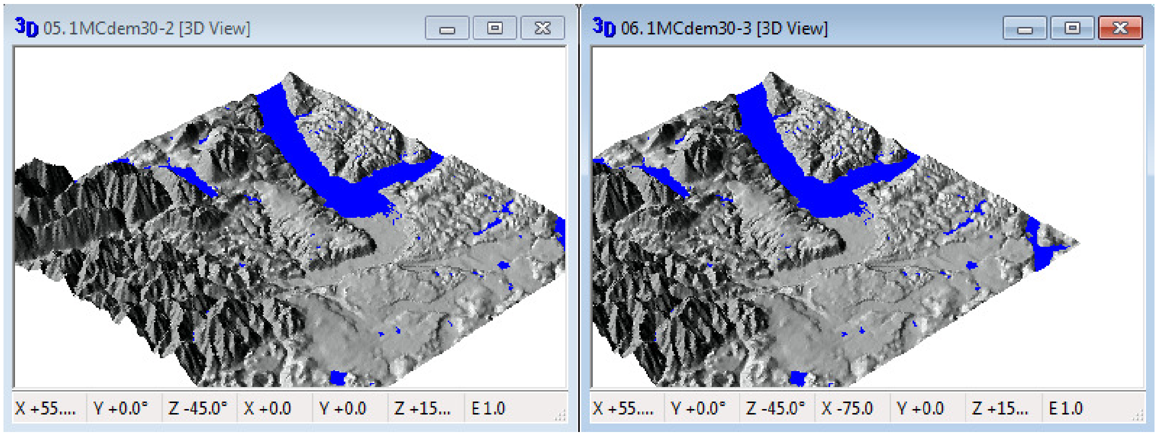


Figure 7-22. Using the "Shift Left" tool.

The value for the X shift in the graphic on the left is showing +0.0. The value for the X shift in the graphic on the right is showing –75.0. The "Right" option on the toolbar will move the perspective to the right along the X axis.

In addition to the options available on the 3D View dropdown menu on the Menu Bar and on the toolbar, the '3D-View' properties page 'Shift: Left/Right' parameter can be used to enter a specific positive or negative value for the position of the perspective along the X axis.

3D View: Properties: Shift Up/Down, 3D View: Shift: Down, 3D View: Shift: Up
The Shift "Up" and "Down" options control the position of the perspective view along the Y axis. Figure 7-23 displays a 3D view window using the default settings when I first execute the 3D view mode. The graphic on the right shows the same 3D view window with the only change being the use of the "Up" option on the toolbar to move the perspective along the Y axis a distance value of 60 from the default of 0.

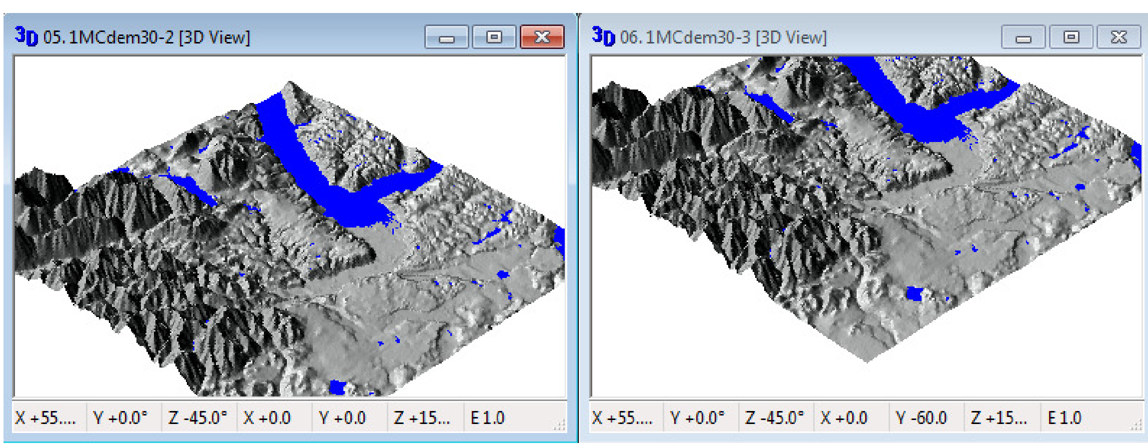


Figure 7-23. Using the "Shift Up" tool.

The value for the Y shift in the graphic on the left is showing +0.0. The value for the Y shift in the graphic on the right is showing -60.0. The "Down" option on the toolbar will move the perspective the opposite direction along the Y-axis.

In addition to the tools available on the 3D View dropdown menu on the Menu Bar and on the toolbar, the ‘3D-View’ properties page ‘Shift: Up/Down’ parameter can be used to enter a specific positive or negative value for the position of the perspective along the Y axis.

3D View: Properties: Shift In/Out, 3D View: Shift: Forward, 3D View: Shift: Backward

The default setting for the position of the perspective relative to the Z axis is 1500. The default setting for both the X and Y axes is 0. The Shift "Forward" and "Backward" options control the position of the perspective view along the Z-axis. The Shift "Forward" function moves the perspective forward along the Z-axis and the Shift "Backward" function moves it backward along the Z-axis.

Figure 7-24 displays a 3D view window on the left using the default settings when I first execute the 3D view mode. The graphic on the right shows the same 3D view window with the only change being using the "Backward" option on the toolbar to move the perspective along the Z axis a distance value of 100 from the default of 1500. Each click of the mouse on the "Backward" function increments the position along the Z axis by 10 distance units. Each click on the "Forward" function decrements the position along the Z axis by 10 distance units.

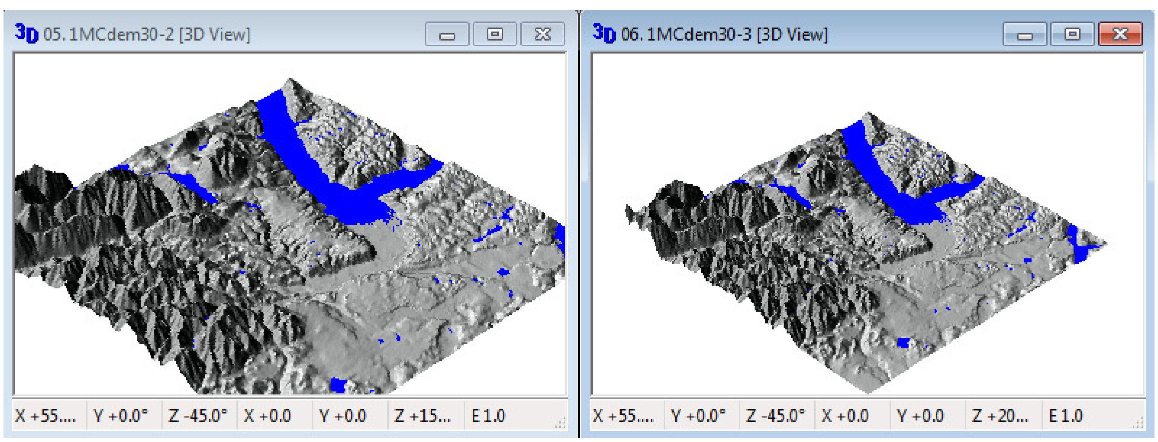


Figure 7-24. Using the "Shift Backward" option.

The value for the Z shift in the graphic on the left is showing 1500.0. The value for the Z shift in the graphic on the right is 2000.0.

In addition to the tools available on the 3D View dropdown menu on the Menu Bar and on the toolbar, the ‘3D-View’ properties page ‘Shift: In/Out’ parameter can be used to enter a specific positive or negative value for the position of the perspective along the Z axis.

3D View: Decrease Exaggeration [F1], 3D View: Increase Exaggeration [F2]
The exaggeration factor applies to the ratio between the horizontal and vertical scales. The default entry for exaggeration is 1.0. This value means no exaggeration. In Figure 7-25 there is an information field labeled E near the bottom right side of the 3D view window. This is where the exaggeration value for the current perspective displays.

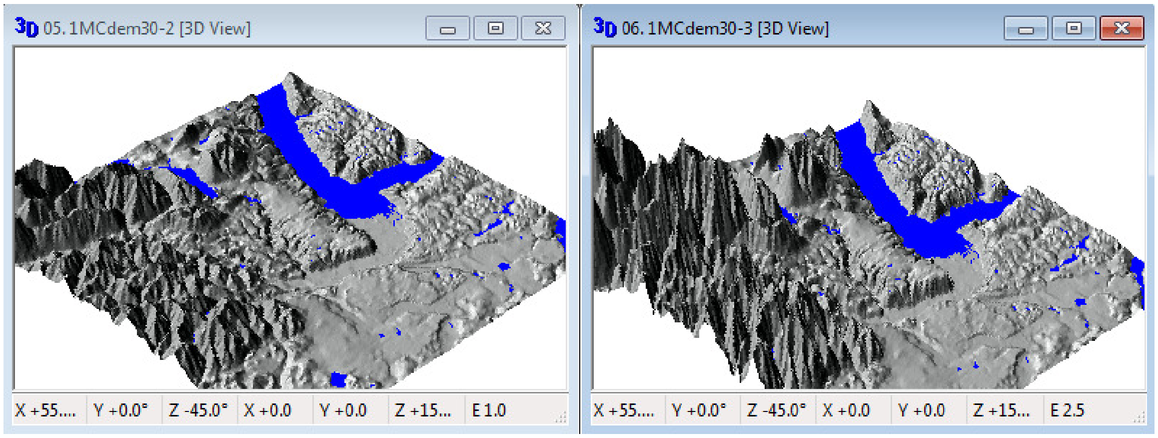


Figure 7-25. The effect of the exaggeration factor.

The graphic on the right in Figure 7-25 shows the perspective using an exaggeration factor of 2.5. The "Decrease Exaggeration" and "Increase Exaggeration" options control the amount of exaggeration. I can also enter a specific exaggeration factor into the value field to the right of the 'Exaggeration' parameter on the '3D-View' properties page.

3D View: Properties: Projection, 3D View: Central Projection
The 'Properties' window projection area has two parameters. One is named 'Projection'. When I click in the value field to the right of the 'Projection' parameter, a popup list displays with two choices: Central or Parallel. "Central" is the default.

The Menu Bar 3D View dropdown menu has one projection choice: Central Projection. On the dropdown menu, the "Central Projection" option has a check beside it in the list. If I click on the "Central Projection" option when it is checked, the check disappears and the projection switches to the "Parallel" option.

The "Decrease Perspectivic Distance" and "Increase Perspectivic Distance" options on the 3D View dropdown menu are not available when the projection choice is "Parallel". They are only available when the "Central" projection option is selected.

3D View: Projection: Perspectivic Distance
The default value for the 'Perspectivic Distance' parameter on the '3D-View' properties page is 1500. Note that this is the same default value used for the 'Shift: Z' parameter. The 'Perspectivic Distance' value for the current perspective is viewed in the 'Properties' window. It displays in the value field to the right of the 'Perspectivic Distance' parameter.

The "Decrease Perspectivic Distance" and "Increase Perspectivic Distance" options on the 3D View menu appear to move the perspective model along the Z axis similar to using the Shift: Backward and Shift: Forward options. The difference being that lower values move the model closer along the Z axis and higher values move the model further out along the Z axis. The perspective distance values do the opposite; lower values move the model further out and higher values move the model closer.

Perspectivic distance and shift, although they have a similar effect on the model, are different. SAGA applies perspectivic distance like a camera focal length, the shorter the focal length the more distant the model appears; the longer the focal length the closer the model appears.

3D View: Decrease Perspectivic Distance [F5], 3D View: Increase Perspectivic Distance [F6]
In Figure 7-26, the graphic on the left is a perspective with all parameters set to their defaults. The graphic on the right displays the perspective after using the "Decrease Perspectivic Distance" option to reduce the distance to 1350 units (from the default of 1500). I move the mouse pointer to the "Decrease Perspectivic Distance" option and press the left mouse button. This decrements the distance by 50 distance units. Each click on the "Increase Perspectivic Distance" option increments by 50 distance units.

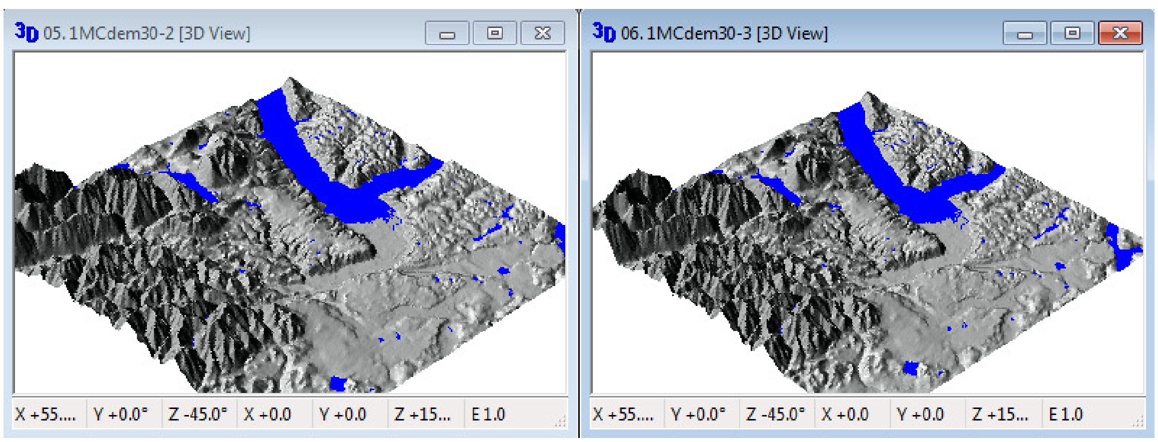


Figure 7-26. The effect of "Perspectivic Distance".

Introduction to Anaglyphs
An anaglyph is an image consisting of two slightly different perspective views of the same subject. The two perspectives are superimposed using contrasting colors, one with red and the other with green. This produces a three-dimensional effect when viewed through two correspondingly colored filters (glasses with red and green lenses).

Most of us have the capability with our eyes and brains to see in stereo, sometimes referred to as binocular or stereo vision. Using this capability we perceive depth; for example, the ability to tell if an object is three feet or three inches away from us or thirty yards or thirty feet away. Both of our eyes are on the front of our faces and each see a slightly different angle of the same thing. Close one eye, then close the other, you will notice there is a slightly different view of the same thing. Our brains put these two views together to get a 3-D or stereo image of our surroundings.

Anaglyphs do the same thing by tricking our eyes into doing the same thing they normally do, except with a flat picture. The anaglyph is a stereo image. The two different views, with a 2-degree viewpoint separation, are plotted on top of each other. One image is plotted in green, and the other in red. Viewing the image through anaglyphic glasses, that have red and green lens, produces the stereo effect. The image is processed so each eye sees a slightly different view and our brain combines them to give the effect of depth perception.

There are softcopy photogrammetric software packages that use the anaglyph for processing scanned aerial photographs into corrected images (rectified and orthographic).

3D View: Properties: Anaglyph [S], 3D View: Anaglyph
The '3D View' properties page includes two parameters related to anaglyphs. One is 'Anaglyph' and the second one is 'Eye Distance [Degree]'. Similar options are available on the 3D View Menu Bar dropdown list of options. These options are "Anaglyph", "Decrease Eye Distance", and "Increase Eye Distance".

The 'Anaglyph' parameter on the properties page and the "Anaglyph" option on the 3D View menu perform the same function. The 'Anaglyph' parameter on the properties page is a toggle check box parameter. The default is for it to be in off status not showing a check in the check box. Moving the mouse pointer into the check box and pressing the left mouse button changes the status to on and a check mark appears in the check box. The 3D view window quickly transforms to an anaglyph view. The same result occurs if I click on the "Anaglyph" option in the 3D View menu of options. Figure 7-27 compares a 3D view window with the 'Anaglyph' parameter off versus the same 3D view window with it on.

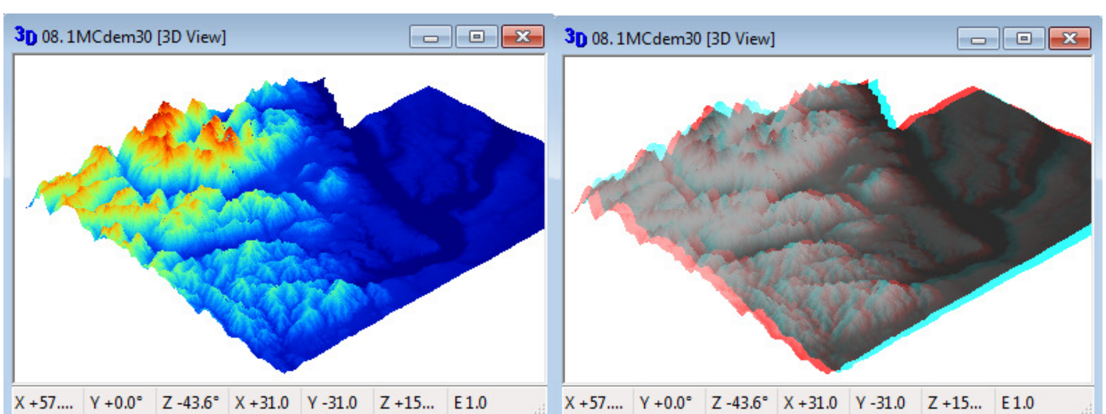


Figure 7-27. Comparing a 3D View window to an anaglyph map view window.

A perspective view of the anaglyph map view window on the right is possible using the special anaglyphic glasses.

3D-View: Decrease Eye Distance, 3D View: Increase Eye Distance
These two menu options relate to the anaglyph display. They increase or decrease the viewing angle between the eyes.

3D View: Properties: Eye Distance [Degree]
This is a properties parameter for anaglyph displays. This parameter serves the same function as the "Decrease Eye Distance" and "Increase Eye Distance" options in the 3D View menu options list. The value entered into the value field is the angular displacement between the pair of images, i.e., the red and green (or blue) images. The default is 2 degrees. A value of 0 results in identical images or no displacement for both colors. The value can range from 0 to 180.

3D View: Properties: Background Color
This is a properties parameter. The default is for the background behind the perspective in the 3D view window to be white. When I click with the mouse pointer (while holding down the left mouse button) in the value field for the 'Background Color' parameter, a column of color swatches displays. Selecting any of the swatches replaces the current background color with that of the chosen swatch.

The remainder of this section for 3D view covers the options in the 3D View title dropdown menu that are not duplicated by parameters in the 3D View parameters page.

3D View: Interpolated Colors
I can turn this option on by moving the mouse pointer over the 3D View menu title and pressing the left mouse button. Then I move the mouse pointer over the "Interpolated Colors" option in the dropdown list of options and press the left mouse button. A check mark appears to the left of the option in the dropdown menu for the 3D View Menu Bar title when the feature is on. The default is for 'Interpolated Colors' to be off.

This parameter smoothes the gradient between display color classes particularly along a border where significant contrast might exist. The effect of this parameter is easier viewed by zooming in on high contrast areas.

3D View: Save As Image…
This option is for saving a 3D view window as an image. When I select the option, a 'Save As Image' dialog window is displayed (Figure 7-28).

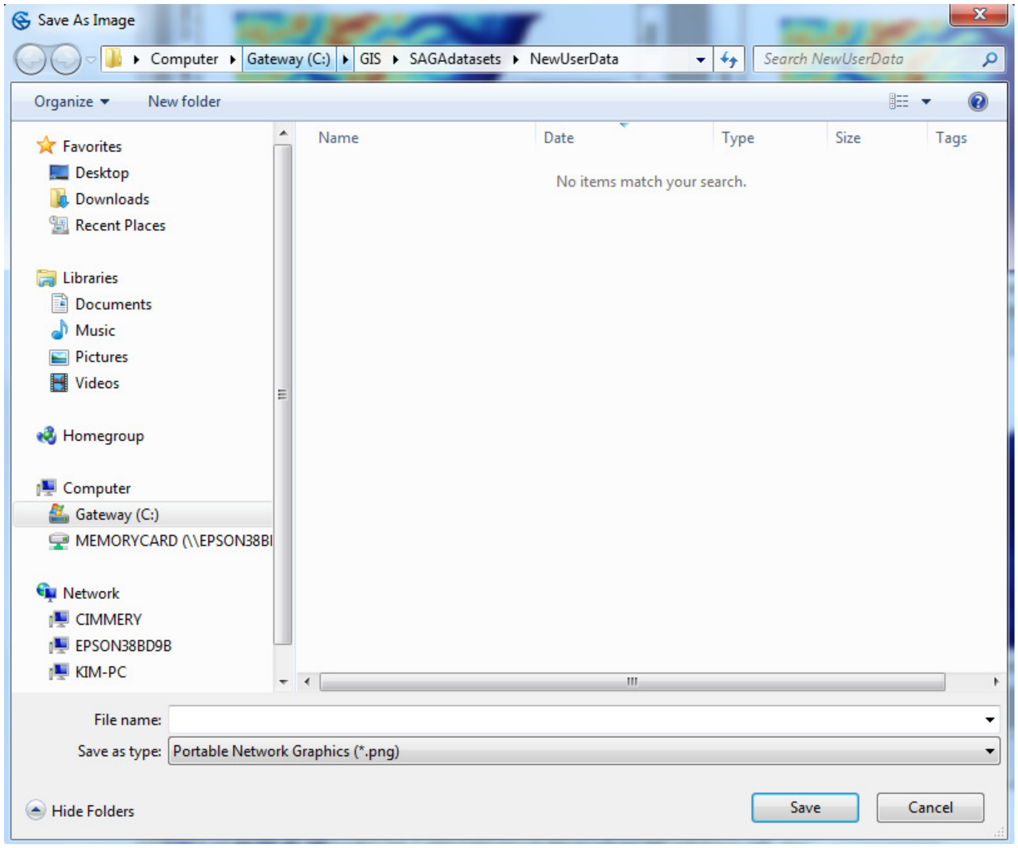


Figure 7-28. The 'Save As Image' dialog window.

I can browse to a different folder if the path displayed is not where I want to save the image.

There are several file formats supported. The default is the "Portable Network Graphics" format (.png). Other choices include:

Windows or OS/2 Bitmap (*.bmp)
JPEG-JFIF Compliant (*.jpg)
Tagged Image File Format (*.tif)
CompuServe Graphics Interchange (*.gif)
Zsoft Paintbrush (*.pcx)

You can see from the list that SAGA supports a good selection of image formats. The format I use depends on how I intend to use the image.

I have created a perspective in a 3D view window that I saved in the .jpg format. Figure 7-29 displays the saved 3D view window as a saved .jpg file.

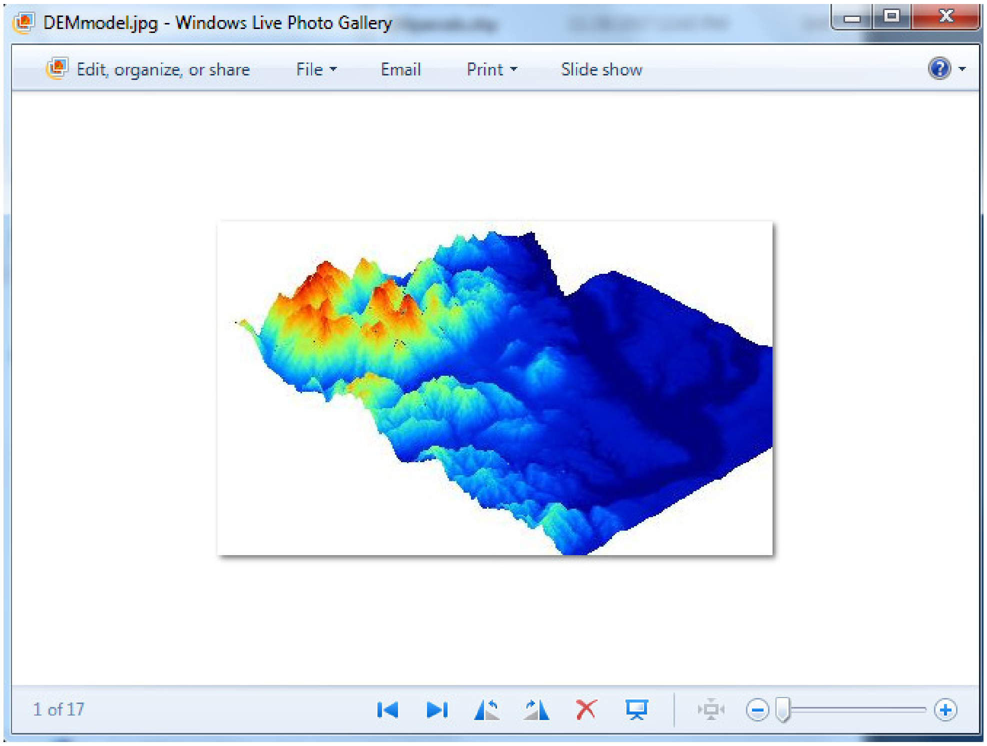


Figure 7-29. A .jpg file of a perspective image created in SAGA.

Notice in Figure 7-29 that only the image part of the perspective is saved. The values for the parameters in the information fields at the bottom of the 3D view window are not part of the saved image.

3D View: Sequencer

The "Sequencer" option is available on the 3D View Menu Bar dropdown list of options.

The "Sequencer" options support the creation and view of a fly-through sequence of images. The "Sequencer" runs in the background when the 3D view mode is active. The commands available supporting the "Sequencer" are:

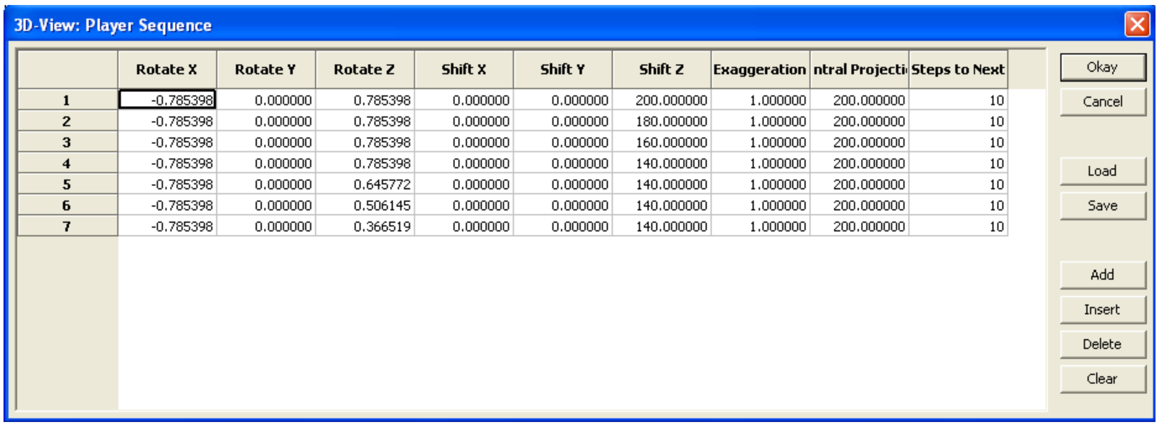
Add Position [Ctrl + A]
Delete Last Position [Ctrl + D]
Delete All Positions
Edit Positions
Play Once [Ctrl + P]
Play Loop [Ctrl + L]
Play and Save As Image

I can capture "screen shots" of a perspective by choosing the "Add Position" option in the "Sequencer" popup menu on the 3D View dropdown menu of options or using the shortcut Ctrl-A. This does not actually capture a screen image. It copies the current perspective parameter settings for the current 3D view window into a table named 3D

View: Player Sequence. The parameters are entered as a record in the table (i.e., one record per image).

When I use the shortcut Ctrl-A I have discovered that after I make an adjustment to the model position (e.g., a rotate or shift move), before I press the Ctrl-A key combination, I must click with the mouse in the 3D view window to make it the active window. Otherwise, pressing the Ctrl-A keys does not send the model parameters to the sequencer file.

Figure 7-30 displays the table after I use the Ctrl-A shortcut seven times.



	Rotate X	Rotate Y	Rotate Z	Shift X	Shift Y	Shift Z	Exaggeration	ntral Projecti	Steps to Next
1	-0.785398	0.000000	0.785398	0.000000	0.000000	200.000000	1.000000	200.000000	10
2	-0.785398	0.000000	0.785398	0.000000	0.000000	180.000000	1.000000	200.000000	10
3	-0.785398	0.000000	0.785398	0.000000	0.000000	160.000000	1.000000	200.000000	10
4	-0.785398	0.000000	0.785398	0.000000	0.000000	140.000000	1.000000	200.000000	10
5	-0.785398	0.000000	0.645772	0.000000	0.000000	140.000000	1.000000	200.000000	10
6	-0.785398	0.000000	0.506145	0.000000	0.000000	140.000000	1.000000	200.000000	10
7	-0.785398	0.000000	0.366519	0.000000	0.000000	140.000000	1.000000	200.000000	10

Figure 7-30. The '3D View: Player Sequence' table of frames.

The table in Figure 7-30 displays by choosing the "Edit Positions" command in the 3D View dropdown menu on the Menu Bar. Looking at the table in Figure 7-30, I can see that the parameters collected include the rotation angles and the shift distances for the X-, Y-, and Z-axes. The exaggeration factor and perspective distance values for the projection are also collected.

On the right side of the 3D-View: Player Sequence table window I see a set of buttons. I can easily edit entries or make my own entries to the sequencer using the Add, Insert, and Delete buttons. Once I make any changes, I click on the Okay button. Then I can go to the "Sequencer" option in the Menu Bar 3D View dropdown menu, and view the animated "flight" by choosing the "Play Once" option. As an alternative to the "Play Once" option I could continue adding more records to the table.

When I choose the "Play and Save As Image" option on the 3D View dropdown menu, SAGA builds a sequence of images using the parameter values recorded for the frames I captured. In my example, I captured 7 frames. In the table in Figure 7-30, the last column is named "Steps to Next". The numeric entries in this column specify to SAGA how many "interpolated" frames to insert between the captured frames in the final movie. These "interpolated" frames help smooth out the transition or animation between frames. I am using the default value 10 in this example. This means that the movie, for 7 records, will have 60 frames or steps when it is saved.

After choosing the "Play and Save As Image" option, the ‘Save As Image’ dialog window displayed (see Figure 7-28). I choose the .jpg format as I did previously, enter a name for my animation sequence, and click on the Okay button.

The sequence of frames displays. After it displays, I navigate to the folder I saved the sequencer output. Sixty new saved JPEG files exist that can be used to create a movie file. I also tested the other file formats. There may be issues associated with some of the image formats, some of them will not work consistently or may be disabled.

The only problem I encountered was when I used the "Play Loop" command. I could not figure out how to get out of the loop. After some trial and error, I discovered that selecting the "Play Loop" command a second time stops the loop.

I can re-play the same sequence at a later time by saving the ‘Player Sequence’ table in a text file. Once saved, whenever I want, I can re-load the sequence table and execute the "Play Once" command.

Introduction to the Print Layout

A print layout is created from a map view window. There are three ways to display a print layout view of a map view window. The 'Show Print Layout' icon ( ) on the toolbar can be clicked on with the mouse pointer. The "Show Print Layout" option on the Menu Bar: Map dropdown list of options can be chosen. The "Show Print Layout" option available in the Maps tab area of the Manager can be chosen by right-clicking with the mouse on a map view window name and choosing the function from the popup list of options.

Using one of the three ways, a layout view window displays in the work area. I notice the new title Layout appears on the Menu Bar. I click on the Layout menu and the dropdown list of options displays (Figure 7-31).

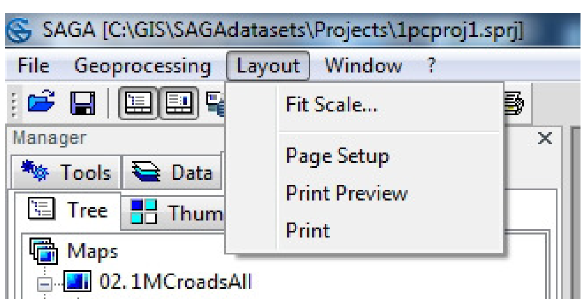


Figure 7-31. The Menu Bar Layout dropdown list of options.

The Layout menu is available whenever the active window for the work area is a print layout window.

In addition to the Layout Menu Bar menu, a topical set of icons is added to the toolbar. Figure 7-32 displays the updated toolbar.

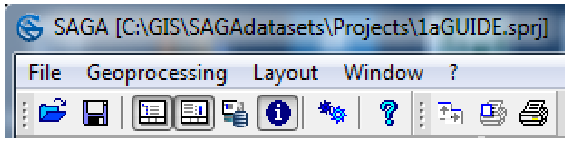


Figure 7-32. Adding Layout options to the toolbar.

Table 7-2 is a cross-reference between these new icons and the Layout options described in this chapter.

Table 7-2. Layout Menu Options

Layout Options	Toolbar Icons
Page Setup	
Print Preview	
Print	

Other SAGA cartographic features can be applied to a map view window that is going to become a print layout. These features are covered in other chapters of this User Guide. These features include a north arrow and scale bar.

Show Print Layout, Map: Show Print Layout, Maps Tab: Show Print Layout
There are three ways to create a print layout from a map view window. A print layout view window is created for the current active map view window when the option is chosen.

When a map view window is active in the work area, one of the icons in the topical icon set added to the toolbar is "Show Print Layout". This is the icon: . I move the mouse pointer over the icon and press the left mouse button. A print layout view window displays in the work area for the active map view window.

The Menu Bar Map dropdown list of options includes "Show Print Layout". I move the mouse pointer to the Menu Bar Map menu and press the left mouse button. I choose the "Show Print Layout" option on the dropdown list of options. A print layout view window displays in the work area for the active map view window.

The third way to create a print layout view window for a map view window is from the Maps tab area of the Manager. I move the mouse pointer into the Maps tab area of the Manager over the map name and press the left mouse button. I choose the "Show Print Layout" from the popup list of options and a print layout view window displays in the work area for the map view window I selected in the Maps area.

Layout: Fit Scale
Figure 7-33 displays a print layout view window for the ‘1MCrelief’ map view window. This map consists of a grid layer for topographic relief named '1MCrelief' and a polygon shape layer for water bodies named '1MCwaters-Poly'. I see in the layout view window,

near the bottom left corner, the text "Map Scale 1:324846.276425". This is the map scale (representative fraction) for the layout window. I had to zoom in on that area of the layout window in order to interpret the text. Much of the text is not clear. For example, the coordinates along the inner frame are not interpretable. The numeric values along the outer frame are clear but it is not clear what these values represent.

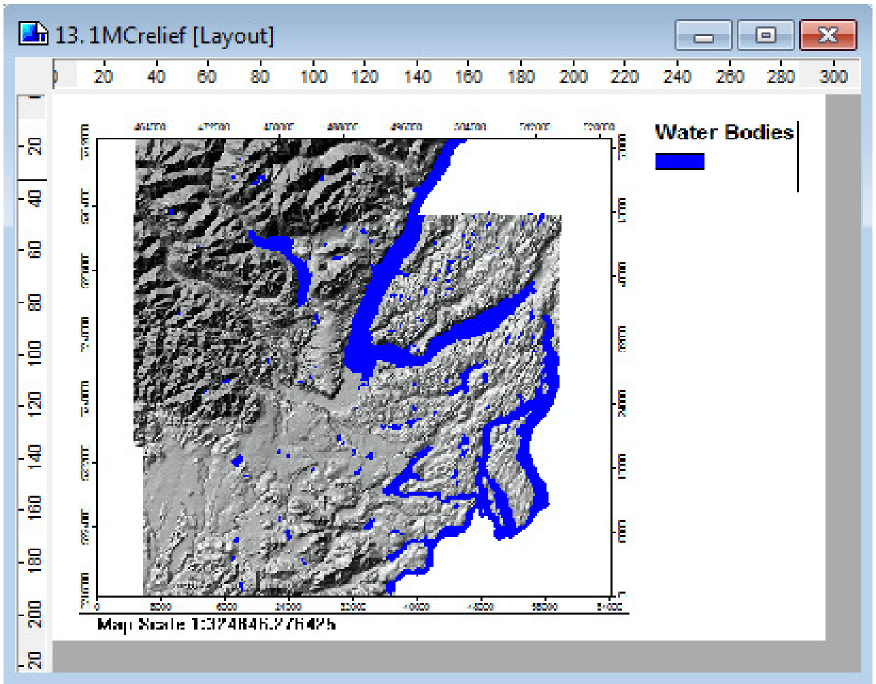


Figure 7-33. The layout view for the '1MCrelief' map view window.

The "Fit Scale" option available in the Menu Bar Map Layout dropdown menu, is intended to enter a different scale than the one calculated as the default and adjust the map view and layout view windows accordingly. I may want to produce a layout using a standard map scale. The scale for the layout view window and the map view window for the same layer can be changed. When I click on "Fit Scale" the dialog window in Figure 7-34 displays.

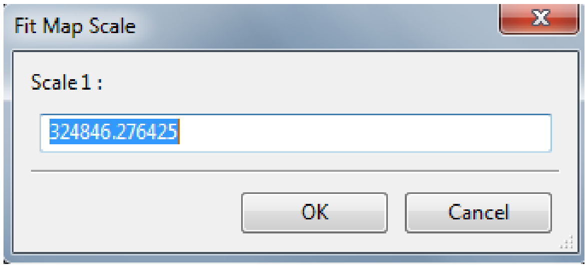


Figure 7-34. The 'Fit Map Scale' dialog window.

The data entry field contains the default scale that SAGA used in the initial layout view window. I can replace the scale in the data field with one I would rather use, e.g., 350000.

The map in the layout view window in Figure 7-35 uses the new map scale of 350000.

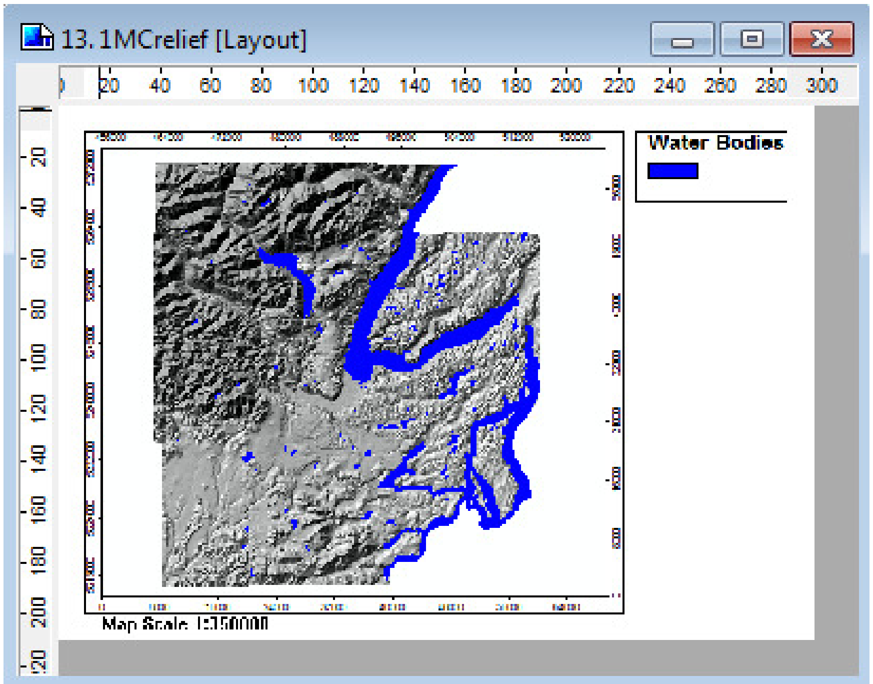


Figure 7-35. The '1MCrelief' map view window using a scale of 1:350000.

The parameters for any map view windows in the Maps tab area of the Manager for a work session save in the configuration file when I exit from SAGA. They also save whenever a project definition is updated or created. The configuration file normally opens each time I execute SAGA, restoring the layer, map and table environment at the time of the prior exit. Loading a project restores the layer, map and table environment to when the project was defined. The 'Fit Scale' parameter for a map or layout is not saved as part of the project environment.

If I make the map view window for the grid layer active, select the "Zoom To Full Extent" tool, the map view window as well as the corresponding layout view window returns to the full extent view. The scale for the layout view window will change back to the full extent scale.

The "Zoom" [] tool on the toolbar can be used to interactively adjust the scale displayed in the layout view window. When I zoom in, using the tool in a map view window, the displayed extent (map area) and the scale value at the bottom of the layout window change accordingly. Also, many of the "Zoom to …" commands available in the Map title dropdown menu cause the map extent and scale in the layout view window to be adjusted.

When the layout view window is active, if I move the mouse pointer over it, I see the mouse pointer turn into a small magnifying glass. When I click with the left mouse button, with the magnifying glass active, I zoom in on the view window. Clicking with the right mouse button will zoom out.

Layout: Page Setup
The 'Page Setup' dialog window is accessed from either the Menu Bar Layout dropdown list of options or from the "Page Setup" icon on the toolbar.

The "Page Setup" options relate to paper size, source of paper from printer, page orientation, and side margins. Figure 7-36 displays the 'Page Setup' dialog window.

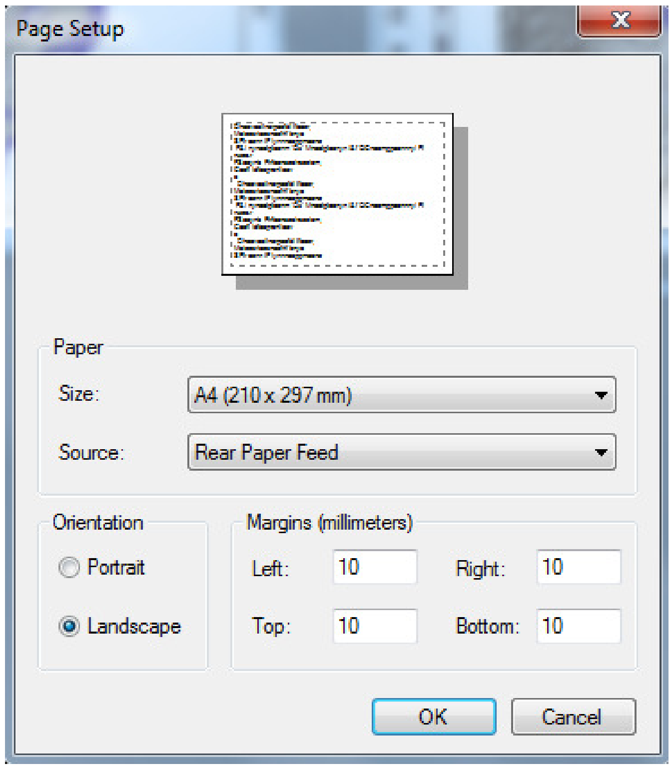


Figure 7-36. The 'Page Setup' dialog window.

The 'Size' parameter supports 17 standard sizes plus one named "User-Defined". The default size is "A4 (210 x 297 mm)". The 17 options are a mixture of metric and inch dimensions.

The 'Source' parameter has two options: Rear Feed - Borderless and Rear Paper Feed. The default is "Rear Paper Feed". There are two button options for the 'Orientation' parameter. They are Portrait and Landscape. The default is Landscape.

Entries for the four 'Margins' parameters are in millimeters regardless of whether the size selection is metric or inches. There are four parameters: Left, Top, Right, and Bottom. The default millimeter entry is 10.

Once the entries are made the user clicks on the OK button at the bottom of the window.

Layout: Print Preview
When this option is chosen, a print preview window displays on the screen. Figure 7-37 displays an example for the '1MCrelief' layout view window.

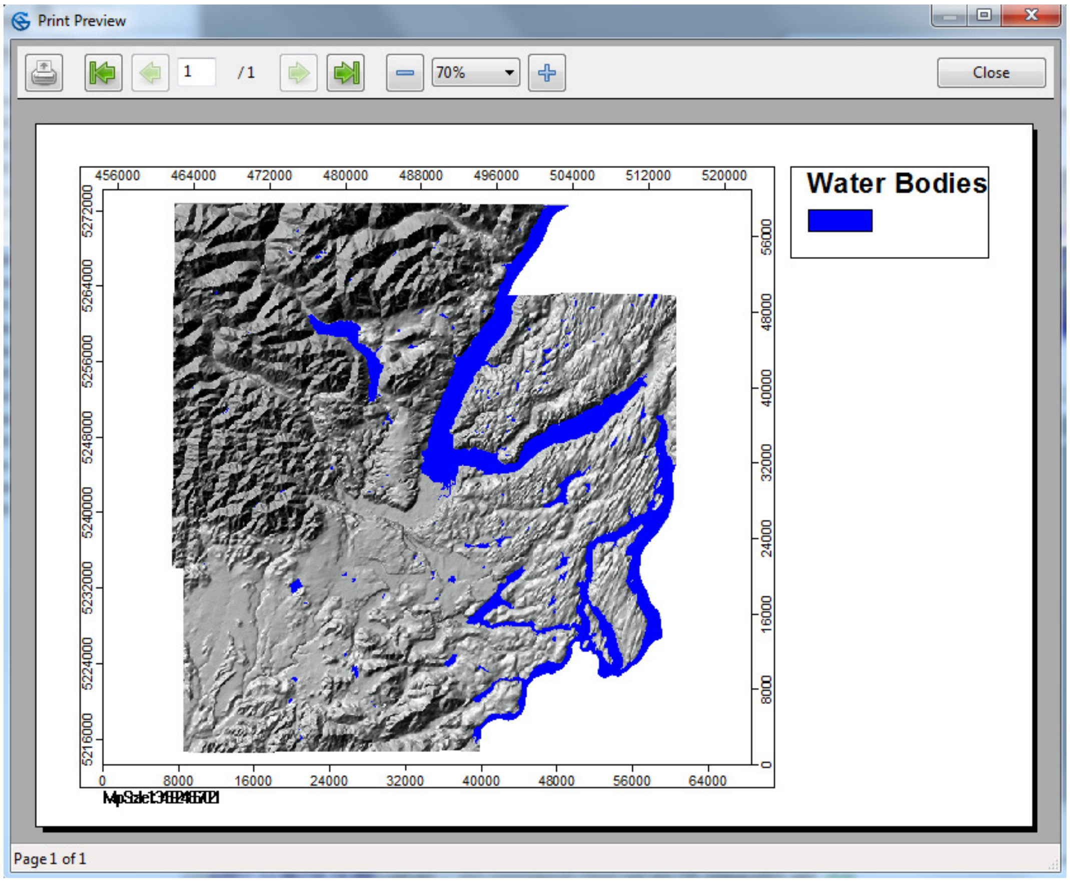


Figure 7-37. The 'Print Preview' window for the '1MCrelief' layout view window.

Buttons at the top of this window support several options. The button on the far left will bring up your host system 'Print' dialog window. This is used to make a hard copy of the layout window being previewed. The next four buttons are for moving around in a multi-page preview. Even though the display routine is capable of a multi-page document, SAGA does not output a multi-page document for a print layout. The last three buttons are for zooming in and out either using the + or - keys or selecting a specific percentage. The Close button is used to exit the "Print Preview" option; or I could click on the "X" in the upper right corner of the window.

Layout: Print
Choosing this option displays the 'Print' dialog window displayed in Figure 7-38.

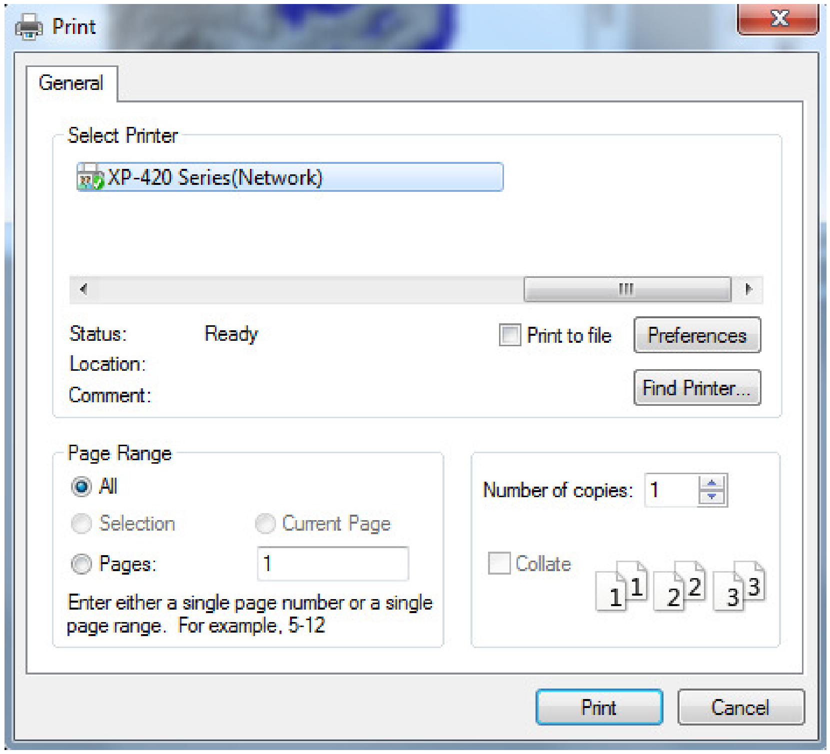


Figure 7-38. The 'Print' dialog window.

The dialog window in Figure 7-38 is the same window displayed when I click on the Print button in the print preview window. This is a standard window used for sending a file to a printer for a hard copy.

Introduction to the Histogram Function

The "Histogram" option is available for all three layer categories. This command may not be as effective with shape layers as with grid and point cloud layers. With shape layers, the x-axis (horizontal) displays the range of data values for a numeric attribute in the attribute table linked to the shape layer. The y-axis (vertical) is for the frequency of objects having the same data value. The y-axis for grid and point cloud layers is the number of grid cells or points having the same data value. My experience, so far, has been mostly using histogram with grid layers.

Histogram

The "Histogram" option is executed by right-clicking on a grid, point cloud or shape layer name in the Data tab area of the Manager and choosing the "Histogram" option from the popup menu of options.

When a histogram view window is the active window in the work area, the Histogram menu appears on the Menu Bar (Figure 7-39).

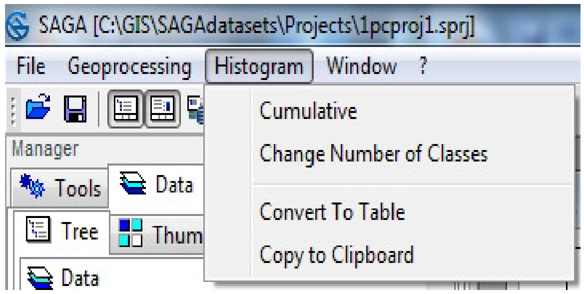


Figure 7-39. The Histogram menu options.

In addition to the Histogram Menu Bar menu, a topical set of icons is added to the toolbar. Figure 7-40 displays the updated toolbar.

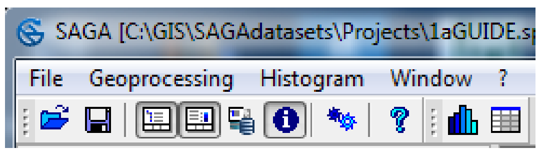
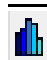


Figure 7-40. Adding Histogram options to the toolbar.

Table 7-3 is a cross-reference between these two new icons and the Histogram options described in this chapter.

Table 7-3. Histogram Menu Options

Histogram Options	Toolbar Icons
Cumulative	
Convert to Table	

Histogram: Cumulative

Figure 7-41 displays a histogram for a digital elevation grid layer named '1MCdem30'. The only difference between the two histograms in the figure is display size. The view window for the bottom one is larger; the data did not change. I can see that the data values on the x-axis change because of the available display space. The upper histogram has tick marks along the x-axis for every 5th display class. The larger version of the same histogram has tick marks along the x-axis for every 4th display class.

The default number of classes for a histogram is 100. The class interval can be verified by dividing the data range for the grid cell data values by 100. For example, the data range for the '1MCdem30' layer is 0 to 6379. Dividing the range by 100 means the class interval is 63.79.

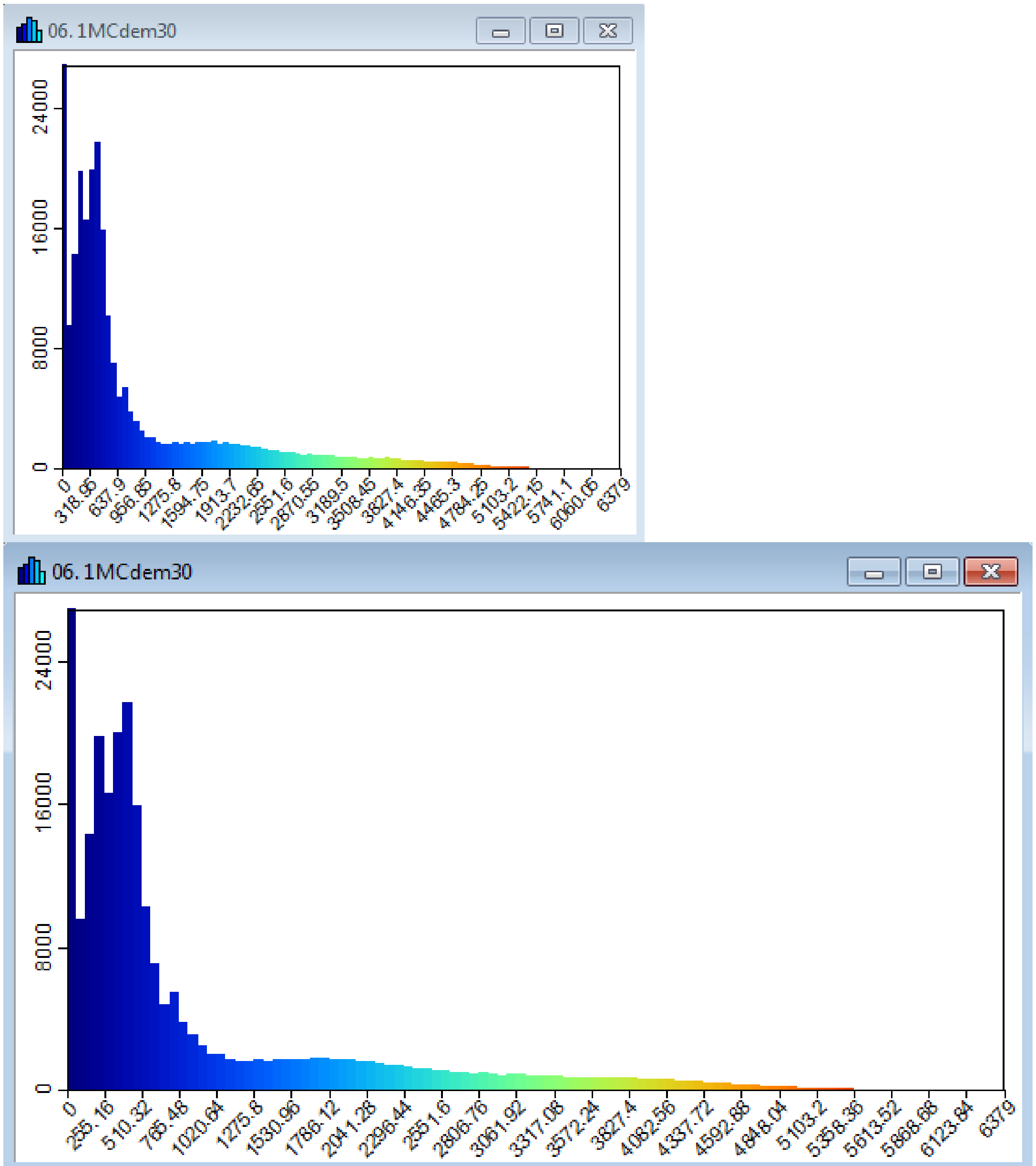


Figure 7-41. The histogram for the digital elevation grid layer.

The cumulative histogram for the same layer displays in Figure 7-42.

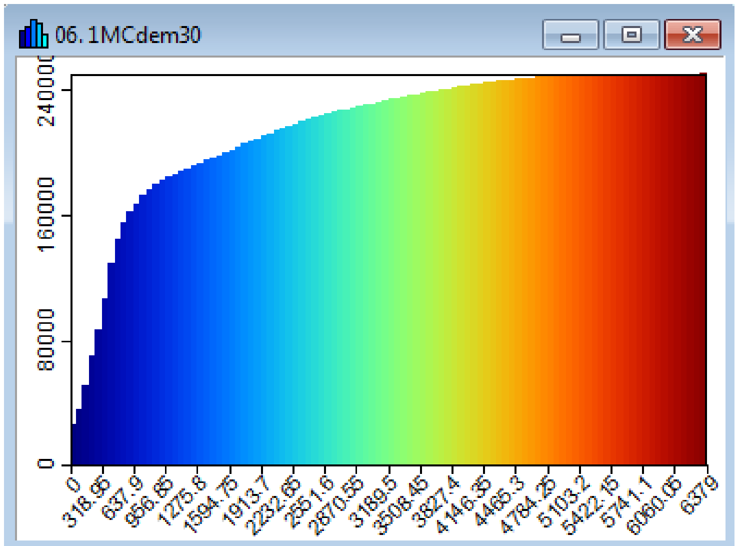


Figure 7-42. The cumulative histogram for the digital elevation grid layer.

The x-axis still identifies the 100 display classes of elevation, using the same class interval of 63.79. Due to display area, the tick marks represent every fifth display class. The scale on the y-axis has changed. The scale now ranges from 0 to 240000.

The cumulative histogram is the sum of the class and all classes below it. It is a running total of the frequencies. The frequency for the first class is about 26000 and for the second class it is about 10000. Adding 26000 and 10000 is 36000. The cumulative frequency for the third class, in the graph, appears to be around 50000. This is how the cumulative histogram is created.

Histogram: Change Number of Classes
The default number of classes is 100. This option allows for creating a histogram using a different number of display classes than 100.

Histogram: Convert To Table
The "Convert to Table" option converts a histogram from its graph form to a tabular form. Figure 7-43 displays the first 20 display classes for the histogram table for the digital elevation grid layer I have been using as an example.

03. Histogram: 1MCdem30

	CLASS	AREA	COUNT	CUMUL	NAME	MIN	CENTER	MAX
1	1	293103435.562875	26915	26915	0 < 63.79	0	31.895	63.79
2	2	104456554.1118	9592	36507	63.79 < 127.58	63.79	95.685	127.58
3	3	155933423.511975	14319	50826	127.58 < 191.37	127.58	159.475	191.37
4	4	215457977.804625	19785	70611	191.37 < 255.16	191.37	223.265	255.16
5	5	181111024.961775	16631	87242	255.16 < 318.95	255.16	287.055	318.95
6	6	217527071.349375	19975	107217	318.95 < 382.74	318.95	350.845	382.74
7	7	236682521.58735	21734	128951	382.74 < 446.53	382.74	414.635	446.53
8	8	173400929.016075	15923	144874	446.53 < 510.32	446.53	478.425	510.32
9	9	111567701.926125	10245	155119	510.32 < 574.11	510.32	542.215	574.11
10	10	76904940.06855	7062	162181	574.11 < 637.9	574.11	606.005	637.9
11	11	52925234.8815	4860	167041	637.9 < 701.69	637.9	669.795	701.69
12	12	59981932.8657	5508	172549	701.69 < 765.48	701.69	733.585	765.48
13	13	41283861.200775	3791	176340	765.48 < 829.27	765.48	797.375	829.27
14	14	34183603.352475	3139	179479	829.27 < 893.06	829.27	861.165	893.06
15	15	27987212.68425	2570	182049	893.06 < 956.85	893.06	924.955	956.85
16	16	22629349.39995	2078	184127	956.85 < 1020.64	956.85	988.745	1020.64
17	17	22400660.113425	2057	186184	1020.64 < 1084.43	1020.64	1052.535	1084.43
18	18	19318799.72835	1774	187958	1084.43 < 1148.22	1084.43	1116.325	1148.22
19	19	18164463.3297	1668	189626	1148.22 < 1212.01	1148.22	1180.115	1212.01
20	20	17870434.247025	1641	191267	1212.01 < 1275.8	1212.01	1243.905	1275.8

Figure 7-43. The histogram table.

The table has 8 columns. The "CLASS" column identifies a class number. In this example, the classes are numbered 1 to 100. The "AREA" column is a calculation of how much map area the class occupies. This is determined by using the entry for the "COUNT" column (the number of grid cells in the class) multiplied by the area of a grid cell. The grid system cell size is 104.355 by 104.355 or 10,889.97 square meters. It is easy to verify how the area is calculated by multiplying one of the count entries (e.g., the 20th display class having a count of 1641) times the grid cell area.

The "CUMUL" column is a running total of number of grid cells. The "COUNT" for class 1 is added to the "COUNT" for class 2. The cumulative count for 1 and 2 is added to the "COUNT" for class 3 and so on.

The "NAME" column is a text or string column. The definition of each class appears in this column. For example, "CLASS" 17 has the name "1020.64 < 1084.43". The class interval is 63.79. The lower class boundary is 1020.64 and the upper class boundary being 1084.43 (or 1020.64 + 63.79).

The "MINIMUM", "CENTER", and "MAXIMUM" columns are numeric entries defining three characteristics for each class: the lower and upper class boundaries and the class center point.

Histogram: Copy to Clipboard

This option copies the active histogram to the system clipboard. The clipboard content can be pasted into one of many graphic programs for other purposes.

Introduction to the Scatter Plot

The "Scatterplot" option is available for grid and shape layers. However, it is not working correctly in SAGA Version 5; it does work correctly in SAGA Version 6. A scatter plot displays the relationship of one grid layer to another, i.e., one variable to another variable.

I choose the "Scatterplot" option by right-clicking with the mouse on a grid layer name in the Data tab area list of layers. I choose the option from the popup list that displays. The layer the command is chosen from, is by default, one of the two input layers for this option. The default grid layer is the X or dependent variable and its' values plot on the x-axis of the output scatter plot.

The ‘Scatterplot’ parameters window displays. I choose the second input for the scatter plot. The data values of this second input plot on the y-axis of the scatter plot and serve as the Y or independent variable. The second input may be either a grid or a point shape layer. Once I have made entries for the parameters I click on the Okay button to display the resulting scatter plot view window in the work area.

When a scatter plot view window is the active view window in the work area the Scatterplot menu is added to the Menu Bar. Figure 7-44 displays the Scatterplot menu title and its dropdown list of options.

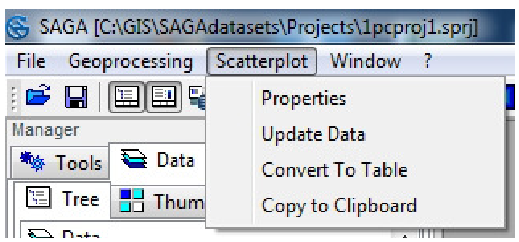


Figure 7-44. The Scatterplot Menu Bar list of options.

In addition to the Scatterplot Menu Bar menu, a topical set of icons is added to the toolbar. Figure 7-45 displays the updated toolbar.

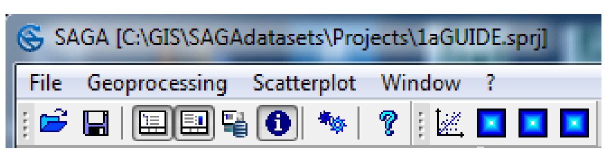


Figure 7-45. Adding Scatterplot options to the toolbar.

Table 7-4 is a cross-reference between these two new icons and the Scatterplot options described in this chapter.

Table 7-4. Scatterplot Menu Options

Scatterplot Options	Toolbar Icons
Properties	
Update Data	
Convert to Table	
Copy to Clipboard	

I observe that the same icon represents three of the scatter plot options. I tested whether each icon was for the identified option. They are; I do not know why different icons are not used.

Scatterplot: Properties

The first option in the Scatterplot menu is "Properties" (Figure 7-46). A "Properties" dialog window also displays when the "Scatterplot" function first executes.

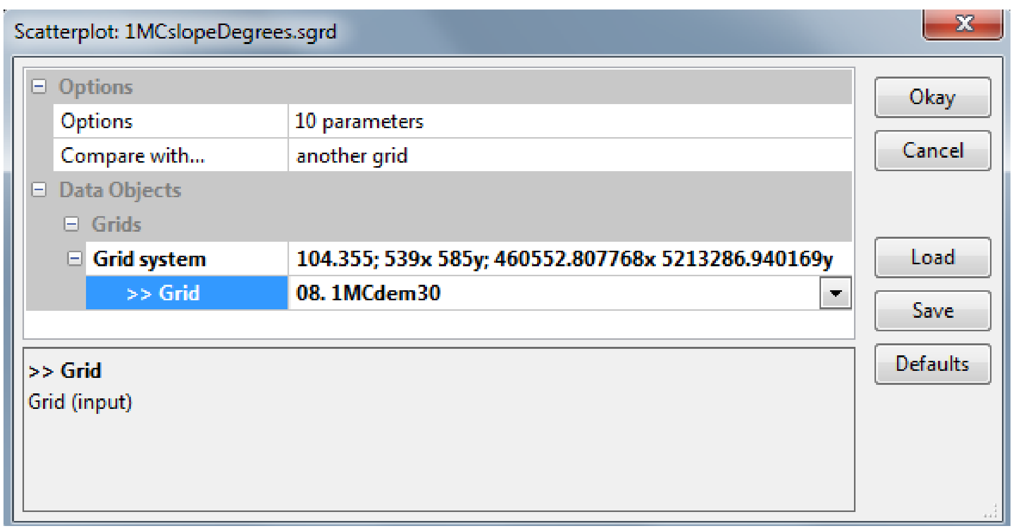


Figure 7-46. The "Properties" dialog window.

I can see by the title for the properties dialog window, "Scatterplot: 1MCslopeDegrees.sgrd", that the dependent variable (and the source for data values for the x-axis) is the slope grid layer named '1MCslopeDegrees'. When I move the mouse pointer into the value field over the ellipsis to the right of the 'Options' parameter and press the left mouse button, the 'Options' dialog window displays. As the text "10 parameters" indicates in the value field, there are 10 parameters in the 'Options' dialog window.

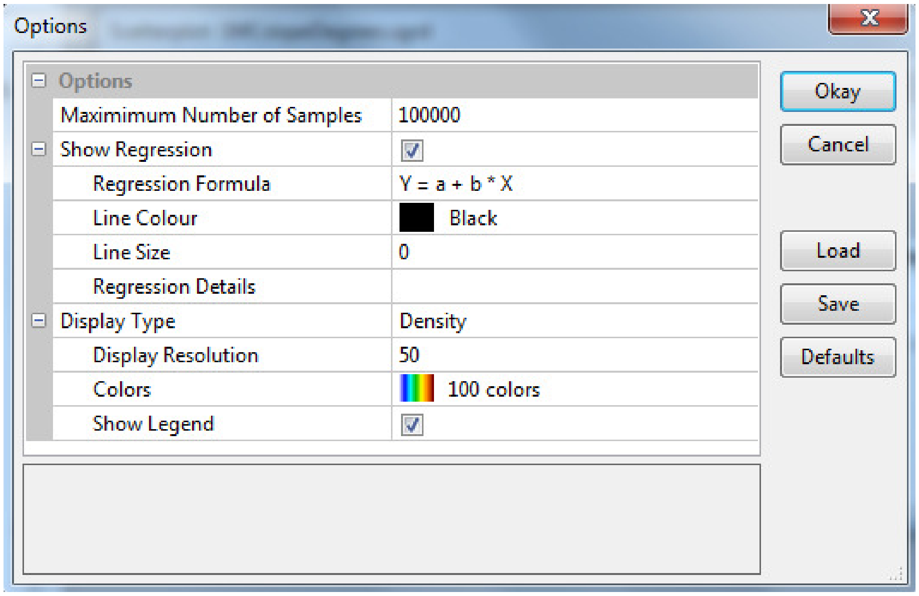


Figure 7-47. The 'Options' dialog window.

Scatterplot: Properties: Options: Maximum Number of Samples
The default for the 'Maximum Number of Samples' parameter is 100000. This is the most number of samples to be considered in the scatter plot. This does not mean that 100000 samples exist for the two input grid layers. I believe the theoretical maximum number of samples is the number of grid cells common between the two layers when none of the layer grid cell values contain the no data value.

It appears that this property is used when a large number of samples are being processed. The amount of time involved can be reduced by entering a smaller value for this parameter.

Scatterplot: Properties: Options: Show Regression
The 'Show Regression' parameter is a toggle check box parameter. The default is for the parameter to be on with a check mark displayed in the check box. When this parameter is on, the regression formula for the relationship between the dependent and independent variables is plotted. The solution regression formula displays above the scatter plot in the scatter plot view window. The regression line plots as part of the scatter plot. Statistics for the regression are available for display using the 'Regression Details' information parameter in the 'Options' dialog window.

I can toggle the 'Show Regression' parameter to off by moving the mouse pointer into the check box and pressing the left mouse button. The check mark disappears and the parameter is off.

When the 'Show Regression' parameter is off, the Regression Formula, Line Colour, Line Size, and Regression Detail parameters are not displayed or available in the 'Options' dialog. The regression formula above the scatter plot and the plotted regression line will not display as part of the scatter plot. The regression solution is calculated. If I want to see the regression solution information I can toggle the 'Show Regression' parameter back to on status and view the information in the 'Regression Details' information parameter text window.

Scatterplot: Properties: Options: Show Regression: Regression Formula
This option is for choosing the form of the regression formula to apply. There are six choices. The default is Y=a+b*X. The other choices are Y=a/(b-X), Y=a/(b-X), Y=a*X^b, Y=a e^(b*X), and Y=a+b*ln(X). I can iterate back and forth to determine which is the best formula.

Scatterplot: Properties: Options: Show Regression: Line Colour
The value field to the right of this parameter displays a color swatch for the selected color for the plot of the regression line. The default is for the line to be black. I move the mouse pointer into the value field and press the left mouse button. A popup column of color swatches with colors named displays. I can choose a new line color from the popup list.

Scatterplot: Properties: Options: Show Regression: Line Size
The default entry for line size is 0. This actually defaults to a line size of 1. I can use the mouse to edit the entry for line size.

Scatterplot: Properties: Options: Show Regression: Regression Details
This is a popup information field. It contains statistics related to the regression solution. Figure 7-48 displays an example involving a scatter plot with slope degrees as the dependent variable and elevation the independent variable.

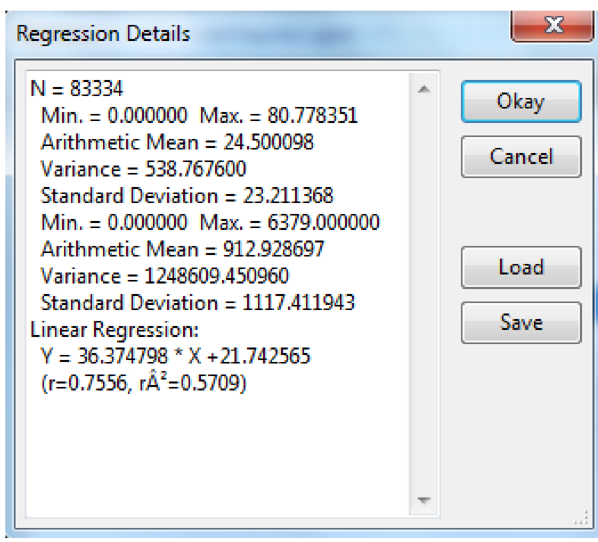


Figure 7-48. An example of the 'Regression Details' information field.

The first entry in the example is "N = 83334". This is also the default entry in the value field for the 'Regression Details' parameter after the scatter plot regression is solved. This default entry varies depending on the solution.

Scatterplot: Properties: Options: Display Type
There are two display options for the 'Display Type' parameter: Density and Points. Figure 7-49 compares the two types.

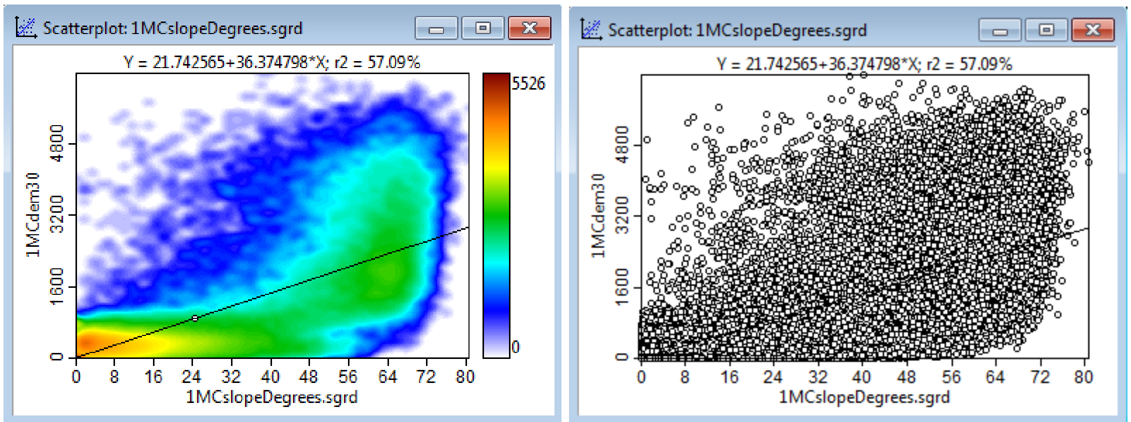


Figure 7-49. Comparing the Density and Points display types.

The "Density" option is used for the left scatter plot and the "Points" option used on the right scatter plot. The "Density" type uses color for displaying point density to enhance interpretation of the relationship between the two variables. The "Points" display type plots individual points for each sample coordinate pair.

The "Density" option includes three display related parameters. These parameters are not available if the "Points" option is used.

Scatterplot: Properties: Options: Display Type (Density): Display Resolution
Figure 7-50 displays two scatter plots using the same parameter entries except the one on the left uses 20 for the 'Display Resolution' parameter and the one on the right uses 40 for the same parameter.

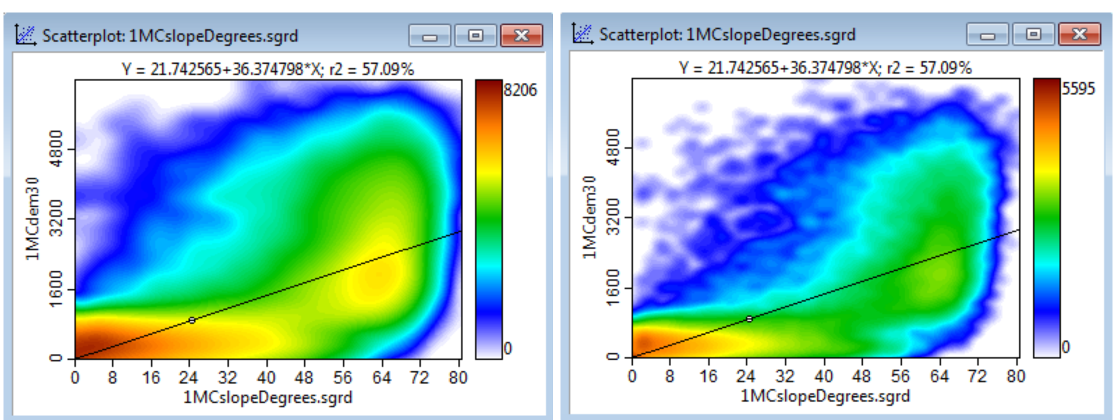


Figure 7-50. Comparing resolution entries of 20 and 40.

The higher the value for the 'Display Resolution' the more detail shows on the scatter plot.

Scatterplot: Properties: Options: Display Type (Density): Colors
The 'Colors' parameter is where I can select a color palette. This option uses the 'Color' dialog window described elsewhere in this User Guide.

Scatterplot: Properties: Options: Display Type (Density): Show Legend
The 'Show Legend' parameter is a toggle check box parameter supporting the "Density" type option. When I move my mouse pointer into the toggle check box and press the right mouse button the status will toggle to off, and the check mark disappears.

Scatterplot: Properties: Compare with...
This parameter has two options: another grid and points. When "another grid" is the option, a second grid layer is the source of data values for the independent variable. Two additional parameters become available: 'Grid system' and '>> Grid'.

A point shape layer attribute can be the data source for the independent variable. This option is available when the "points" option is used for the 'Compare with...' parameter. Two additional parameters become available: '>> Points' and 'Attribute'.

Scatterplot: Properties (another grid): Grids: Grid system
This is one of two parameters available when "another grid" is the option for the 'Compare with...' parameter. This grid system must be the one the grid layer chosen for the '>> Grid' parameter is a member.

Scatterplot: Properties (another grid): Grids: >> Grid
This is the second of two parameters available when the "another grid" is the option for the 'Compare with...' parameter. The '>> Grid' parameter is for choosing the grid layer that is the source of data values for the independent variable of the regression formula. The grid layer must be available for the work session, on the layer list in the Data tab area of the Manager, in order for it to be chosen.

Scatterplot: Properties (points): >> Points
This is the first of two parameters available when "points" is the option for the 'Compare with...' parameter. The point shape layer must be loaded into the work session and on the list of layers in the Data tab area of the Manager in order to be chosen.

Scatterplot: Properties (points): Attribute
An attribute in the attribute table linked to the point shape layer is chosen to be the source of data values for the independent variable of the regression formula.

Scatterplot: Update Data
Edits can be made to the two input layers to a scatter plot. The "Update Data" option is executed to implement any edited data values of the two input layers.

Scatterplot: Convert to Table
This option creates a table version of the scatter plot. Figure 7-51 displays an example.

02. Scatterplot: [1MCdem30]-[1MCslopeDegree...

	ID	1MCdem30	slopeDegrees
1	1	112	3.198141
2	2	167	13.536998
3	3	184	3.808185
4	4	340	44.259537
5	5	415	33.720825
6	6	238	28.670797
7	7	464	27.260418
8	8	215	7.229778
9	9	473	12.120559
10	10	281	14.994376
11	11	466	37.727833

Figure 7-51. An example scatter plot table.

The example in Figure 7-51 is just a small portion of the table as the full table consists of 83334 rows or records; one row per pair of X,Y data values.

The default name of the table is "Scatterplot: [X-dependent variable]-[Y-independent variable]". For example, the table in Figure 7-51 involves two grid layers, one for elevation and one for slope. The name of the table is 'Scatterplot: [1MCdem]-[1MCslopeDegrees]'.

The table includes one record for each X-Y pair. There are three data columns. The first column is for a unique ID for each point pair. The next two columns are for the x- and y-axis values. The columns are named for the layers providing the data values. In the example table, I can see that the X and Y columns are labeled with the grid layer names "1MCdem30" and "1MCslopeDegrees".

Scatterplot: Copy to Clipboard
This option is for copying the scatter plot view window to the system clipboard. The clipboard content can be pasted into a number of different graphic or word processing programs.

Let's look at an example scatter plot.

This scatter plot involves the relationship between a dependent variable for elevation and an independent variable for precipitation. Data values for the dependent variable or X plot on the x-axis and data values for the independent variable or Y plot on the y-axis. Figure 7-52 displays the scatter plot view window.

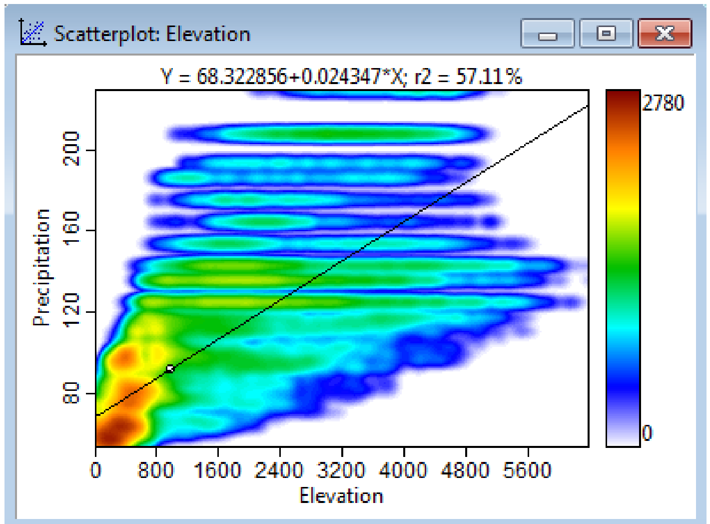


Figure 7-52. The 'Scatterplot: Elevation' view window.

The default labels for the x- and y-axes are the grid layer names for the independent and dependent variables '1MCdem30' and '1MasonCtyPrecipGR'. These names are actually the entries for the 'Name' parameter in the Settings tab area of the Object Properties windows for the layers. I edited these 'Name' parameters to "Elevation" and "Precipitation" as better references for the numeric values on the two axes.

The legend on the right side of the plot identifies density or number of points. The yellow and colors tending to red indicates densities from around 1850 to 2780. Light shades of blue indicate low densities or frequencies.

At the top of the scatter plot is the solved regression formulae for the relationship between the two variables. Also, note that the r^2 statistic displays. The regression line (the black line) crosses the y-axis at 68.322856.

The 'Regression Details' information parameter on the 'Options' page provides statistics for the two input grid layers and summarizes the linear regression solution.

Introduction to the Diagram

The "Diagram" option is available in the Data tab area of the Manager for any shape layer. One or more attributes in the linked attribute table for a shape layer are the source of data values for one or more data graphs. I move the mouse pointer over a shape layer name and press the right mouse button. I move the mouse pointer to the "Attribute" option on the dropdown list of options, and choose the "Diagram" option on the popup list of options.

When a diagram view window is the active view window in the work area the Diagram menu appears on the Menu Bar. Figure 7-53 displays the Diagram menu and its dropdown list of options.

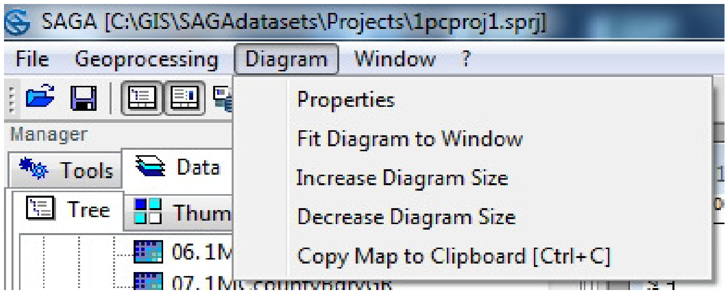


Figure 7-53. The Diagram Menu Bar list of options.

This title remains on the Menu Bar while the diagram window is the active window in the work area.

In addition to the Diagram Menu Bar menu, a topical set of icons is added to the toolbar. Figure 7-54 displays the updated toolbar.

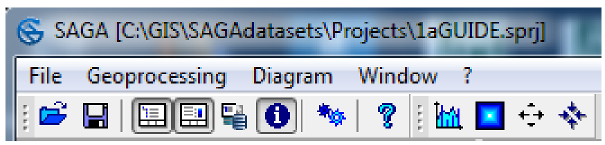


Figure 7-54. Adding Diagram options to the toolbar.

Table 7-5 is a cross-reference between these new icons and the Diagram options described in this chapter.

Table 7-5. Diagram Menu Options

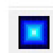
Diagram Options	Toolbar Icons
Properties	
Fit Diagram to Window	
Increase Diagram Size	
Decrease Diagram Size	

Diagram: Properties

The first option in the Diagram menu is "Properties" (Figure 7-55). A 'Properties' dialog window also displays when the "Diagram" option is first chosen.

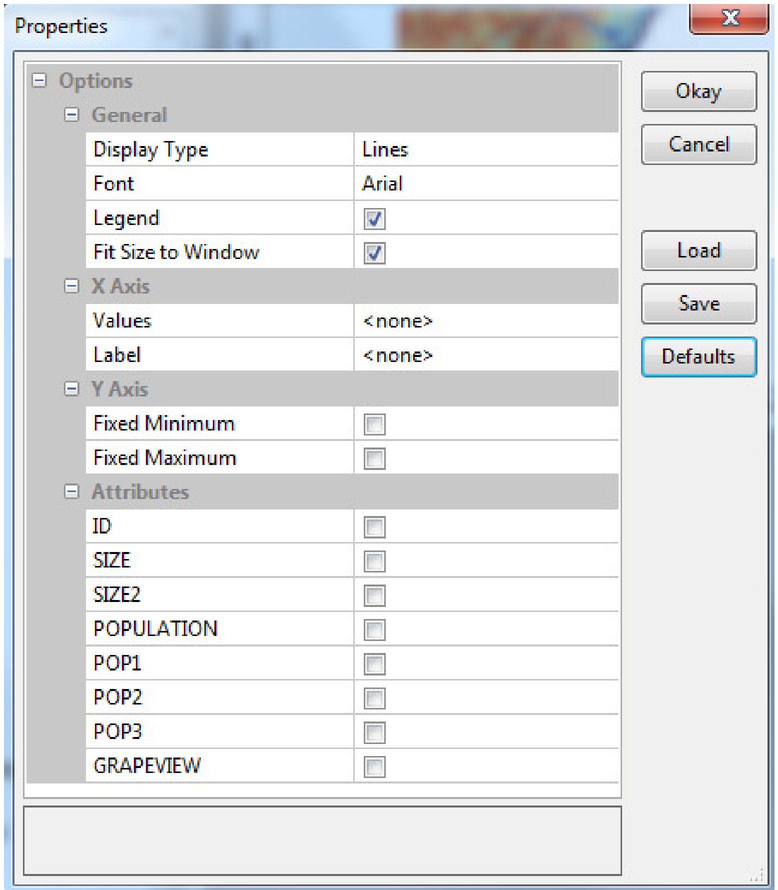
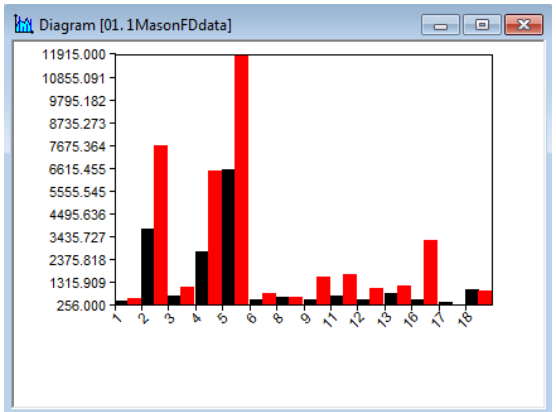
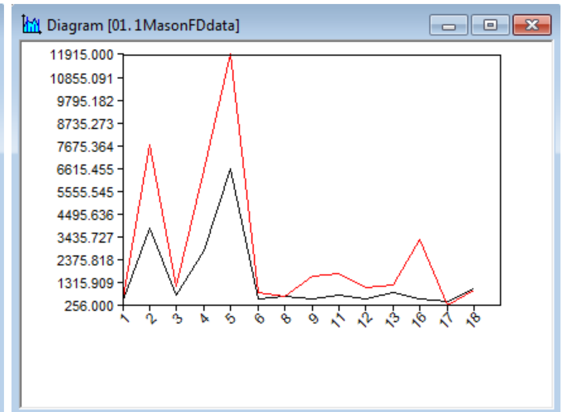


Figure 7-55. The Diagram "Properties" page.

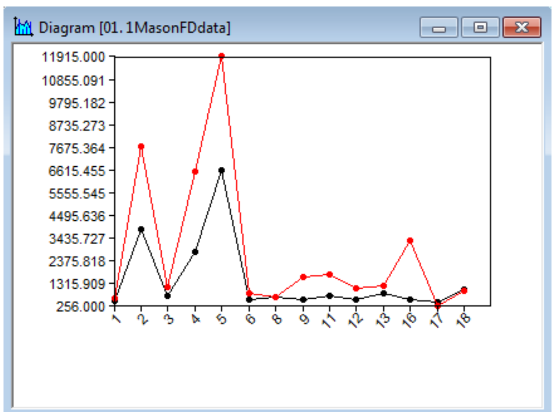
Diagram: Properties: General: Display Type
This parameter has four options: Bars, Lines, Lines and Points, and Points. "Lines" is the default. Figure 7-56 displays an example of each display type.



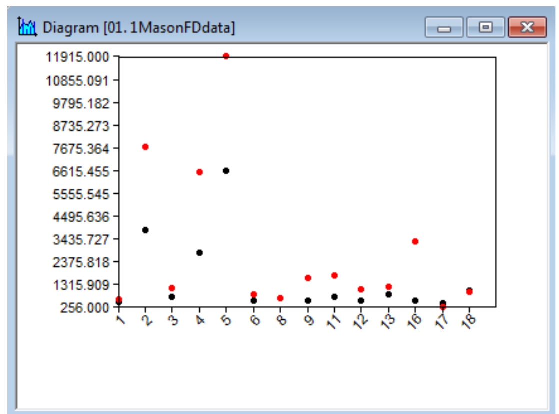
Bars



Lines



Lines and Points



Point

Figure 7-56. Comparing the diagram display types.

Diagram: Properties: General: Font
The default entry in the value field to the right of the 'Font' parameter is "Arial". I click on the ellipsis symbol that displays in the value field. A 'Font' dialog window displays (Figure 7-57).

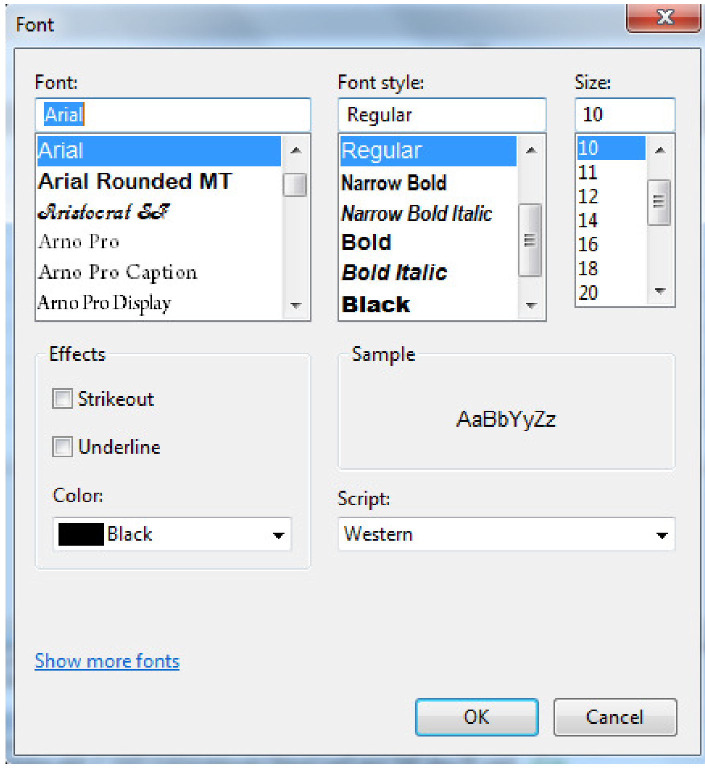


Figure 7-57. The 'Font' dialog window.

I can choose from a full range of available fonts, font styles, and sizes. The diagram view window in Figure 7-58 shows the result with my choices of the Font "Tahoma", Font style "Bold", and 14 for "Size".

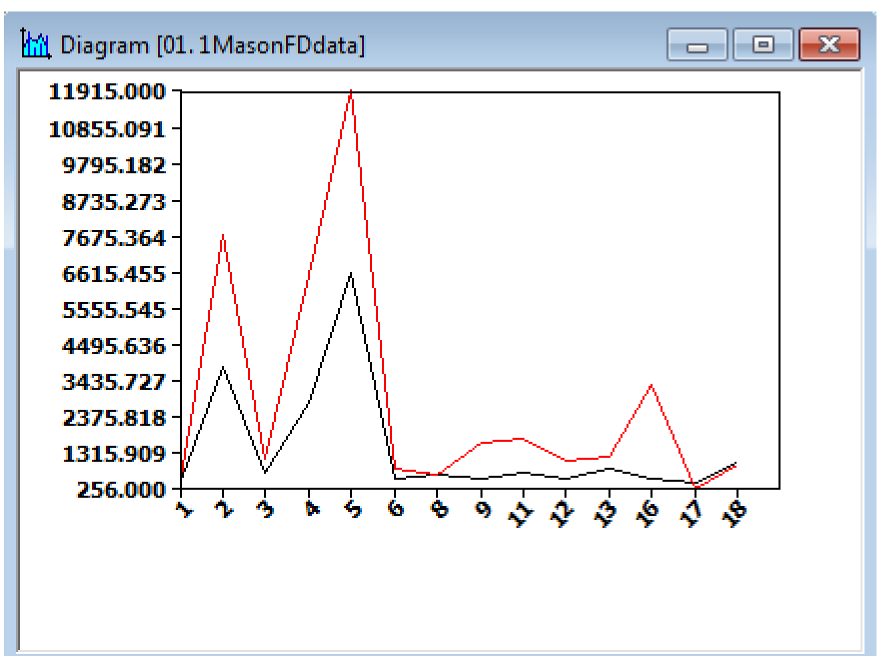


Figure 7-58. Using the Tahoma font, bold font style, and size 14.

Diagram: Properties: General: Legend
This parameter determines whether a legend displays in the diagram window or not. This is a toggle check box parameter. The default is for the parameter to be on with a check mark displayed in the check box. I can change the status to off by moving the mouse pointer into the check box and pressing the left mouse button. This removes the check mark changing the status to off. Figure 7-59 displays a diagram with the legend parameter toggled to on.

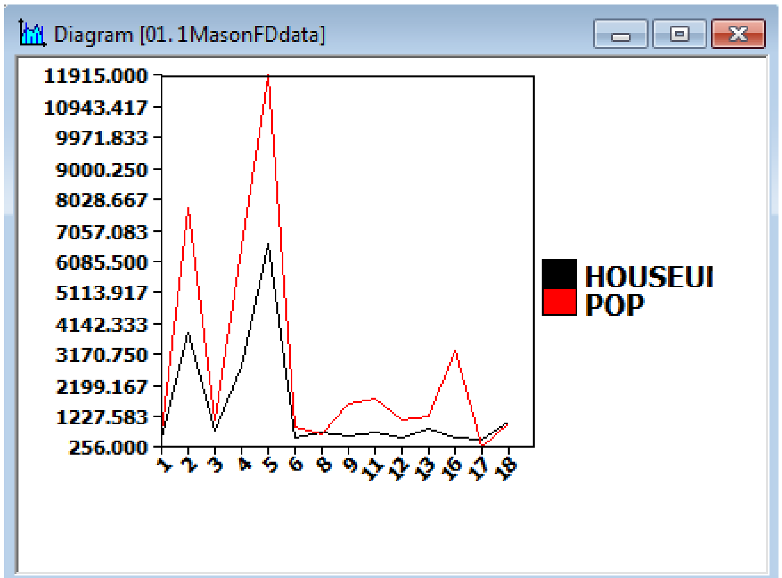


Figure 7-59. A diagram with the legend displayed.

The diagram view window in Figure 7-59 is the same as appears in Figure 7-58 except with a legend displayed. I can see that one of the legend titles is truncated at 6 characters. It should be "HOUSEUNITS". The "HOUSEUNITS" is an attribute in the attribute table linked to the '1MasonFDdata' polygon shape s layer. The attribute name is used for the legend title. I can shorten the name in the attribute table using the rename command and it would display better as part of a diagram legend.

Diagram: Properties: General: Fit Size to Window
This is a toggle check box parameter. The parameter is in on status if a check mark displays in the check box. When this parameter is on, the diagram in the diagram view window automatically adjusts to the size of the view window. This means that if I use the mouse to adjust either, or both the width and height of the window, the diagram within the window will adjust as the window changes dimensions.

I can toggle this parameter to off and the check mark will not display in the check box. When the parameter is off the diagram does not adjust to the dimensions of the view window. When I adjust the view window dimensions the diagram retains its current size.

Diagram: Properties: X Axis: Values
The two choices to display information along the x-axis are to display data values or data labels but not both. This parameter is for choosing an attribute as the source of data values for the x-axis coordinates. Any numeric attribute in the shape layer attribute table is available to provide x-axis data values. When an attribute is chosen for the 'Values' parameter the 'Label' parameter is not available.

Diagram: Properties: X Axis: Label
This is the second choice to display information along the x-axis. The entry for the 'Label' parameter provides the source of labels for the x-axis. Any numeric or text attribute in the shape layer attribute table can be used to provide x-axis labels. When an entry appears for this parameter, the default entry for the 'Values' parameter is "<none>". If an attribute other than "<none>" is chosen for the 'Values' parameter the 'Label' parameter becomes not available.

This parameter may or may be used to assign a "Label" that qualifies the data values used for the x-axis. The numbers used in the earlier examples, 1 through 18, are fire district numbers. They are the data values entered for the "FPDIST" attribute. The expectation would be that the label "FPDIST" (or "Fire Protection District") is used for the x-axis label along with the data values 1 through 18. This is not the case.

Diagram: Properties: Y Axis: Fixed Minimum
The default minimum data value for the y-axis is the lowest minimum data value for any numeric attribute chosen to plot. This parameter can be used to enter a different minimum data value.

Diagram: Properties: Y Axis: Fixed Maximum
The default maximum data value for the y-axis will be the largest maximum data value for any numeric attribute chosen to plot. This parameter can be used to enter a different maximum data value.

Diagram: Properties: Attributes
There are two parameters for each numeric attribute in the attribute table linked to the shape layer. One is a toggle check box parameter. When a check mark displays in the check box, the attribute is chosen to plot in the diagram. Once it is in on status, a second parameter appears for choosing a color for its plot line. A default color is chosen and displayed in a color swatch. I can move the mouse pointer over the triangle on the far right of the value field and press the left mouse button. A popup list of available colors displays. I can use the mouse to choose one.

Diagram: Fit Diagram to Window
This Diagram menu option is used if the 'Fit Size to Window' parameter on the 'Properties' page is in off status. When that parameter is off the graphic in the diagram view window does not expand or shrink to fit in the window. I use the "Fit Diagram to Window" option on the Diagram menu to enlarge or shrink the diagram to the view window dimensions.

Diagram: Increase Diagram Size
This option increases the size of the diagram. The size can increase so it is larger than the view window. In that case, the area outside of the view window is not seen.

Diagram: Decrease Diagram Size
This option decreases size of the diagram within the diagram view window. The size can decrease to a size much smaller than the view window.

Diagram: Copy Map to Clipboard [Ctrl+C]
This command copies the diagram view window to the system clipboard. Once it is on the clipboard it can be pasted into a number of different graphic or word processing programs.

Chapter 8 – Working with Tables in SAGA

There are several key areas in SAGA where table data is important. This chapter will introduce you to the Menu Bar Table menu options and other functions and commands available for displaying and editing tables. In addition, I will explore a few of the areas in the basic SAGA environment where tables serve specific roles.

The Menu Bar File "Load" Table Option

The File menu on the Menu Bar supports an option for "Table". I click the mouse on the "Table" option. A popup list displays (Figure 8-1). I click the mouse on the "Load" command.

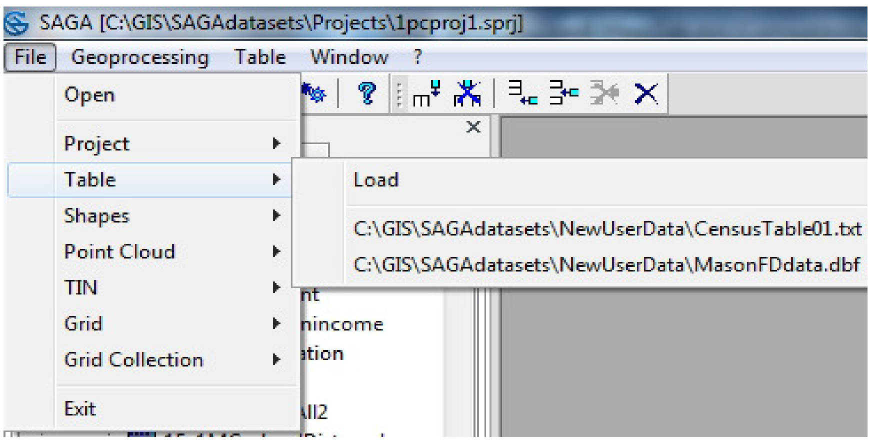


Figure 8-1 The 'Load' option for tables in the Menu Bar File dropdown menu.

I can see, displayed below the "Load" command in Figure 8-1, a list referencing the storage paths for two tables. It is a short list of table files previously loaded with the "Load" command in earlier work sessions. Up to 17 previously loaded tables can potentially be listed. Each can be loaded from the list.

I have a table created for re-classifying precipitation values (using the *Grid - Tools/Reclassifying Grid Values* tool) that I will load. Clicking on the "Load" command, the 'Load Table' dialog window displays (Figure 8-2).

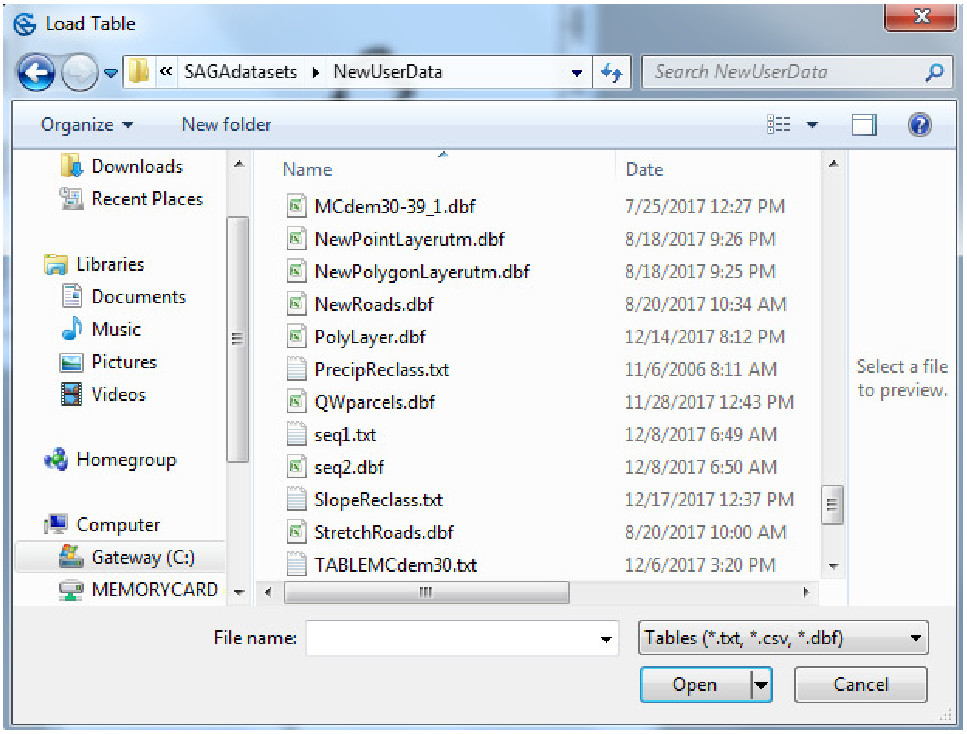


Figure 8-2. The 'Load Table' dialog window.

The data field at the top of the window is used to choose the storage folder containing a table file I want to open. The table file I want to open is a text file named 'SlopeReclass'. Using the mouse, I select the table file name. The chosen file name displays in the "File name:" data entry field toward the bottom of the window. I could load more than one by simultaneously pressing the Shift or Ctrl key at the same time as I choose additional table files.

Notice in the files type data field at the bottom, that the default is set to "Tables (*.txt, *.csv, *.dbf)". The .txt is the standard, space delimited text format. The .csv, "comma separated text", is a variation of the default .txt format. The .dbf is the dBase file format. This is the format used for storing attribute tables linked to shape layers. The other option, if I click on the small triangle to the right, is "All Files". Once I make my choice or choices, I click on the 'Open' button.

I may not notice any change if I am not viewing the bottom portion of the list of layers in the Data tab area of the Manager window. Toward the bottom of the list is the "Tables" portion of the Data tab area. Viewing this area of the list, I see that the 'SlopeReclass' table file has been loaded (Figure 8-3).

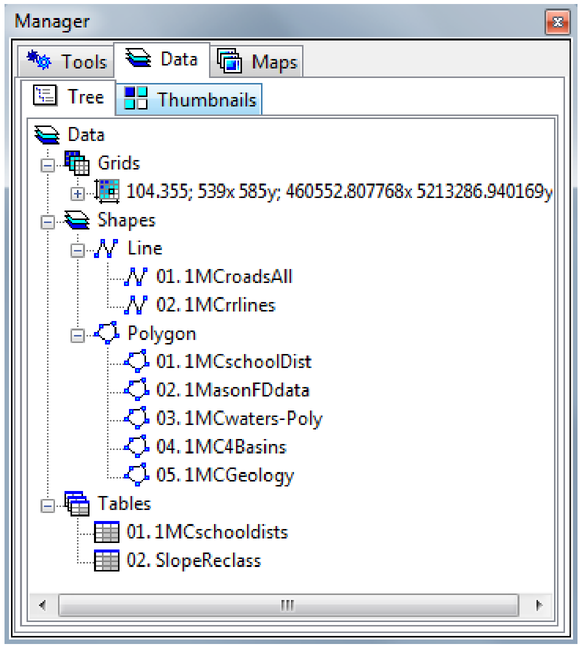


Figure 8-3. The “Tables” section of the Data tab area of the Manager window.

I have minimized some of the section views in the Data tab area list but not the "Tables" area in Figure 8-3.

An alternative exists to using the "Load" command that appears in the File dropdown menu. If a table file is listed for the current work session and I want to load another, when I right-click on the “Tables” title in the layer list in the Data tab area of the Manager window (see near the bottom of Figure 8-3), the short popup list in Figure 8-4 appears.

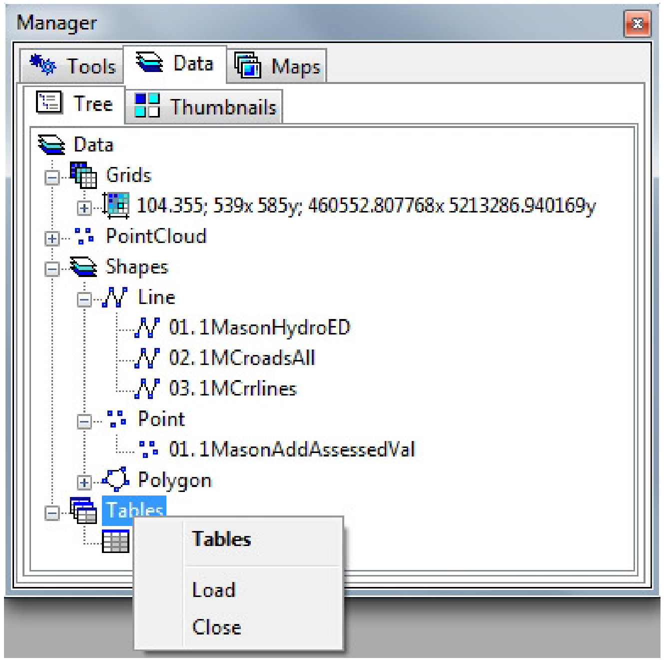


Figure 8-4. The "Tables" popup list of options.

The "Load" option on the popup list functions the same as the similar command on the Menu Bar File menu.

The Table Options on the Menu Bar and Toolbar

The table file 'SlopeReclass' is opened by double-clicking with the mouse on its' name in the "Tables" section of the layer list or I can click with the right mouse button on its' name and select the "Show Table" command from the popup list.

The table displays in a table view window. When the table view window displays, the Menu Bar and the toolbar are updated to include options for editing tables. The Menu Bar will include a new menu, Table, and a set of table icons are appended to the toolbar. Figure 8-5 displays the toolbar modifications.

Figure 8-5. The Menu Bar and toolbar modifications.

In Table 8-1 is a list of some of the edit tools available in the Table menu with their toolbar icon equivalents displayed to the right.

Table 8-1. Table Menu Options

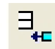
Table Options	Toolbar Icon
Add Field	
Delete Fields	
Add Record	
Insert Record	
Delete Record	
Delete All Records	

Table options are available for selection in the Menu Bar Table menu, displayed in Figure 8-6.

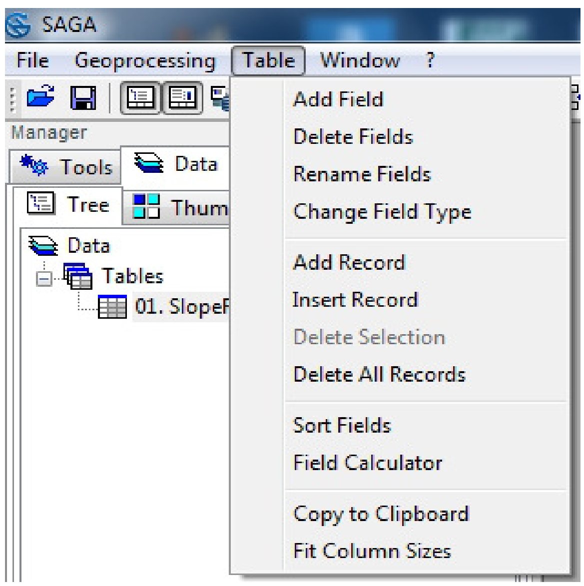


Figure 8-6. The Menu Bar Table menu of options.

Table options are also available on the toolbar, as noted. Most of these options can be selected from a table view window. I move the mouse pointer into the row of field names for a table and press the right mouse button. The list of column related table options display (see Figure 8-7).

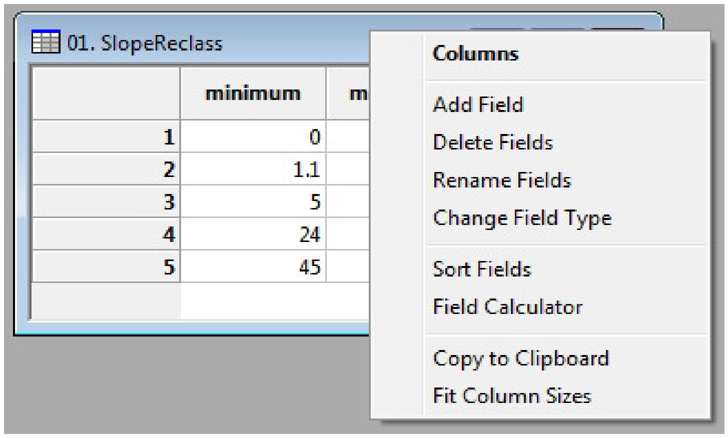


Figure 8-7. The table column list of table options.

A similar list of table row functions is available. I move the mouse pointer into the left most column in the table view window and press the right mouse button. The list of row related table functions display in Figure 8-8.

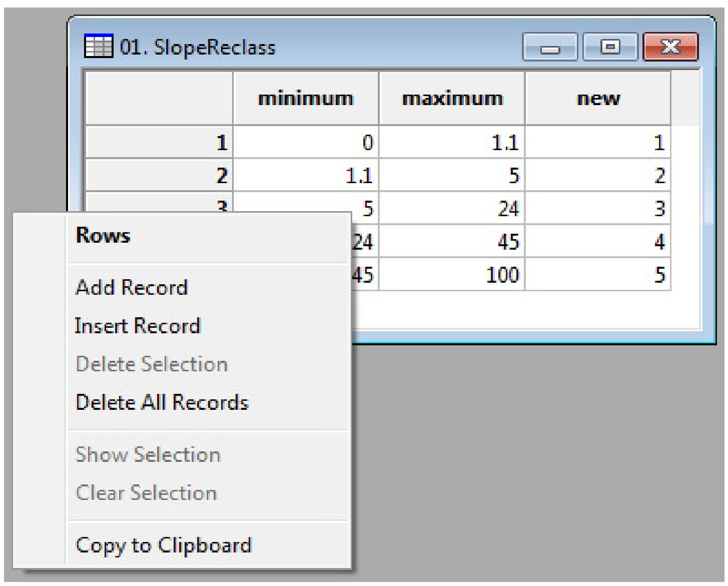


Figure 8-8. The table row list of table functions.

I can see there is overlap between the Menu Bar Table menu options and the options available from a table view window for columns and rows. Table 8-2 compares the three sources of table function options.

Table 8-2. Comparing Table Options

Function Name	Table Menu	Column Option	Row Option
Add Field	Yes	Yes	
Delete Fields	Yes	Yes	
Rename Fields	Yes	Yes	
Change Field Type	Yes	Yes	
Add Record	Yes		Yes
Insert Record	Yes		Yes
Delete Selection	Yes		Yes
Delete All Records	Yes		Yes
Sort Fields	Yes	Yes	
Field Calculator	Yes	Yes	
Copy to Clipboard	Yes	Yes	Yes
Fit Column Size	Yes	Yes	
Show Selection			Yes
Clear Selection			Yes

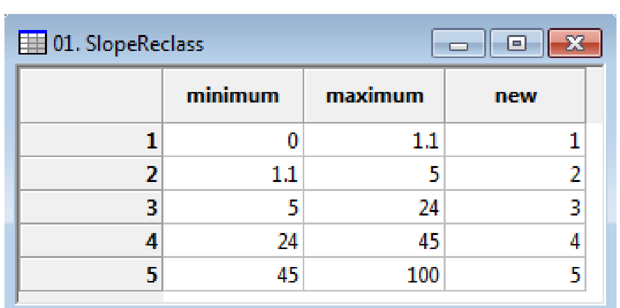
These options are described and explored in the remainder of this chapter. At the beginning of each section, it will be identified which option list or lists the function is available. For example, the first function in the table, "Add Field", is preceded by:

Table: Add Field, Column: Add Field

There are 12 options on the Menu Bar Table menu. Eight of these options are available from a table view window by moving the mouse pointer into the row of field names and pressing the right mouse button. Five of these options are available using the table view window row list of edit functions. Two options on the row list are unique and only available on the row list.

Table: Add Field, Column: Add Field

Some tables in SAGA serve a specific purpose to provide input to a function, command, or tool. The table displayed in Figure 8-9 is an example. This table is named 'SlopeReclass'.


01. SlopeReclass

	minimum	maximum	new
1	0	1.1	1
2	1.1	5	2
3	5	24	3
4	24	45	4
5	45	100	5

Figure 8-9. The 'SlopeReclass' table.

The table provides recode information for the *Grid - Tools/Reclassify Grid Values* tool. There are 5 rows in the table and 3 columns. Each row defines a data range to recode and a new data value to replace the data range. The number of rows is adjusted depending on the recode task. In the 'SlopeReclass' table, the first row assigns the new data value 1 to the grid cells having data values 0 through 1.1. The new data value 2 is assigned to grid cells having the data values 1.1 through 5 and so on. The tool expects this table to be in this structure. If I add a field to the 'SlopeReclass' table, the tool the table provides input will not accept the table. Thus, the format of the 'SlopeReclass' table is specific for the input requirements of the *Reclassify Grid Values* tool.

Adding a field is an option for other types of tables (e.g., attribute tables related to shape layers). The following discussion uses the '1MCschoolPop' dBase (.dbf) table. This is the attribute table linked to the '1MCschoolPop' polygon shape layer.

When I choose the "Add Field" edit tool, the 'Add Field' dialog window in Figure 8-10 displays.

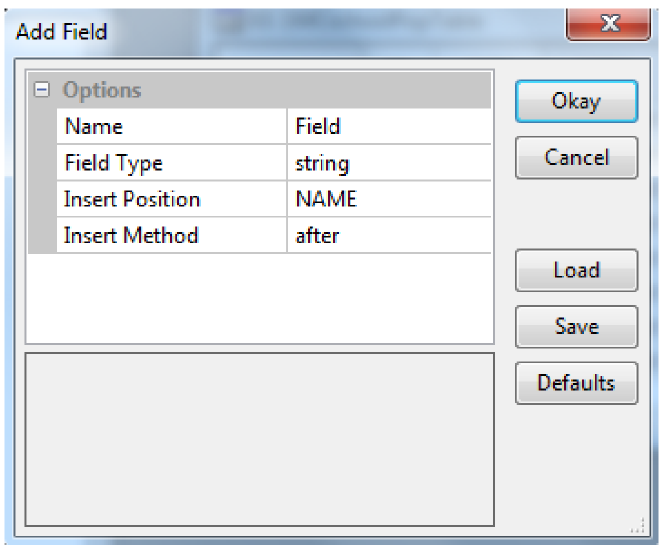


Figure 8-10. The 'Add Field' edit tool dialog window.

The dialog window has four options. The first one, 'Name', is for entering a meaningful name for the new column or attribute field. When I click on the value field to the right of the 'Name' option, I can enter text for a new name. The default is "Field".

The second option, "Field Type", is for choosing the data type for the attribute values. The default is "string". This would be for text data. Clicking with the mouse pointer in the value field to the right of the 'Field Type' label causes a popup list of options to be displayed (Figure 8-11).

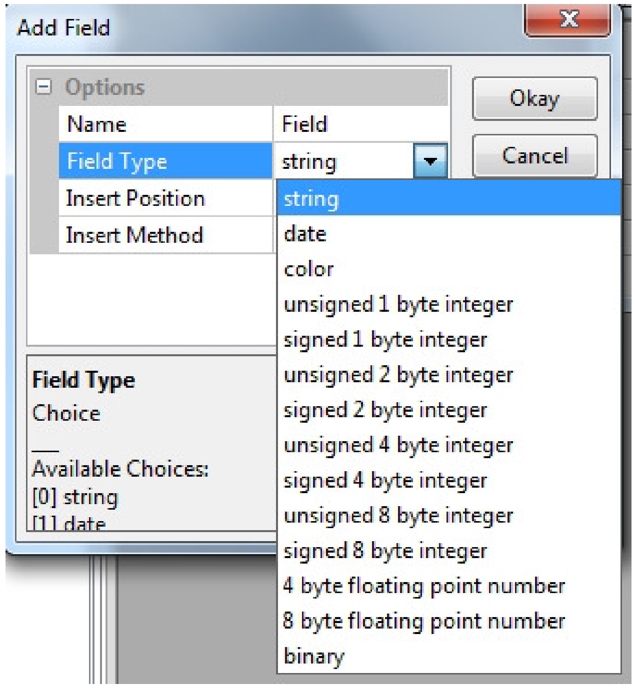


Figure 8-11. The options for 'Field Type'.

I use the "string" data type when I want to "document" a data field or enter alphanumeric data values. Most SAGA commands and tools, involving tables or outputting tables, work with numeric data types. There are exceptions. For example, the *Shapes – Tools/Search in attributes table* tool searches for a text string in an attribute table.

The "Insert Position" and "Insert Method" options relate to the location of the new field (column) in the table. In Figure 8-10 above, the "NAME" field is the 11th and last column in the '1MCschoolPop' table. The 'Insert Method' has "after" selected. This would mean that the new field or column is added as the 12th column or attribute following the "NAME" column. The other 'Insert Method' option is "Before".

Table: Delete Fields, Column: Delete Fields
Table columns or attribute fields are deleted using the "Delete Fields" option. When I select the "Delete Fields" edit tool, a dialog window displays (Figure 8-12).

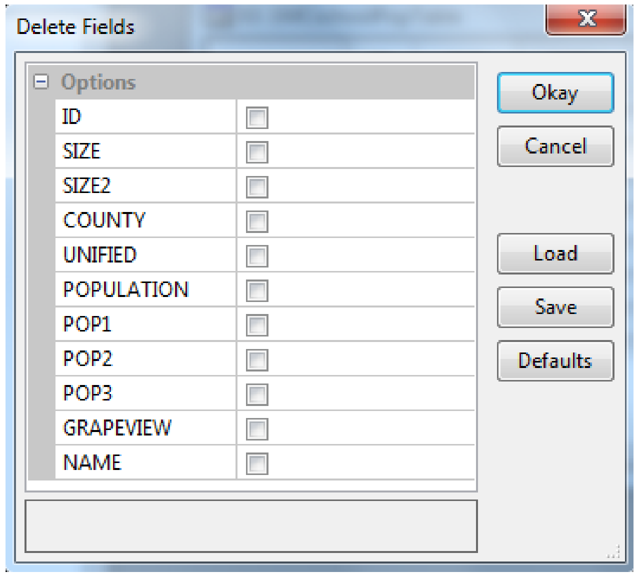


Figure 8-12. The 'Delete Fields' dialog window.

The dialog window displays the field names (as options) for the fields in the table. Each field is a check box option. The default is that the boxes are un-checked. If I want to delete a column or attribute field I click in the box to the right of the name of the field. A check appears in the check box. When I click the Okay button in the upper right of the dialog window, SAGA deletes the fields that have checks in the check boxes.

Table: Rename Fields, Column: Rename Fields
This option is for renaming field names in a table. When I choose the option, the 'Rename Fields' dialog window in Figure 8-13 displays.

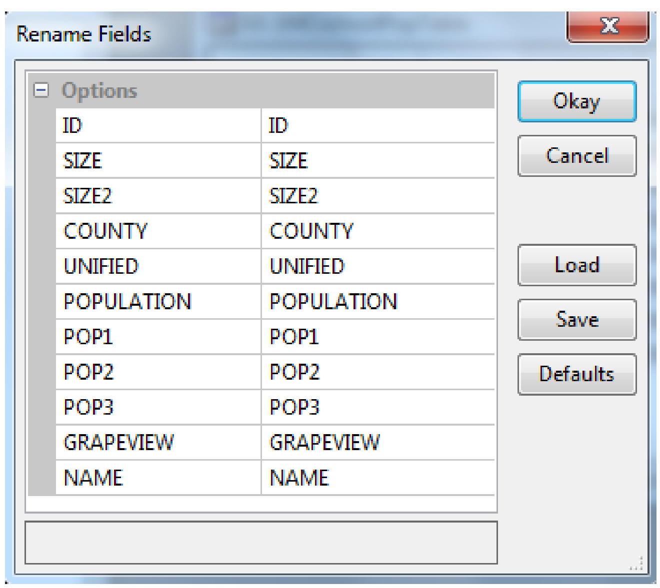


Figure 8-13. The 'Rename Fields' dialog window.

The two columns display the current field names. The right column is where I can change a field name.

Table: Change Field Type, Column: Change Field Type
Each field or attribute of a table has an assigned field or data type. Figure 8-14 displays the 'Change Field Type' dialog window and the content for data types for the '1MCschoolPop' table.

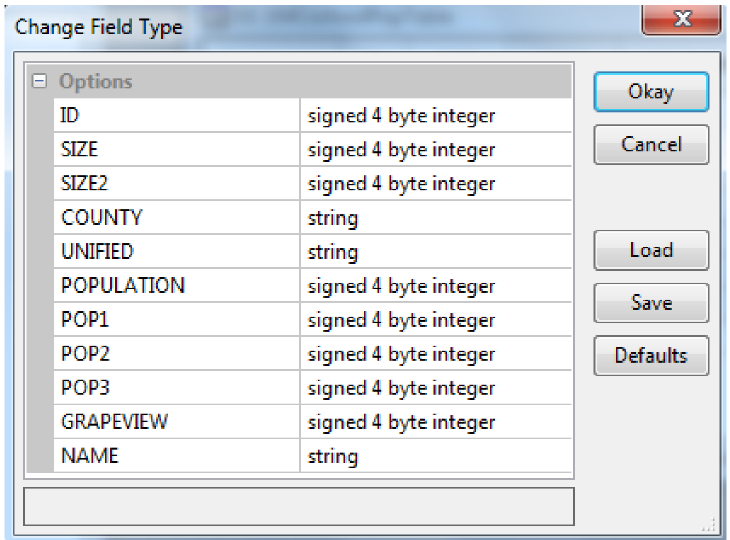


Figure 8-14. The 'Change Field Type' dialog window.

The dialog in Figure 8-14 lists 11 fields. Eight of the fields use the "signed 4 byte integer" data type and 3 use the "string" data type. Figure 8-15 lists the data types supported in SAGA for table fields.

string
data
color
unsigned 1 byte integer; integer values from 0 to 255
signed 1 byte integer; integer values from –128 to 127
unsigned 2 byte integer; integer values from 0 to 65535
signed 2 byte integer; integer values from –32768 to 32767
unsigned 4 byte integer; integer values from 0 to 4294967295
signed 4 byte integer; integer values from -2147483648 to 2147483647
unsigned 8 byte integer; integer values from 0 to 18,446,744,073,709,551,515
signed 8 byte integer; integer values from + or - 9,223,372,036,854,775,808
4 byte floating point number; real values with seven digits precision
8 byte floating point number; real values with fifteen digits precision
binary; values of 0 and 1

Figure 8-15. Data types supported for table fields.

I can change the data type for a field by moving the mouse pointer into the value field to the right of the field name and pressing the left mouse button. A popup list of the data type options displays. I move the mouse pointer over the choice I want to make and press the left mouse button. This chooses the option. Then I click with the mouse on the Okay button.

Table: Add Record, Row: Add Record
This edit tool adds a new blank record to the bottom of the table. When I select this edit option for the '1MCschoolPop' table, a row 9 is added at the bottom. A new record will have 0's entered for numeric fields and blanks for non-numeric fields.

Table: Insert Record, Row: Insert Record
The "Insert Record" edit option inserts a new, blank record immediately above the current active record. I can make a record the current active one by clicking on the row number in the far left column corresponding to the row I want to be active. If the current active record is number 3, when I select the "Insert Record" command, the number 3 and following rows increment by 1 and a new blank row for row 3 appears.

Table: Delete Selection, Row: Delete Selection
This edit option deletes the current active row or record. The row numbers will automatically adjust their numbers as required.

Table: Delete All Records, Row: Delete All Records
This could be a dangerous edit option. When I select it, all records (rows) are deleted. I will not be asked if I am sure or really want to take this action. The "Delete All Records" option does not affect the data file structure for the table. The structure does not change. The table remains, containing no records.

A stored table is not affected unless I save the table using the previously used table file name.

Table: Sort Fields, Column: Sort Fields
A 'Sort Table' dialog window displays when this edit option executes. This dialog window displays in Figure 8-16.

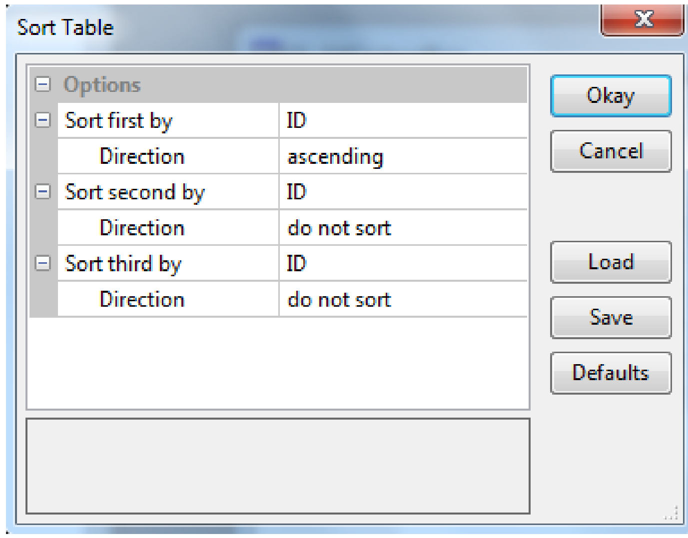


Figure 8-16. The 'Sort Table' dialog window.

Up to three fields can be used to sort the table records. There are three parameters for choosing a field or attribute for up to three sort levels in the case of a nested sort. The first field in the table is the default entry for the first parameter, 'Sort first by'. I move the mouse pointer into the value field to the right of the 'Sort first by' parameter and press the left mouse button. A popup list of the available fields displays. I use the mouse to choose the field to sort. Each of the sort ... by parameters also has a 'Direction' parameter. This parameter has three choices: do not sort, ascending, descending. The 'Direction' parameter related to the 'Sort first by' parameter has a default entry of "ascending".

I can use the same process described above for implementing a nested sorting process using the 'Sort second by' and 'Sort third by' parameters.

The result of executing the "Sort Fields" option is a re-ordering of the rows based on the option settings used. A sort can also be executed by double-clicking with my mouse on the attribute field I want to sort. The first time I use this approach on a field, the default "ascending" is applied. The second time, the "descending" sort is automatically executed.

Table: Field Calculator, Column: Field Calculator
The "Field Calculator" option is very similar to executing the *Table - Calculus/Field Calculator* tool. The difference being that here it is executed from a table view window. The information available in the Description tab in the Object Properties window for the tool *Field Calculator* applies for the Table: Field Calculator and Column: Field Calculator options.

The "Table Field Calculator" option uses a formula involving one or more table fields and places the results in a new or existing field in the table. The table fields must contain numeric field type data. The 'Table Field Calculator' parameters window in Figure 8-17 displays when I choose the "Field Calculator" option.

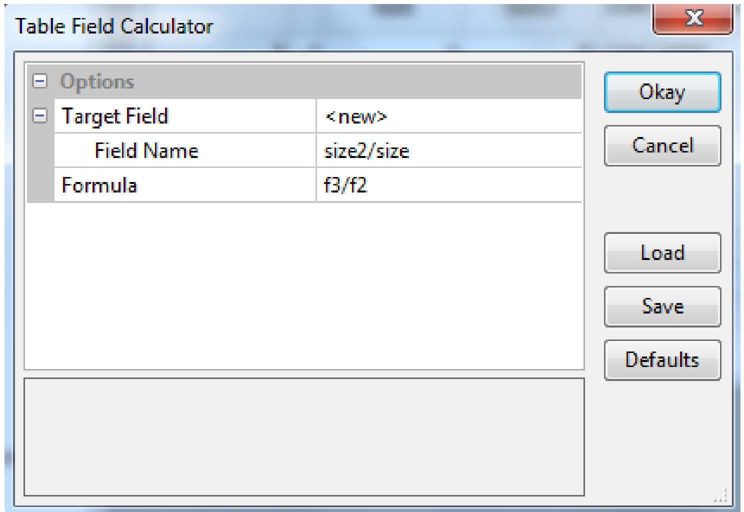


Figure 8-17. The 'Table Field Calculator' parameters window.

The 'Target Field' is where I choose to output the results of a formula calculation. The default entry is "<new>". This default is similar to using "<create>". The name for the new field will be the default entry for the 'Field Name' parameter, "Result", or I can replace the default with a different entry for the field name. Whichever approach is used, the new field is appended as the last column in the table.

The last parameter in the window is 'Formula'. The equation is entered in the value field to the right of the 'Formula' name. Fields in the table can be used in the formula as variables. They are referred to according to their column number or by their attribute name in the table, i.e., f1, f2, f3, etc., or LENGTH, PSI, etc. As an example, the second column ("LENGTH") in a table is road length in feet. I want to create a new field that contains road length in miles. The formula would be "f2/5280".

Rather than using a variable reference f1 or f2, etc., the reference in the formula can also be to the actual field name. The field name is enclosed in brackets. Here is an example. The formula above would be "[LENGTH]/5280".

Table: Copy to Clipboard, Column: Copy to Clipboard, Row: Copy to Clipboard
The "Copy to Clipboard" option copies a table or a highlighted portion of a table to the system clipboard. The content of the clipboard can be pasted into a graphic or word processing program.

Table: Fit Column Sizes, Column: Fit Column Sizes
When I use this tool, SAGA adjusts the width of each column of a table to a column width based on the longest data entry in the column. All of the columns of the table are adjusted when this command is executed.

Row: Show Selection
Rows or records in a table are often in selection status. Records of an attribute table linked to a shape layer are selected when their corresponding objects are selected in a

map view window using the Action tool from the toolbar or because of applying a tool or the records are selected in the table using the Action tool. When the attribute table is large, using the "Show Selection" option displays only the records in the table that are in selection status. No other records will display. A check mark appears to the left of the "Show Selection" option in row list of options. I choose the "Show Selection" option a second time to revert to the standard display for all the records of the attribute table.

Row: Clear Selection
This unselects any records of a table.

Displaying a Table of Grid Layer Data Values
One approach for a graphic interpretation of layer data values is to use the histogram option. A graphic histogram can be converted to a table. In this example I am going to use the slope grid layer named '1MCslopeDegrees'.

First I am going to use the "Histogram" option to create a graphic histogram for the '1MCslopeDegrees' grid layer. The "Histogram" option is executed by right-clicking with the mouse pointer on the grid layer name in the Data tab area of the Manager. I choose the "Histogram" command from the popup list that displays. The default is for the histogram to have 100 classes.

The histogram is a graphic display of the frequency of data values by display classes for a grid layer. For display purposes, the grid cell data values are classified according to the display classes. The no data values (-99999) are not part of the histogram. Figure 8-18 displays a map view window for the slope grid layer for Mason County, Washington. The histogram for the layer displays on the right.

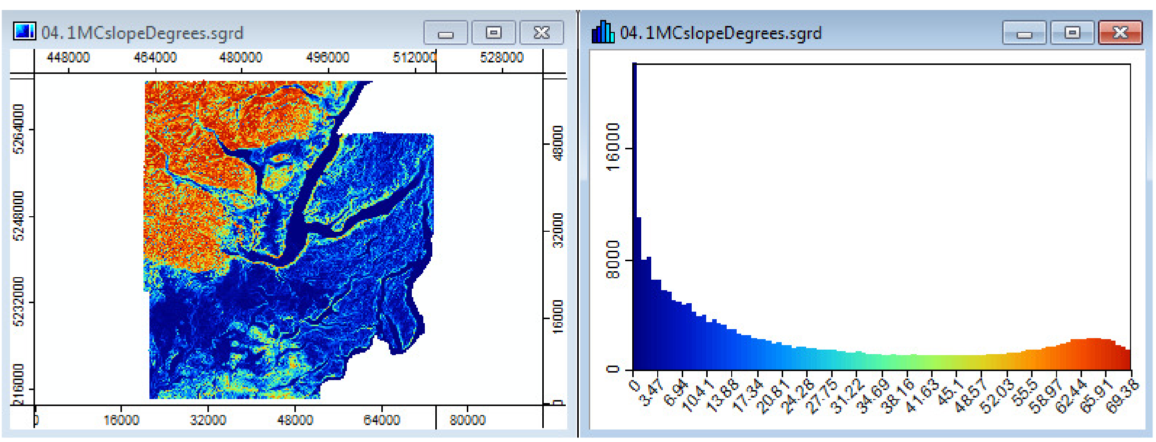


Figure 8-18. The '1MCaspectDeg' layer and histogram.

In the histogram, data value display classes are along the bottom on the x-axis. The frequency of occurrence for the cell values in each class are on the vertical y-axis.

When the histogram view window displays in the work area, the Histogram menu is available on the Menu Bar. Figure 8-19 displays the revised Menu Bar.

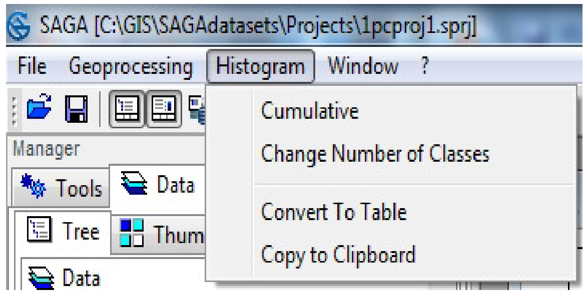


Figure 8-19. The Histogram menu on the Menu Bar.

The dropdown menu displays when I click on the Histogram menu. It contains four options: Cumulative, Change Number of Classes, Convert To Table and Copy to Clipboard.

The "Convert To Table" command produces a table version of the graphic histogram. The table file becomes available in the layer list in the "Tables" section of the Data tab area of the Manager window (Figure 8-20). The default name is "Histogram:" concatenated with the name of the layer.

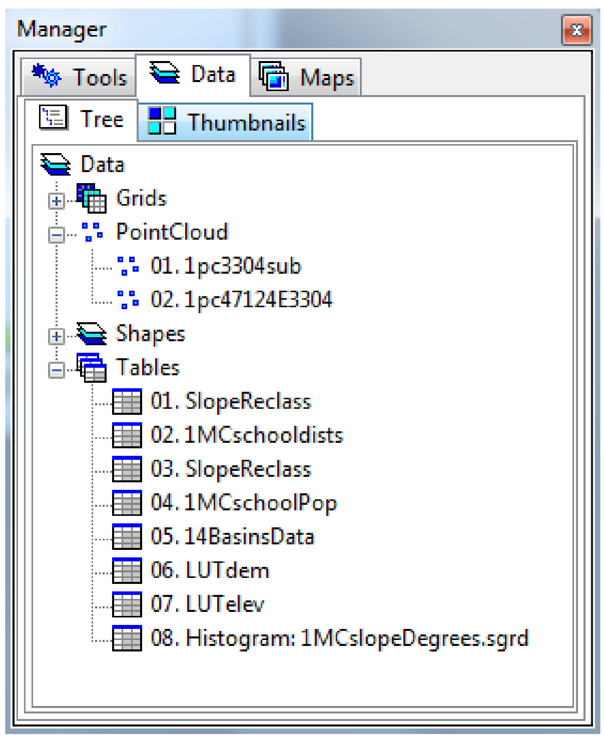


Figure 8-20. The “Tables” section of the Data tab area of the Manager.

The table can be displayed by double-clicking on its’ name in the list or right-clicking on the table name and selecting the "Show Table" option from the popup list of options.

When a table view window opens in the display area, the menu Table appears in the Menu Bar.

Figure 8-21 shows a small portion of the 100-row, 8-column table created for the slope grid layer histogram.

08. Histogram: 1MCslopeDegrees.sgrd

	CLASS	AREA	COUNT	CUMUL	NAME	MIN	CENTER	MAX
1	1	240733588.9487	22106	22106	0 < 0.81	0	0.4052	0.8104
2	2	138193668.8573	12690	34796	0.81 < 1.62	0.8104	1.2156	1.6208
3	3	110990533.7268	10192	44988	1.62 < 2.43	1.6208	2.026	2.4312
4	4	94633804.7573	8690	53678	2.43 < 3.24	2.4312	2.8363	3.2415
5	5	82371703.0131	7564	61242	3.24 < 4.05	3.2415	3.6467	4.0519
6	6	72254924.5759	6635	67877	4.05 < 4.86	4.0519	4.4571	4.8623
7	7	70512530.0119	6475	74352	4.86 < 5.67	4.8623	5.2675	5.6727
8	8	65699165.0288	6033	80385	5.67 < 6.48	5.6727	6.0779	6.4831
9	9	61539198.0073	5651	86036	6.48 < 7.29	6.4831	6.8883	7.2935
10	10	58598907.1805	5381	91417	7.29 < 8.1	7.2935	7.6986	8.1038
11	11	56039765.1647	5146	96563	8.1 < 8.91	8.1038	8.509	8.9142

Figure 8-21. The '1MCslopeDegrees' grid layer histogram in its' table form.

Each row of the table defines a display class and data columns display statistics for the class. There are eight columns or attribute fields: CLASS, AREA, COUNT, AREA, CUMUL, NAME, MIN, CENTER, and MAX.

I can see that the class interval for the 100 display classes is .81. The COUNT column shows the frequency (number of cells) for each of the slope display classes. For example, CLASS 4 shows a frequency of 8690 grid cells having data values between 2.43 and 3.24. The values in the AREA column are the COUNT value (number of cells) times the physical area of a cell. A cell is 104.355 meters by 104.355 meters; 10889.97 square meters in area. The square meters cell area times the COUNT value is the total area for the class in square meters.

The display class name is the class interval. The display class name is entered for the NAME field in text. The MIN, CENTER, and MAX fields are numeric entries defining the display class interval and its data value center

I can save this table and re-open it for later SAGA work sessions. A saved version can also be opened with a spreadsheet application, such as Microsoft Excel. The table can be saved in the text (*.txt), Comma Separated Values (*.csv), or Dbase (*.dbf) formats. The "Load" option in the Menu Bar File dropdown menu option "Table" will load any of the three file formats.

All of the table edit tools introduced earlier in this chapter are available for use with the histogram table. These options become available when the table of histogram values table view window is the active window in the work area.

The Layer Color Lookup Table

A "Lookup Table" option is available in the Settings tab area of the Object Properties window for a layer. The Display: Colors: Type parameter has several available options depending on the layer type. I click in the value field to the right of the ‘Type’ parameter name and a popup list of options displays. One of the list options is “Lookup Table”.

I choose the "Lookup Table" option. Depending on the type of layer, one or two additional parameters become available. One is the 'Table' parameter. If the layer is a shape or point cloud layer, a second parameter named 'Attribute' displays.

The default entry in the value field to the right of the ‘Table’ parameter name is “Table (columns: 5; rows: 2)”. When I click in the field with the mouse pointer, an ellipsis symbol appears. When I click on the ellipsis symbol, the default lookup table is displayed (Figure 8-22).

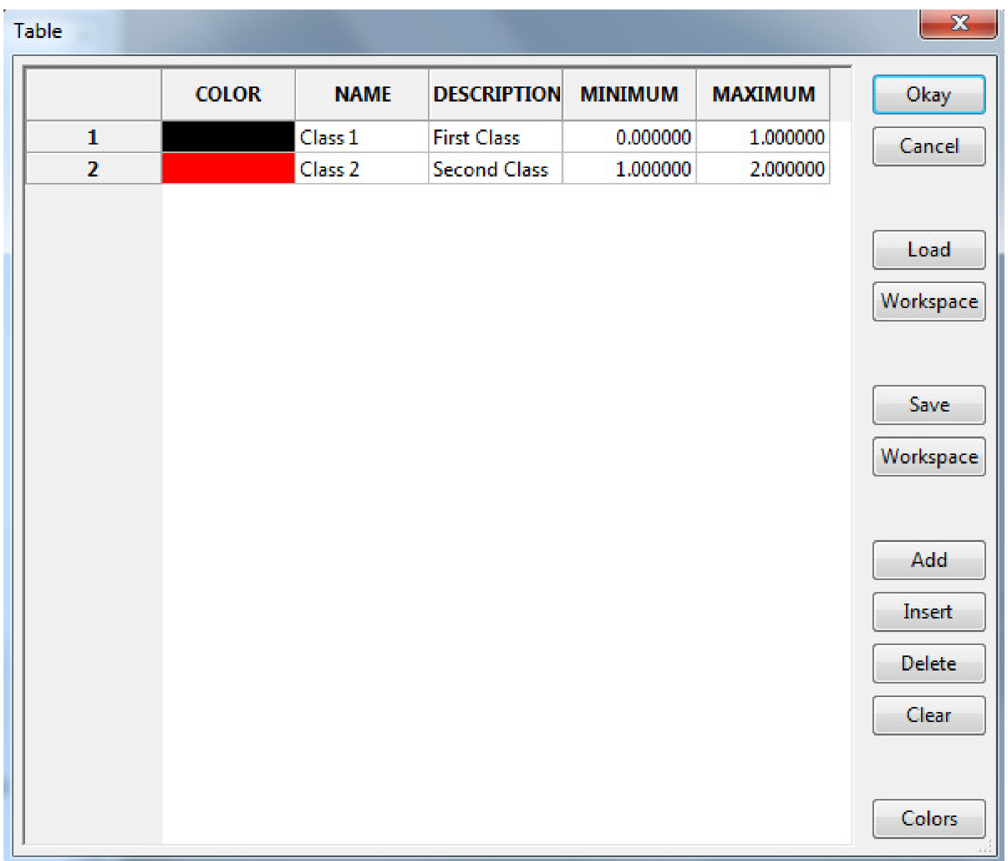


Figure 8-22. The default lookup table for a grid layer.

Displaying the lookup table does not cause any addition to the Menu Bar. A lookup table is a special type of table used for assigning display colors to layer data classes. The table edit options described earlier in this chapter are not available for this type of table. There are edit options available in the 'Table' dialog window as buttons on the right side of the window. In Figure 8-22 I can see the four edit buttons Add, Insert, Delete, and Clear.

Using the edit buttons available in the 'Table' dialog window, I create the lookup table in Figure 8-23 for the '1MCdem30' grid layer. The data range of elevations for this layer is from 0 to 6379 feet. The color assignments are made by clicking with the mouse in the "COLORS" column box and choosing a color on the 'Color' palette window.

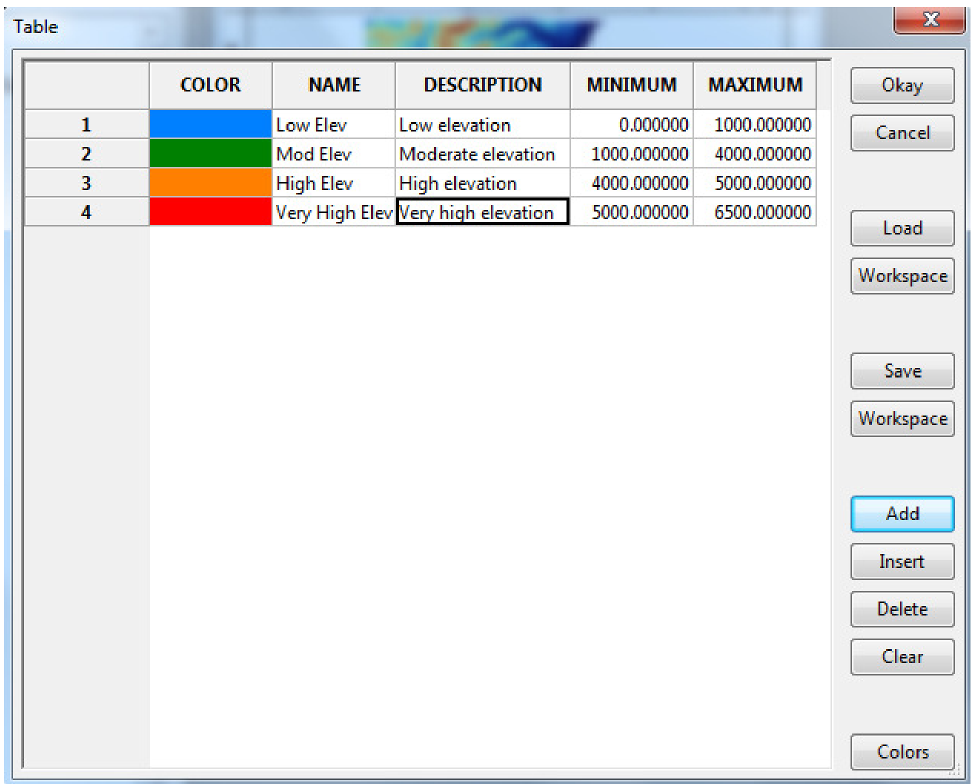


Figure 8-23. The lookup table for elevation.

This lookup table has four display classes. Each display class has a color identified in the COLOR column. A name for each class appears in the NAME column. The MINIMUM and MAXIMUM columns identify the elevation boundaries for the display classes.

I click with the mouse on the Okay button to exit the 'Table' dialog window. Then I click on the Apply button at the bottom of the Object Properties window. The lookup table is applied to the grid layer. The lookup table is a display parameter related to the layer.

A lookup table is one of the display parameters for a layer that is saved as an element of a project definition and the configuration file. In these cases, the lookup table is available for the layer when it is loaded as part of a project (i.e., because it was saved as a parameter for the layer) or if the layer and lookup table were available in the previous work session. The configuration file is based on the workspace of the last SAGA exit.

There are two approaches to retaining a lookup table for future work sessions independent of a project definition or configuration file.

The first approach starts with the lookup table and its' color assignments saved to the "Tables" area of the Data tab area of the Manager using the Workspace button beneath the Save button on the 'Table' dialog window. When I click with the mouse on the Workspace button beneath the 'Save' button, the 'Save to Workspace' dialog displays (Figure 8-24).

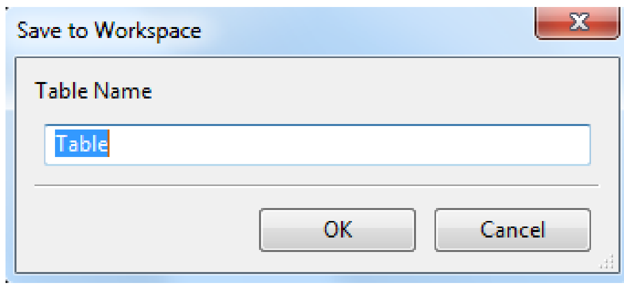


Figure 8-24. The 'Save to Workspace' dialog window.

This dialog window has a single data entry field for a name to assign the lookup table. The table is not stored outside of random access memory. It is available in the Data tab area of the Manager in the "Tables" section as a lookup table. I enter a name, "LUTdem", and click with the mouse on the 'OK' button. I check in the Data tab area of the Manager and see that a new table named 'LUTdem' shows in the "Tables" section list.

I move the mouse into the Data tab area of the Manager, right click with the mouse on the 'LUTdem' name, and choose the "Save as..." option. The 'Save Table' dialog window in Figure 8-25 displays.

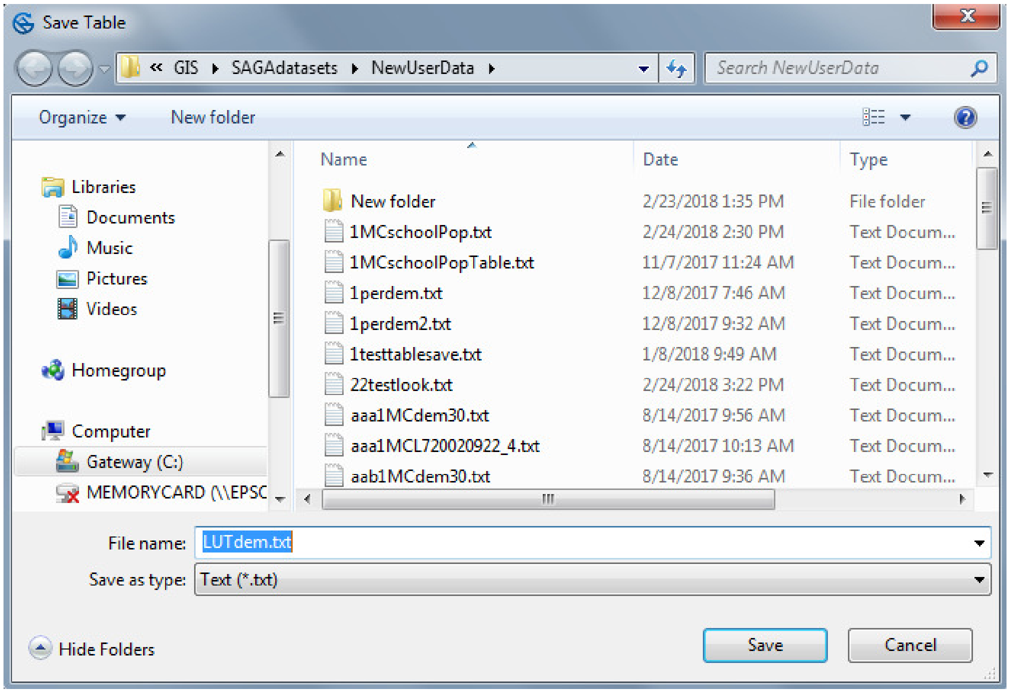


Figure 8-25. The 'Save Table' dialog window.

I can navigate to an appropriate storage location and save this lookup table as a new table file. This table file can be loaded into the 'Table' dialog window using the Load button on the right side of the 'Table' dialog window.

The table file saved using the Workspace button just below the Save button still exists. This lookup table can be loaded from the "Tables" area for use with a layer using the Workspace button beneath the Load button on the 'Table' dialog window. This Workspace button only loads tables placed in the Data tab area for the Manager using the Workspace button beneath the Save button.

The second approach uses the Save button on the 'Table' dialog window. Rather than temporarily saving the lookup table to the "Table" section of the Data tab area of the Manager, the Save button saves it as a table file in a storage location. I click with the mouse on the Save button and the 'Save Table' dialog window in Figure 8-25 display. I navigate to where I want to save the lookup table and click with the mouse on the Save button at the bottom of the window. This lookup table can be reloaded using the Load button on the 'Table' dialog window (see Figure 8-23).

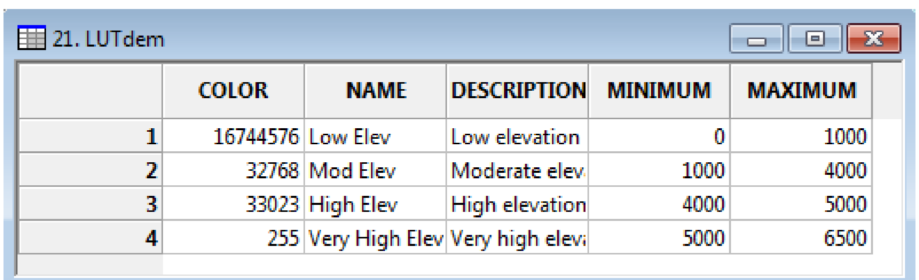
The above approaches are specific to dealing with the lookup table in its role as assigning colors for the display of layer values.

During my next SAGA work session, I load the ‘1MCdem30’ grid layer for which the 'LUTdem' lookup table was developed.

I click on the '1MCdem30' grid layer name in the Data tab area of the Manager window. In the Settings tab area of the Object Properties window, I select the "Lookup Table" option in the value field to the right of the 'Type' parameter. When I click with the mouse pointer in the field, an ellipsis symbol appears. Clicking on the ellipsis, the default color lookup table displays as it appears in Figure 8-22. Since I want to load the 'LUTdem' color lookup table, I click on the Load button that appears on the table dialog window, browse to where the 'LUTdem' text file is stored, select the file, and load it. Once it is loaded I click on the Apply button at the bottom of the Object Properties window and my custom lookup table is used for elevation display in the grid layer

I can load the lookup table independent of its role as a lookup table. It can be loaded with the File: Table: Load Table option into the work session. Using the File: Load: Table option in the File dropdown menu, I am going to load the 'LUTdem' table file. Once it is loaded into the work session, the file name appears in the "Tables" section in the layer list displayed in the Data tab area of the Manager window.

I move the mouse pointer over the 'LUTdem' table name and press the left mouse button twice. The table opens in a table view window in the work area. When I do that, the Table menu is added to the Menu Bar with the various table edit tools and the toolbar is updated with the edit tools as well. The 'LUTdem' file displays in Figure 8-26.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1	16744576	Low Elev	Low elevation	0	1000
2	32768	Mod Elev	Moderate elev	1000	4000
3	33023	High Elev	High elevation	4000	5000
4	255	Very High Elev	Very high elev	5000	6500

Figure 8-26. Viewing the 'LUTdem' lookup table.

You might expect the 'LUTdem' table to appear like the table in Figure 8-23. But it does not. The "Color" column is displaying numeric definitions representing colors rather than actual color swatches. As pointed out earlier, the "Load" option in the File dropdown menu loads the lookup table as a normal table and not as one designed as a lookup table. The 'Load' and 'Load: Workspace' buttons available on the 'Table' dialog window are for loading lookup tables for their purpose.

The numeric definitions for colors can be edited if you know how the numbers are used for defining colors. It is much easier to load the lookup table using the features on the 'Table' dialog window to make any edits.

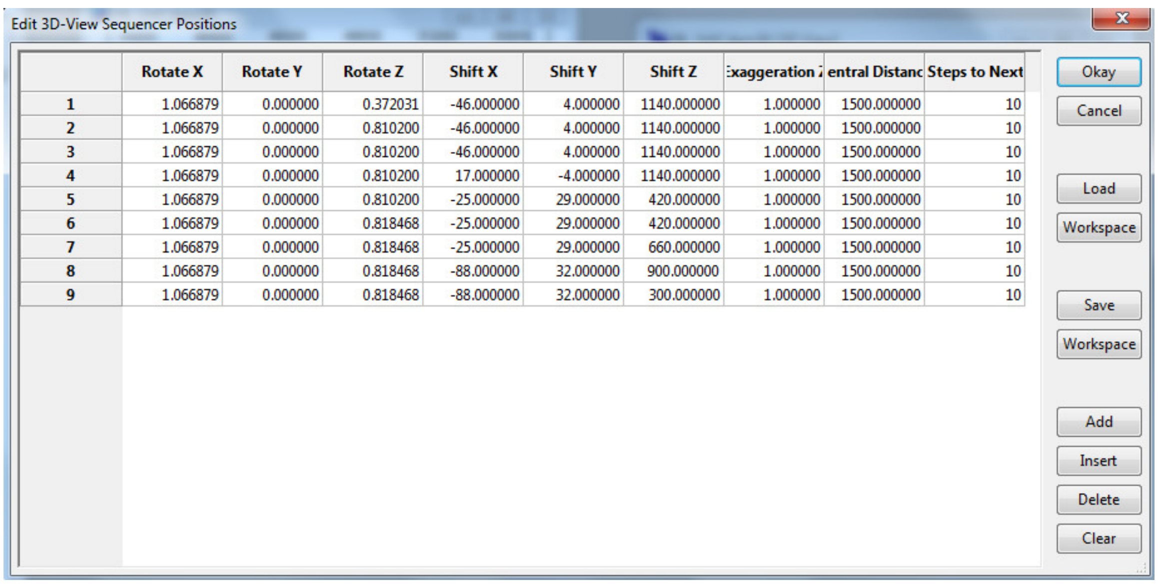
The Player Sequence Table
The 3D View function in SAGA uses a table called 'Player Sequence'. This table stores 3D model rotation and orientation values that are used to create a "fly through" view of a 3D view window. The table was discussed in the 3D-View section in Chapter 7.

A set of model rotation and orientation values are captured from a 3D view window each time the key combination Ctrl-A is pressed. There are 8 values captured that become a row entry in a sequencer table.

Figure 8-27 displays an example of what I am referring to as a sequencer table. This is the 'Edit 3D-View Sequencer Positions' dialog window that displays when I choose the "Edit Positions" option on the Menu Bar 3D View menu (this menu is only available while a 3D View window is the active window in the work space).

Like the lookup table discussed in the previous section, this is a special table and not supported in SAGA by the standard options available from the Menu Bar Table menu.

I have been using the Ctrl-A key combination to capture 9 sets of rotation and orientation model settings. I choose the "Edit Positions" option on the Menu Bar 3D View menu and the dialog window in Figure 8-27 displays.



	Rotate X	Rotate Y	Rotate Z	Shift X	Shift Y	Shift Z	xaggeration	entral Distanc	Steps to Next
1	1.066879	0.000000	0.372031	-46.000000	4.000000	1140.000000	1.000000	1500.000000	10
2	1.066879	0.000000	0.810200	-46.000000	4.000000	1140.000000	1.000000	1500.000000	10
3	1.066879	0.000000	0.810200	-46.000000	4.000000	1140.000000	1.000000	1500.000000	10
4	1.066879	0.000000	0.810200	17.000000	-4.000000	1140.000000	1.000000	1500.000000	10
5	1.066879	0.000000	0.810200	-25.000000	29.000000	420.000000	1.000000	1500.000000	10
6	1.066879	0.000000	0.818468	-25.000000	29.000000	420.000000	1.000000	1500.000000	10
7	1.066879	0.000000	0.818468	-25.000000	29.000000	660.000000	1.000000	1500.000000	10
8	1.066879	0.000000	0.818468	-88.000000	32.000000	900.000000	1.000000	1500.000000	10
9	1.066879	0.000000	0.818468	-88.000000	32.000000	300.000000	1.000000	1500.000000	10

Figure 8-27. The 'Edit 3D-View Sequencer Positions' dialog window.

I notice that the dialog window is similar to the 'Table' dialog window. The option buttons displayed on the right side are the same, for example. And these buttons operate in the same manner as described for the 'Table' dialog window.

The dialog window in Figure 8-27 can be saved as a table, temporarily, in the "Tables" section of the Data tab area of the Manager using the Save button over the Workspace button. I click on the Save button and the 'Save to Workspace' dialog (see Figure 8-24) displays requesting a file name to use for the table. I enter a name and click with the mouse on the Okay button. The dialog window is now a temporary table listed in the "Tables" section of the Data tab area of the Manager. It is available in memory and is not stored.

This new table is available for use in a 'Edit 3D-View Sequencer Positions' dialog window. The Load button above the Workspace button can be used to load this new text table into an 'Edit 3D-View Sequencer Positions' dialog window that has been displayed using the 3D View menu option Sequencer: Edit Positions.

The Save button in the 'Edit 3D-View Sequencer Positions' dialog window can be used to store a table text file of the 3D model positions in a storage folder. I click with the mouse on the Save button and a 'Save Table' dialog window displays. I can enter a name for a new table file and store it in a storage folder.

The Load button will reload the stored table text file. I choose the "Edit Positions" option on the Menu Bar 3D View menu (this menu is only available while a 3D View window is the active window in the work space). I click with the mouse on the Load button and a 'Load Table' dialog window displays. I can navigate to where the table text file is stored, choose the file name, click on the Open button, and the stored table text file displays in the 'Edit 3D-View Sequencer Positions' dialog window.

I can use the Menu Bar: File: Table: Load option to load the stored table. I click with the mouse on the Table: Load option. The 'Load Table' dialog window displays. I navigate to where the table text file is stored, choose the file name, click on the Open button, and the stored table text file displays in the "Tables" section of the Data tab area of the Manager.

I double-click on the table file name in the "Tables" list and the table displays in the work space (Figure 8-28).

07. SeqDEM2

	Rotate X	Rotate Y	Rotate Z	Shift X	Shift Y	Shift Z	Exaggeration Z	Central Distance	Steps to Next
1	0.893089	0	-0.396833	0	0	1500	1	1500	10
2	0.919826	0	-0.016535	0	0	1500	1	1500	10
3	1.066879	0	0.884606	-34	9	540	1	1500	10
4	0.87972	0	0.710992	-34	9	1260	1	1500	10

Figure 8-28. The '3D View: Player Sequence' table.

The table view window is the active window in the work space. The Menu Bar now displays the Table menu title. The dropdown list of options are available for use with the 'SeqDEM2' table.

Summary
The 3D View "Edit Positions" option displays a 'Edit 3D-View Sequencer Positions' dialog window. When perspective rotation and orientation values are collected using the Ctrl-A key combination they will display in this window. The Workspace button below the Save button is used to temporarily store this dialog window as a table in the "Tables" section of the Data tab area of the Manager. The Load button is used to reload the perspective information into a displayed 'Edit 3D-View Sequencer Positions' dialog window.

The Save button on the displayed 'Edit 3D-View Sequencer Positions' dialog window can be used to save a table text file to a storage location. The Load button can be used to reload a stored table text file into a 'Edit 3D-View Sequencer Positions' dialog window.

And, lastly, the File: Table: Load option can be used to load a table text file into the "Tables" section of the Data tab area of the Manager.

The Shape Layer Attribute Table

A shape layer is not a single file; it consists of several data files. The .shp file contains the geometry for the layer objects. The .shx file is an index of the geometry. A third file is one containing attributes for each object. This third file is referred to as an attribute file.

An attribute file contains records, one for each layer object, and each record shares an identical structure of fields or attribute fields. Each record field is a descriptor or attribute for the object. Attribute files in SAGA are normally stored as dBase files (.dbf). The attribute file is an automatic load when the shape layer it is linked, is loaded. This file can also be loaded independent of its attribute table role using the Menu Bar File: Table: Load option.

Attribute tables for shape layers can be edited outside of SAGA, e.g., with Excel. Before I edit an attribute table I do two things. First, I add a column to the attribute table, usually it becomes the second or third column in the table, that identifies the original row number of the table row. It is important that the original row order of the table is not changed because it is synchronized with index data used by other files making up the layer. Editing the attribute table can involve sorting the rows into a different order based on attribute values. Before saving a changed attribute file it must be sorted into its original row order.

The second task is to make a back-up copy of the layer, including the attribute file. The easiest way to do this is to move my mouse pointer over the file name in the Data tab area of the Manager. When I press the right mouse button, a popup list of options appears. I choose the "Save Shapes As…" option and follow the instructions. Having a backup copy is a final solution to restoring the layer if the file somehow becomes compromised.

A shape layer attribute file can be loaded using the "Table" option in the Menu Bar File menu. I move the mouse pointer over the File menu. A popup list of options displays. I move the mouse pointer down to the "Table" option and choose the "Load" option in the popup list of options. When I choose the "Load" option, the ‘Load Table’ dialog window appears (Figure 8-29).

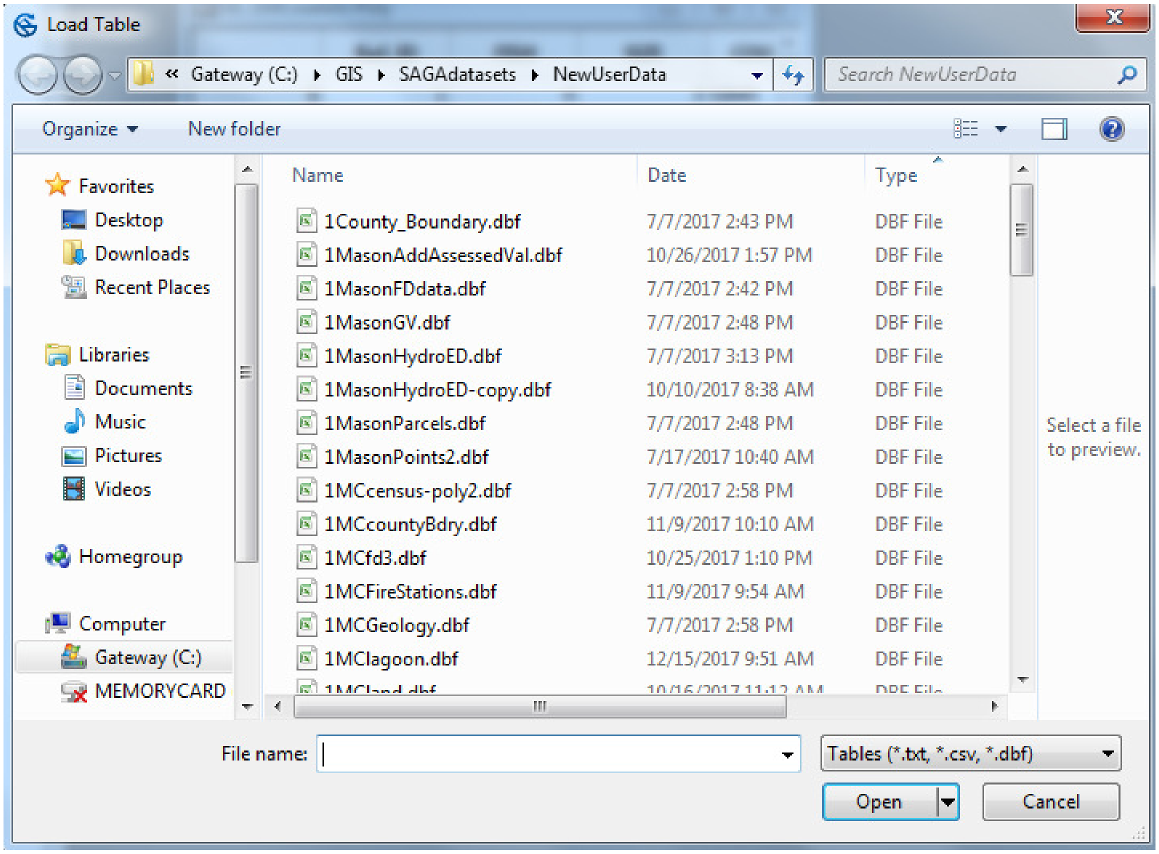


Figure 8-29. The 'Load Table' dialog window.

If the default storage location listed in the information field at the top of the 'Load Table' dialog window is not where the shape layer is stored with the attribute data file I want to open, I can navigate to the correct storage location.

Toward the bottom of the window is a data field for choosing a file format labeled "Files of type:". The default file format listed is "Tables [*.txt, *.csv, *.dbf]". A second choice is visible, when I click on the small triangle at the right side of the field, named "All Files".

The default file format for shape layer attribute tables is the dBase (.dbf) format. It is possible that a .dbf file will not be an attribute table but a table used by some other function in SAGA. When I select the "All Files" option in the "Files of type:" field, I will see a list of all the files in the storage location. Knowing that the file format for the geometry of a shape layer is in the .shp format can help in locating the correct attribute table for a shape layer. For example, Figure 8-30 displays the 'Load Table' dialog window with the "All Files" option selected.

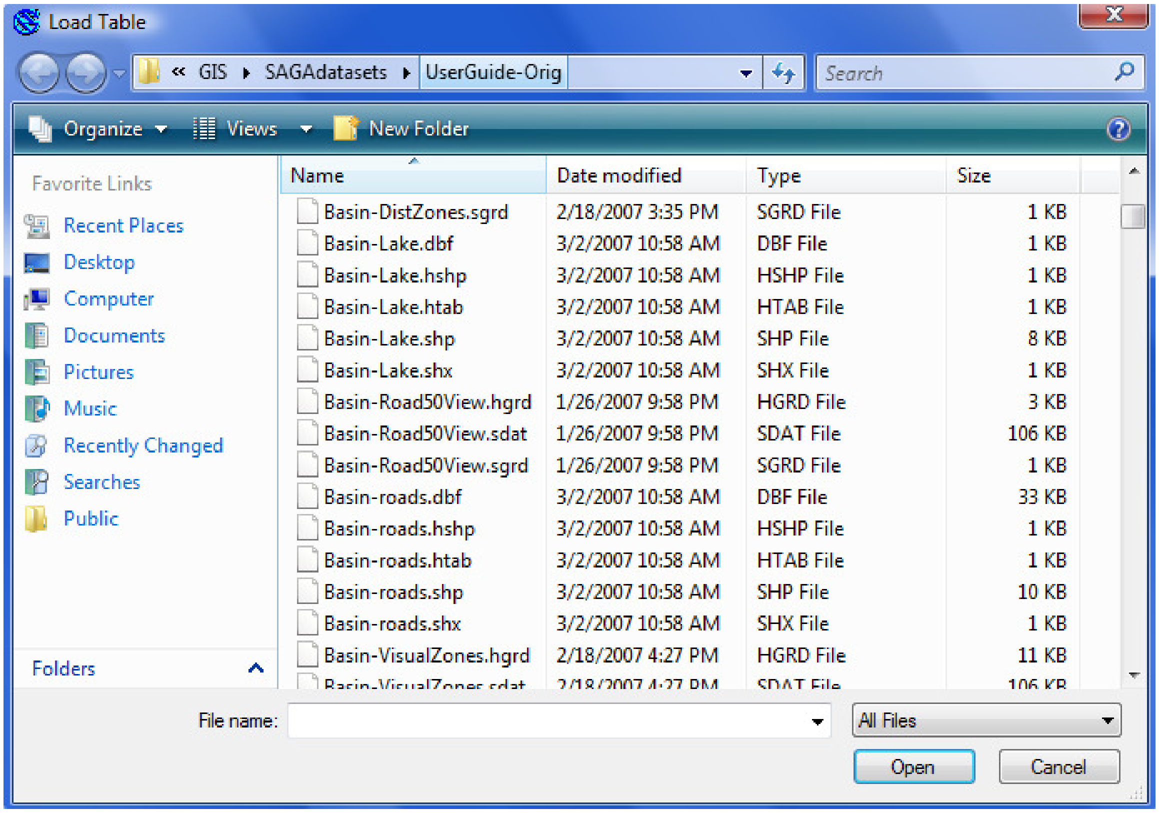


Figure 8-30. The 'Load Table' dialog window using the "All Files" choice.

Notice in the list that the two shape layers ('Basin-Lake' and 'Basin-roads') are each defined by five files: .dbf, .htab, .hshp, .shp, and .shx. The .dbf file is the attribute table.

There are two ways in SAGA to display an attribute file linked to a shape layer. A convenient approach is to move your mouse pointer over the shape layer name in the Data tab area of the Manager. Press the right mouse button and a popup list of options appears. See Figure 8-31.

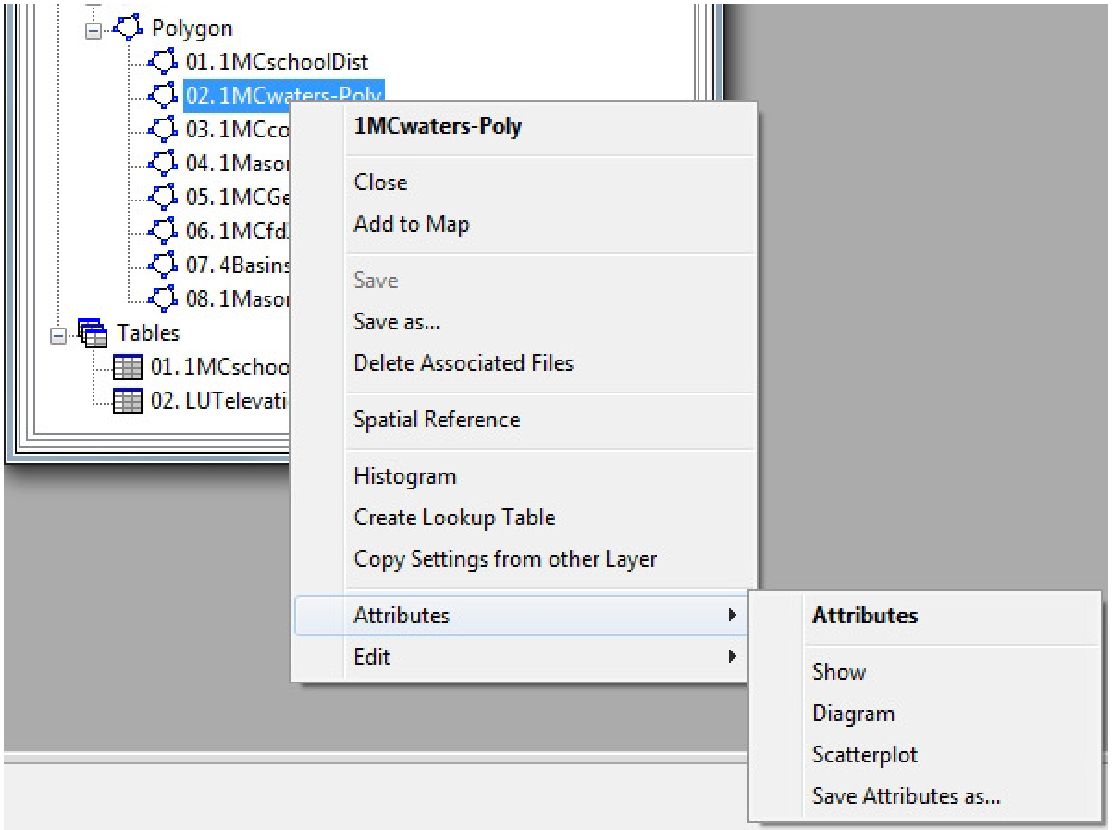


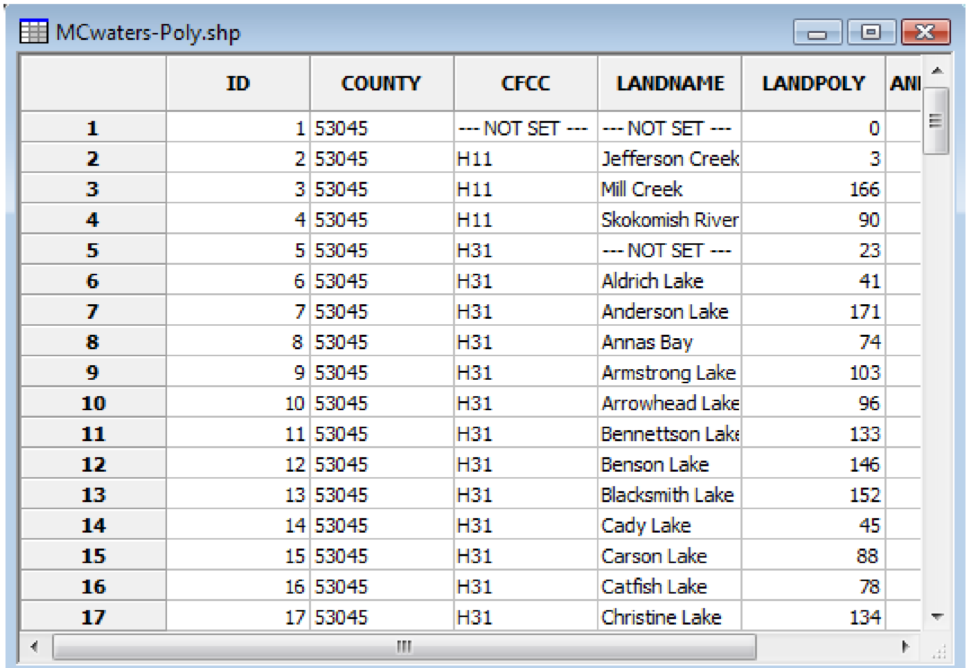
Figure 8-31. The popup list of options for a shape layer.

Move the mouse pointer over the "Attributes" option near the bottom of the popup menu and a second popup list of options displays. Choose the "Show" option. When I choose this option the attribute table for the shape layer displays in the viewing area of the Manager.

A .dbf can also be displayed using the "Show" command available if the table has been loaded into the work session. If, during the current work session or as part of a project, a table has already been loaded, its' name appears in the "Tables" section of the Data tab area in the Manager window. When I right-click on a table name in the list, one of the commands in the popup list that appears will be the "Show" command.

I want to open the attribute table file for the '1MCwaters-Poly' shape layer. The layer is not available in the work session. I use the "Load" command available from the "Table" option in the Menu Bar File menu. The 'Load Table' dialog displays. I navigate to the storage folder the '1MCwaters-Poly' shape layer is stored. I click with the mouse on the '1MCwaters-Poly' attribute file name (the .dbf format file) in the window, its' name now displays in the "File name:" data field. I click on the Open button and SAGA loads the file for use in the work session. This action does not bring the spatial objects of the layer into the work session.

I open the file in a table view window by clicking twice on the table file name that is in the “Tables” section of the Data tab area of the Manager window (or I right-click on the table file name and select the "Show Table" option from the list). Figure 8-32 displays a portion of the table that in a table view window.


MCwaters-Poly.shp

	ID	COUNTY	CFCC	LANDNAME	LANDPOLY	ANI
1	1	53045	--- NOT SET ---	--- NOT SET ---	0	
2	2	53045	H11	Jefferson Creek	3	
3	3	53045	H11	Mill Creek	166	
4	4	53045	H11	Skokomish River	90	
5	5	53045	H31	--- NOT SET ---	23	
6	6	53045	H31	Aldrich Lake	41	
7	7	53045	H31	Anderson Lake	171	
8	8	53045	H31	Annas Bay	74	
9	9	53045	H31	Armstrong Lake	103	
10	10	53045	H31	Arrowhead Lake	96	
11	11	53045	H31	Bennettson Lak	133	
12	12	53045	H31	Benson Lake	146	
13	13	53045	H31	Blacksmith Lake	152	
14	14	53045	H31	Cady Lake	45	
15	15	53045	H31	Carson Lake	88	
16	16	53045	H31	Catfish Lake	78	
17	17	53045	H31	Christine Lake	134	

Figure 8-32. The ‘MCwaters-Poly’ shape layer attribute file.

In summary, these are the two methods for opening an attribute table file; one, using the Attribute: Show Table option on the popup list of options displayed when you right-click on the shape layer of interest in the Data tab area of the Manager. The second method is to use the "Load" option available in the Menu Bar File dropdown menu. This latter approach is used most often with non-attribute tables.

Once the table view window is open, the Table menu appears on the Menu Bar. The options available in the Table dropdown were discussed earlier in this chapter in the “The Table Options on the Menu Bar and Toolbar” section along with four additional commands that are available: Fit Column Sizes, Sort Fields, Rename Field and Fit Row Sizes.

I can edit data contained in the table. Using the mouse, I can click in an attribute field and highlight the entry in the field. When the entry is highlighted, I can use the keyboard to edit the entry or replace the highlighted entry by pasting text from the clipboard. When a change is made in the table, the "Save Shapes" command becomes available. This command is in the popup list that appears when I move the mouse pointer over a shape layer name in the Data tab area of the Manager and right-click with the mouse button. Choosing the "Save Shapes" option saves the change as part of the attribute file linked to the shape layer.

Changes to the attributes for an object can be made in a semi-interactive fashion when the shape layer is displayed in a map view window and the layer is the active layer. Click on the Attributes tab at the top of the Object Properties window. The display for the Object Properties window will appear blank but the Attributes tab is selected. Choose the Action () icon on the toolbar. When I move the mouse pointer into the map view window and click on an object of the shape layer, the object will be highlighted. If the shape layer contains points or lines, the objects highlight in red. If the layer is a polygon shape layer, the polygon object outline will be in red and yellow filled. These colors can vary depending on your parameter settings.

As soon as I select a shape layer object, the attributes for the object display in the Attributes tab area in the Object Properties window. I can edit attribute values in the Attribute tab area. Once a change is made, if I want to make it a permanent change, I press the Enter key on the keyboard. The Apply button at the bottom of the Object Properties window becomes available. When I click on the Apply button the 'Attributes' dialog window in Figure 8-33 displays.

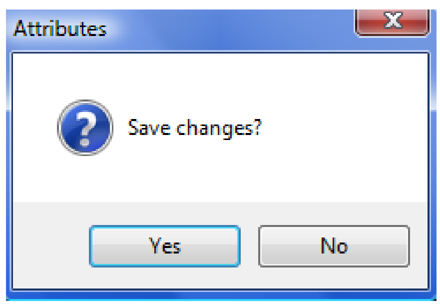


Figure 8-33. The 'Attributes' dialog window.

This dialog window is a simple "Yes" or "No" question for saving the change. Selecting "Yes" and the change will stay, temporarily, in the table. Another result of choosing "Yes" is that the "Save Shapes" option becomes available. If I want the change to be permanent, i.e., saved as part of the linked attribute table, I must re-save the shape layer using the "Save Shapes" command.

A variation of this method is to display the attribute table in a table view window in the work area at the same time the shape layer map view window displays in the work area. I use the Action tool as described above to select an object to edit in the map view window. The corresponding attribute table record for the selected object becomes a selected record in the attribute table. I use the table view row option "Show Selection" to display the selected record of the table. I can edit the attributes for the object in the table row.

As noted above, the edits I make to an attribute table will not take effect until I re-save the shape layer. When I edit an attribute table that I have loaded using the "Load" table command (that is, the shape layer was not loaded, only the attribute table was loaded) from the Menu Bar File dropdown menu, I can save it by right-clicking on the table name in the Data tab area of the Manager window. The "Save Table" command will show up as active if I have made a change to the table. Otherwise, the command is grayed out on the popup list of options.

The Microsoft Excel program can be used to edit a shape layer attribute file. In this case it is very important, as noted earlier, to make a copy of the original attribute .dbf file. A .dbf (dBase) file can be opened in Excel. It is important to not change the order of the records in the file unless a column for sorting is added into the table. I usually insert a new column named "SORTID". Before I do anything else I number the records using this column, starting with 1 in the first row to whatever number is needed for the last row. After making edits or additions, I sort the file using the "SORTID" column to return the records to their original order.

Note that when I use the table sort capability in SAGA I do not have to be concerned about the order of the records as SAGA maintains the integrity of the record order.

Recent releases of Excel do not include the capability of exporting or saving a .dbf format file. The workaround is to export the file as a .txt file from Excel. Then, in SAGA, use the "Load" option in the File dropdown option "Table" to load the .txt file into a work session. The name appears in the "Table" section of the Data tab area of the Manager. Click with the mouse on the name of the .txt file and choose the "Save as ..." option. On the 'Save Table' dialog that appears, change the entry for the "Save as type:" data field from "Text (*.txt)" to "Dbase (*.dbf)" and click the mouse on the 'Save' button. SAGA converts it into a .dbf file. This file can serve as the attribute file for the linked shape layer. This is an inconvenient workaround, but it works quite well. I can use the efficiency of Excel in working with dBase files and restoring the dBase files in SAGA.

Using the Field Calculator [Shapes] Tool

One of the most used tools with grid layers is the *Grid - Calculus/Grid Calculator*. The comparable tool for use with shape layers is the *Table - Calculator/Field Calculator (Shapes)*. It is used with attribute tables linked to shape layers. The attributes of an attribute table linked to a shape layer are the inputs for equation variables. The *Table - Calculator/Field Calculator* tool is used with tables in general. The fields or columns of those tables are the inputs for equation or formula variables.

In this example, I am going to generate a new attribute field for the ‘1MCschoolDist2’ shape layer. This layer has polygon objects representing school districts for Mason County, Washington. There are eleven attributes for the school district polygons or objects. Two of the attributes are “POP2015” and “POP1990”. They identify the district populations in 2015 and 1990.

I am going to create a new attribute for the difference in population between 2015 and 1990 for the school districts. It will be named "POPDIFF".

When I execute the tool *Table – Calculus/Field Calculator (Shapes),* the ‘Field Calculator [Shapes]' parameters window in Figure 8-34 displays.

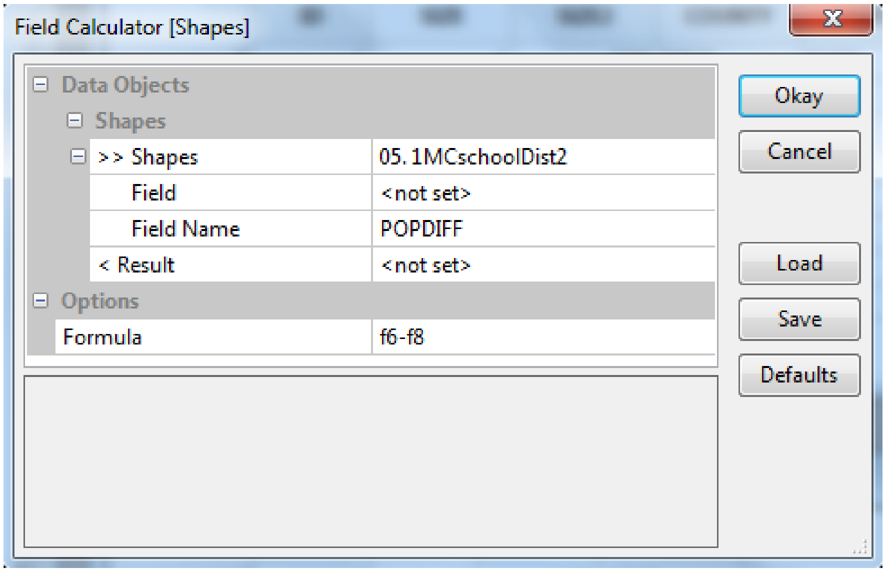


Figure 8-34. The ‘Field Calculator [Shapes]’ parameters window.

The entry for the '>> Shapes' input parameter is the school district polygon shape layer '1MCschoolDist2'. The second parameter, 'Field', is used if an attribute is already in the attribute table where the output from the formula is to be placed. The default is "<not set>". If there is an attribute available for the output, I move the mouse pointer into the value field to the right of the 'Field' name and press the left mouse button. I choose the attribute name on the popup list of layer attributes.

When the "<not set>" entry is used for the 'Field' parameter, it means that a new attribute is going to be added to the existing attribute table. The name for the new attribute is entered for the 'Field Name' parameter. Here, I have entered "POPDIFF" as the new attribute. It will be the last attribute in the attribute table. If a field had been chosen for the 'Field' parameter, the 'Field Name' parameter would not be displayed in the window.

The default for the output parameter '< Result' is "<not set>". The default means that the output from the formula is appended to the existing attribute table of the '1MCschoolDist2' layer. The "POPDIFF" attribute becomes the 12th attribute for the existing attribute table. The "<create>" option can be chosen for the output parameter. If it is used, a new version of the input layer is output. The difference between the input layer and the new version is that the attribute table for the new version includes the 12th attribute "POPDIFF".

The value field to the right of the 'Formula' parameter is for entering an equation for calculating the new attribute data values. Existing attributes in the attribute table can be used as variables in an equation. The attributes are referenced by their position in the table or by their attribute name. The first attribute in the table is referred to as "f1", the fourth attribute as "f4", and so on. Attributes do not have to be used in an equation. The equation I enter for this example is "f6-f8". I am subtracting the 1990 population (the eighth field in the table) from the 2015 population (the sixth field in the table). If I use the attribute names as variables, the equation I enter is "[POP2015]-[POP1990]".

The 'Selection' parameter is used if I do not want to output a calculation for each object. I can select rows in the table. When I turn on the toggle check box 'Selection' parameter (clicking the mouse in the check box), a check mark appears in the check box. The formula only calculates output values for the records selected when the tool executes. When no records are selected the 'Selection' parameter does not display in the window.

I have entered the required entries for the tool to execute. I click on the Okay button and the tool executes.

When I look at the Description tab for the '1MCschoolDist2' shape layer in the Object Properties window, I see that the new attribute "POPDIFF" has been added to the list of attributes. The modified attribute table displays in Figure 8-35.

01. 1MCschoolDist2

	ID	SIZE	SIZE2	COUNTY	UNIFIED	POP2015	POP1	›OP199(	POP3	GRAPEVIEW	NAME	POPDIFF
1	1	1	1000	53045	02490	2000	200	900	900	0	ELMA	1100
2	2	1	2000	53045	03240	1753	646	677	430	0	GRAPEVIEW	1076
3	3	4	2000	53045	03600	4843	2211	2422	211	0	HOOD CANAL	2421
4	4	4	2000	53045	04800	1241	310	631	300	0	MARY M KNIG	610
5	5	4	6000	53045	05790	11046	2762	5523	2762	0	NORTH MASC	5523
6	6	4	6000	53045	06750	7948	1987	3974	1987	0	PIONEER	3974
7	7	8	4000	53045	07900	20692	5173	6346	9173	0	SHELTON	14346
8	8	8	4000	53045	08220	1954	89	977	889	0	SOUTHSIDE	977

Figure 8-35. The modified attribute table for the '1MCschoolDist2' shape layer.

The shape layer must be saved to make the additional attribute a permanent part of the layer.

Using the mouse, I right-click on the shape layer name in the Data tab area of the Manager. I click with the mouse on the "Save" option in the popup list of options. I would use the "Save Shapes As…" option if I had used the "<create>" option for the '< Result' parameter and assigned a new name.

Using the *Join Attributes from a Table [Shapes]* tool

The *Table - Tools/Join Attributes from a Table (Shapes)* tool is used to add column information from a table to a shape layer attribute table as additional attributes. It is necessary that the two tables have one attribute or column that contains the same data to serve as a link between the two tables.

Let's look at a simple example involving four watershed basins. The four watershed basins are polygon objects for the '1MC4Basins' shape layer. The attribute table linked to the layer contains three attributes: ID, WATERSHED, NAME. The watersheds are referred to as 39, 41, 43 and 44. These are the data values for the "WATERSHED" attribute.

There is a data table named '14BasinsData'. This table includes 10 columns of data for the four watershed basins. There are four rows in the table, 1 per watershed basin. Three columns are labeled BASINID, PERIMETER, and AREA. The entries for the "BASINID" column are the watershed numbers 39, 41, 43, and 44. The remaining 7 columns contain descriptive elevation and slope data values.

Figure 8-36 displays these two tables.

01. 1MC4Basins

	ID	WATERSHED	NAME
1	1023	43	Avery
2	1997	44	Jester
3	1001	39	Lower Candle
4	1009	41	Thomas

05. 14BasinsData

	BASINID	PERIMETER	AREA	MINELEV	MAXELEV	ELEVRANGE	MINSLOPPE	MAXSLOPE	SLOPERANGE	AVERAGESLOP
1	39	55099.44	38964298.437	39	3258	3219	0	71.658607	71.658607	39.267322
2	41	43411.68	32277859.298	734	3314	2580	1.997751	73.017136	71.019384	56.31517
3	43	41115.87	30012746.365	104	2359	2255	0	69.558014	69.558014	26.368226
4	44	39654.9	35250820.023	148	2375	2227	0	69.297729	69.297729	24.985262

Figure 8-36. The attribute and data tables.

The upper table in Figure 8-36 is the attribute table linked to the '1MC4Basins' polygon shape layer. The lower table is the data table that will provide an additional 10 attributes for the layer. The "WATERSHED" and "BASINID" attribute and column contain the same data values referring to the four watershed basins. As you can see they do not have to have the same title (attribute or column name) but they do have to contain the same data values that have the same meaning.

The parameters page for the *Table - Tools/Join Attributes from a Table (Shapes)* tool displays in Figure 8-37.

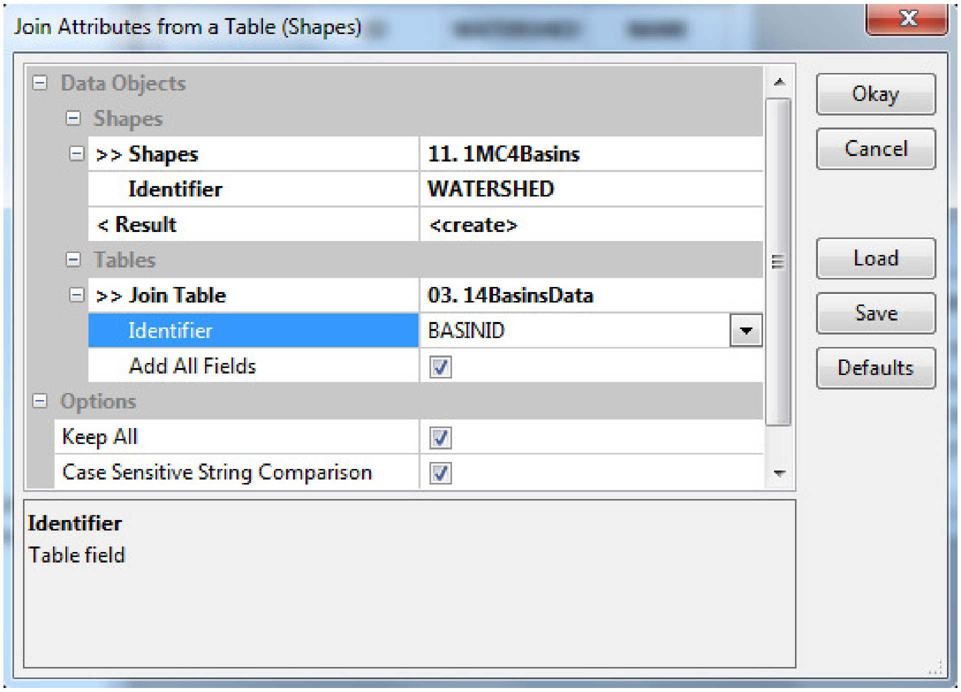


Figure 8-37. The parameters page for the Table - Tools/Join Attributes from a Table (Shapes) tool.

The '1MC4Basins' polygon shape layer is chosen for the input parameter '>> Shapes'. The 'Identifier' parameter is for identifying the attribute in the layer attribute table that has a set of data values in common with a column in the data table. The "WATERSHED" attribute is chosen for this parameter.

I entered the "<create>" option for the output parameter '< Result'. Another choice is to use the default "<not set>" entry and append the data from the data table to the existing attribute table. Using the "<create>" option means a new layer is output that includes the updated attribute table.

I choose the '14BasinsData' table for the input parameter '>> Join Table'. As noted earlier, the "BASINID" column contains the same set of data values as the "WATERSHED" attribute for the '1MC4Basins' layer. I choose the "BASINID" column for the 'Identifier' parameter for the '14BasinsData' table.

The 'Add All Fields' parameter is for specifying if all the table columns are to be appended to the attribute table linked to the output layer or only selected ones. I am using the default so that all will be appended. If I only want to add a subset of the attributes I can change the status of this parameter to off by clicking with the mouse in the check box. The check mark would disappear. A new parameter appears named 'Fields'. I click with the mouse pointer in the value field to the right of the parameter name and I can choose from the displayed list the data columns to append. These are toggle check box parameters.

I make the entries for the tool parameters and click on the 'Okay' button. A new polygon shape layer named '1MC4Basins [14BasinsData]' is output. The attribute table linked to the new layer displays in Figure 8-38.

01. 1MC4Basins [14BasinsData]

	ID	WATERSHED	NAME	PERIMETER	AREA	MINELEV	MAXELEV	ELEVRANGE	MINSLOPPE	MAXSLOPE	SL
1	39	39	38.000000	55099.44	38964298.437	39	3258	3219	0	71.658607	
2	41	41	7.000000	43411.68	32277859.298	734	3314	2580	1.997751	73.017136	
3	43	43	36.000000	41115.87	30012746.365	104	2359	2255	0	69.558014	
4	44	44	30.000000	39654.9	35250820.023	148	2375	2227	0	69.297729	

Figure 8-38. A portion of the attribute table linked to the new '1MC4Basins [14BasinsData]' layer.

Chapter 9 – Object Properties for Grid Layers

This chapter discusses properties associated with grid layers. With the Object Properties window displayed, when I click on a grid layer name or thumbnail, the property settings for the layer update the content in the Settings tab area of the Object Properties window.

The Settings Tab of the Object Properties Window for Grid Layers

Figure 9-1 shows the three major property categories for a grid layer: General, Display, and Colors.

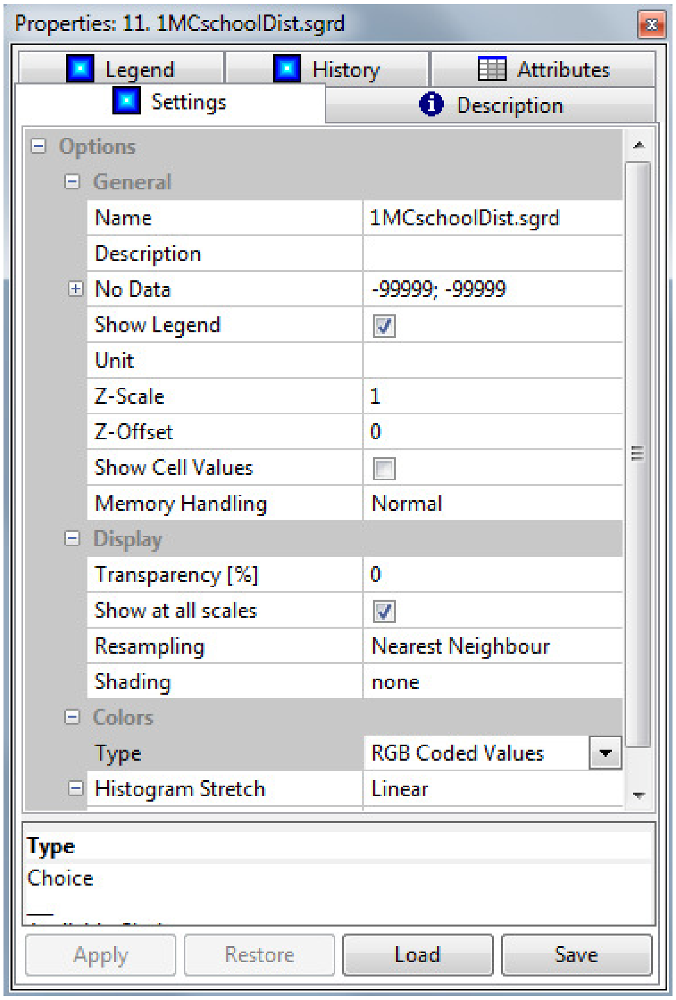


Figure 9-1. The three major property categories for grid layers.

At the bottom of the Object Properties window is a row of buttons: Apply, Restore, Load, and Save. The Apply and Restore buttons are grayed out and not available until I make a change to a parameter. When I click with the mouse to choose an option in a parameter value field and make a change to the parameter entry, the Apply button becomes available. The Apply button text displays in bold. I must click the Apply button to enable the change. If the parameter is one requiring entering data into a value field, e.g., a number, after I key in the information I must press the Enter key on the keyboard. The

Apply button then changes from grayed out status to active status. Clicking on the Apply button updates any parameter changes.

The Restore button acts like a cancel button. If I have made changes to parameters, have not used the Apply button to implement them, and decide that I do not want them to apply, I click on the Restore button and the parameters return to their pre-change condition.

When a layer is saved, the default parameters or edited parameters are not stored as part of the layer. Can the parameter settings be saved?

The Save button on the Object Properties window for the layer saves a set of layer parameters for a single layer in a data file (using the .sprm file format) for later recall. Once the parameter .sprm file exists, it can be loaded using the Load button. The content of this file is identical to the layer content saved as part of a configuration or project file. As you learned earlier in this guide (Chapter 8), this same procedure is used to save the parameters for a map view window.

Another way parameters are saved is in a configuration file, 'saga_gui.cfg'. Layer and map view window parameters are stored in a configuration file when I exit SAGA. I can choose not to use the configuration file when SAGA starts up by choosing the "[empty]" option on the 'Select Startup Project' dialog window.

Another option is to define a project. I can save a project file at any time during a work session. The project file, .sprj, is almost identical to a configuration file. The layer, map view window, and table parameters for the current layers, map view windows, and tables save in a project definition.

The structure and content of the .cfg, .sprj, and .sprm files are very similar. A .sprm file only stores layer parameters for a single layer or a single map view window. A .sprj or project file captures the parameters related to a current set of layers, map view windows and tables in a work session. A configuration file is like a project file except it is captured as part of an exit from SAGA.

A number of parameters relate to the SAGA operating and display environment. These are settings like what storage location are libraries loaded from or what the default settings are for how the Manager window looks, default window view window size, etc. These parameters are saved in a .ini file. A .ini file is created when SAGA is executed. This .ini file is replaced by a new .ini file when I exit SAGA. The .ini file saves a set of work session operational parameters. The most recently created .ini file is used at the next SAGA startup.

When I start up SAGA, if I select the "[last state]" option, the .cfg file determines the layers, map view windows, and tables that load for the work session. I will see a series of "load" messages appear in the 'Message' window. If I choose a project instead of "[last state]", the project file provides the same information for the new work session as the .cfg file.

Each parameter has a default setting. Whenever I load a grid layer into a work session using the Grid: Load command on the File dropdown list of options on the Menu Bar, the default parameter options are applied for the loaded file.

In summary, for any layers, when a layer saves, none of the parameters, whether default or modified, are saved with the layer set of files. However, when I save a project or exit a work session, the current parameters for the layers and map view windows are saved in a project file (.prj) or a configuration file (.cfg). Using the Save button at the bottom of the Object Properties window saves the layers parameters in a .sprm file. This file can be re-loaded if the same layer parameters are needed again.

General Parameters
Figure 9-2 displays a list of the parameters available in the "General" area of the Object Properties window for a grid layer.

⊟ General	
Name	1MCdem30
Description	
⊞ No Data	-99999; -99999
Show Legend	☑
Unit	
Z-Scale	1
Z-Offset	0
⊟ Show Cell Values	☑
Font	Arial
Size	15
Decimals	2
⊟ Boundary Effect	full frame
Color	☐ White
Memory Handling	Normal

Figure 9-2. The General category of parameters.

Did you notice the "-" and "+" symbols in boxes to the left of some of the options in Figures 9-1 and 9-2? A "+" means additional parameters can be viewed by clicking on the "+" symbol. For example, in Figure 9-1 there is a "+" to the left of the 'No Data' parameter. I click on the "+" with the mouse pointer and two additional parameters display: 'Minimum' and 'Maximum'.

General: Name
The entry for the General: Name parameter serves as a reference or alias for the layer when it is available in a work session. This is not the name of the file used for storing the layer although it could be. This is the name used, for example, in the layer list in Data tab area of the Manager window.

The value field to the right of the ‘Name’ label is where I enter text for a name. If I click on the value field with my mouse and highlight the name, I can enter a new name or edit the existing one. Whatever text appears in this value field is used by SAGA as a reference for the layer by tools and SAGA functions.

An example in SAGA where the entry for the 'Name' parameter is used is the title for the layer legend. When I click on the Legend tab at the top of the Object Properties window for a layer, the title for the legend is the entry for the ‘Name’ parameter. It will also be the title for the legend when I use the ‘Show Print Layout’ option. If I want a different title for the legend, this is the parameter to change. This parameter is very useful in designing map output.

General: Description
I can enter text, free-form, in the value field to the right of the 'Description' parameter name. I move the mouse pointer over the ellipsis on the far right and press the left mouse button. The 'Description' entry form in Figure 9-3 displays.

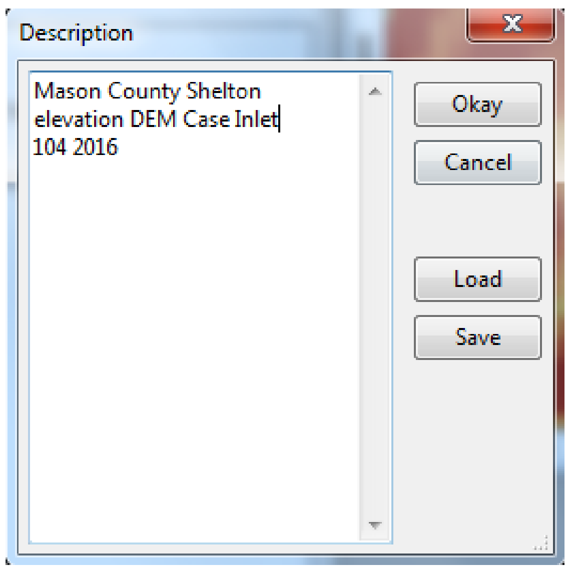


Figure 9-3. The 'Description' entry form.

I move the mouse pointer into the form and press the left mouse button. I can now enter text through the keyboard. In Figure 9-3 I have entered text keywords for a layer. I click on the Okay button with the mouse pointer and the text I entered displays in the 'Description' value field.

The information entered for the 'Description' parameter is searchable. The names of attributes in attribute tables for shape layers are also searchable. SAGA has a search function (described in Chapter 2 of this User Guide) that looks for selected text contained in this value field (as well as text entered for the 'Name' parameter) and attribute table column names. Only layers available in the current work session are searchable.

The search function is accessed in the Data and Maps tab areas of the Manager window. Move the mouse pointer over the word "Data" or "Maps" near the top of the Manager window and press the right mouse button. At the bottom of the popup list of options is an option named "Search for...". I click on it with the mouse. The 'Locate...' dialog window displays. I enter "Shelton" into the value field to the right of the 'Search for...' parameter. I click on the toggle check box for the 'Description' parameter and a check mark appears in the box. Next I click on the Okay button. A second 'Locate...' window displays containing the name of the '1MCdem30' grid layer whose 'Description' parameter includes the text described in Figure 9-3.

The amount of text that can be entered into the 'Description' entry form appears to be unlimited. I have entered over 1000 characters without a problem.

General: No Data, Minimum, Maximum

The no data value may be a range of values, having a minimum and a maximum, or a single value. When a single value is used, the same entry is used for the 'Minimum' and 'Maximum' parameters. A common SAGA no data value is -99999.

Every grid system has a map extent and each grid layer that is a member of the grid system has the same map extent. This map extent is rectangle shaped enclosing the map data. X coordinate values define the west and east sides and Y coordinates defines the north and south sides. These values are viewed in the Description tab area of the Object Properties window for the layer. The west and south coordinates are the coordinate values of the southwest corner and are the X, Y values that are part of the grid system definition.

One obvious role for the no data value is to identify grid cells within a map extent that fall outside of a study area boundary. A study area is often defined by a physical feature such as a watershed boundary or by a political entity such as county or province. Study area boundaries can be irregular in shape. A boundary may follow a physical feature such as a ridgeline or an administrative characteristic such as a township-range division. The study area boundary is fully enclosed by the map extent rectangle. Grid cells within the map extent but outside the irregular outline of a study area contain no data values while grid cells within the study area potentially contain valid data values.

A data theme may not be present in every grid cell of a study area. For example, a stream network exists in cells traversed by a stream. Grid cells not traversed by a stream may contain the no data value just like grid cells outside of the study area. On the other hand, every grid cell of a study area and area outside of a study area has an elevation. The no data value would be stored in grid cells outside of the study area but within the map extent.

How is a no data value assigned to a grid layer? There are several ways this can occur. If a grid layer is created by another GIS, e.g., ArcGIS, it is assigned a no data value when created. When the grid layer is imported into SAGA, the import tool interprets the no data value. Many tools in SAGA create new grid layers as output. These tools will define the no data value for the output layers.

The *Grid - Gridding/Shapes to Grid* tool is used to convert shape layers to grid layers. The 'Output Values' parameter has three options: attribute, data / no data, and index number. The output grid layers for the "data / no data" and "index number" options are assigned a no data value of 0 while the output using the "attribute" option is assigned a no data value of -99999. The *Shapes - Tools/Create New Shapes Layer* tool assigns the no data value -99999 to shape layers it creates. The *Grid - Tools/Reclassify Grid Values* tool is used to reclassify the data values of a grid layer. It can also be used to change the current no data value to a different no data value.

One of the grid layer parameters in the Settings tab area of the Object Properties window is General: No Data. There are actually two parameters defining it: Minimum and Maximum. These parameters can be used to identify an existing data value of the layer to be the new no data value. The old no data value then becomes a valid data value, it does not go away.

No data values are saved with a grid layer just like any other grid cell data value. The no data value is also a layer parameter and is one of the parameters saved in the .sprm, .sprj, and .cfg files. These files were explained at the beginning of this chapter.

How does a no data value affect results? This depends on the purpose of a tool and the options supported in a tool.

There are some grid layer actions where any grid cell containing a no data value will produce a no data value in the corresponding grid cell of an output grid layer. For example, if two or more grid layers are involved in a *Grid - Calculus/Grid Calculator* formula, any grid cell containing a no data value on any of the input layers will produce no data values in the corresponding grid cells of an output layer.

Let's look at a *Grid Calculator* example involving a small watershed basins grid layer ('1MC4BasinsGR'). Each grid cell within four contiguous basins contains the data value 1. The no data value for grid cells outside of the basins is -99999. The four contiguous basins lie within the county study area. I have an elevation layer, '1MCdem30' with data values ranging from 0 to 6379 feet. The no data value for grid cells outside of the county study area is -99999. Figure 9-4 displays these two maps.

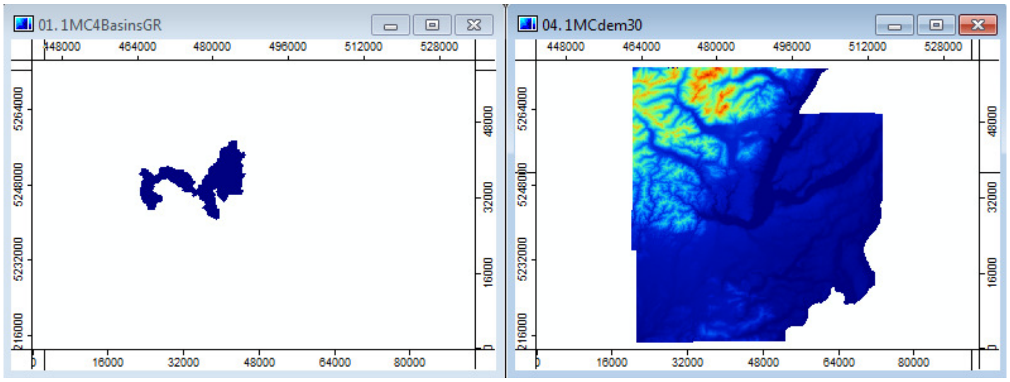


Figure 9-4. The watershed basins (on the left) and the elevation layer (on the right) map view windows.

I want to create an elevation map for only the four contiguous watershed basins. I can do this using a multiplying formula, multiplying the watershed basins data values times the elevation layer data values. The data value for the basins layer is 1. When I multiply the elevation grid cells by the basin grid cells (containing 1) the output layer '1MCBasinsElev' will contain elevation data values for the basins.

What happens to the grid cells of the watershed basins layer containing the no data value -99999? A no data value of a layer creates a corresponding no data value on the output grid layer regardless of data values on any other input grid layers. In this case, grid cells outside of the basins on the output layer will contain no data values.

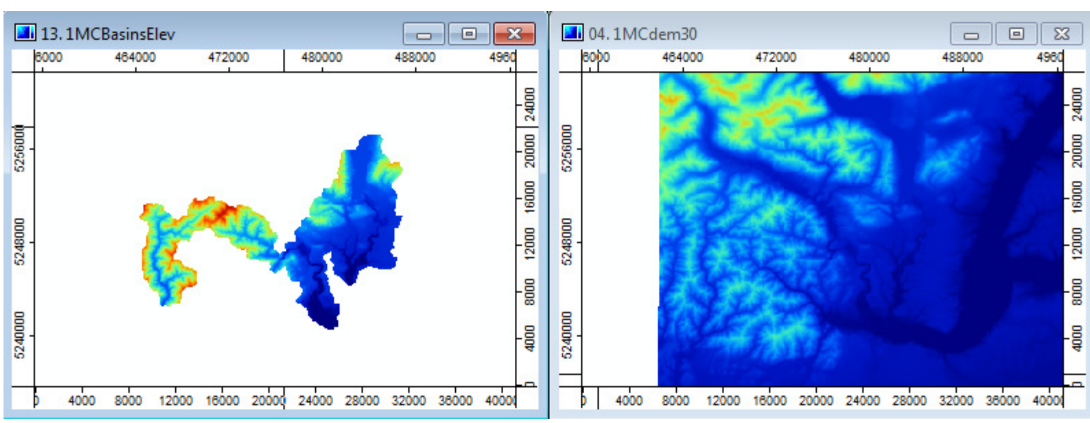


Figure 9-5. Comparing the new basins elevation and elevation grid layers.

The area around the basins is zoomed in on for display purposes. I can see that grid cells outside of the basins on the new '1MCBasinsElev' grid layer contain the no data value.

What if my goal was to create an output layer that shows the location of the four contiguous watershed basins on the elevation grid layer? I don't want to display elevations for the basins I just want a layer that includes the basins location and displays that location in a solid color relative to elevations on the elevation layer.

The approach used above will not work since grid cells containing the no data value produce no data values on the output grid layer. There is an option for the *Grid - Calculus/Grid Calculator* tool to change the way the no data value acts. It is a toggle box parameter named 'Use No Data'. Figure 9-6 displays the parameter entries I used for the tool.

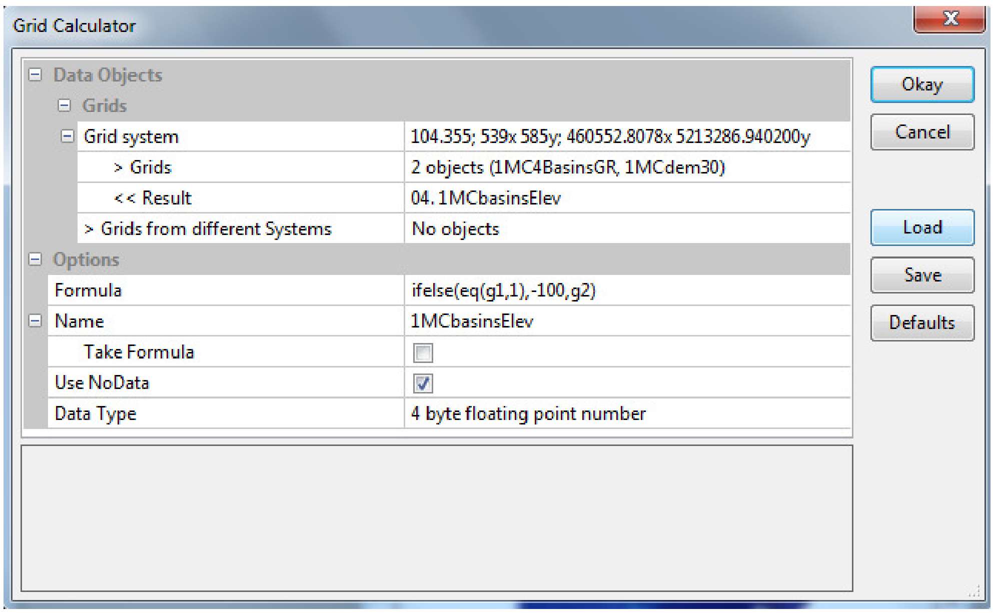


Figure 9-6. Parameter entries for the *Grid - Calculus/Grid Calculator* tool.

The '1MC4basinsGR' and '1MCdem30' grid layers are chosen for the input parameter '> Grids'. The equation I enter for the 'Formula' parameter is "ifelse(eq(g1,1),-100,g2)". The variable "g1" refers to the '1MC4basinsGR' layer and "g2" refers to the '1MCdem30' layer. The equation checks the '1MC4basinsGR' layer grid cell value to see if it is a 1. If it is a 1 (true) it is a basins grid cell. The grid cell value for the corresponding grid cell of the output grid layer is a -100. This value will not conflict with any elevation values on the county DEM layer.

Note that a check mark appears in the toggle box for the 'Use NoData' parameter. This means the no data value -99999 for the '1MC4basinsGR' layer is interpreted as a valid data value. In my equation, if the first condition fails, it means the grid cell is not a basins grid cell but is one outside of the basins. Now that the no data value is treated as a valid data value, the data value for the '1MCdem30' layer is stored for the corresponding grid cell of the output grid layer.

The *Grid - Tools/Proximity Grid* tool calculates distance from features of a grid layer. For example, I have a road layer ('1MasonTransGR'). Grid cells traversed by a road contain a data value for the road feature. Grid cells not traversed by a road contain the no data value. One of the outputs of this tool is a grid layer of distances from features to grid cells containing the no data value. This is an example of a tool that depends on the existence of no data values and actually produces data values (distance values) for corresponding grid cells of the output grid layer.

It is important to understand how grid layer no data values can affect outputs and how unexpected and unwanted output results can be avoided.

General: Show Legend
This parameter affects the "Show Print Layout" option available on the Menu Bar Map dropdown menu when a map view window displays in the work area. The default is for this toggle check box parameter to be on. This means when I choose the "Show Print Layout" option the legend for the grid layer displays on the right of the layer in the 'Layout' view window.

Figure 9-7 displays two versions of the same layout view window. The one on the left includes the legend, the 'Show Legend' parameter is on. The map view window on the right does not display a legend; the parameter is off.

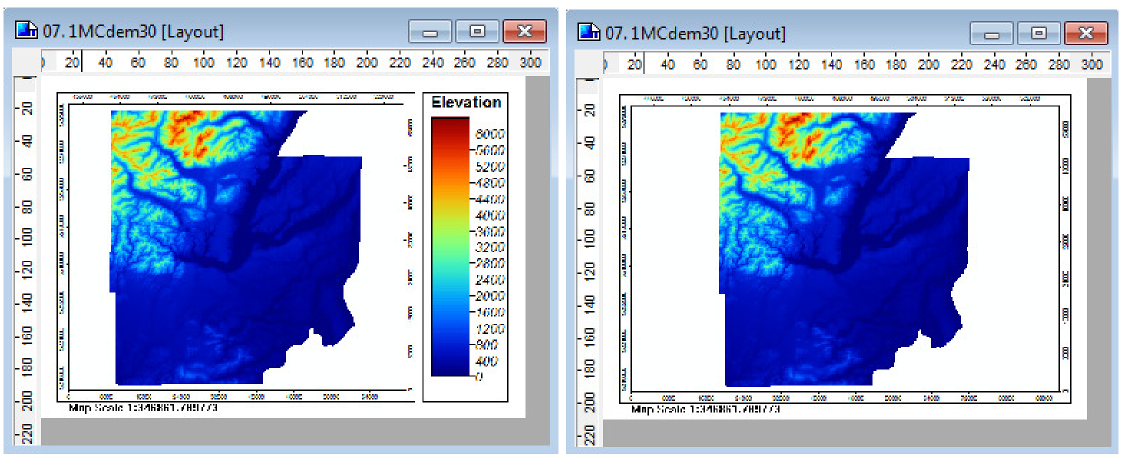


Figure 9-7. Two map layout windows – one with a legend (on the left) and one without.

The "Show Print Layout" option available on the Map dropdown list of options on the Menu Bar creates both layout views in Figure 9-7. The toggle check box for the 'Show Legend' parameter for the '1MCdem30' grid layer displays a check for the layout view on the left. Before creating the layout view on the right, I moved the mouse pointer into the check box and pressed the left mouse button. This toggled the parameter from on to off status. The check mark disappeared. The change takes affect when I click on the Apply button at the bottom of the Object Properties window for the layer.

The title for the legend is the text entered for the General: Name parameter in the Object Properties window for the layer. Usually I use the layer file name for the General: Name parameter. When I load the elevation grid layer into a work session, the entry for the 'Name' parameter is the file name, '1MCdem30'. In the layout view window I want the title for the legend to relate to the theme for the grid layer, "elevation". I changed the text entry for the 'Name' parameter to "Elevation". That is why the legend title is "Elevation".

Another place the legend can be viewed is in the Legend tab of the Object Properties window. This parameter does not affect the display of the legend in that area.

General: Unit

The General: Unit parameter is for identifying a unit for the data values of a grid layer. This parameter relates to the display of information at the bottom of the work area window. Notice that there are three information display fields labeled X, Y, and Z.

The X, Y and Z display fields show the current X and Y coordinates and the grid cell data value for the mouse pointer location for the active layer. The default entry for the 'Unit' parameter is for it to be blank. In this case, there is not any text or information displayed in the Z display field except for the grid cell data value. In the case where the 'Unit' parameter value field contains text for what the data values represent, this text displays in the Z display field following the grid cell data value.

Examples for text entries for the 'Unit' parameter include meters, feet, District, parcel, etc. The purpose of the 'Unit' parameter is to qualify what the data values for the layer represent.

A lookup table includes columns for name, description, minimum, maximum, etc. The name column of the lookup table provides "unit" information for the Z display field regardless of the entry in the 'Unit' parameter. Thus, when the "Lookup Table" option for the Colors: Type parameter is chosen for the layer, any entry for the 'Unit' parameter is ignored.

Let's look at an example involving the '1MCcensustracts' grid layer. The data values for the grid cells represent a 4-digit census tract identification number. All the grid cells within a specific census tract have the same tract identification number as a data value. The census tract number ranges from 9601 to 9616. I should note that even though these are numeric values, in this case they are used as categorical labels rather than for mathematical purpose.

I am going to enter the text “Tract ID” in the value field for ‘Unit’. I move the mouse pointer into the value field to the right of the 'Unit' parameter name. There are two approaches to entering text for this parameter. I can press the left mouse button and directly key the text "Tract ID" into the value field or I can click on the ellipsis on the far right and enter the text in the 'Unit' data entry window that displays, and then click on the 'Okay' button.

Figure 9-8 shows an example of 'Units' blank versus 'Units' set to "Tract ID".

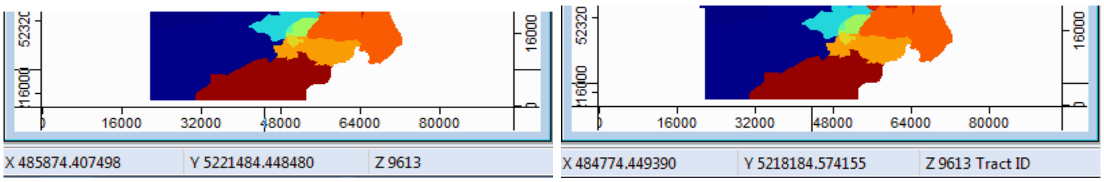
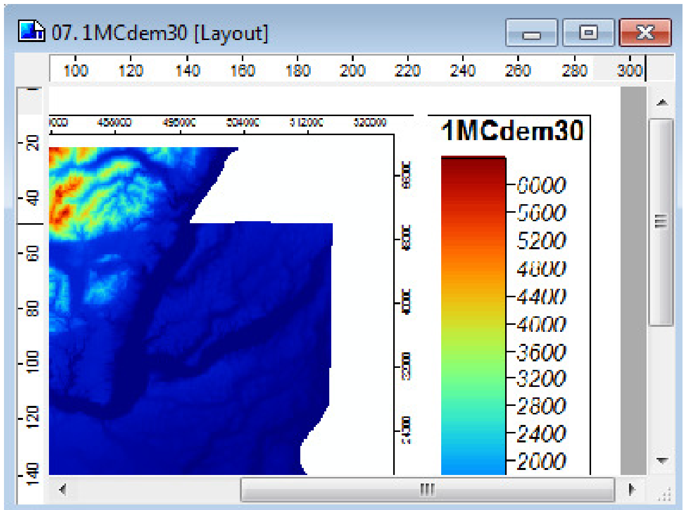


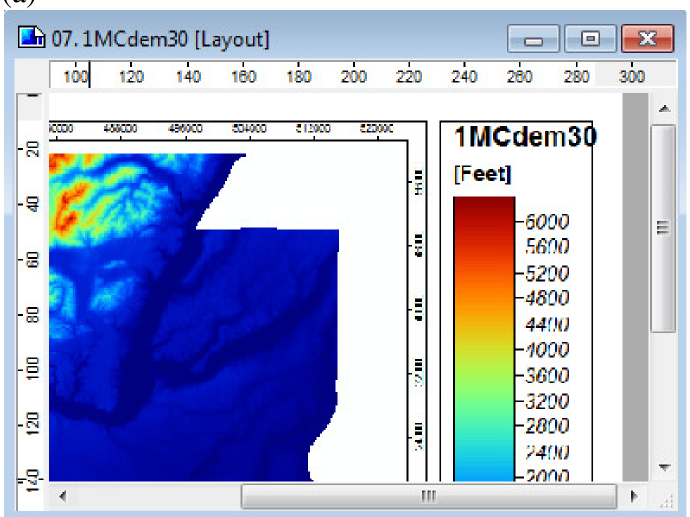
Figure 9-8. The 'Unit' parameter and the "Z" display field.

Notice at the bottom of the work area the X, Y, and Z display fields. The graphic on the left uses the default blank for the 'Unit' parameter. Note that the data value "9613" displays in the Z display field and is not followed by any text. I then enter "Tract ID" for the value field to the right of the 'Unit' parameter and click on the 'Apply' button. The graphic on the right in the figures uses the "Tract ID" entry for the 'Unit' parameter. I can see that the data value "9613" displays in the Z display field and the data value is followed by the text "Tract ID".

Another option that is affected by the entry for the 'Unit' parameter is the "Show Print Layout" option. Figure 9-9 shows an enlargement of the legend area of a map layout view window for the elevation grid layer '1MCdem30'. The 'Show Legend' toggle box parameter is checked, in on status.



(a)



(b)

Figure 9-9. Using the "Unit" parameter with the layer legend display.

Figure 9-9 (a) displays the map layout window for the '1MCdem30' grid layer using the default entry of blank for the 'Unit' parameter. Figure 9-9 (b) shows the map layout window for the same grid layer with "Feet" entered for the value field to the right of the 'Unit' parameter. I can see the text "[Feet]" at the top of the legend.

General: Z-Scale

The entry for the General: Z-Scale parameter serves as a multiplier applied to the data values of a grid layer when they appear in the Z display field and histogram. The default is 1. I can edit this value field. This multiplier does not change the grid data values. It only affects how the values display.

There may be times when I want the data values displayed in the Z display field at the bottom of the work area converted to different units. For example, if I want elevation values stored in feet to display as yards I could enter .333 for the 'Z-Scale' parameter.

This is the multiplier for converting feet to yards. Or, more commonly, if I want the elevations that are in feet to be displayed in meters I would multiply using the feet to meter conversion factor, .3048. In this latter case, in the ‘Unit’ value field discussed earlier, I would enter “Meters” so the viewer would know that the elevations displayed are in meters rather than some other unit. Remember, applying a ‘Z-Scale’ does not change the data values stored for the grid cells. It is merely applying a multiplier when the data value displays. I can use the *Grid Calculator* to change the actual grid data values if I want to convert the stored data values to different units.

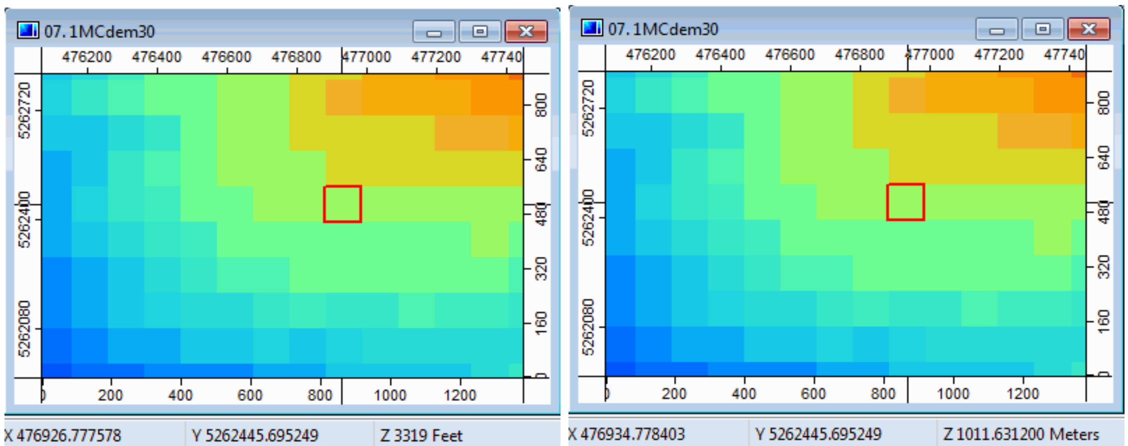


Figure 9-10. Using a ‘Z-Scale’ to convert elevation feet to meters for display.

Two versions of the elevation map ('1MCdem30'), display in Figure 9-10. The elevation values stored for the layer are in feet. I used the Action tool on the tool bar to select a grid cell. It is outlined in red. Let's look at the information displayed below the map view windows.

The map view window on the left displays elevation values in feet. In this case, the entry for the 'Unit' parameter is "Feet" and the entry for the 'Z-Scale' parameter is the default "1". Note the X, Y, and Z display fields at the bottom of the Manager window. The display for the Z field is "3319 Feet".

The one on the right displays the elevation values converted from feet to meters. I entered "Meters" for the 'Unit' parameter and .3048 for the 'Z-Scale' parameter. I can see that X and Y coordinates, at the bottom of each, identify the same cell location. The data value in feet is 3319 and in meters the value displayed is 1011.

General: Z-Offset
This parameter setting affects how data values display; it does not change data values. The number entry, depending on whether it is positive or negative, is added to or subtracted from stored data values as they display.

For example, in the previous example, a grid cell contains the data value 3319. I can enter 10 for the 'Z-Offset' parameter and this data value now displays as 3329.

General: Show Cell Values
I use this parameter a lot to view the data values stored for grid cells. I might question the results of applying a tool. This feature allows me to view the grid cell values calculated by the tool. This is a toggle check box parameter. The default is for this parameter to be in off status. I move the mouse pointer into the check box and press the left mouse button. If the check box was blank, it will now contain a check mark indicating its status is on. The setting for this parameter is only in effect for the current work session. This is not one of the parameters that saves in the configuration or project files.

Four new parameters are active when this parameter is in on status: Font, Size, Decimals, and Boundary Effect. The 'Font' and 'Size' affect how data numbers display regarding font type and font size. The default for 'Font' is "Arial" and for 'Size' the default is 15.

Sometimes, especially if a layer uses 4 or 8 byte floating point data type, the data values displayed for grid cells are unreadable because they all run together due to the number of digits displayed past the decimal point. The General: Show Cell Values: Decimals parameter controls the number of digits displayed after the decimal point.

Figure 9-11 displays the same zoomed in area of the '1MCdem30' elevation layer in two map view windows. The entry for the 'Unit' parameter is "Meters" and the stored elevation values convert to meters using a multiplier of .3048 for the 'Z-Scale' parameter.

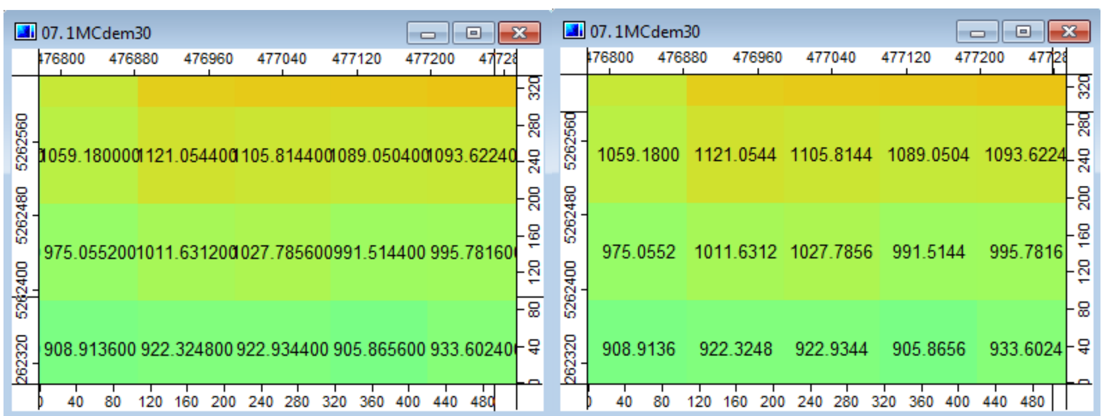


Figure 9-11. Comparing entries for the 'Decimals' parameter.

I entered 6 for the 'Decimals' parameter for the '1MCdem30' elevation grid layer in the map view window on the left in Figure 9-11. I changed it to 4 for the map view window on the right. I can see that it is easier to see the cell values on the right.

The other parameter, 'Boundary Effect', has ten options. This parameter affects how the values are highlighted or shadowed. There is also a 'Color' parameter. I usually use the "none" option.

General: Memory Handling
The '1MCaspectDeg' grid layer is used in the discussion of memory handling. This layer uses about 1.20 MB of disk storage space.

Generally, all SAGA operations for grid layers require the data to be loaded into memory. When the layer is too large to be resident in memory, a file caching option can be turned on. File caching involves the swapping of data between storage and memory as needed for computations. Operations for large datasets can continue, however, the computation time may be extended because of the ongoing data swapping.

The value field to the right of the General: Memory Handling parameter displays a small triangle. I move the mouse pointer over the triangle and press the left mouse button twice. A popup list of three options displays: Normal, RTL Compression, File Cache.

The default is "Normal". If the "RTL Compression" or "File Cache" options are chosen, they are applied to the layer for the current work session. The values for these parameters save in the configuration file when I exit SAGA, save as part of a project file, and save as part of a .sprm file. Thus, the values reload as part of the configuration file the next time the SAGA starts. They reload as part of a project if saved as part of the project. The individual layer parameters file can be loaded to restore the parameter values at the time it the .sprm file was created.

I did encounter a problem when choosing "File Cache" as an option after "Normal" was the chosen option. SAGA can crash. If "RTL Compression" is chosen, there is not a problem. This has been corrected in SAGA Version 6.

The values are not reloaded if the layer itself is reloaded using the File: Grid: Load option. This option loads the actual data but the defaults for the parameter settings are used.

With the default setting "Normal", no special memory or disk storage saving techniques are used. If one of the other two options is chosen, the General: Buffer Size MB parameter appears in the row just below the General: Memory Handling parameter.

I notice in the Description tab area of the Object Properties window that two information items relate to memory handling: Memory Size and Memory Compression. The information for Memory Size is the amount of memory the grid layer occupies. The Memory Compression information item only displays if the "RTL Compression" or "File Cache" options are chosen for the General: Memory Handling parameter. Memory Compression is a percent value. The smaller the percent the more compression has been applied.

Figure 9-12 displays the two General: Memory Handling related parameters in the Object Properties window if either the "RTL Compression" or "File Cache" options is chosen for the 'Memory Handling' parameter.

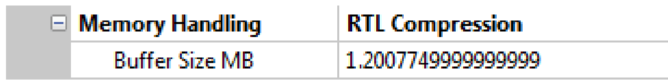


Figure 9-12. The two 'Memory Handing' parameters.

Figure 9-12 shows the additional parameter General: Memory Handling: Buffer Size MB that displays when choosing either of these options for the 'Memory Handling' parameter. Both of these options relate to file compression procedures applied to reduce the amount of space a layer uses in memory.

The Description tab information displayed when either "RTL Compression" or "File Cache" is selected has the information item 'Memory Size' listed at 1.20 MB and the additional entry called 'Memory Compression' showing a value of 75.98. I interpret the 75.98 number to mean that the data file is compressed to 75.98 percent of the original size.

General: Memory Handling: Buffer Size MB
SAGA automatically enters a default value in the value field. This is the amount of storage space taken up by the layer files. I can change this value by clicking in the value field to the right of the 'Buffer Size MB' label and enter a new number. The change will only be in effect during the current work session. When the layer is reloaded using the 'Load' command, the 'Memory' parameter is automatically set by SAGA to the default that is the amount of disk storage the grid layer takes. A default or a changed value entered in the immediately prior work session is reloaded as part of the loading of layer parameters from the system configuration file (*.cfg). This is also true if a project file (*.sprj) is re-loaded in which the 'Buffer Size MB' for a layer was changed from the default and for an individual layer parameters file (*.sprm) saved using the Save button on the Object Properties window.

Outside of the three files discussed above (*.cfg, *.sprj, *.sprm) the only place the buffer size displays is in the value field for the 'Buffer Size MB' parameter.

There is a set of global parameters that relate to how file caching is implemented. These parameters can be viewed from the "Data" title in the Data tab area of the Manager window. Move the mouse pointer over the "Data" title and press the left mouse button. These parameters display in the Settings tab of the Object Properties window.

There are four parameters related to 'File Caching':
Automatic (a check box parameter)
Threshold for automatic mode [MB]
Confirm file caching
Temporary files

Chapter 4 includes a discussion of these parameters.

Display Parameters

Figure 9-13 displays a list of the parameters available in the "Display" section of the Object Properties window for a grid layer.

Display	
Transparency [%]	0
Show at all scales	☑
Resampling	Nearest Neighbour
Shading	none

Figure 9-13. The Display category of parameters.

Display: Transparency [%]

I often want to display a layer using a background layer in the same map view window. For example, I display a bedrock grid layer map with a shaded relief layer in the background or a satellite image as background for on-screen digitizing vegetation stands. The Display: Transparency [%] parameter allows me to adjust the transparency of a grid layer to a value between 0% and 100%. At 100%, the grid layer is fully transparent. I find that I tend to set this parameter to around 50% when I want a filtered view of the background layer.

The default entry for the parameter is 0. Figure 9-14 displays four map view windows. Map view window (1) is the shaded relief I want to use as a backdrop. Map view window (2) is for Mason County school districts. It is this layer I will set to a transparency level of 50%. Map view window (3) is for water areas in Mason County. Map (4) is the map view window displaying all three layers.

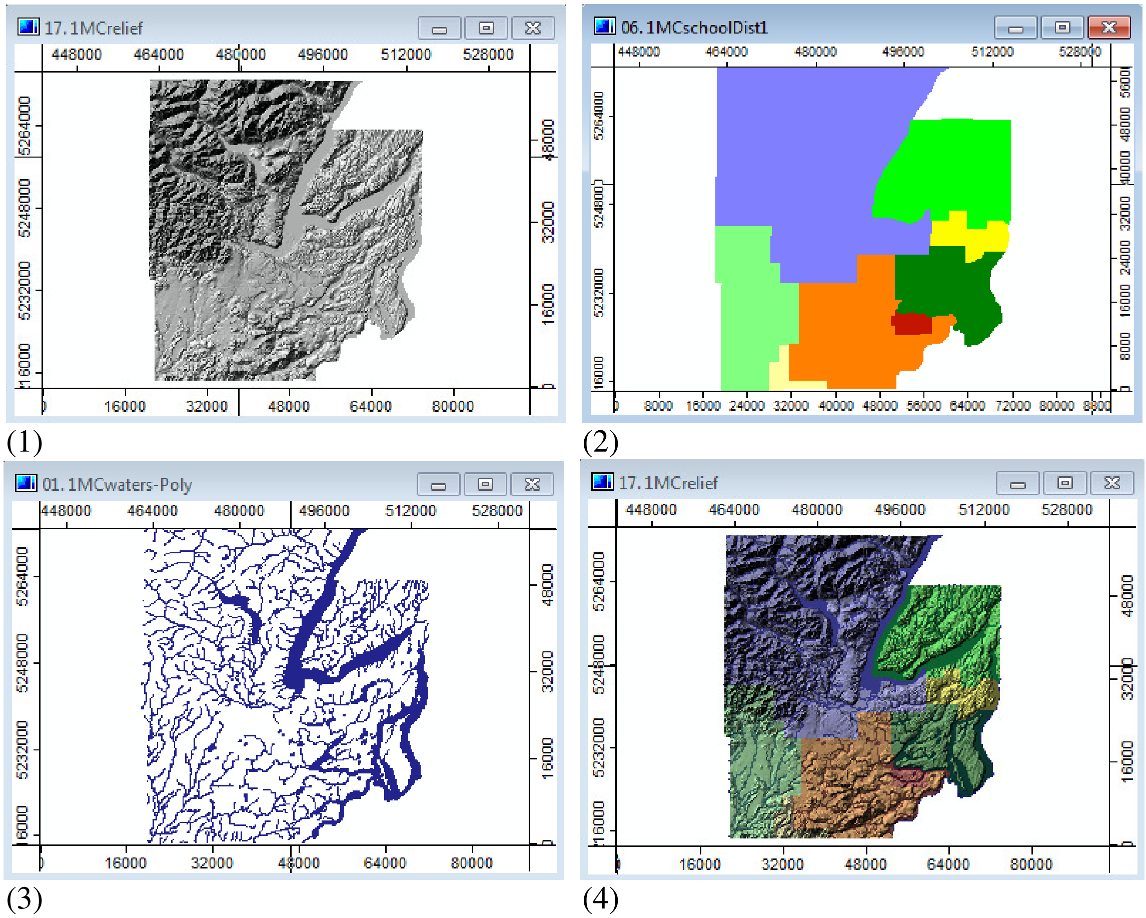


Figure 9-14. The ‘Transparency’ parameter for the school districts layer set to 0%.

My goal was for the shaded relief to set a background pattern. In order to see the pattern through the originally opaque school district layer '1MCschoolDist1' I set the transparency level for the layer to 50%. The order of these layers in the layer stack for the map view window, Figure 9-14 (4), is:

1. 1MCwaters-Poly.
2. 1MCschoolDist1.
3. 1MCrelief.

Display: Show at all scales
This is a toggle check box type parameter. The default is for this parameter to be in on status. The grid layer displays at any scale when this parameter is on (has a check in the box). I can change this parameter to off status by moving the mouse pointer into the box and pressing the left mouse button. The check mark in the box disappears and three additional parameters display just below the 'Show at all scales' parameter.

Display: Show at all scales: Scale Range, Minimum, Maximum
One of the additional parameters is 'Scale Range'. Supporting 'Scale Range' are parameters for setting the minimum scale range ('Minimum') and the maximum scale

range ('Maximum'). The values entered for the 'Minimum' and 'Maximum' parameters define the scale range (the minimum map scale and the maximum map scale) for a map view window within which the layer displays. The layer does not display if the scale of the map view window is outside the defined scale range.

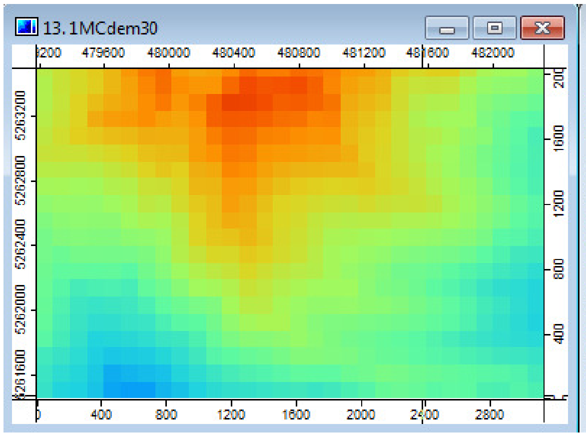
The values entered for these parameters are in map distance units. If the scale bar is not displayed in the map view window, the numbers for the tick marks along the bottom and right sides of the map view window are map distance units. A layer will display in the map view window if the range for either the bottom or right scales (whichever one is the lesser) is greater than the minimum and less than the maximum.

For example, I have a map view window displaying a grid layer. The map distance range for the bottom side of the window is 72000; the range for the right side is 62000. The map distance range of 62000 is the lesser of the two. I enter 15000 for the 'Minimum' and 70000 for the 'Maximum'. I zoom out changing the map distance range to over 89000. The map does not display in the window because 89000 exceeds the 'Maximum' 70000. I choose the "Zoom to Previous Map Extent" option. Now I zoom in. When the map distance range reaches less than 15000, the map should not display. I have zoomed in a couple times, the current map distance range is 18000 and the map displays. I zoom in one more time, the range changes to 8800, less than 15000. The map does not display in the window.

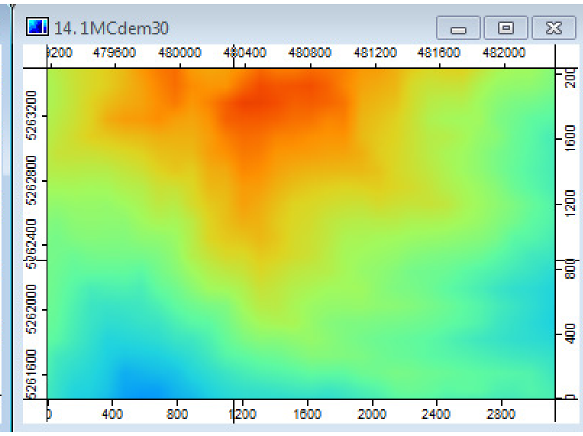
Display: Resampling
This parameter defines an interpolation scheme that is applied on color boundaries between grid cells containing different data values. The interpolation results in a gradient or smoothing for boundaries rather than an abrupt line. Data values are not changed. The default entry is “Nearest Neighbour”.

A popup list appears when I click with the mouse pointer in the value field to the right of the ‘Interpolation’ label. This list has four choices: Nearest Neighbour, Bilinear Interpolation, Bicubic Spline Interpolation, and B-Spline Interpolation.

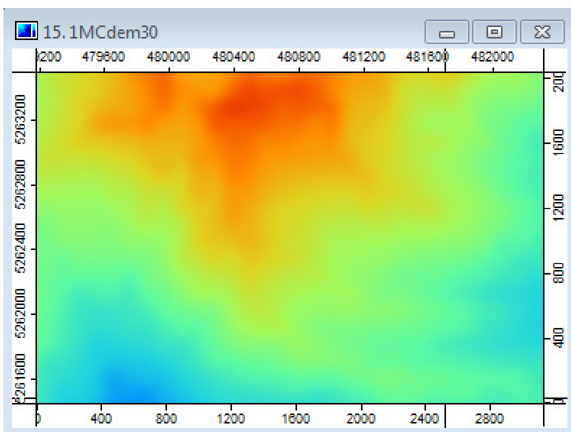
Grid layers displaying continuous data benefit most from this parameter. Using any of the options other than “Nearest Neighbour” tends to soften or smooth the gradient between data display colors. The class boundary is smoothed. Figure 9-15 displays examples of each option with an elevation grid layer. The "Nearest Neighbour" option applies the least amount of smoothing.



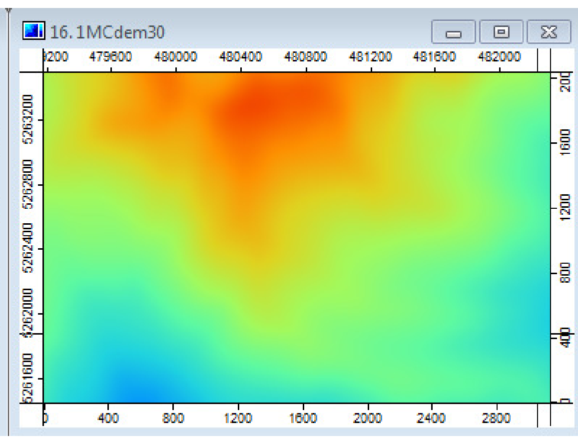
(a) Nearest Neighbour



(b) Bilinear Interpolation



(c) Bicubic Spline Interpolation



(d) B-Spline Interpolation

Figure 9-15. Examples of the 'Resampling' parameter options.

I have to look real close to see any difference in the results of the four options. I can see that the smoothest option looks like "B-Spline Interpolation" in Figure 9-15 (d).

This parameter is not available if the "Lookup Table" option is used for the Colors: Type.

Display: Shading

The Display: Shading parameter supports the application of shaded relief techniques to simulate a shaded relief perspective for a grid layer. Generally, I use the *Terrain Analyses - Lighting, Visibility/Analytical Hillshading* tool to create a shaded relief grid layer from a DEM or elevation grid layer input. This parameter appears to be a shortcut to that approach. The discussion for this parameter uses the '1MCdem30' elevation grid layer for examples.

In the case of using the *Analytical Hillshading* tool, a new grid layer is produced. Data values, in radians, represent the surface and the incoming light. Using the 'Shading' parameter produces a shaded relief like view without replacing the original data values.

The default entry for the 'Shading' parameter is "none". The two other options are "normal" and "inverse". When either "normal" or "inverse" is selected for the parameter, five new parameters appear for characteristics to produce a shaded relief view of a grid layer.

Briefly, the 'Azimuth' parameter is the from direction of a light source. Direction is in degrees clockwise from North. The default entry is 315, a direction halfway between due West and due North.

The 'Height' parameter is for identifying the height of the light source above the horizon. This is measured in degrees. The default entry is 45.

The 'Exaggeration' parameter is usually associated with 3-D perspective views. The exaggeration factor increases vertical exaggeration, particularly for a study area having little relief. That is not how this parameter works with this simulated shading routine. The default entry is 1. The default entries for the 'Minimum' and 'Maximum' parameters are 0 and 1.5.

Using the default entries for these parameters results in a moderate contrast relief display of the '1MCdem30' elevation grid layer.

An entry of 0 for the 'Exaggeration' parameter produces no shading effect. Any value greater than 0 causes a shading or relief-like effect. The lower the value, e.g., .1, the greater the amount of contrast.

The 'Minimum' and 'Maximum' parameters contribute to brightness. The default entry for 'Minimum' is 0 and the default entry for 'Maximum' is 1.5. Using the defaults for these two parameters and an entry of 1 for the 'Exaggeration' parameter produces a moderate level of brightness for relief. Values for 'Minimum' greater than 0 decrease brightness. An entry of .5 produces no brightness, just blackness, removing the relief effect. The higher the value for the 'Maximum' parameter, the more brightness.

Colors Parameters
Figure 9-16 displays a list of the parameters available in the Colors area of the Object Properties window for a grid layer.

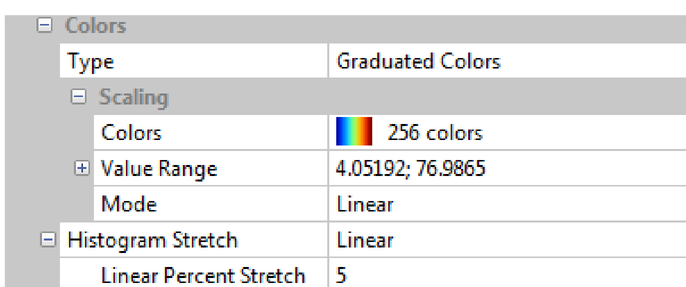


Figure 9-16. The Colors category of parameters.

Colors: Type
There are seven options for the Colors: Type parameter. They are: Single Symbol, Lookup Table, Discrete Colors, Graduated Colors, Shade, RGB Composite, and RGB Coded Values. Each option has additional parameters that become available when the option is chosen. The "Discrete Colors" and "Graduated Colors" options have the same set of parameters. The other options each use a unique set of support parameters.

I move my mouse pointer over the small triangle on the right side of the value field to the right of the 'Type' parameter name. I press the right mouse button and a popup list displays the names of the seven options for the 'Type' parameter. I move the mouse pointer over the option I want to use and press the left mouse button. Once I choose an option, the supporting parameters for the option become visible and available.

The 'Histogram Stretch' parameter and its' support parameters are available for each of the seven options. Let's take a brief look at these parameters since they are available for each of the Type options.

The 'Histogram Stretch' parameter has three choices: Linear, Standard Deviation, and Percentile. Each of these defines a data range for display.

The "Linear" option has a support parameter named 'Linear Percent Stretch'. The value entered for this parameter is a percent. It identifies the percent of the data range that is truncated from each end of the data range. For example, elevations for the '1MCdem30' layer range from sea level (0) to 6379 feet. I enter 5 for the 'Linear Percent Stretch' parameter. Five percent of the data range is 318.95. The low end is truncated from 318.95 to 0. The upper end is truncated from 6060.05 to 6379. This means that the display data range utilizing the full color palette is from 318.95 to 6060.05. The values truncated on the low end display using the left-most shade of the color palette and the values truncated on the high end display using the right-most shade of the color palette.

The "Standard Deviation" option sets the display range based on the standard deviation of the data. When the option is chosen, a new parameter, 'Standard Deviation', appears. I can specify how many standard deviations around the arithmetic mean of the data I want to define the display data range; the more standard deviations the greater the data range.

The arithmetic mean for the elevations on the '1MCdem30' layer is 912.504 and the standard deviation is 1117.267. I choose "Standard Deviation" for the 'Histogram Stretch' parameter and enter "2" for the 'Standard Deviation' parameter. This means the display data range is plus or minus 2 standard deviations of the arithmetic mean. One standard deviation is 1117.267 so two standard deviations is 2234.534. Subtracting this value from the mean results in a minimum value of -1322.03. The actual minimum of the data is 0.

The 'Keep in Range' parameter is only available for the "Standard Deviation" option. The default is for this parameter to be in on status. This means that when the minimum data value for the data range is different than the one calculated using the "Standard Deviation" option, the minimum data value for the data range is used and the calculated value for the data range is ignored. In the above case this means the minimum defaults to 0 since there are no data values between 0 and the calculated minimum of -1322.03.

The maximum calculated for the data range is 3147.038. These settings produced the map on the right in Figure 9-17.

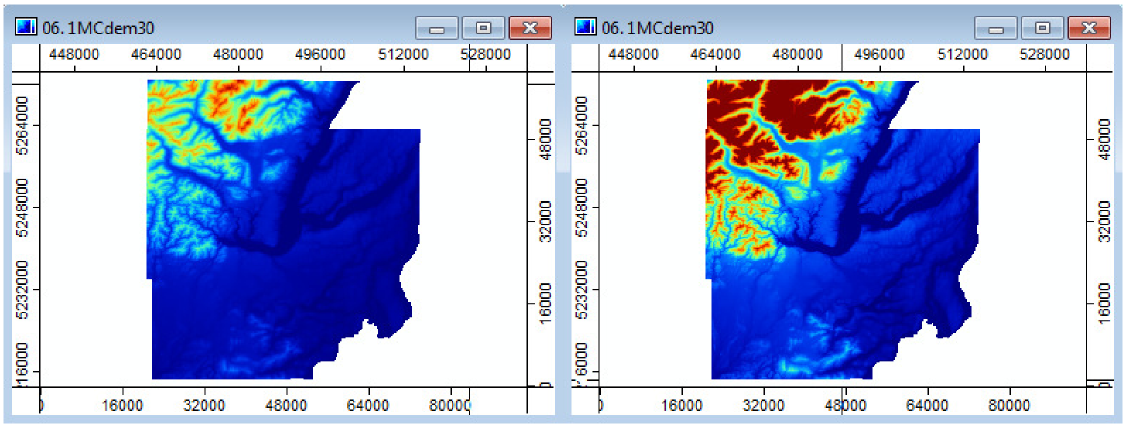


Figure 9-17. The full data range display versus a 2 standard deviation data range.

I viewed the parameter settings for the layer in the Settings tab of the Object Properties window. My estimate for the data range based on two standard deviations around the arithmetic mean of the data is correct. The minimum data value for display data range is 0 and the maximum data value is 3147. Notice that the full display range on the left shows detail in the northwest quadrant of the map view window. This is where the higher elevations are located. Elevations above 3147 are truncated in the map view window on the right. Notice how the furthest right shade of the color palette displays elevations between 3148 and 6379 (dark red) and detail is lost in that elevation range.

The third choice is "Percentile". There is a parameter of the same name that supports this choice. The value entered for the new parameter is a percent and identifies the percent of grid cells on the low and high ends of the data range that are truncated. For example, if I enter 10 for the new 'Percentile' parameter, if my study area includes 500,000 grid cells, looking at the cumulative grid cell data values, the data value for the 50,000th grid cell identifies the low end of the data range and the data value for the 450,000th grid cell identifies the high end of the data range. The truncated data values are displayed using the leftmost color of the color palette or the rightmost color of the color palette.

The remainder of this section is a discussion of each of the seven 'Type' parameter options. It is important to note that even though a parameter is available for a particular 'Type' option, this does not mean it is relevant to the option. In other words, it may not have any effect on how data values display.

Colors: Type: Single Symbol

The “Single Symbol” option might be more practical when used with a layer type other than a grid layer, e.g., using this option with a shape layer.

Colors: Type: Single Symbol: Color
The 'Color' parameter is similar to the 'Colors' parameters available for the type options "Discrete Colors" and "Graduated Colors". The difference is in singular versus plural. The 'Color' parameter becomes available when the "Single Symbol" option is chosen. A color swatch displays in the value field to the right of the 'Color' parameter name. I move the mouse pointer into the value field and press the left mouse button. A popup list of color swatches and color names displays. Figure 9-18 displays an example.

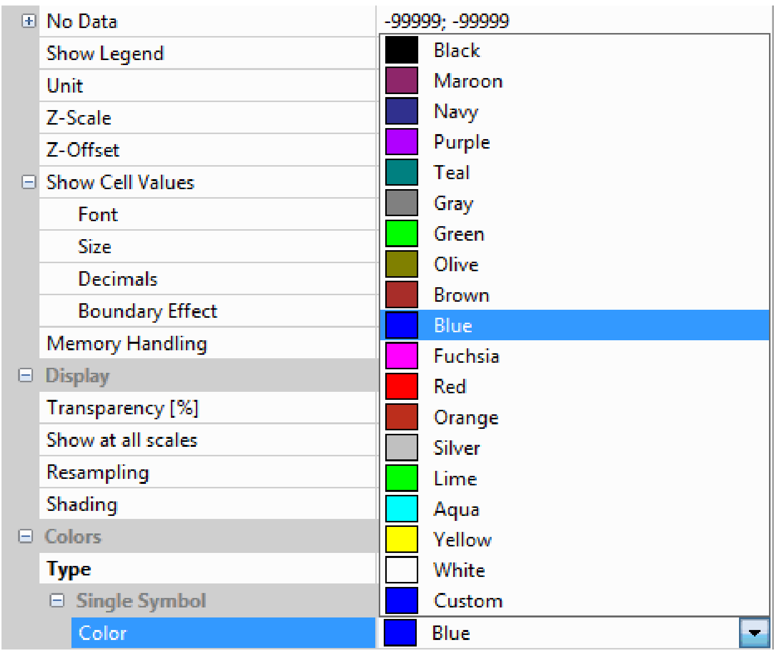


Figure 9-18. An example of the color swatch list for the "Single Symbol" option.

I move the mouse pointer over the one I want to choose and press the left mouse button. Then I click on the Apply button at the bottom of the Object Properties window and the change takes effect.

The single color chosen is used to "fill" all the grid cells of the elevation grid layer, '1MCdem30', that contain valid data values and not the no-data value. Since the same color is used to display any data value, there is no visual differentiation between data values or categories.

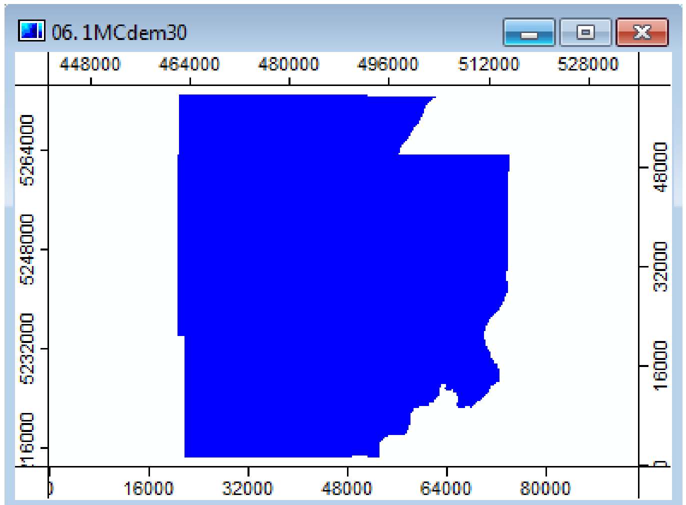


Figure 9-19. The '1MCdem30' grid layer.

The elevations '1MCdem30' grid layer is displayed in Figure 9-19.

There are two additional parameters to use with the "Single Symbol" option. The first one is 'Histogram Stretch'. This option has three choices: Linear, Standard Deviation, and Percentile. Each of these defines a data range for display. These options were explained earlier.

The choices for 'Histogram Stretch' do not cause any change in how data values of a grid layer display if the "Single Symbol" option is chosen for the Colors: Type option.

Colors: Type: Lookup Table
The lookup table is a valuable tool for assigning colors to grid layer display classes or data categories. This option is used with continuous or categorical type data values.

Colors: Type: Lookup Table: Table
The "Lookup Table" option uses a parameter named 'Table'. The entry in the value field to the right of the 'Table' parameter is the current table size, in number of rows and columns. The default is "Table (columns: 5, rows: 2)". The five columns in a lookup table are COLOR, NAME, DESCRIPTION, MINIMUM, and MAXIMUM.

The lookup table displays in the work area by moving the mouse pointer over the ellipsis in the value field to the right of the 'Table' parameter and pressing the left mouse button.

Figure 9-20 displays the default lookup table 'Table' window available when a grid layer is first opened.

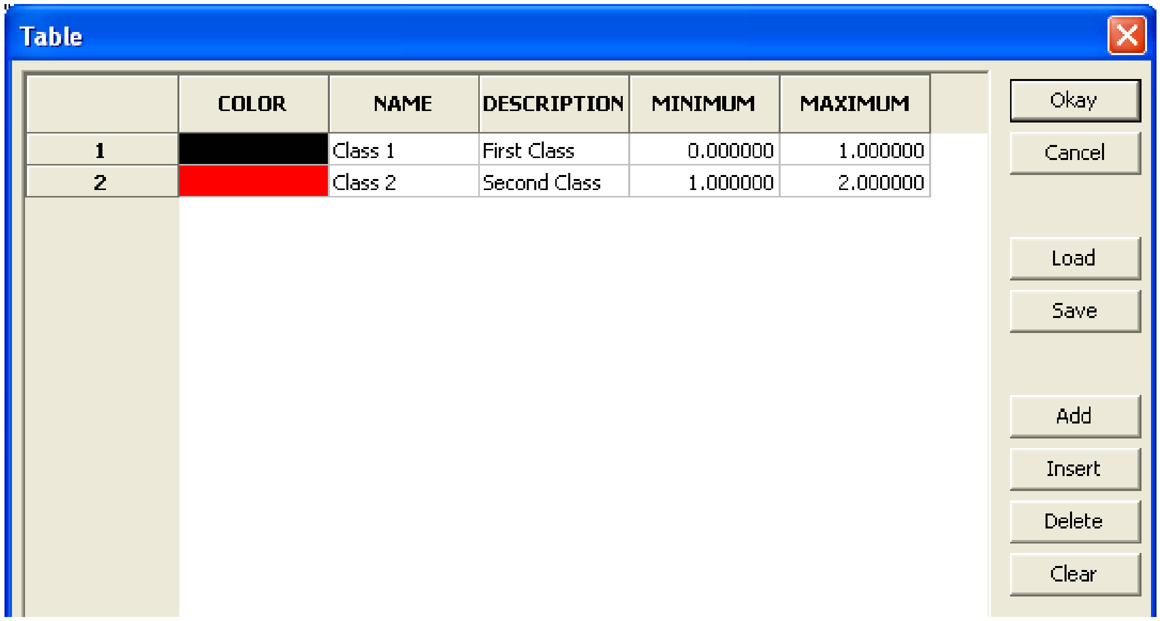


Figure 9-20. The default 'Table' dialog window for a grid layer.

The table structure is rows and columns. A row represents a data display class. The columns are characteristics. I can adjust the height of the rows as well as the widths of the columns using the mouse. Let's take a look at the five columns.

When I click in the color column for a data display class, a table of color swatches like the one in Figure 9-21 appears. I choose a color for a data class by clicking the mouse pointer on the color swatch in the color table that I want to use. When I click on the option 'Define Custom Colors >>' at the bottom of the color table display I can customize a color definition. After clicking on the color swatch that I want to use, I click on the OK button. The chosen color becomes the color attribute for the data class and appears in the "COLOR" column.

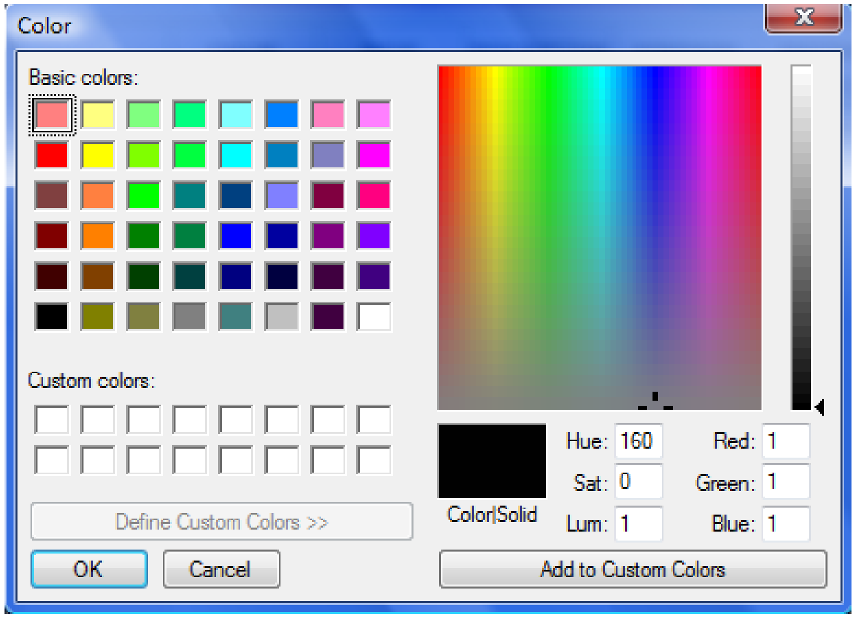


Figure 9-21. The 'Color' window for assigning data class colors to grid data values in a lookup table.

The next column, "NAME", is for assigning a name to the data display class. This text is used in the Z information field at the bottom of the work area. As I move the mouse pointer over the grid cells of a layer in a map view window, the text in the "NAME" field for the data display class, displays in the Z information field to the right of the X and Y coordinate information fields. The text in the "NAME" fields is also used with the legend for the layer.

In Figure 9-22, the "Lookup Table" for a census tract grid layer displays on the left. These data values for the layer represent categorical type data. To the right of the table is the legend for the grid layer using the text entered for the "NAME" field in the table.

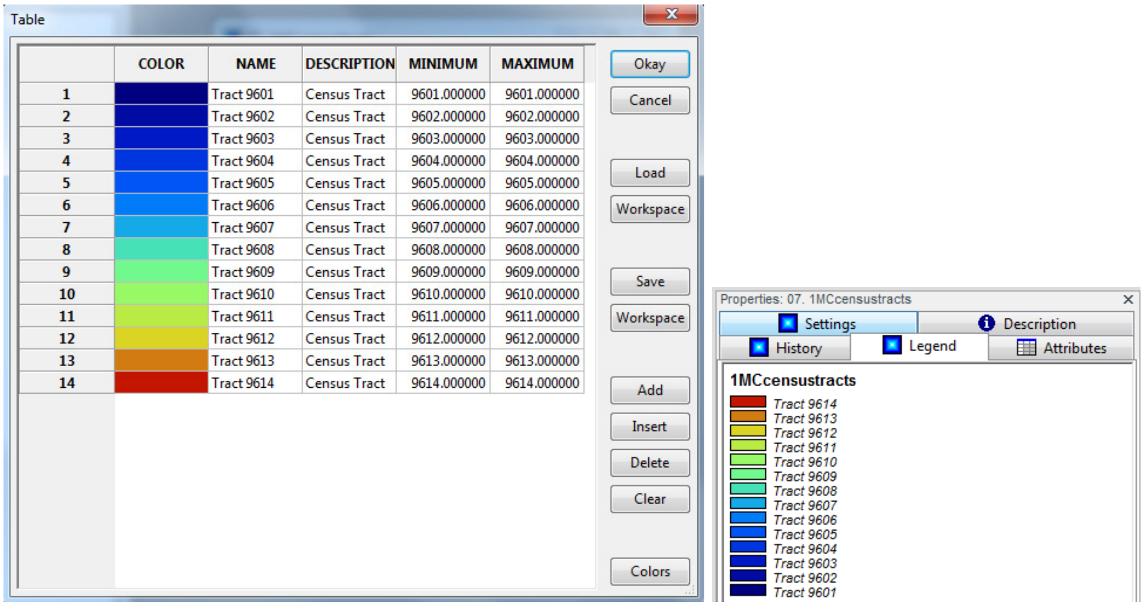


Figure 9-22. The ‘Table’ and resulting legend for the census tracts grid layer.

The “DESCRIPTION” column contains additional text information about the data display class. This information is not used anywhere by SAGA. Its primary purpose is to provide more information about the class defined by the interval.

The “MINIMUM” and “MAXIMUM” fields define the class interval, i.e., the lower and upper boundaries of the data display class.

The buttons on the right include Okay for when I complete the data entry; Cancel to cancel the data entry process.

Notice the Load and Save buttons. Figure 9-23 displays the 'Save Table' dialog window that displays when I click on the Save button.

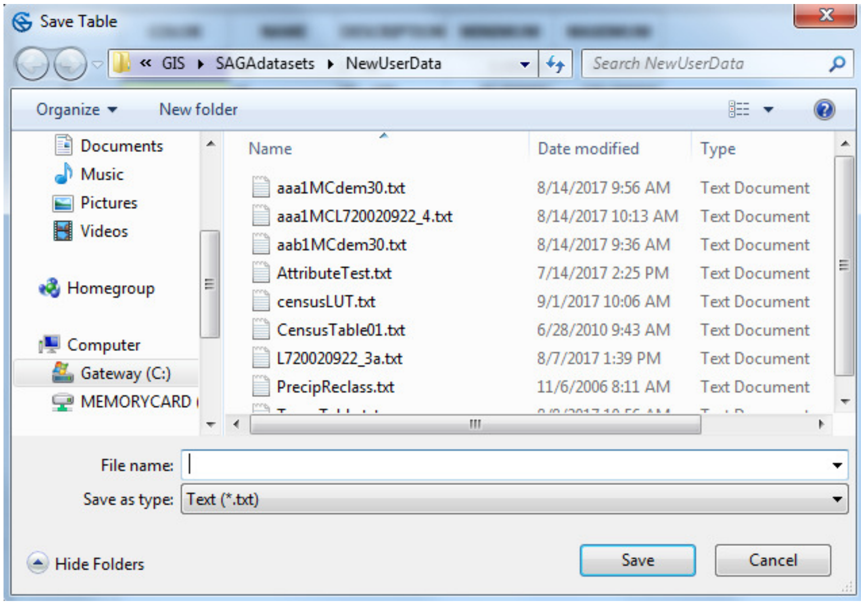


Figure 9-23. The 'Save Table' dialog window.

I use features available in the window to navigate to a folder I want to save the table. The default format for the table is "Text (*.txt)". In addition to this format, the "Save as type:" data field supports Comma Separated Values (*.csv) and DBase (*.dbf). The "File Name:" data field is where I enter a name for the saved lookup table. A .mtab file also saves for reading the .txt file as metadata. I click on the Save button at the bottom of the window to continue. I click on the Okay button on the 'Table' dialog window. Last, I click with the mouse pointer on the Apply button at the bottom of the Object Properties window.

The Load button is used to load a stored lookup table. Figure 9-24 displays the 'Load Table' dialog window.

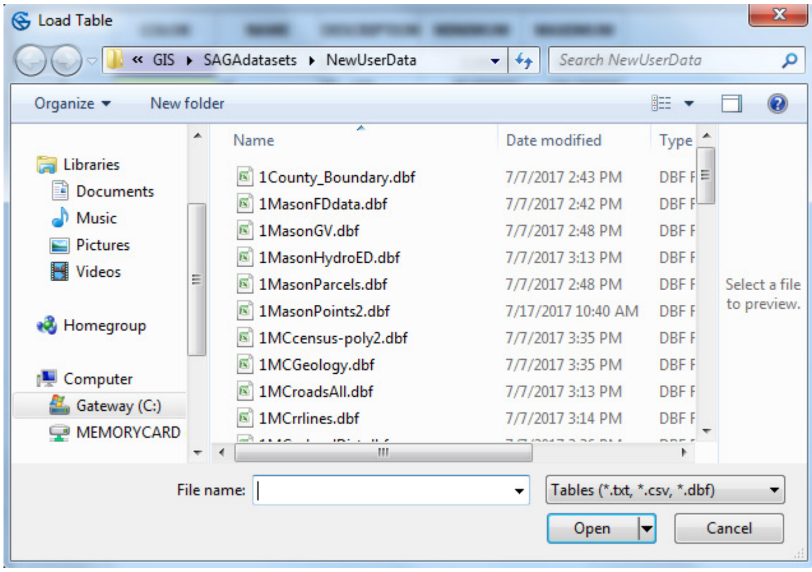


Figure 9-24. The 'Load Table' dialog window.

As with the 'Save Table' dialog window, available options are used to navigate to the storage location of the lookup table. The default entry for table format is "Tables (*.txt, *.csv, *.dbf)". The name of the table to load can be entered from the keyboard into the "File name:" data field or I can click with the mouse on a name in the list of file names in the dialog window. Once the table file name is chosen, I click on the Open button at the bottom of the 'Load Table' dialog window. Then I click on the Okay button on the 'Table' dialog window and finally the Apply button at the bottom of the Object Properties window.

Just below the Load and Save buttons is a button labeled Workspace. The one below the Save button creates a text file available in the Data tab area of the Manager window. This action does not really save or store the table. The table is available in memory for the current work session. After clicking on the Workspace button below the Save button, the window in Figure 9-25 displays.

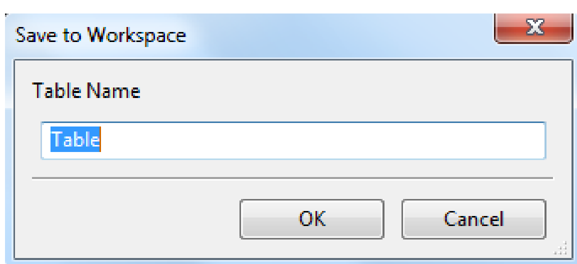


Figure 9-25. The 'Save to Workspace' window.

I enter into the data field on the 'Save to Workspace' dialog window the name of the saved lookup table. After entering a name, I click on the OK button and continue. I click on the Okay button on the 'Table' dialog window and then I click on the Apply button at the bottom of the Object Properties window. The table name appears in the "Tables" section of the Data tab of the Manager.

The Workspace button below the Load button is for loading a lookup table temporarily available in memory. The name of the lookup table displays in the "Tables" section of the Data tab area of the Manager. When I click on the Workspace button below the Load button the 'Load from Workspace' dialog window in Figure 9-26 displays.

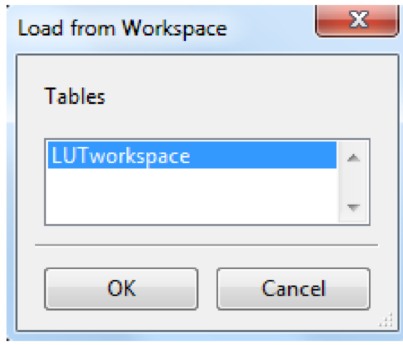


Figure 9-26. The 'Load from Workspace' window.

I choose the lookup table to load from the list (if more than one on the list) and click with the mouse pointer on the OK button. I move the mouse pointer over the Okay button on the 'Load Table' dialog window and press the left mouse button. Then I click on the Apply button at the bottom of the Object Properties window and the map view window updates using the re-loaded lookup table.

The four buttons Add, Insert, Delete, and Clear manage table rows. Clicking on the Add button inserts a new row at the bottom of the existing rows. The Insert button inserts a new row above the currently active row. The Delete button deletes the currently active row. Clicking on the Clear button deletes all of the rows in the lookup table.

The last button in the 'Table' window is Colors. There are two sources for colors used in the lookup table. The first one, the 'Color' dialog window, is displayed in Figure 9-27 on the left. It displays if I click the mouse pointer on a color in the "COLOR" column of the table. The second one, the 'Colors' dialog window, displays if I click with the mouse pointer on the Colors button at the bottom of the 'Table' window. It is displayed on the right in Figure 9-27.

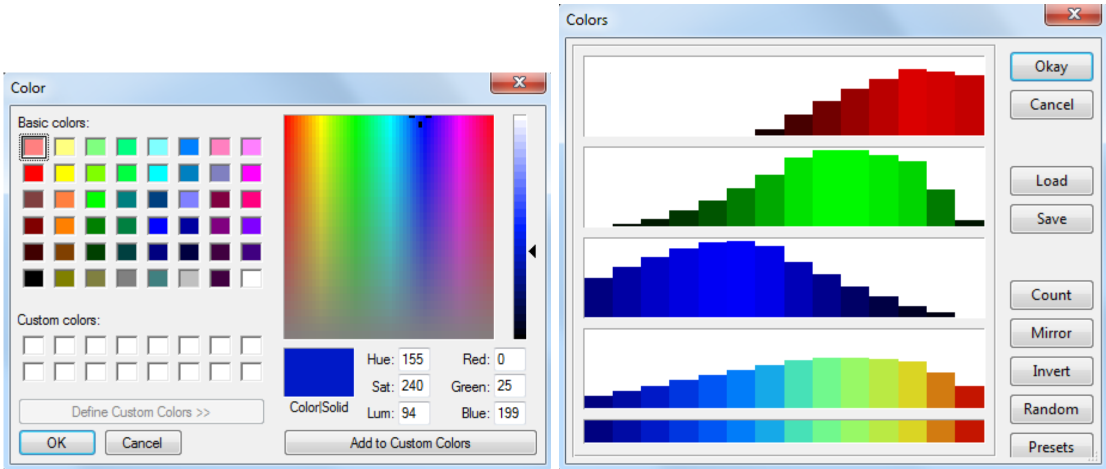


Figure 9-27. The two sources for colors used in the lookup table.

The 'Colors' dialog window supports a seemingly unlimited number of color selection options. The primary difference between the two windows is that the 'Colors' dialog window allows the use of a color palette for setting the display colors for the lookup table. I can use the Load button to navigate to the storage area for color palettes or I can use the Presets button to load a palette from the list of presets. I can also define my own palette using the three color graphs in the window.

The 'Color' dialog window assigns a specific color, from a matrix of "Basic colors" swatches, to a single data display class. I can also use the color gradient display on the right side to create a custom color moving the triangle up and down the color column. I can use the 'Color' dialog window after choosing a color palette from the 'Colors' dialog window to replace the color for a single data display class. The two sources of colors can complement the use of each other.

As was the case with the "Single Symbol" option, there are two additional parameters to use with the "Lookup Table" option. The first one is 'Histogram Stretch'. This option has three choices: Linear, Standard Deviation, and Percentile. Each of these defines a data range for display.

The choices for 'Histogram Stretch' do not appear to cause any change in how the data values of a grid layer display when the "Lookup Table" option is chosen for the Colors: Type parameter.

Figure 9-28 displays a lookup table developed for a slope aspect grid layer. Data values for slope aspect range from 0 to 360 degrees. The data value is the orientation of the slope surface to a compass direction. The aspect grid layer '1MCaspectDeg' uses the "4 byte floating point" data type. In this example, I am aggregating the continuous grid cell data values into four display classes (four quadrants of the compass) for display purposes. The new display classes are NE, SE, SW, and NW.

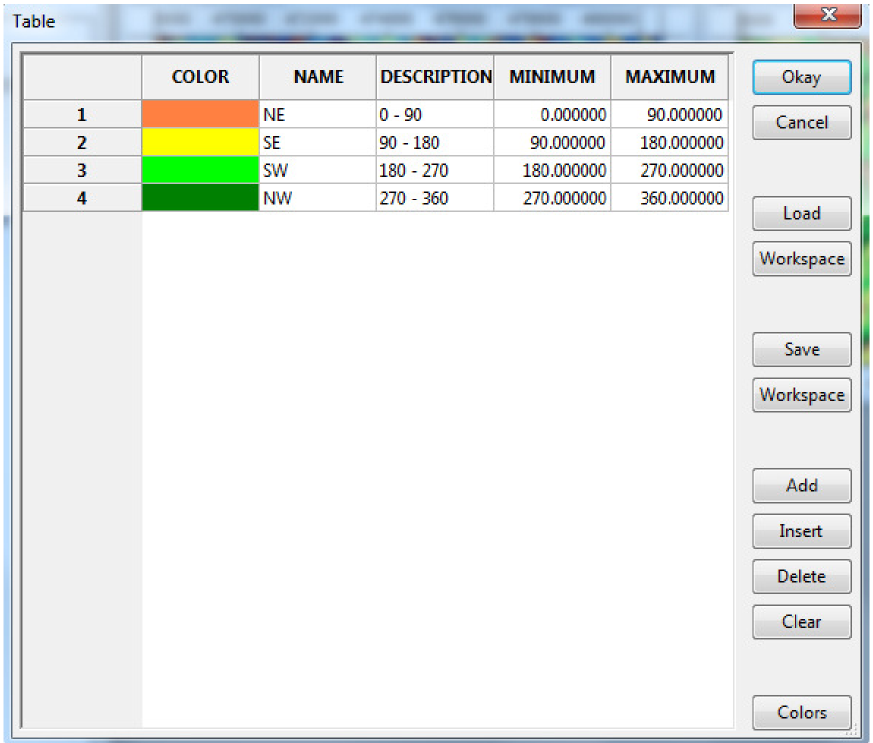


Figure 9-28. A "Lookup Table" for displaying cell values using four data display classes.

Figure 9-29, on the left, shows the '1MCaspectDeg' grid layer prior to applying the lookup table in figure 9-28. The graphics on the right show the same '1MCaspectDeg' layer using the lookup table to aggregate the data values into four display classes.

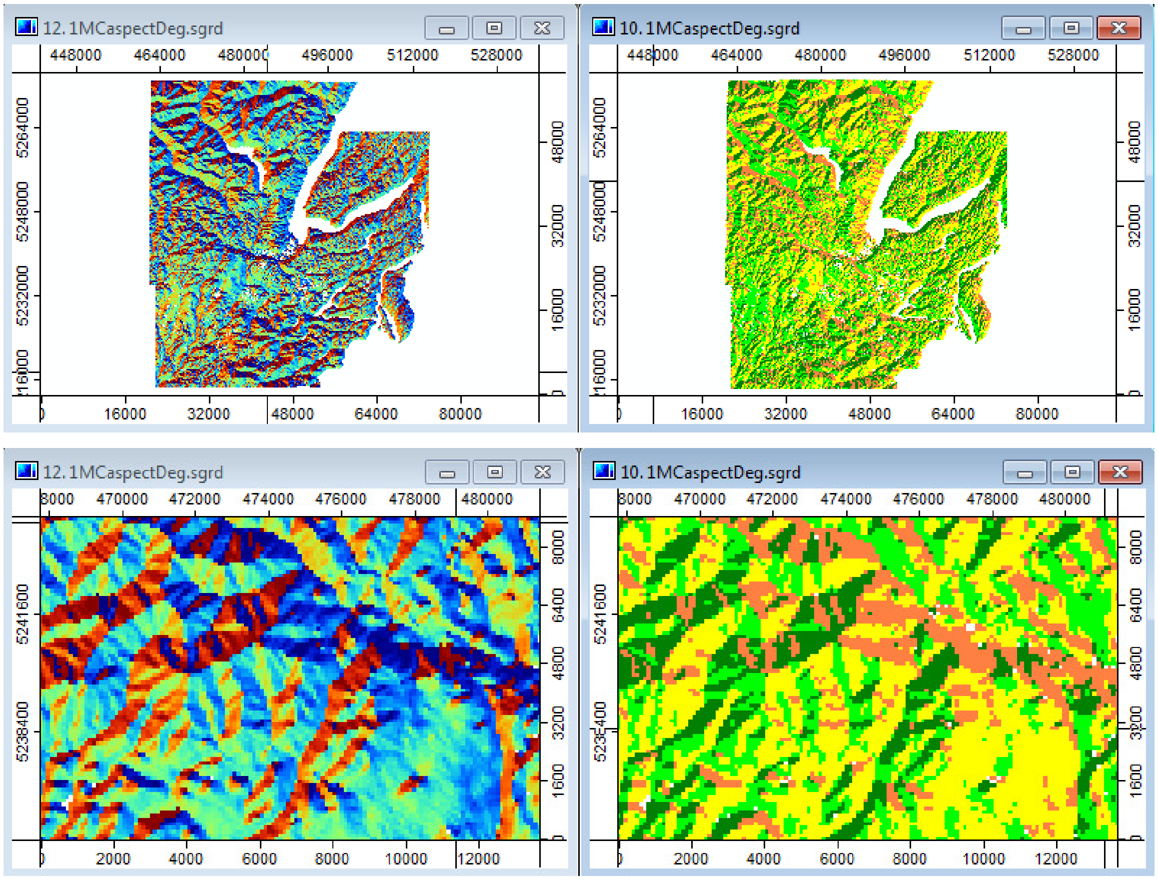


Figure 9-29. How the 'Lookup Table' affects the appearance of a grid layer.

The bottom two map view windows in Figure 9-29 are zoomed in views of the same area.

The default lookup table, available in the value field to the right of the 'Table' parameter, has been used to explain the "Lookup Table" option for the Colors: Type parameter. The "Create Lookup Table" option, available for layers listed in the Data tab area of the Manager, is another option that provides a table for the 'Table' parameter. This option is described in Chapter 4.

Colors: Type: Discrete Colors

This option works with grid layers containing continuous or discrete data values. The data values are classified into the number of discrete display classes identified by the entry for the 'Count' parameter. Each data display class uses a color of a color palette.

Colors: Type: Scaling: Colors

Here is an example. I have a precipitation grid layer named '1MasonCtyPrecipGR'. The data values are for precipitation in inches for Mason County Washington. The data values range from 53 to 230.

Using the Colors: Type: Scaling: Colors parameter, I click with the mouse on the ellipsis in the value field. The 'Colors' dialog window displays. I click with the mouse on the

Count button and enter 5 for the "Count" variable. The data range is 177 (i.e., 230 - 53). Dividing the range by 5 calculates a display class interval of 35.4. Class 1 is from 53.0 to 88.4. Grid cells having precipitation data values between 53.0 and 88.4 fall within this display class. Class 2 is from 88.4 to 123.8. Class 5 has a lower boundary of 194.6 and an upper of 230.

I can view the legend for the layer by clicking with the mouse on the Legend tab in the Object Properties window. The legend displays in Figure 9-30.

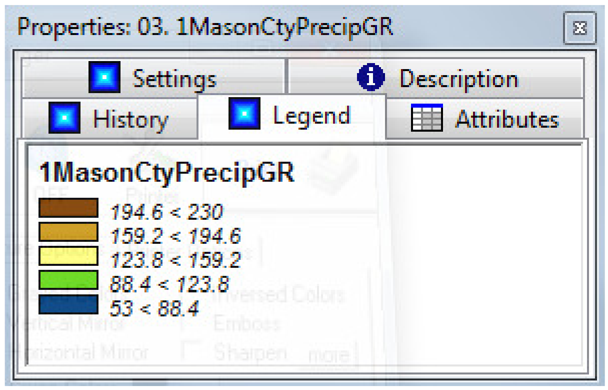


Figure 9-30. The legend created with the 'Discrete Colors' option.

There are 5 discrete display classes based on the 35.4 class interval. I can see that the minimum and maximums for the classes are as expected. Each display class uses a discrete color for displaying the precipitation boundaries for display class definition and class interval.

Figure 9-31 displays a map view window for the precipitation grid layer '1MasonCtyPrecipGR'. The Colors: Type parameter option is "Discrete Colors". In summary, I clicked the mouse pointer on the ellipsis in the value field to the right of the Colors: Type: Scaling: Colors' parameter. On the 'Colors' dialog window that displayed I clicked on the Count button and entered the number 5 in the 'Input' window. Then I clicked on the Okay button on the 'Colors' dialog window.

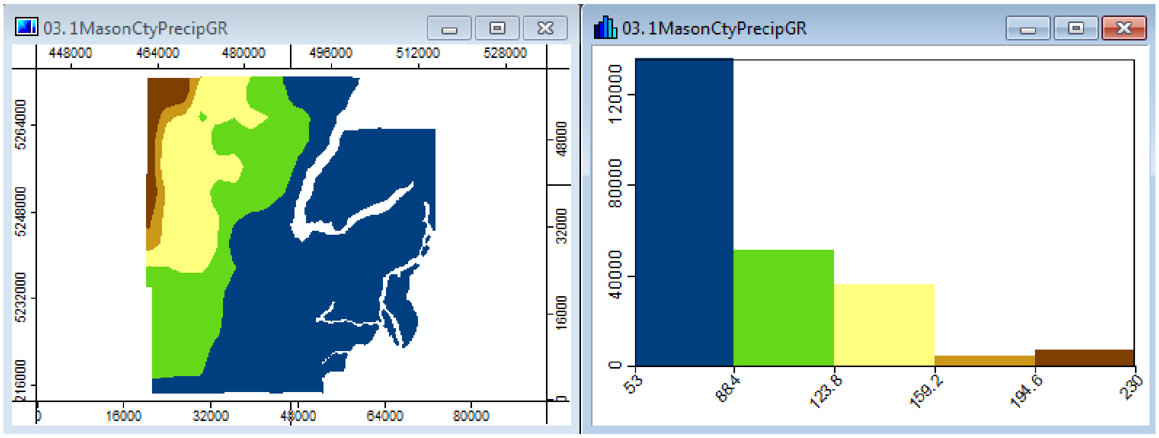


Figure 9-31. The '1MasonCtyPrecipGR' map view window and corresponding histogram.

Several more parameters become available when the "Discrete Colors" option is chosen for the Colors: Type parameter. These parameters are also used with these Colors: Type parameter options: Graduated Colors, Shades, RGB Composite, and RGB Coded Values.

Colors: Type: Scaling: Value Range

The first one is 'Value Range'. This is the data value range the display classes cover.

Colors: Type: Scaling: Value Range: Minimum, Maximum

I can enter values for the minimum and maximum ends of a display value range. The value range used for the '1MasonCtyPrecipGR' layer in the map view window in Figure 9-31 was from 53 to 230, the full range of the data. I can enter a new value for the minimum end of 88.5 and a new maximum value of 159.2. This defines a new display range of data values from 88.4 to 159.2. Figure 9-32 displays the results.

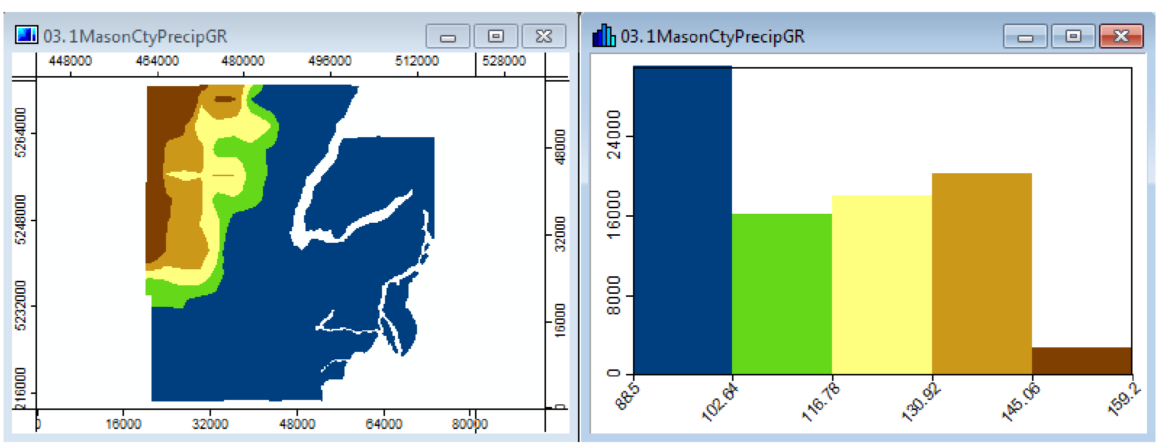


Figure 9-32. Using a display range of 88.5 to 159.2 for the '1MasonCtyPrecipGR' layer.

A set of new display classes is defined based on the new data range. I did not change the number of classes. The new data range is 70.7. The new class interval is 14.14. The classes are 88.5 - 102.64, 102.64 - 116.78, 116.78 - 130.92, 130.92 - 145.06, and 145.06 - 159.2. I can see that the precipitation values less than 88.5 are displayed in blue and values greater than 159.2 display in dark brown. Even though they display using the colors for the two classes, they do not count into the frequency for the two classes.

Colors: Type: Scaling: Mode
The Colors: Type: Scaling: Mode parameter is available for these Colors: Type parameter options: Discrete Colors, Graduated Colors, Shades, RGB Composite, and RGB Coded Values.

The 'Mode' parameter has three options: linear, logarithmic (up), logarithmic (down). "Linear" is the default. Another parameter, 'Logarithmic Stretch Factor' displays if either of the logarithmic options is chosen.

The logarithmic options support the display of large data ranges. One of the terrain analysis related layers is catchment area, '1MCcatchmentArea'. When I first viewed the layer in a map view window, it was difficult to visually interpret the data display. I checked the value range in the Object Properties window and saw that the data range was from 10890 to 610292992, an extremely large data value range.

Using the 'Mode' parameters I made a couple changes to improve the visual display of the data. First, I chose the "Logarithmic (up)" option from the list of 'Mode' choices. Next I experimented with the 'Logarithmic Stretch Factor' to find a value that results in a more detailed display of the layer. On the left in Figure 9-33 is the original '1MCcatchmentArea' grid layer prior to any adjustments. The graphic on the right shows the same layer after I made the adjustments described above.

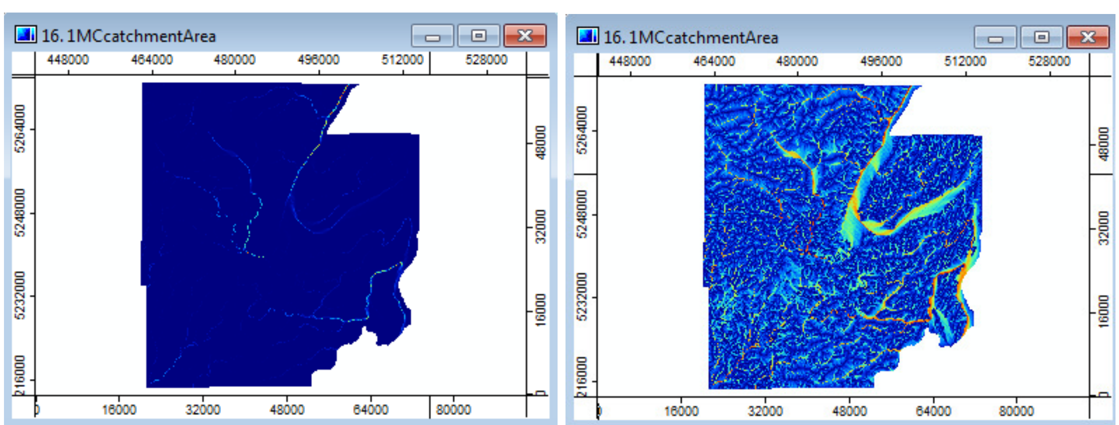


Figure 9-33. An example of using the "Logarithmic (up)" option with a catchment area grid layer.

Additional parameters are for the 'Histogram Stretch' parameter options. These options effect the display data range when the "Discrete Colors" option is chosen for the Colors:

Type parameter. I refer you to the beginning of this section for a description of the "Linear", "Standard Deviation", and "Percentile" options for the 'Histogram Stretch' parameter.

Colors: Type: Graduated Colors
This option is almost the same as the "Discrete Colors" option. The same parameters provide support. The primary difference is the assignment of colors for display classes. Viewing Figures 9-30, 9-31, and 9-32, I can see that discrete display classes are used with the "Discrete Colors" option. In particular, in Figure 9-30, I can see by the legend that display classes are applied. That is not the case with the "Graduated Colors" option. A color ramp of a gradient of colors is used for displaying grid layer values with this option. The data values are interpreted as continuous data values.

Let's look at how this option works with the '1MCslopeDegrees' slope grid layer.

The data range for the slope data values is from 0 to 81.0384 degrees for a range of 81.0384. Figure 9-34 displays a map view window for the slope grid layer '1MCslopeDegrees'. The Colors: Type parameter option is "Graduated Colors".

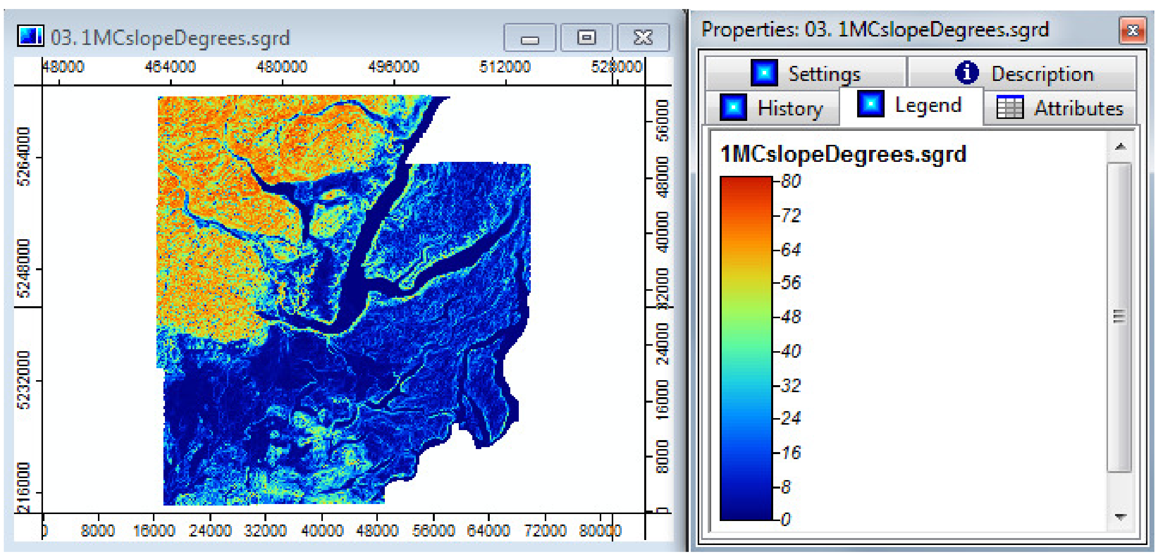


Figure 9-34. The '1MCslopeDegrees' map view window and Legend tab content.

I see that the legend for the '1MCslopeDegrees' map is not based on discrete classes but instead uses a color ramp; a gradient of colors from dark blue for a data value of 0 to dark red for a data value greater than 80. Figure 9-35 displays the same layer and associated legend using the "Discrete Colors" option.

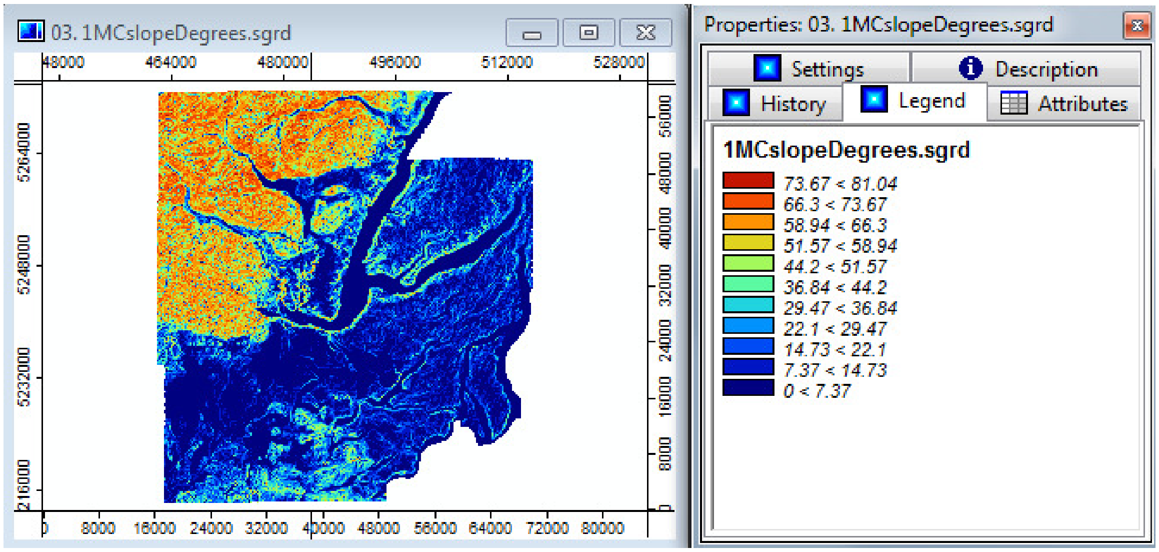


Figure 9-35. The '1MCslopeDegrees' map, legend when "Discrete Colors" option is used.

Comparing Figure 9-34 and 9-35 I see the primary difference being the use of discrete display classes for the "Discrete Colors" option and a color gradient for the "Graduated Colors" option.

Additional parameters are for the 'Histogram Stretch' parameter options. These options effect the display data range when the Discrete Colors, Graduated Colors, Shades, and RGB Composite options are chosen for the Colors: Type parameter. I refer you to the beginning of this section for a description of the "Linear", "Standard Deviation", and "Percentile" options for the 'Histogram Stretch' parameter.

Colors: Type: Shade

The "Shade" option is an abbreviated version of the "Graduated Colors" option. The difference being the 'Colors' parameter is replaced by the Shade: Coloring parameter. This parameter has eight preset color palette options: bright - dark; dark - bright; white - cyan; cyan - white; white - magenta; magenta - white; white - yellow; yellow - white. The first two, bright - dark and dark - bright are grayscale palettes.

The 'Histogram Stretch' parameter options are available and affect the output display data range.

Colors: Type: RGB Composite

Another option of interest for the Colors: Type is “RGB Composite”. A color composite is often associated with image enhancement for satellite imagery.

The "RGB Composite" option for the 'Type' parameter is a relatively quick way to display a color composite without creating a new grid layer. If I need a RGB composite layer, I can create one using the *Visualisation/RGB Composite* tool.

RGB composite images, created from satellite digital data, are often designed to emphasize vegetation or geologic surface features. Assigning specific satellite bands to the three colors can result, for example, in visual differentiation between deciduous and conifer vegetation or an emphasis on discerning certain aspects of mineral deposits.

A false color infrared composite is an "RGB Composite". In this image, the near-infrared portion of the electromagnetic spectrum in combination with the green and red portions, accentuate or enhance the appearance of vegetation using shades of red. In particular, this type of composite image became popular with scenes captured by satellites of the Landsat program. In addition to a false-color infrared composite is a true color composite that associates satellite bands with colors to render a true color image.

The following explanation is oriented around producing an RGB composite display using a near-infrared band in combination with green and red bands for a Landsat 7 scene. Thus, three grid layers are involved, each representing a specific portion of the electromagnetic spectrum. Band 2 captures the green portion of the spectrum. Band 3 captures the red portion and band 4 captures a near-infrared portion. The RGB assignments are red for band 4, green for band 3 and blue for band 2.

As a first step, I am going to set the 'Histogram Stretch' parameter to "Percentile" for each of the three input grid layers. I enter 0 for the 'Percentile' parameter. Using the "Percentile" option with an entry of 0 means the full range of data values for the grid layers is used. The 'Histogram Stretch' parameter setting for the input layers influences the resulting RGB composite. I will discuss these settings again.

Here is how I enter the settings for the 'Histogram Stretch' for one of the layers. I make the '1MCL720020922_2' grid layer in the Data tab of the Manager window the active layer. In the Settings tab of the layer Object Properties window I change the 'Histogram Stretch' parameter for the '1MCL720020922_2' layer by moving the mouse pointer into the value field to the right of the 'Histogram Stretch' parameter and press the left mouse button. I choose the "Percentile" option on the popup list of three options. The new 'Percentile' parameter displays. I replace the current entry with 0 and click on the Apply button at the bottom of the Object Properties window. I follow this same process for the other two band grid layers: '1MCL720020922_3' and '1MCL720020922_4'. The three input grid layers are now ready.

I initiate the "RGB Composite" Colors: Type option with one of the three input layers in active status. It does not make any difference which one. I am going to use the near-infrared layer '1MCL720020922_4' of the Landsat 7 scene. I move the mouse pointer into the Data tab area of the Manager window over the grid layer name '1MCL720020922_4'. I press the left mouse button and the layer name becomes highlighted. I click on the Settings tab in the Object Properties window. I move the mouse pointer down to the Colors: Type parameter and choose the "RGB Composite" option.

When I choose the "RGB Composite" option a new section titled "RGB Composite" displays. This section is where I choose which layers are to be associated with red, green, or blue in the composite image. Figure 9-36 displays the "RGB Composite" section of the grid layer parameters.

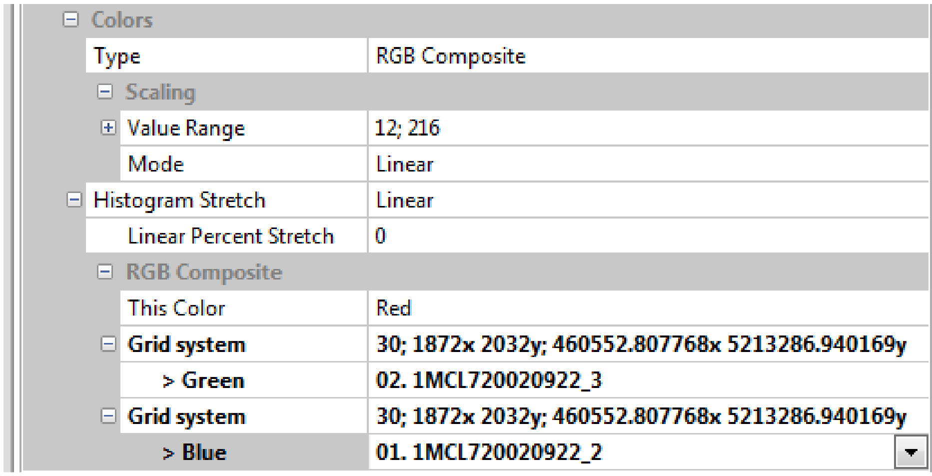


Figure 9-36. Example settings for the “RGB Composite” setting.

The ‘This Color’ parameter is for the current, active layer, '1MCL720020922_4'. This is the layer for which the "RGB Composite" is chosen for the Colors: Type parameter. There are three choices for 'This Color': Red, Blue, or Green. I have chosen "Red". This means that the data values of the near-infrared band, '1MCL720020922_4', display in the composite using the red channel. When I choose "Red" the other two color related parameters change to '> Green' and '> Blue'. If I had chosen "Green" the other two would have changed to '> Red' and '> Blue'.

The 'Grid system' parameters are for choosing the grid system or systems (in the case where more than one system is involved) the grid layer is a part that is going to be chosen for the color parameter.

The color green is assigned to the grid layer '1MCL720020922_3'. This band captures the red portion of the electromagnetic spectrum. The color blue is to be assigned to the grid layer '1MCL720020922_2'. The three bands are part of the same grid system. I choose the grid system for the first 'Grid system' parameter and choose the '1MCL720020922_3' grid layer for the input '> Green' parameter. I choose the same grid system for the second 'Grid system' parameter and the '1MCL720020922_2' grid layer for the input '> Blue' parameter. Once I make my choices I click on the Apply button at the bottom of the Object Properties window and the display composite is created.

Figure 9-37 (on the left) displays the composite display using the settings in the "RGB Composite" section in Figure 9-36. The active grid layer happens to be band 4 (near infra-red spectral reflectance).

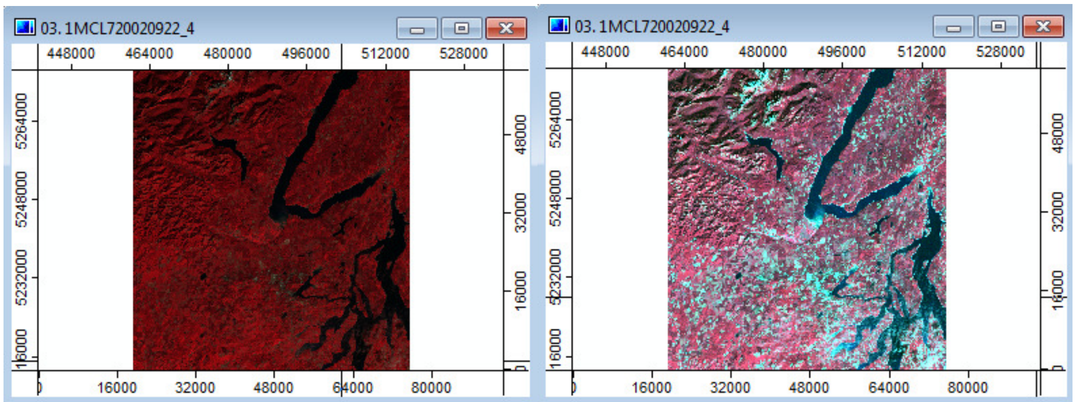


Figure 9-37. Example composite display using the "RGB Composite" choice.

The RGB composite map view window on the left appears quite dark and difficult to interpret. This is because the 'Histogram Stretch' parameter for each of the three input grid layers are set to use the full range of data values for each layer. I am going to change the 'Histogram Stretch' parameter to "Standard Deviations" and use 2 for the 'Standard Deviations' parameter for each of the three input layers. As I change this setting for each layer, the composite image display automatically updates. The final RGB composite displays on the right in Figure 9-37.

None of the display options explained in this section change data values. The options change the visual appearance of a grid layer. The intent is to color enhance content or isolate a feature or features of interest.

At the beginning of the section I referenced the *Visualisation/RGB Composite* tool. This tool can produce an RGB composite grid layer. The data values for this layer are the actual red-green-blue numbers defining a particular color shade and hue. Figure 9-38 displays a composite created by the *Visualisation/RGB Composite* tool.

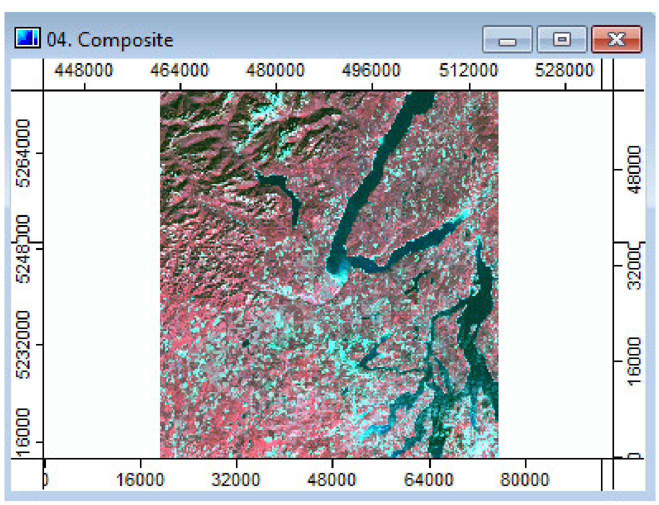


Figure 9-38. A composite created by the *Visualisation/RGB Composite* tool.

The same grid layers and settings used with the Colors: Type "RGB Composite" option are used as parameters for the *Visualisation/RGB Composite* tool. The two composites are quite similar in appearance.

The other popular composite image is a true color composite. Three input grid layers representing the three Landsat bands 1 (blue), 2 (green) and 3(red) are used. The red is assigned to band 3, green to band 2 and blue to band 1. The same entries are used for the 'Histogram Stretch' parameters ("Standard Deviation", 'Standard Deviation' set to 2). An example output displays in Figure 9-39.

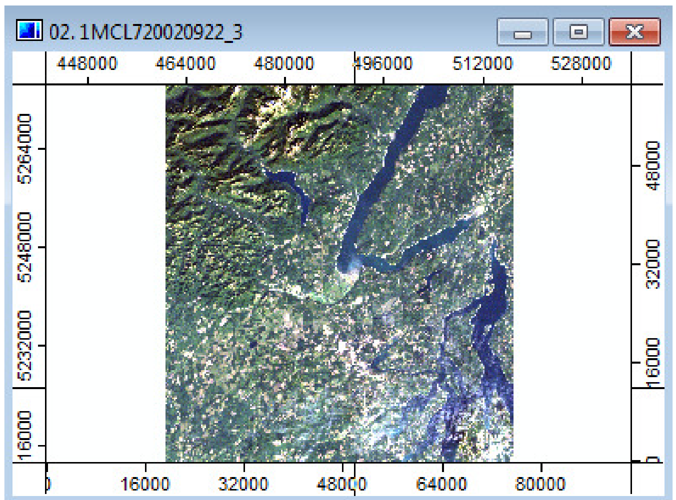


Figure 9-39. A true color composite using Colors: Type "RGB Composite".

Colors: Type: RGB Coded Values
The "RGB Coded Values" option for Colors: Type is for displaying grid layers that use RGB coded values as data values. For example, the RGB composite grid layers produced with the *Visualisation/RGB Composite* tool contain RGB coded values as data values.

The 'Histogram Stretch' parameter does not support RGB coded values.

The Description Tab of the Object Properties Window
Figure 9-40 displays the Description tab of the Object Properties window for a ground slope (in degrees) grid layer. Users cannot directly edit data displayed in the 'Description' window.

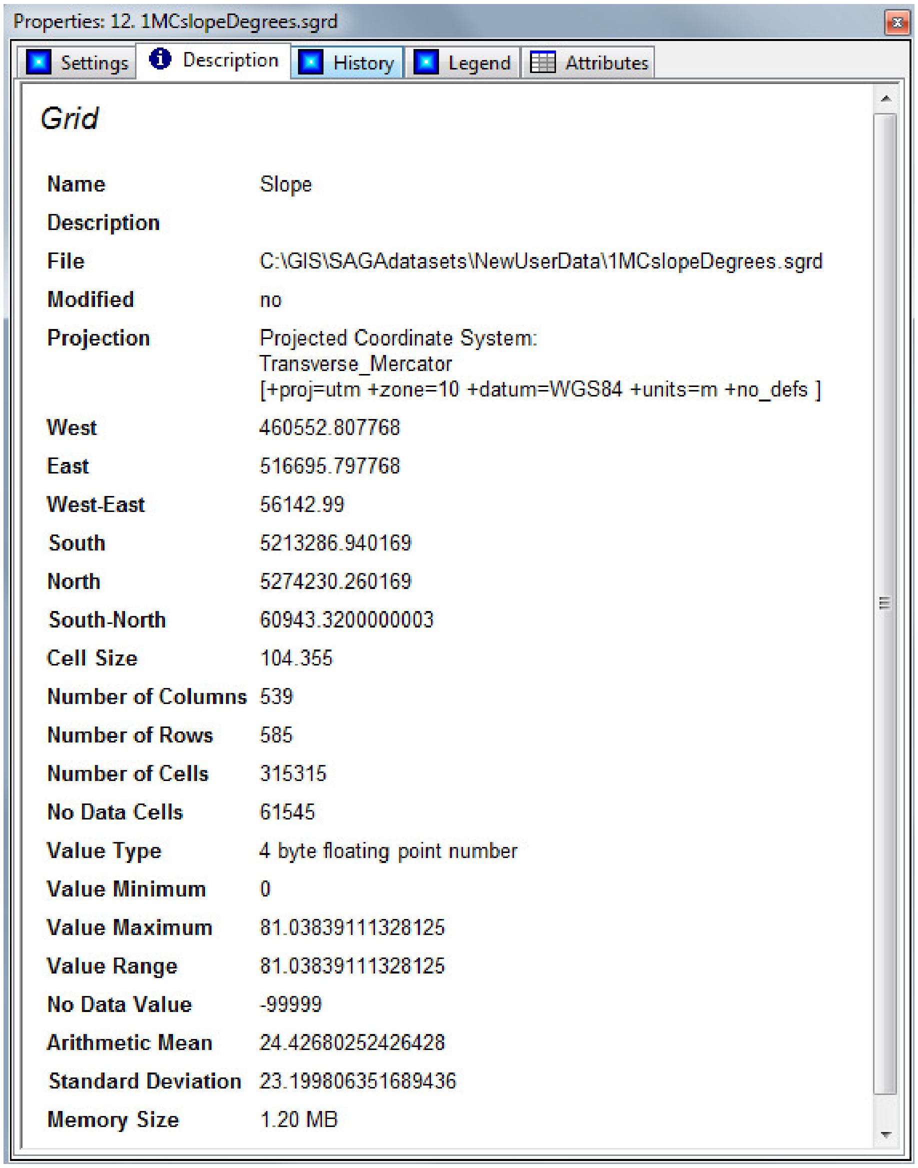


Figure 9-40. The Description tab area for the '1MCslopeDegrees' grid layer.

The Description tab of the Object Properties window displays information for a selected layer. The "Name" display field displays the entry for the 'Name' parameter in the Settings tab area of the Object Properties window. Immediately under the "Name" field is a "Description" field. Information entered for the 'Description' parameter displays for this field. If this parameter does not have an entry, the field is blank. Below it is the file name and storage path for the layer files on the desktop system. In this example, the name used for the 'Name' parameter is "Slope" and the data 'File' name is "1MCslopeDegrees.sgrd". I usually use the layer file name for the 'Name' parameter. The exception is when I use the layer in a layout view window and I want to use a title for the legend that better describes the layer values units of the values.

The "Projection" information describes the projected coordinate system. This coordinate system information is stored in a .prj file for the layer. The information is entered with the "Spatial Reference" option available for the layer in the Data tab of the Manager window or using the *Projection - Proj.4/Set Coordinate Reference System* tool. This information can be updated or changed using the tools available in the Projection library. This information can be missing; in this case a .prj file for the layer does not exist.

The next several variables relate to the grid system definition in terms of metric coordinates and rows and columns of grid cells.

The West, East, South, and North information fields list the UTM coordinate for the sides of a bounding box for the grid system. The West-East and South-North identify distances in meters across the bounding box.

The grid cell size is square, 104.355 meters on a side. The matrix of grid cell rows and columns for the grid system is 539 grid cells wide by 585 grid cells high. The number of rows and columns is determined by dividing the West-East and South-North distances by the grid cell size. There are 315,315 cells in the bounding box.

A study area falls within the bounding box. Valid data values occur in grid cells that fall within the study area. The study area is irregular in shape and lies within the bounding rectangle described above. Grid cells within the bounding rectangle but outside of the irregular shape of the study area contain the no data value -99999. There are often grid cells within a study area that are treated as no data cells for a particular layer theme; for example, grid cells on a road grid layer that do not fall on a road or areas that have not been mapped for the theme. The information field "No Data Cells" identifies the number of grid cells in the layer containing the no data value.

The ‘Value Type’ information field displays the type of numeric values stored in the layer. The various types of numeric data supported in SAGA display in the list below. Grid layers only contain numeric data values. The name reference that SAGA uses for each data type is in quotes.

"unsigned 1 byte integer"; integer values from 0 to 255
"signed 1 byte integer"; integer values from –128 to 127
"unsigned 2 byte integer"; integer values from 0 to 65535
"signed 2 byte integer"; integer values from –32768 to 32767
"unsigned 4 byte integer"; integer values from 0 to 4294967295
"signed 4 byte integer"; integer values from -2147483648 to 2147483647
"unsigned 8 byte integer"; integer values from 0 to 18,446,744,073,709,551,515
"signed 8 byte integer"; integer values from + or - 9,223,372,036,854,775,808
"4 byte floating point number"; real values with seven digits precision
"8 byte floating point number"; real values with fifteen digits precision
"binary"; values of 0 and 1

The “4 byte floating point number” text used in Figure 9-40 for the ‘Value Type’ refers to "4 byte floating point number"; real values with seven digits precision.

The layer values are described in the Value Minimum, Value Maximum, Value Range, Arithmetic Mean and Standard Deviation information fields.

The ‘Value Range’ is the maximum value for the layer minus the minimum value. The value range for the '1MCslopeDegrees.sgrd' layer is 81.038. The ‘Arithmetic Mean’ is the result of totaling up all of the data values contained in all of the cells with data and dividing by the total number of cells containing valid data values. In this example the arithmetic mean is 24.427.

The ‘Standard Deviation’ is a measurement of the amount of spread or dispersion of the data values around the arithmetic mean. If a graph of the data dispersion resembles a normal curve or is bell-shaped, 68% of all the data values fall within plus or minus 1 standard deviation of the arithmetic mean. The standard deviation for the '1MCslopeDegrees.sgrd' layer is 23.2. Plus or minus 23.2 around an arithmetic mean of 24.427, means that approximately 68% of all the slopes fall within the data range from 1.227 to 47.627 degrees.

The last variable is ‘Memory Size’. The value represented here is the amount of random access memory it takes to store the layer.

The History Tab of the Object Properties Window
A history file uses the .mgrd file format. The History tab area of the Object Properties window for a layer can provide information on how the layer evolved. Figure 9-41 displays the History tab area for a grid layer named ‘1MCrelief’.

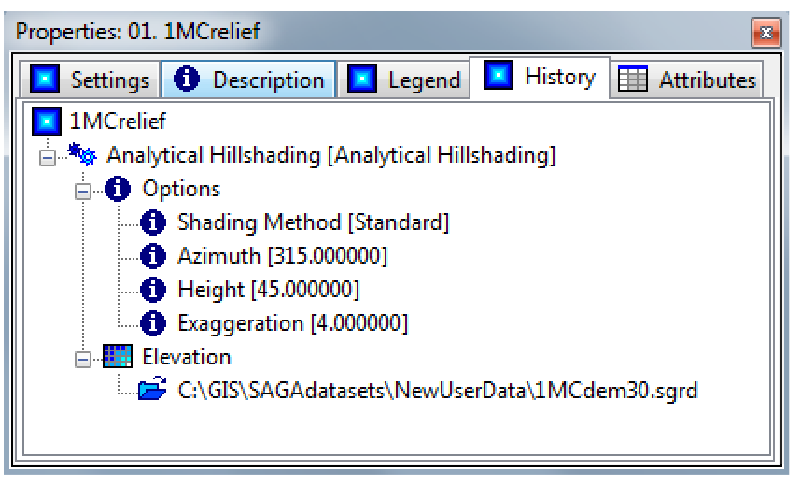
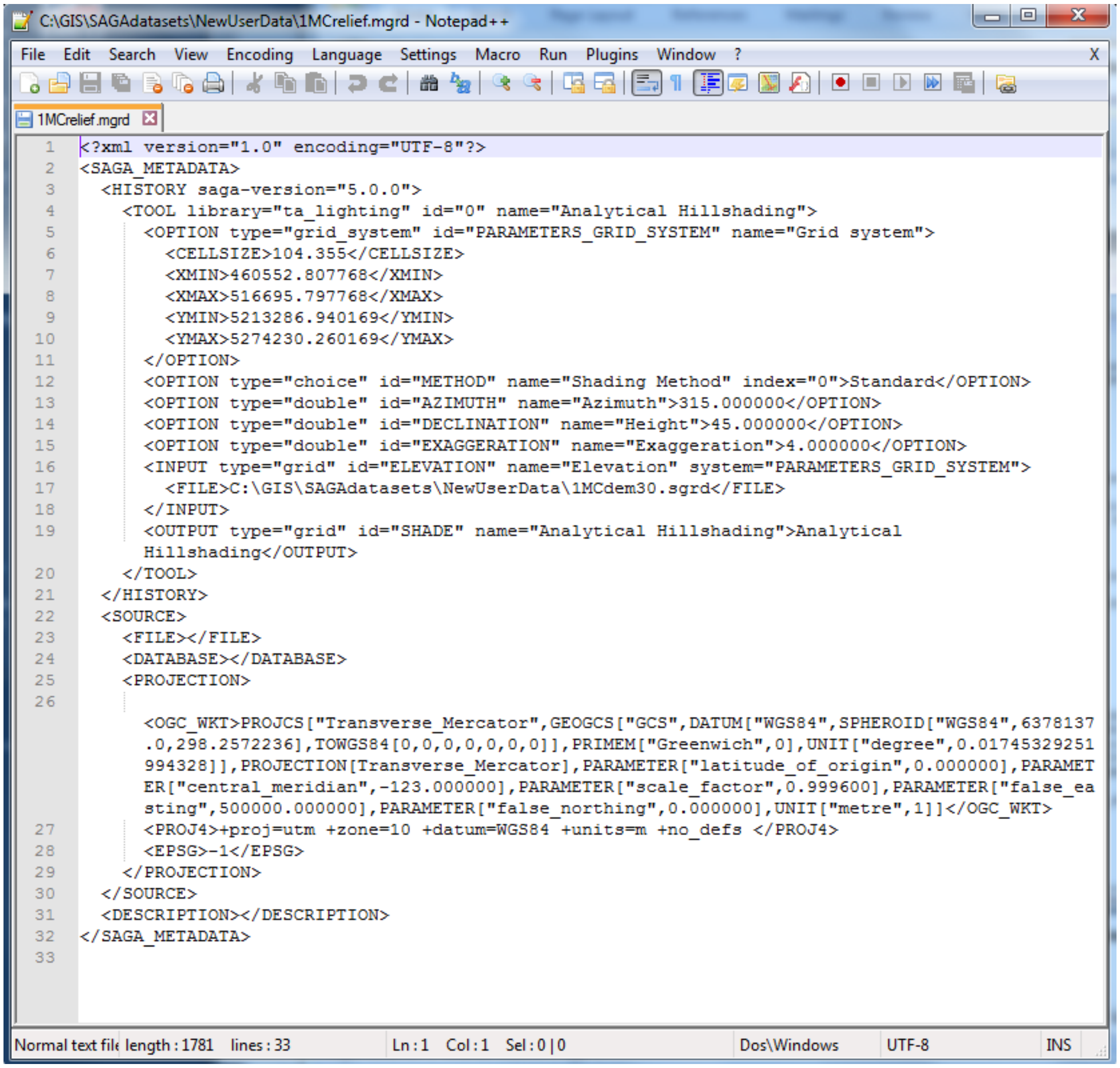


Figure 9-41. The History tab area for the “1MCrelief” grid layer.

The history indicates that the SAGA tool named *Analytical Hillshading* was applied using a grid layer named “1MCdem30.sgrd” for the 'Elevation' input parameter. The options included "Standard" for the 'Shading Method' parameter, 315 for 'Azimuth', 45 for 'Height' and 4 for the 'Exaggeration' parameter.

The history file can be viewed using the 'History' tab. The .mgrd file itself can also be viewed with Notepad ++ and other text editors. Figure 9-42 displays the .mgrd file for the “1MCrelief” grid layer.




```
<?xml version="1.0" encoding="UTF-8"?>
<SAGA_METADATA>
  <HISTORY saga-version="5.0.0">
    <TOOL library="ta_lighting" id="0" name="Analytical Hillshading">
      <OPTION type="grid_system" id="PARAMETERS_GRID_SYSTEM" name="Grid system">
        <CELLSIZE>104.355</CELLSIZE>
        <XMIN>460552.807768</XMIN>
        <XMAX>516695.797768</XMAX>
        <YMIN>5213286.940169</YMIN>
        <YMAX>5274230.260169</YMAX>
      </OPTION>
      <OPTION type="choice" id="METHOD" name="Shading Method" index="0">Standard</OPTION>
      <OPTION type="double" id="AZIMUTH" name="Azimuth">315.000000</OPTION>
      <OPTION type="double" id="DECLINATION" name="Height">45.000000</OPTION>
      <OPTION type="double" id="EXAGGERATION" name="Exaggeration">4.000000</OPTION>
      <INPUT type="grid" id="ELEVATION" name="Elevation" system="PARAMETERS_GRID_SYSTEM">
        <FILE>C:\GIS\SAGAdatasets\NewUserData\1MCdem30.sgrd</FILE>
      </INPUT>
      <OUTPUT type="grid" id="SHADE" name="Analytical Hillshading">Analytical Hillshading</OUTPUT>
    </TOOL>
  </HISTORY>
  <SOURCE>
    <FILE></FILE>
    <DATABASE></DATABASE>
    <PROJECTION>

      <OGC_WKT>PROJCS["Transverse_Mercator",GEOGCS["GCS",DATUM["WGS84",SPHEROID["WGS84",6378137.0,298.2572236],TOWGS84[0,0,0,0,0,0,0]],PRIMEM["Greenwich",0],UNIT["degree",0.01745329251994328]],PROJECTION[Transverse_Mercator],PARAMETER["latitude_of_origin",0.000000],PARAMETER["central_meridian",-123.000000],PARAMETER["scale_factor",0.999600],PARAMETER["false_easting",500000.000000],PARAMETER["false_northing",0.000000],UNIT["metre",1]]</OGC_WKT>
      <PROJ4>+proj=utm +zone=10 +datum=WGS84 +units=m +no_defs </PROJ4>
      <EPSG>-1</EPSG>
    </PROJECTION>
  </SOURCE>
  <DESCRIPTION></DESCRIPTION>
</SAGA_METADATA>
```


Figure 9-42. Display of a portion of the ‘1MCrelief.mgrd” file using Word.

The Legend Tab of the Object Properties Window

The next tab at the top of the Object Properties window is Legend. Figure 9-43 displays the '1MCslopeDegrees' map view window and the Legend tab area for the layer.

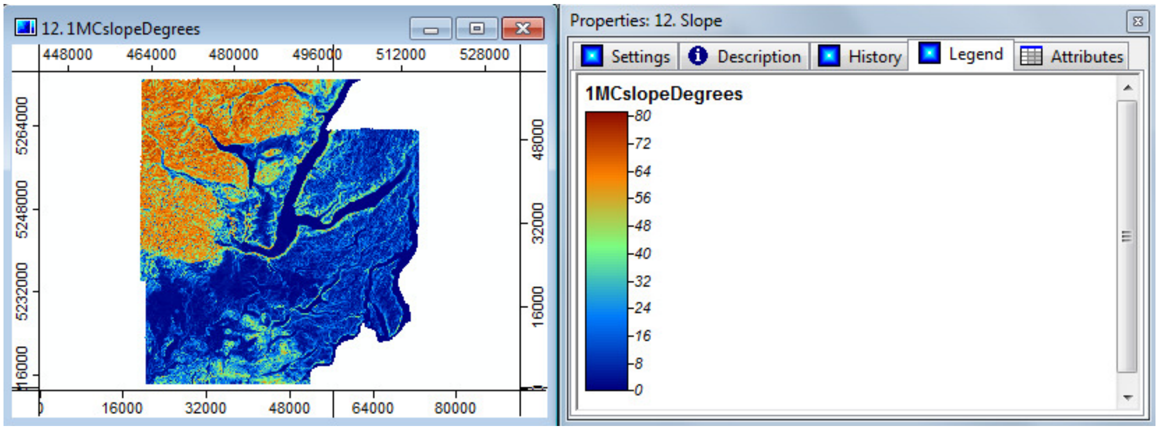


Figure 9-43. The Object Properties window Legend tab area for the 'MCslopeDegrees' grid layer.

Slope is continuous type data rather than discrete. Continuous type data can be measured whereas discrete data is counted. Looking at the legend I see that the data values for slope range from 0 to over 80 degrees. In contrast to continuous type data, discrete data can be considered categorical data. For example, if slope data values are aggregated from their original continuous version into six data categories or classes, each with upper and lower class boundaries, this would be characterized as discrete data classes.

Figure 9-44 shows a legend for slope where the data is portrayed as discrete. Rather than using the default "Graduated Color" option for 'Display: Color Classification: Type' the "Lookup Table" option is used.

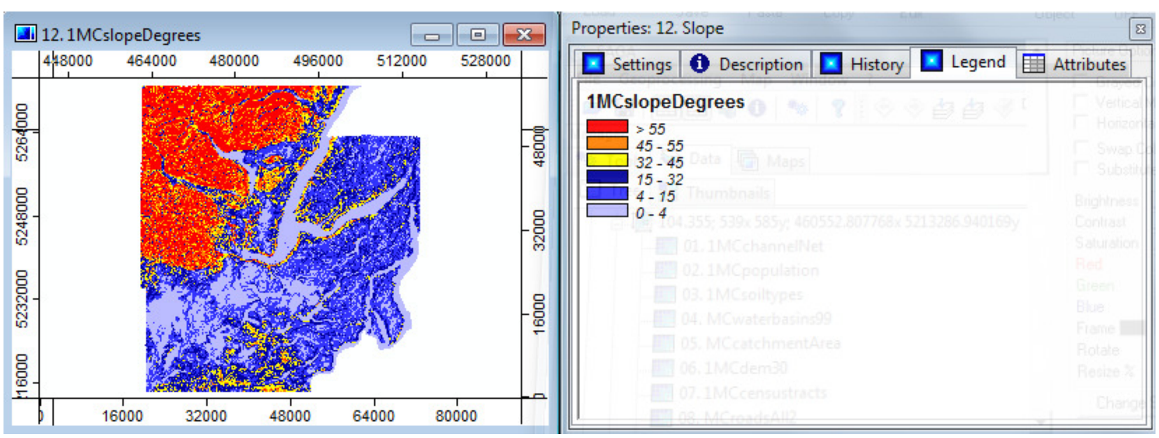


Figure 9-44. The Legend tab area for a discrete data set.

Where a single color box displaying interpolated colors is used for displaying continuous data, discrete data classes are assigned individual boxes and usually unique colors. The data classes have upper and lower data values defining the classes. The class names are entered into the "NAMES" column of the lookup table as descriptive text.

The Attributes Tab of the Object Properties Window

The results of using the Action selection tool to select a single cell or a group of cells are displayed in the Attributes tab of the Object Properties window. The Action selection tool from the tool bar is used to select one or a matrix of cells (one or more contiguous cells). A maximum of 10 rows or 10 columns can be selected. The data values of the selected cells are displayed in a row and column format in the Attributes tab area of the Object Properties window.

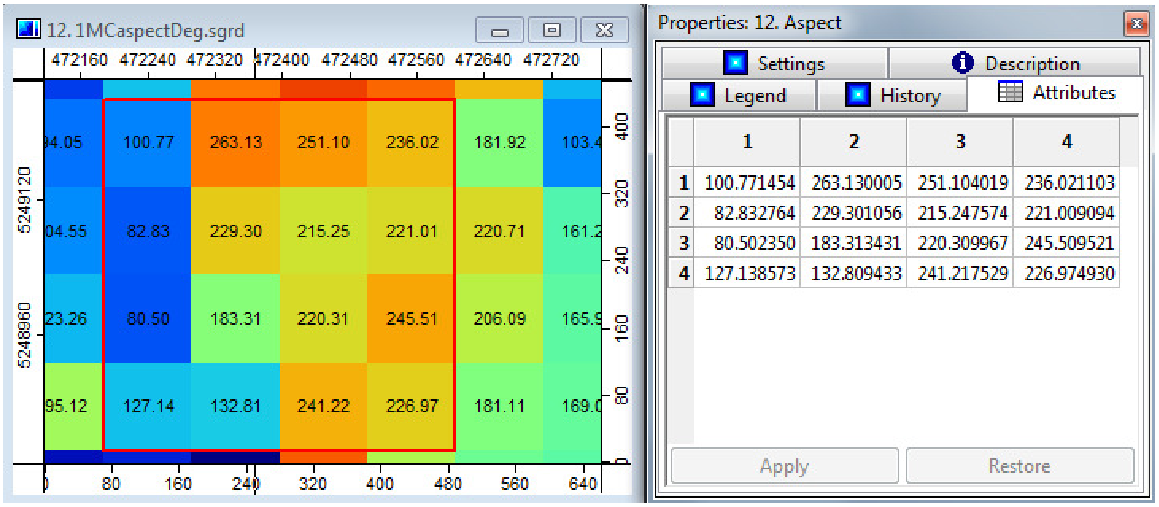


Figure 9-45. A selection on the '1MCaspectDeg' grid layer.

This example uses the aspect grid layer '1MCaspectDeg'. I selected a 4 cell by 4 cell matrix of grid cells. A red box surrounds my selection. The Attribute tab area of the Object Properties window was updated with the selection information. I am using the 'Show Cell Values' parameter to display the grid cell values for the layer in the map view window on the left. This step is not needed to view the cell values in the Attribute tab area; it allows you to see the correlation between the layer and the tab area.

Chapter 10 – Object Properties for Shape Layers

The emphasis for this chapter is parameters associated with shape layers. The Settings tab in the Object Properties window is where parameters for a layer are viewed. With the Object Properties window displayed in the work area, when I click on a shape layer name or thumbnail in the Data tab area of the Manager window, the properties for the layer update the content of the Object Properties window.

Introduction to Shape Layers

Grid cells are the spatial objects of a grid layer while shape layers consist of geometrically and spatially defined objects. Grid layers are single data theme based. Points, lines, or polygons are the spatial objects of shape layers. And, shape layers are multi-themed.

Each shape layer includes an attribute table. Each row in the table is for a specific object of the shape layer. The columns of the table are attributes or characteristics describing the object. For example, a soils shape layer usually consists of polygon objects. Each polygon object represents a soil type delineation. There can be more than one polygon on the layer having the same characteristics. The columns or attributes of the table may identify a soil mapping unit, soil depth, hydrologic group, bedrock type, etc. The attributes describe the polygon objects.

The lowest common denominator or geometric building block for a vector or shape layer is a vertex. A point shape layer consists of objects defined by vertices; a single vertex defines each point object. A scale factor may be involved. At a large scale, examples of point objects include well sites, nest sites, springs, etc. At a small scale points could represent towns and cities even though these features have area. Because of the small scale the towns and cities have no area and can be represented by a point object.

When I connect two vertices with a straight line I have a line or line segment. A line segment can be referred to as an edge. An edge has a beginning and an end point. One or more edges can be joined to make up line objects. Edges can define a road, stream, etc. The points defining the various edges of a line object are referred to as vertices. Vertices can also define changes in the line angle itself. Thus, a linear object is made up of one or more connected line segments or edges. Scale can also be a factor with linear features. For example, roads are normally portrayed by lines. However, at a large scale, roads have width or area and can be portrayed with polygon objects.

A polygon is an area defined by edges enclosing an area. Practically, a polygon is a series of edges where the location of the beginning point of the first edge is identical to the location of the ending point of the last edge enclosing the area. Points defining a polygon object boundary are referred to as vertices.

There are differences between the Object Properties parameters for point, line, and polygon vector or shape layers. For example, line shape layers have a ‘Line Style’ parameter whereas points and polygons do not. Points layer settings include four parameters for positioning label text for a point symbol. Most of the parameters, for all three of the shape types, are discussed in this chapter.

In this chapter, as much as possible, when a parameter is identified for discussion, immediately below the parameter name, I have identified the object type or types using the parameter. For example, the first parameter General: Name is a parameter for all three types. Just below the parameter name appears:

[line, point, polygon]

Recall from earlier in this guide, when a layer is saved, the default parameters or edited parameters are not stored as part of the layer. Display parameter values are saved in three ways.

When a layer is loaded into a work session using a 'Load' command, the defaults for the layer parameters are restored. When I save or re-save a project, the current display parameter values, whether defaults or edited, for all layers available in the work session, are saved as part of the project file (.sprj). When I exit from SAGA, a configuration (.cfg) file is saved. This file contains the same parameter information as a project file.

I can save the parameter values for a specific layer currently displayed in the Settings tab of the Object Properties window using the Save button, at the bottom of the window. This is the only way to explicitly save a set of display parameters for a layer independent of a project environment or the configuration file. The values are saved to a .sprm file. For example, I changed parameter settings for a school district shapes layer. I saved the changed parameter settings using the Save button at the bottom of the Object Properties window. I also saved them as part of a project definition. I can now re-load the saved .sprm file if I want to be sure of using the same modified parameters for the layer in other projects. When I use the layer in another project or load the layer into another project, I can use the Load button at the bottom of the Object Properties window to retrieve the modified set of parameters that have been stored independent of the project environment.

The Settings Tab of the Object Properties Window for Shape Layers

Let's look at the Settings tab area of the Object Properties window for the '1MCwaters-Poly' polygon shape layer. I click on the Data tab of the Manager window and move the mouse pointer over the layer name '1MCwaters-Poly'. I press the left mouse button. The properties for the layer appear in the Settings tab of the Object Properties window. Figure 10-1 shows the properties for the polygon shape layer named ‘1MCwaters-Poly’.

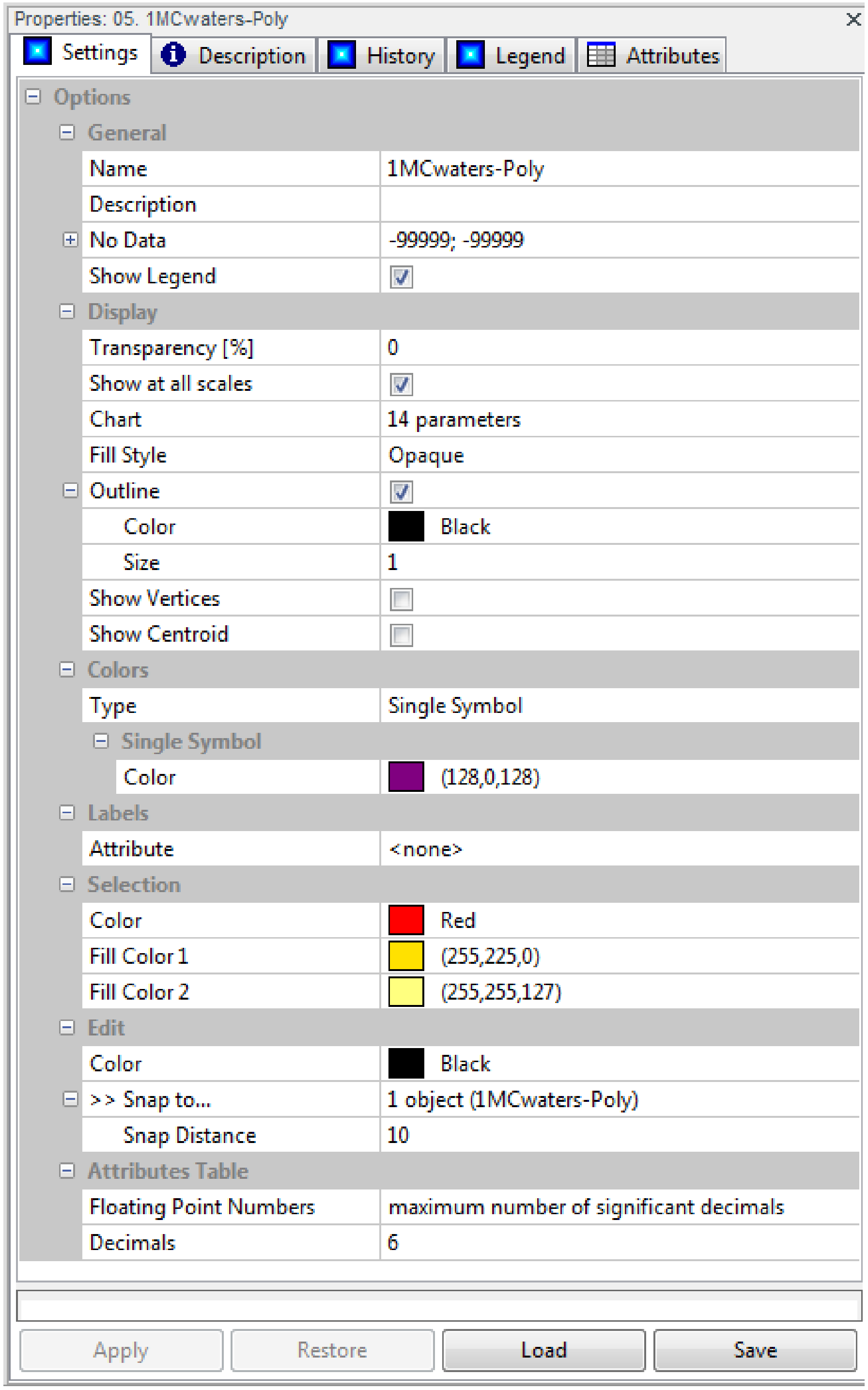


Figure 10-1. The Settings tab for the 'MCwaters-Poly' polygon shape layer.

The settings page displayed in Figure 10-1 looks similar to the one displayed in Figure 9-1 for grid layers. Upon closer comparison, however, I see differences.

Whereas the settings page for a grid layer had three sections, a settings page for a shape layer has seven sections. Both have General, Display, and Colors sections. Shape layers have additional sections supporting attributes and objects. These are: Labels, Selection, Edit, and Attribute Table.

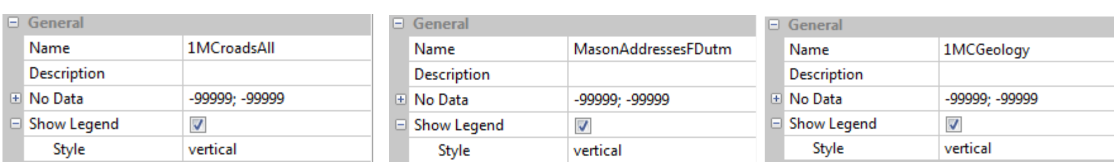
Both settings pages have the same buttons at the bottom of the window: Apply, Restore, Load, and Save. Until I make a change to any of the parameters, the Apply and Restore buttons are grayed out and not available. When I click with the mouse to choose an option in a parameter value field, the Apply button changes and is available. The Apply button text displays in bold. I must click the Apply button for a change to take effect. If the parameter is one requiring me to key information into the value field, e.g., a number, after I key in the information I press the Enter key on the keyboard. The Apply button then becomes active and is not grayed out. Clicking on the Apply button updates any parameter changes.

The Restore button acts like a cancel button. If I have made changes to parameters, have not used the Apply button to enable them, and decide that I do not want to apply them, I click on the Restore button and the parameters return to their pre-change status.

The Save button was introduced earlier. This button saves a set of parameters displayed in the Object Properties window in a .sprm data file for later use. Once the parameter .sprm file exists, the Load button loads it. The content of this file is identical to the layer content saved as part of a configuration or project file.

In Figure 10-1, on the left side of the parameter list, are "-" and "+" symbols in boxes for some of the options listed. A "+" means additional parameters can be viewed by clicking on the "+" symbol. For example, in Figure 10-1 there is a "+" to the left of the 'No Data' parameter. I click on the "+" with the mouse pointer and two additional parameters display: 'Minimum' and 'Maximum'.

General Parameters
Figure 10-2 displays a list of the parameters available in the General area of the Object Properties window for line, point, and polygon shape layers.



Line Point Polygon

Figure 10-2. The General category of parameters.

General: Name
[line, point, polygon]
The value field to the right of this parameter displays the name that the SAGA program uses for this layer. This is not the file name but is a name assigned for referencing the layer. For example, this is the name used in the Data tab area listing available layers in the Manager window. It is the name for a layer in layer lists for choosing input and output for tools.

I can enter a different name or edit the one that appears. I click in the value field with my mouse pointer and highlight the entry. Once I change the name, I must click on the Apply button at the bottom of the window in order for the change take effect. Changing the name does not change the name of the saved file for the layer.

The 'Name' parameter is also the text used when displaying the legend for the layer. When I click on the Legend tab at the top of the Object Properties window, the title for the displayed legend is the entry for the 'Name' parameter. It is the title for the legend when I use the 'Show Print Layout' option. This is an important role for this parameter when I am creating a layer for view by others.

General: Description
[line, point, polygon]
I can enter free-form text that will display in the value field to the right of the 'Description' parameter name. I move the mouse pointer over the ellipsis on the far right and press the left mouse button. The 'Description' entry form in Figure 10-3 displays.

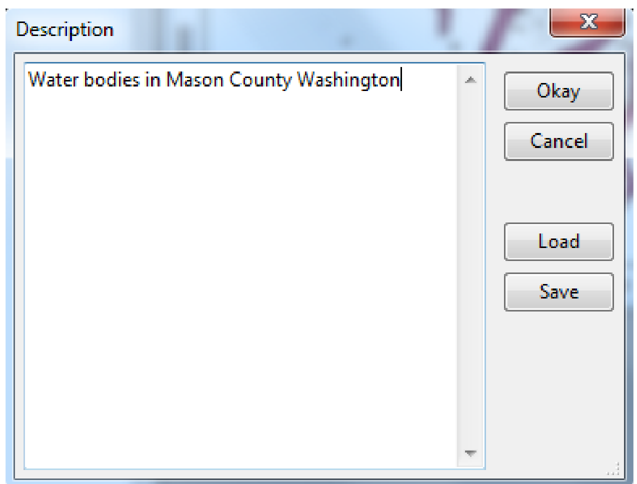


Figure 10-3. The 'Description' entry form.

I move the mouse pointer into the form and press the left mouse button. I enter text from the keyboard. I have entered text describing this layer. I could also enter keywords. I click on the Okay button with the mouse pointer and the text I entered displays in the 'Description' value field.

The information entered for the 'Description' parameter is searchable. The names of attributes in attribute tables for shape layers area also searchable. SAGA has a search function (described in Chapter 2 of this User Guide) to search for selected text contained in this value field (as well as text entered for the 'Name' parameter) and attribute table column names. The search function works with layers available in the current work session.

The search function is accessed in the Data and Maps tab areas of the Manager window. Move the mouse pointer over the word "Data" or "Maps" near the top of the Manager window and press the right mouse button. At the bottom of the popup list of options is an option named "Search for...". The 'Locate...' dialog window displays. I enter "Mason" into the value field to the right of the 'Search for...' parameter. I click on the toggle check box for the 'Description' parameter and a check mark appears in the box. Next I click on the Okay button. A second 'Locate...' window displays containing the name of the '1MCwaters-Poly' polygon shape layer whose 'Description' parameter contains the text described in Figure 10-3.

How much text can be entered for the 'Description' parameter? I am not sure. I have entered over 1000 characters without a problem. This parameter may be under appreciated.

General: No Data
[line, point, polygon]
This parameter specifies a data range to represent “no data”. The two variables are ‘Minimum’ and ‘Maximum’. If the no data value is a single value, e.g., -99999, this value appears for both 'Minimum' and 'Maximum'. If the no data value is a range, e.g., -99999 to -999, -99999 displays for ‘Minimum’ and –999 for ‘Maximum’.

The no data value or values used with a layer are usually determined by how the layer is created. For example, I use the *Shapes - Tools/Create New Shapes Layer* tool to create a new shape layer. By default, this tool defines the no data value for a new layer as -99999. I check the Settings tab area of the Object Properties window for the new layer and see that the no data value is -99999.

An imported layer will have a no data value assigned by the SAGA import tool. Users can edit the entries for the no data value parameters.

General: Show Legend
[line, point, polygon]
This parameter affects the "Show Print Layout" option available on the Menu Bar Map menu. The Map menu is available when a map view window is the active window in the work area.

The default for the 'Show Legend' parameter is for this toggle check box parameter to be on. This means when I choose the "Show Print Layout" option, the legend for the chosen shape layer displays in the view window beside the layer, on the right.

Figure 10-4 displays the two versions of the layout view window. The version on the left includes the legend, the 'Show Legend' parameter is on. The map view window on the right does not include the legend; the parameter is off.

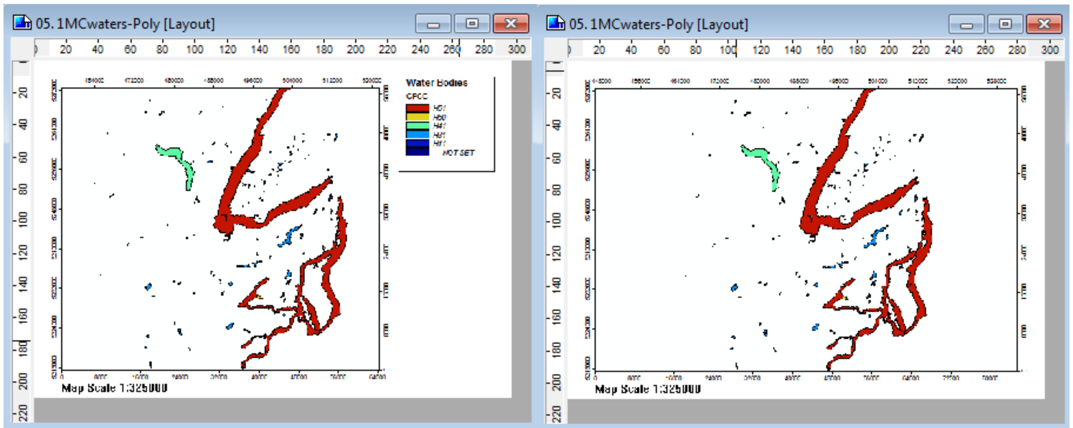


Figure 10-4. Two map layout windows - one with a legend (on the left) and one without.

The Legend tab in the Object Properties window is not affected by this parameter. The Legend tab is discussed toward the end of this chapter. The orientation of the legend is affected by the next parameter.

General: Show Legend: Style
[line, point, polygon]
This parameter is only available if the toggle check box for the 'Show Legend' parameter contains a check (the option is on) and the "Graduated Colors" option is chosen for the Colors: Type parameter. It has two options: vertical and horizontal. The options relate to the orientation of the legend in the layout view window and in the Legend tab display area.

Figure 10-5 displays a layout view window created with the "Show Print Layout" option, on the left, and the view of the Legend tab area of the Object Properties window on the right. In this example, a layer for census tracts is used and the attribute selected is for population. The "Graduated Colors" option is used for the Colors: Type parameter. The 'Show Legend' parameter is on and "horizontal" is chosen for the 'Style' parameter.

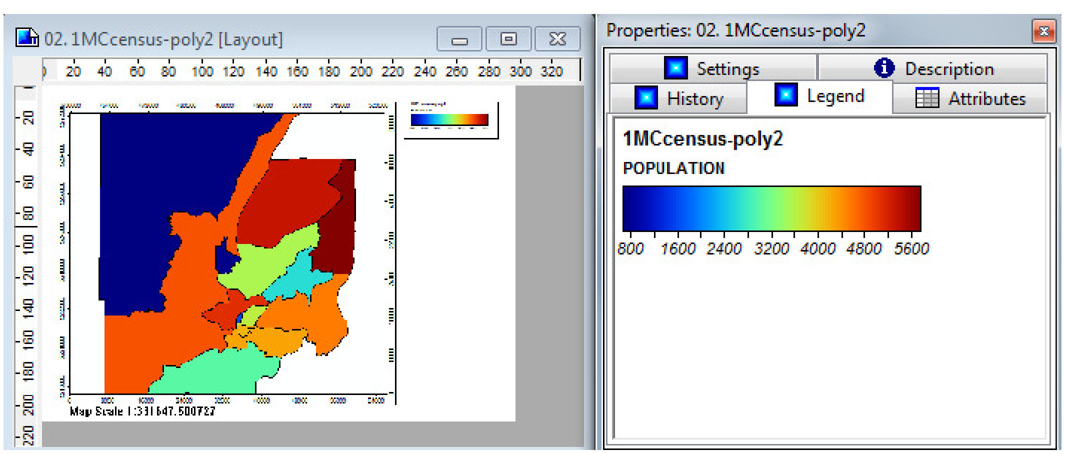
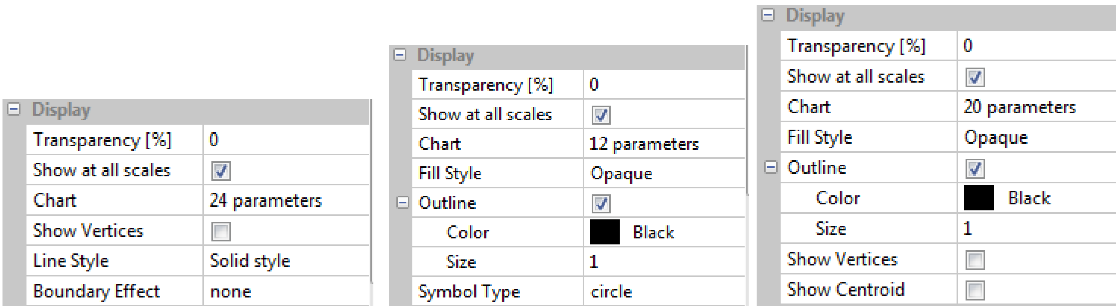


Figure 10-5. Using the "Horizontal" option for the Show Legend: Style parameter.

The legend created is for displaying continuous data using a continuous color ramp or palette.

Display Parameters

Figure 10-6 displays the parameters of the "Display" section of the settings page for a line shape layer, a point shape layer, and a polygon shape layer.



Line Point Polygon

Figure 10-6. The parameters of the "Display" section of the settings page.

The first three "Display" category parameters listed are common between the three shape layer types. These are Transparency [%], Show at all scales and Chart.

Line shape layers include three additional parameters: Show Vertices, Line Style, and Boundary Effect.

Point and polygon objects have four additional "Display" category parameters. These are Fill Style, Outline, Outline Color, and Outline Size. Point shape layers also include a parameter for "Symbol Type" and polygon layers include "Show Vertices" (same parameter identified for line objects) and "Show Centroids".

Display: Transparency [%]

[line, point, polygon]

I use this parameter when I display two or more layers in a map view window and I don't want the top layer in the stack to completely block view of a layer lower down in the stack. I can adjust the ‘Transparency [%]’ parameter (a numeric value) for a layer or layers. The higher the percent number, the more “transparent” the layer becomes.

Figure 10-7 displays the land parcels for a zoomed in portion of Mason County, Washington. The color tint is applied to the polygon objects of a school district layer. The top layer in the layer stack for the map view window is a polygon shape layer for school districts. The second layer for land parcels is below this layer in the stack. In this example, I entered 50 for the 'Transparency [%]' for the school district shape layer. If I had not adjusted the entry for the transparency parameter, the opacity of the school district objects would obscure the parcel layer information.

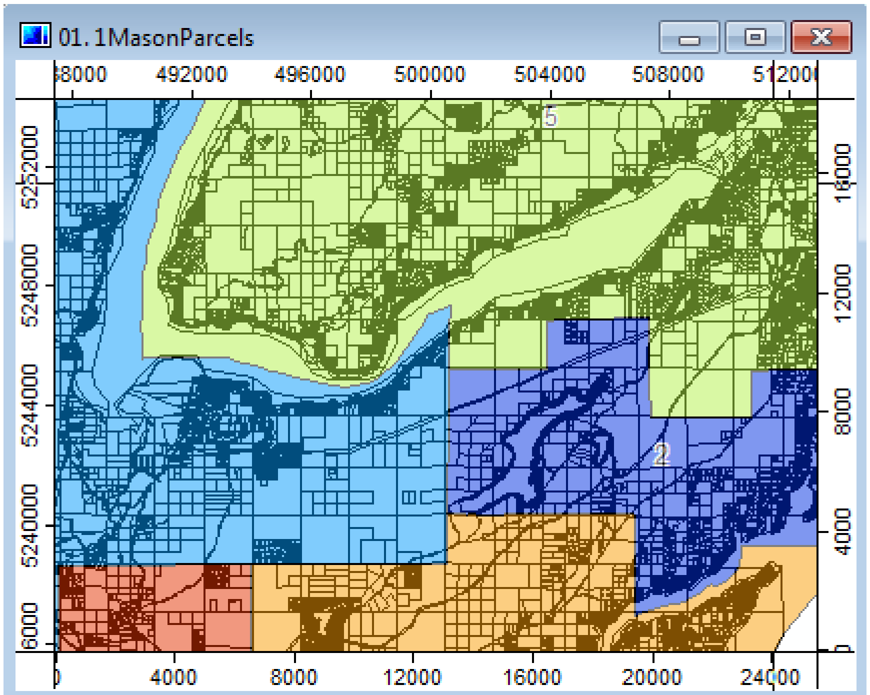


Figure 10-7. Viewing land parcels in school districts.

The option for the 'Fill Style' parameter for the school districts polygon objects in Figure 10-7 is "Opaque". Other options for this parameter identify line patterns. Regardless of whether "Opaque" or a line pattern is used for the 'Fill Style' parameter, the entry for the 'Transparency [%]' parameter applies. It is particularly effective, however, when "Opaque" is the 'Fill Style' option. This is the case in Figure 10-7.

Display: Show at all scales
[line, point, polygon]
This is a toggle check box type parameter. The default is for this parameter to be in on status. The shape layer will display at any scale when this parameter is on (has a check in the box). I can change this parameter to off status by moving the mouse pointer into the box and pressing the left mouse button. The check mark in the box disappears and three additional parameter rows display just below the 'Show at all scales' parameter.

Display: Show at all scales: Scale Range, Minimum, Maximum
[line, point, polygon]
One of the additional parameters is 'Scale Range'. Supporting 'Scale Range' are parameters for setting the minimum scale range ('Minimum') and the maximum scale range ('Maximum'). The values entered for the 'Minimum' and 'Maximum' parameters define the scale range (the minimum map scale and the maximum map scale) for a map view window within which the layer displays. The layer does not display if the scale of the map view window is outside the defined scale range.

The values entered for these parameters are in map distance units. If the scale bar is not displayed in the map view window, the numbers for the ticks along the bottom and right sides of the map view window are map distance units. A layer will display in the map view window if the range for either the bottom or right scales (whichever one is the lesser) is greater than the minimum and less than the maximum.

For example, I have a map view window displaying a grid layer. The map distance range for the bottom side of the window is 72000; the range for the right side is 62000. The map distance range of 62000 is the lesser of the two. I enter 15000 for the 'Minimum' and 70000 for the 'Maximum'. I zoom out changing the map distance range to over 89000. The map does not display in the window. I choose the "Zoom to Previous Map Extent" option. Now I zoom in. When the map distance range reaches less than 15000, the map should not display. I have zoomed in a couple times, the current map distance range is 18000 and the map displays. I zoom in one more time, the range changes to 8800, less than 15000. The map does not display in the window.

Display: Chart
[line, point, polygon]
The purpose of the 'Chart' parameter is to add a bar or pie chart graphic to a map view window for a graphic portrayal of object attribute values.

This example uses the '1MCschoolDist' shape layer. Figure 10-8 displays this polygon shape layer, using the "Transparent" fill style and the school district "ID" attribute for object labels.

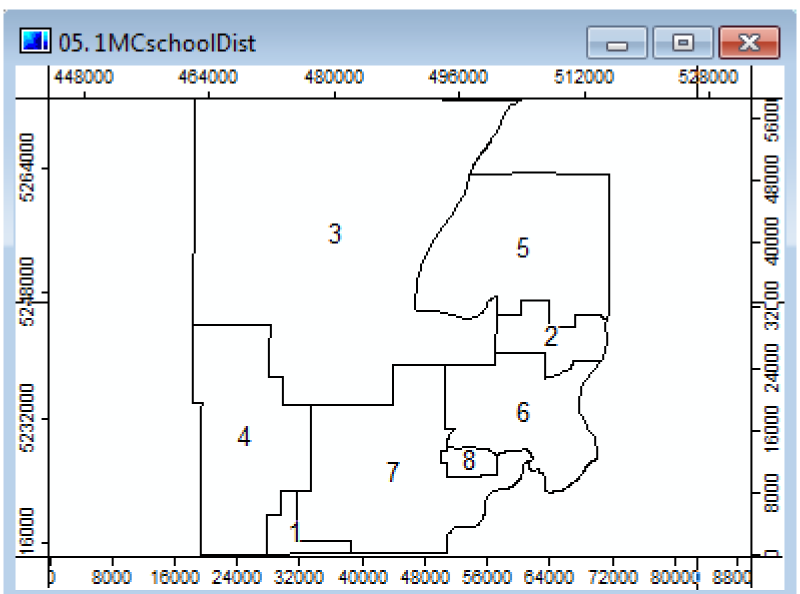


Figure 10-8. The Mason County school district shape layer.

The number that lists in the value field for the 'Chart' parameter, in the Settings tab area for the layer in the Object Properties window, indicates how many numeric attributes are in the attribute table linked to the layer. In the '1MCschoolDist' attribute table, seven of the nine layer attributes are numeric data types.

I click in the value field to the right of the 'Chart' parameter on the ellipsis symbol, the ‘Chart' parameters dialog window in Figure 10-9 displays.

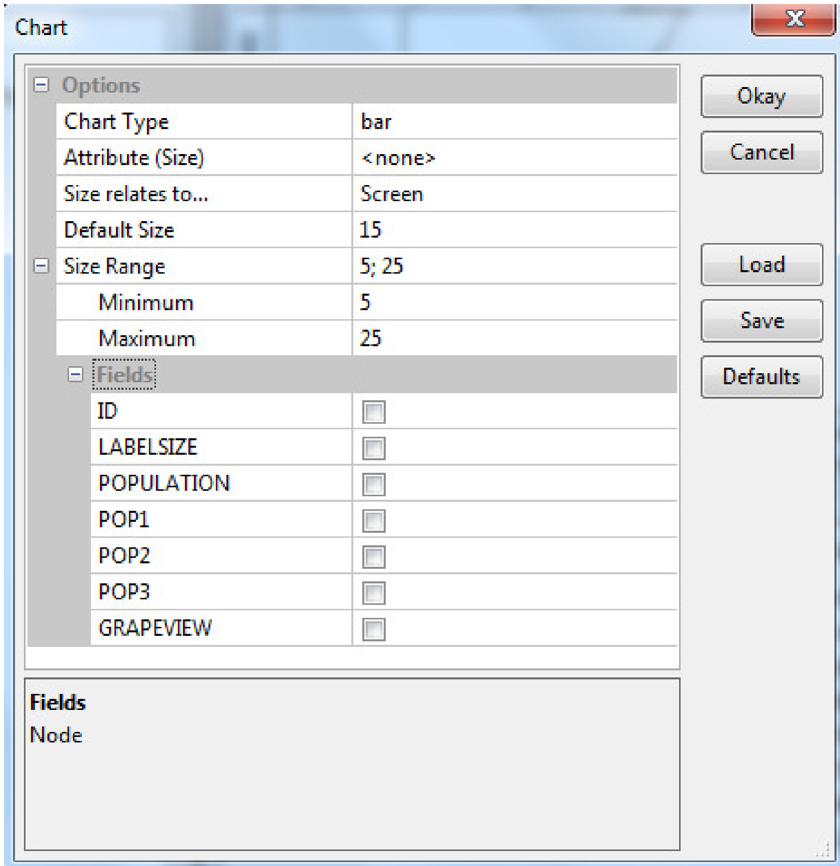


Figure 10-9. The ‘Chart’ parameters dialog window.

The "Options" section lists seven parameters; one of the parameters is an information display ('Size Range') parameter. The ‘Chart Type’ parameter default is “bar”. When I click the mouse pointer in the value field to the right of the ‘Chart Type’ label, a small triangle appears and a popup list of chart type choices displays. The choices for type of chart are bar (not outlined), pie, and pie (not outlined). I am going to change the entry from the default to “pie”.

The units for the 'Default Size' and 'Size Range' parameters are according to the 'Size relates to...' parameter. The units can be in screen units (pixels) or map units. If the "Scale Bar" is visible in the map view window, the numeric values at the tick marks in the frame are X coordinates (bottom and top) and Y coordinates (left and right). If the "Scale Bar" is not used in the map view window, the numeric values at the tick marks in the frame along the bottom and right sides are map distance units.

The default entry for the ‘Attribute (Size)’ setting is "<none>". Using "<none>" means that the size of each chart graphic is determined by the entry for the 'Default Size' parameter and the chosen units. If I enter a 15 for the 'Default Size' parameter, "<none>"

for 'Attribute (Size)', and choose "screen" for the chosen units, each chart graphic is 15 pixels in size. The entry for the 'Default Size' parameter applies if the entry for the 'Attribute (Size)' is "<none>". I can replicate the "screen" size of 15 in "map units" using an entry of 2000.

I can choose a numeric attribute to control the size of the chart graphics (i.e., pies or bars) displayed for the shape layer. The ‘Attribute (Size)’ value field displays a small triangle when I click in the field with the mouse pointer. A popup list displays the names for the numeric attributes in the attribute table. There are seven numeric attributes for the school district layer. I am going to use the "POPULATION" attribute. The data values represent current population for each school district. The lowest population value is 1241 for school district 4. The highest population value is 20692 for school district 7. The populations for the other six districts range in between.

The minimum and maximum values entered for the 'Size Range' parameter determine the size range for each chart graphic. I am going to use map units. I want the largest pie graphic to be 4 times the size of the smallest. I enter 1500 for the 'Minimum' and 6000 for the 'Maximum' parameters. This means that the pie graphs will be proportional in size to their current population. The pie chart for the district having the highest population will be 4 times the size of the pie chart for the district having the smallest population. The pie chart sizes for the other districts will be interpolated within this 1:4 range.

The attribute table for the school district layer is displayed in Figure 10-10. The "POPULATION" attribute is the fifth column in the table. I can see that the district populations are ranked in this order, from lowest to highest: 4, 2, 8, 1, 3, 6, 5 and 7.

I will use 1500 and 6000 for the minimum and maximum entries for the 'Size Range' parameter. This means the chart graphic for district 4 uses the minimum value 1500 and the maximum value 6000 is used by district 7.

01.1MCschoolDist

	ID	SIZE	COUNTY	UNIFIED	POPULATION	POP1	POP2	POP3	GRAPEVIEW	NAME
1	1	1	53045	02490	2000	200	900	900	0	ELMA
2	2	1	53045	03240	1753	646	677	430	1	GRAPEVIEW
3	3	4	53045	03600	4843	2211	2422	211	0	HOOD CANAL
4	4	4	53045	04800	1241	310	631	300	0	MARY M KNIG
5	5	4	53045	05790	11046	2762	5523	2762	0	NORTH MASO
6	6	4	53045	06750	7948	1987	3974	1987	0	PIONEER
7	7	8	53045	07900	20692	5173	6346	9173	0	SHELTON
8	8	8	53045	08220	1954	89	977	889	0	SOUTHSIDE

Figure 10-10. The attribute table for the Mason County school district layer (‘MCschoolDist’).

The section, "Fields", is where I choose one or more numeric attributes to provide the data for display in the chart graphic and a color for each one. There are ten attributes describing the school districts. They are: ID, SIZE, COUNTY, UNIFIED,

POPULATION, POP1, POP2, POP3, GRAPEVIEW and NAME. As noted above, the 'Chart' parameter works with numeric attributes. Seven attributes for school districts are numeric: ID, SIZE, POPULATION, POP1, POP2, POP3, and GRAPEVIEW. In the "Fields" section, I can specify the attributes to be included in the chart along with a color for each. I am going to choose the POP1, POP2, and POP3 attributes so I check the toggle box to the right of each of the field names.

I notice that when I choose an attribute, immediately below the parameter row a new parameter becomes available for choosing a chart display color.

When I finish choosing the options for the parameters, I click on the Okay button. The entries for the 'Charts' parameters are applied when I click on the Apply button toward the bottom of the Object Properties window. The map view window for the shape layer updates. Figure 10-11 displays a before and after of the 'MCschoolDist' shape layer containing polygons for Mason County, Washington.

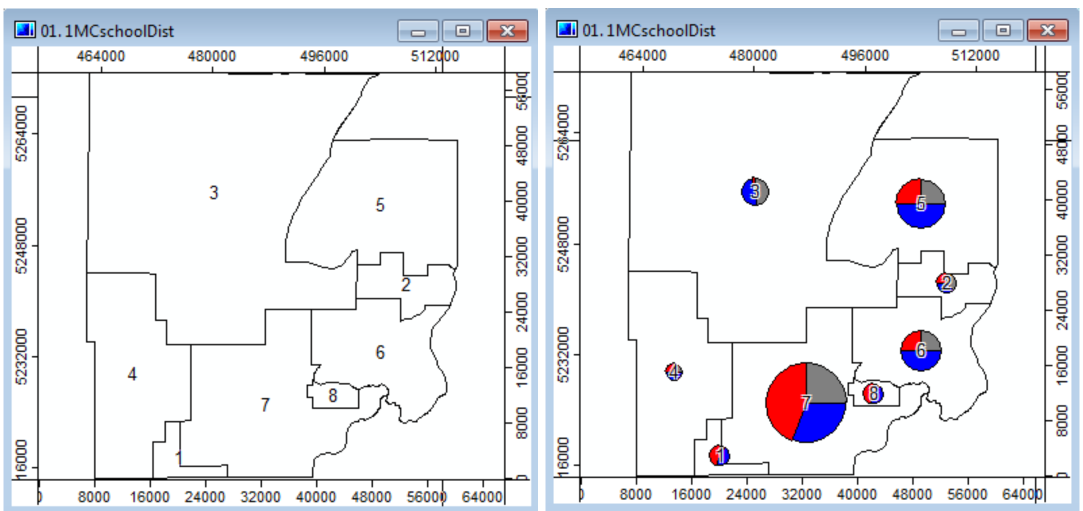


Figure 10-11. Using the 'Charts' parameter with the 'MCschoolDist' shape layer.

I can see, in the map view window on the right in Figure 10-11, that the pie sizes are proportional to the "POPULATION" attribute values for the eight school districts (see Figure 10-10) and that the 'Size Range' parameters set the smallest and largest sizes with the other sizes interpolated within that size range. The pies each contain three slices and the slice size relates to the values for the attributes POP1, POP2, and POP3.

Display: Show Vertices
[lines, polygon]
One of the first topics in this chapter was an introduction to the geometry of shape layers related to vertices, edges (or line segments), and polygons. When a shape layer displays in a map view window, the objects making up the layer are visible. From the earlier discussion, vertices define the beginning and endpoints for edges that form line or polygon objects. This parameter, 'Show Vertices', allows the user to choose whether the vertices defining the line or polygon vector features are visible in a map view window.

The default setting for the toggle check box in the value field to the right of this parameter is for the box to be un-checked, the vertices do not display. The map on the left, in Figure 10-12, shows a drainage line shape layer with the ‘Show Vertices’ check box un-checked. The map on the right is the same line shape layer with the ‘Show Vertices’ check box checked, i.e., turned on.

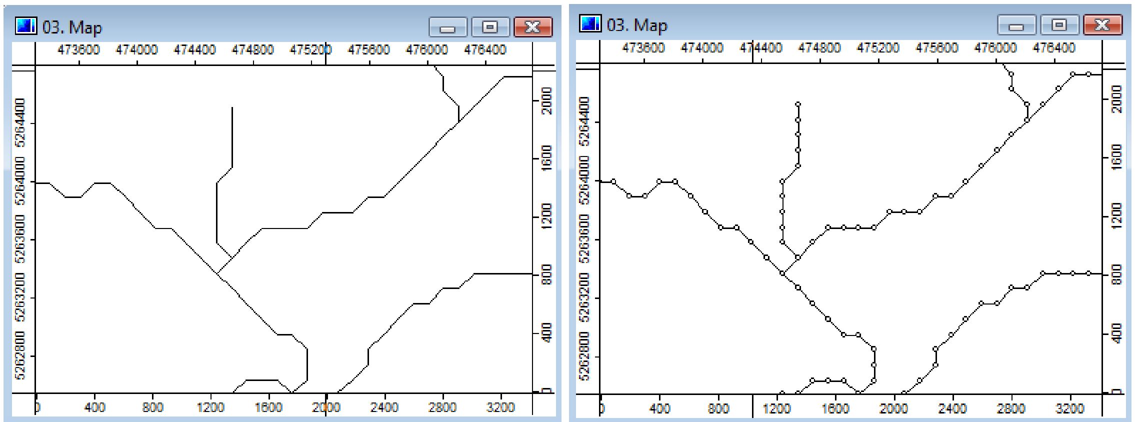


Figure 10-12. Viewing line features on a shape layer with ‘Show Vertices’ turned on.

I can see in the map on the right that small circles display where vertices exist. I find that turning the ‘Show Vertices’ parameter on while editing shape layers helps the edit process.

Display: Line Style

[line]

The ‘Line Style’ parameter is used to choose a pattern for displaying line objects of a line shape layer. The default is “Solid style”. There are 11 line style options. The options list displays when I click with the mouse in the value field to the right of the ‘Line Style’ parameter name. Figure 10-13 displays examples of each line style. I used an entry of 5 for the Size: Attribute: Default: Size parameter. This parameter controls the thickness of the line.

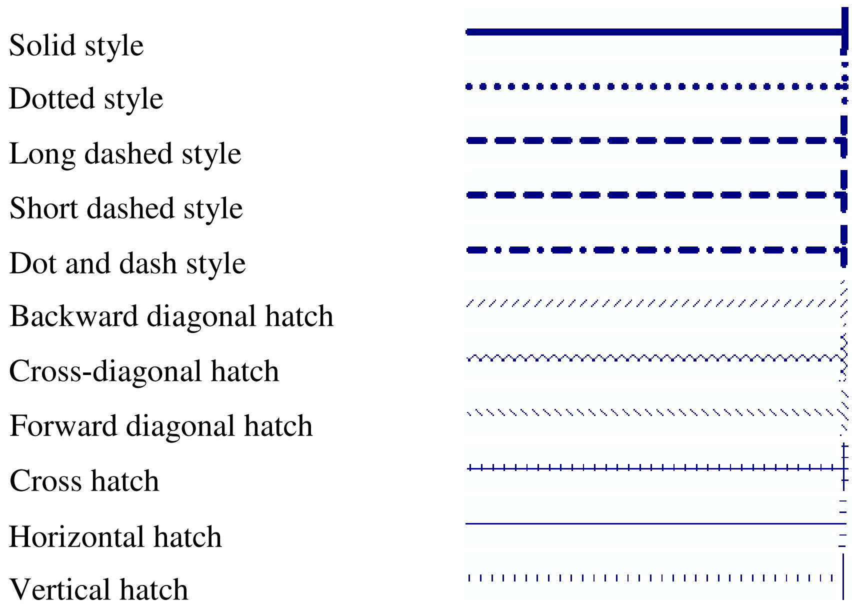


Figure 10-13. Examples of line styles.

The scale of the map view window and the line thickness are factors for whether I use an option other than "Solid style". At a narrow line thickness the styles are not necessarily interpretable unless I zoom in significantly.

Display: Boundary Effect
[line]
This parameter has nine options. The default is "none". The boundary effect is like a one pixel wide outline applied from one of eight directions (top left, top, top right, right, bottom right, bottom, bottom left, left) or from all directions. It is a method to emphasize a line style for displaying a linear feature. A color can be chosen for the pixel wide outline.

Display: Fill Style
[point, polygon]
Polygon features have area. A point object is defined by a single X,Y coordinate pair and does not have area. SAGA displays point objects as symbols and symbols have area. The ‘Fill Style’ parameter controls the area fill pattern for polygon objects and point symbols.

When I click in the value field to the right of the ‘Fill Style’ label, a small triangle appears in the field. The popup list of options displayed in Figure 10-14 becomes available.

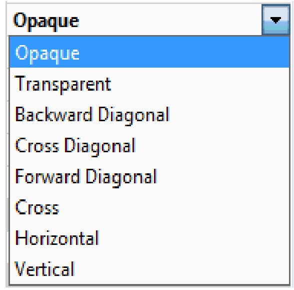


Figure 10-14. The ‘Fill Style’ popup list of options.

The default entry for this parameter is “Opaque”. Objects on polygon and point shape layers using the “Opaque” fill option are solid filled with a color. Polygon object outlines will show through the color if the two colors (for fill and the boundary) are different. In map view windows displaying multiple layers, polygon objects of a top layer will block content of layers below it. Let's briefly explore using fill patterns for water bodies.

Map view windows in the work area display grid, point cloud or shape layers or a mixture of all. I am going to create a map view window displaying two layers. Both are polygon shape layers; one is for school districts and the second one is for water bodies for the same coverage. A major difference between the two polygon shape layers is that the school district layer consists of polygons defining administrative areas for the entire county land and water area. The water bodies layer is for the entire county but its' polygon objects exist only where water areas in the county exist, approximately 8.7% of the county. Figure 10-15 displays a zoomed in portion of the map view window.

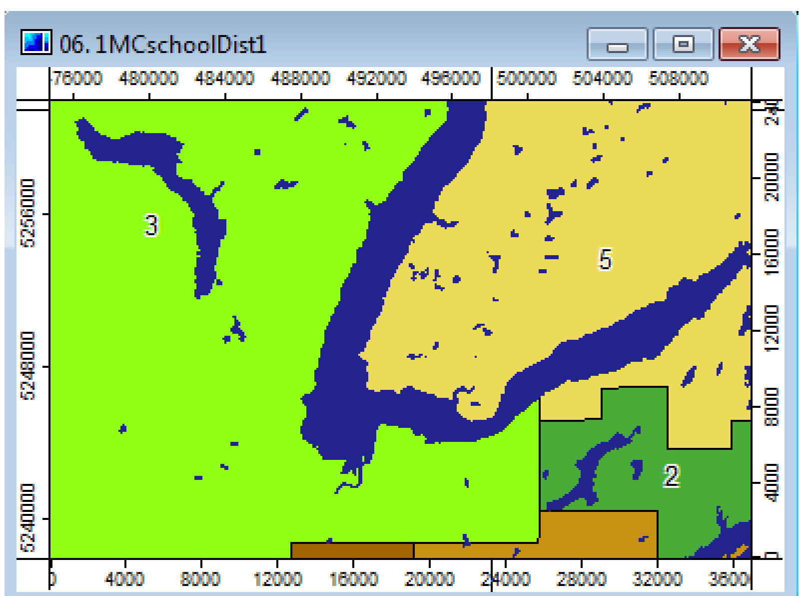


Figure 10-15. A map view window displaying school districts and water bodies.

The blue areas in the map view window are water bodies. The other colors are for school districts.

In the Maps tab area of the Manager window, this map view window is number (06) and listed as below:

06. 1MCschoolDist1
  02. 1MCwaters-Poly
  06. 1MCschoolDist

Since the school district was the first layer identified for the map view window, it became the map view window "name". I can edit the "name" in the Map tab area of the Manager window.

Layers 06 (1MCschoolDist) and 02 (1MCwaters-Poly) are displayed in the map view window. Note that the water bodies layer is the first in the list. The entry for the 'Fill Style' parameter is "Opaque". This means that the solid filled water body polygon objects block some content of the school district layer that they overlay. The "Opaque" option is also used for the 'Fill Style' parameter for the school district layer. If I move the school district layer to the top of the list of two, the school district polygon objects will totally block the view of all water bodies.

I choose the "Transparency" option for the 'Fill Style' parameter for the '1MCwaters-Poly' layer. Figure 10-16 displays the updated map 4. The line boundaries of the water bodies remain visible.

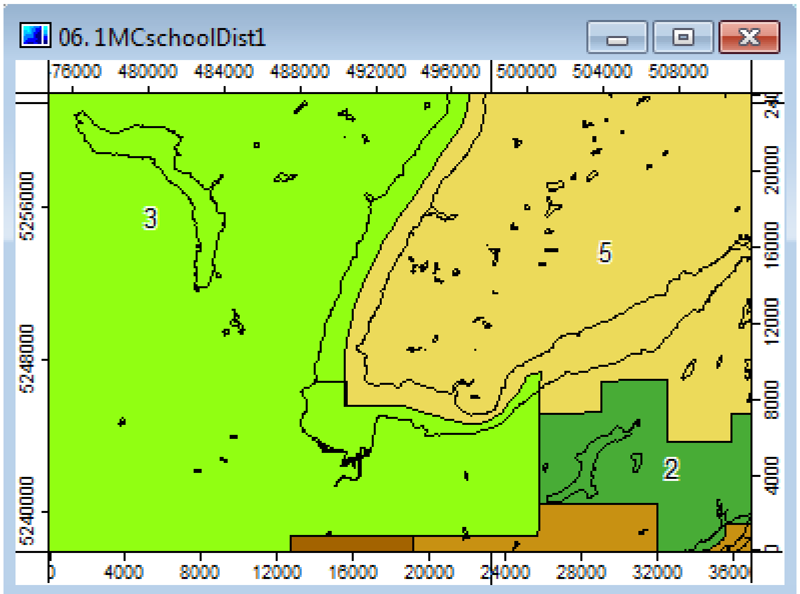


Figure 10-16. Using the "Transparency" option for the 'Fill Style' parameter.

I can now see what the filled water bodies were covering. The toggle check box parameter 'Outline' is checked, is in on status, and black is the selected color for the Outline: Color parameter. I notice that the 'Color' parameter does not have a "none" option. The water body polygon objects are outlined.

I choose the "Forward Diagonal" option for the 'Fill Style' parameter for the water bodies. Figure 10-17 displays the updated map 4.

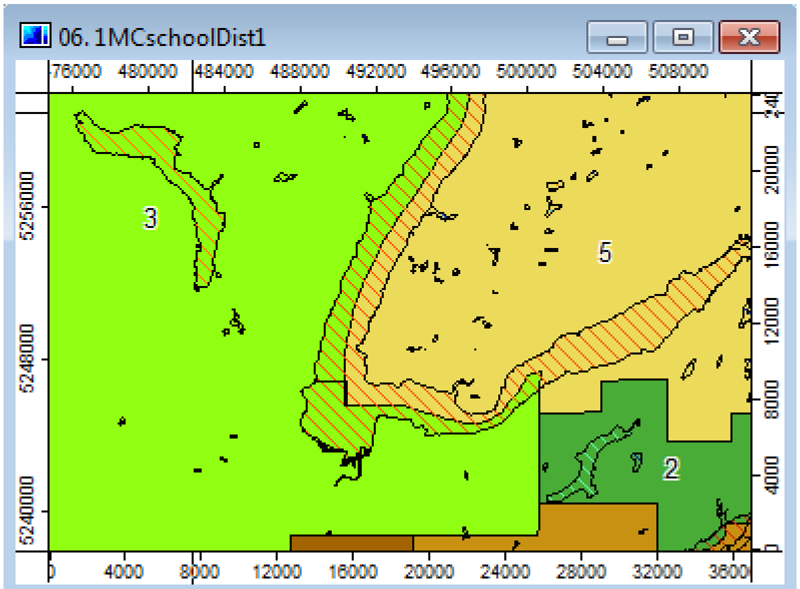


Figure 10-17. The "Forward Diagonal" option for the 'Fill Style' parameter.

The water bodies display a diagonal pattern. I can see the content of the school district layer. The colors for the diagonals depends on the option used for the Colors: Type parameter and any parameters associated with the option. This means that the color used for each fill style, including opaque, is determined by the Colors: Type and a specified attribute.

This example shows the options for the 'Fill Style' parameter act and the importance of the order of display of layers in a map view window.

Display: Outline
[point, polygon]
The default is for the toggle check box in the value field to the right of the ‘Outline’ label to contain a check, placing the parameter in on status. The color for displaying polygon or symbol outlines is selected with the Outline: Color parameter. The color swatch displayed in the value field to the right of the parameter displays the currently chosen color and also provides for choosing a different color. This color is used regardless of the option chosen for the Colors: Type parameter. Clicking in the toggle check box when the check mark is present removes the check mark and turns off this parameter. When the parameter is turned off, outlines may or may not disappear depending on the entry for the 'Fill Style' parameter. Outlines disappear if the "Opaque" or "Transparency" fill options is chosen. If any of the other fill options are chosen, the ones involving diagonals, etc., an outline will remain. The color of the outline depends on the option chosen for the Colors: Type parameter.

Display: Outline: Color
[point, polygon]
The Display: Outline: Color parameter is applied if the toggle check box in the value field to the right displays a check mark. The default color is green.

The color swatch displayed in the value field to the right of the 'Outline' label is the color used for polygon edges or the edges of point symbols. When I click with the mouse pointer in the value field to the right of the Outline: Color label, a small triangle appears in the field and a popup list of color options is displayed (Figure 10-18).

Figure 10-18. List of color options for polygon and symbol boundaries.

I can choose a new color for the boundaries by clicking on the color swatch with the mouse pointer. The color swatch displayed in the value field is the current selected color.

At the bottom of the list in Figure 10-18 is an option labeled "Custom". When I choose this option I can define a custom color for use. Figure 10-19 displays the dialog window for this option.

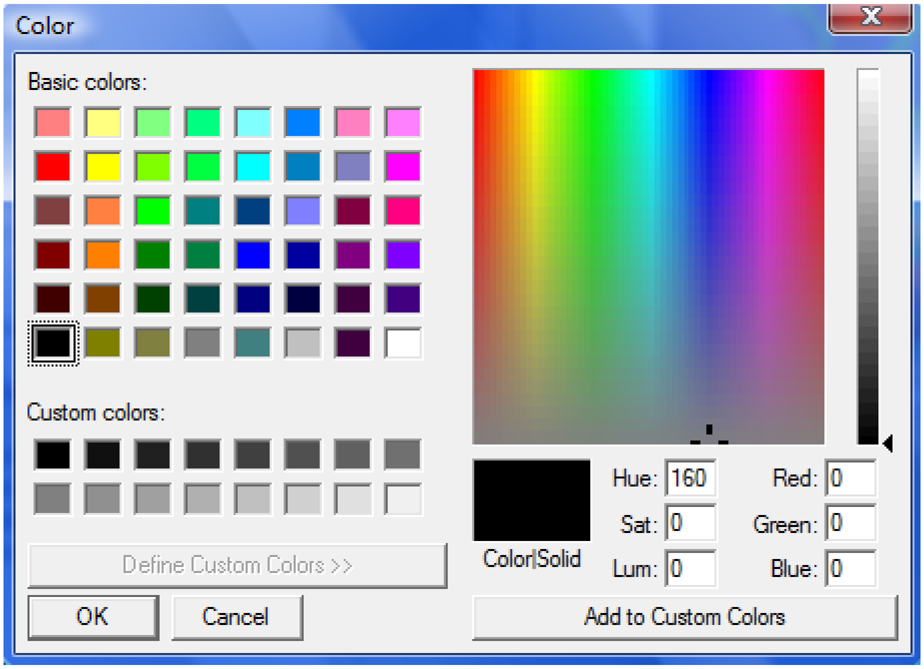


Figure 10-19. Defining a "Custom" color for polygon and symbol boundaries.

Display: Outline: Size
[point, polygon]
The Display: Outline: Size parameter sets the thickness of the polygon and symbol outlines. The default is 0 which automatically converts to a size of 1. Figure 10-20 displays two map view windows using two different settings for Outline: Size for the water bodies polygon shape layer.

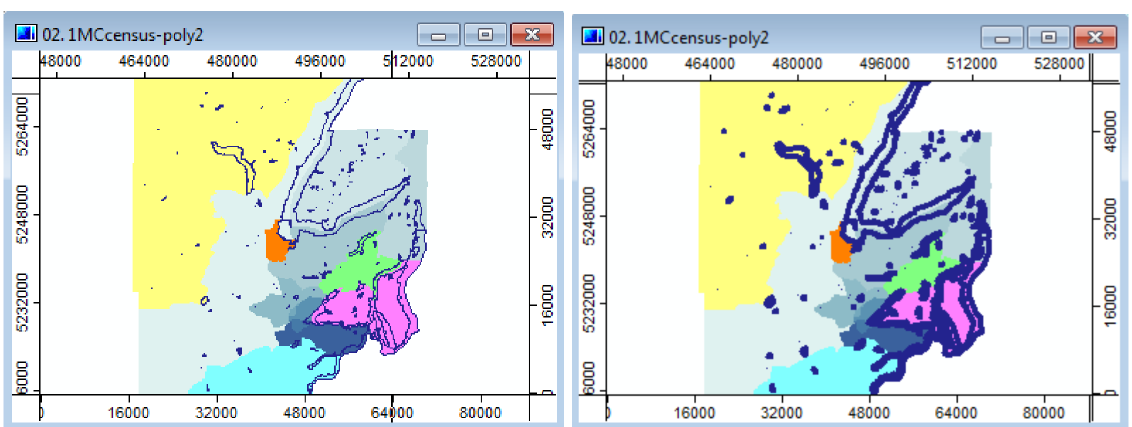


Figure 10-20. Comparing two different 'Outline Size' parameter settings for shape layers.

Each map view window includes the Mason County census tract layer as a backdrop. The map view window on the left shows the shape polygon layer for water bodies with the

Display: Outline: Color parameter set to blue and the Display: Outline: Size parameter set to 1. The map view window on the right has Outline: Size set to 4.

The Outline: Size parameter is applied regardless of which option is set for the Colors: Type parameter.

Display: Symbol Type
[point]
Circle symbols are the default symbol for showing point object location. Other symbol options are available. I click the mouse pointer in the value field to the right of the 'Symbol Type' label. A popup list of symbol options displays (Figure 10-21).

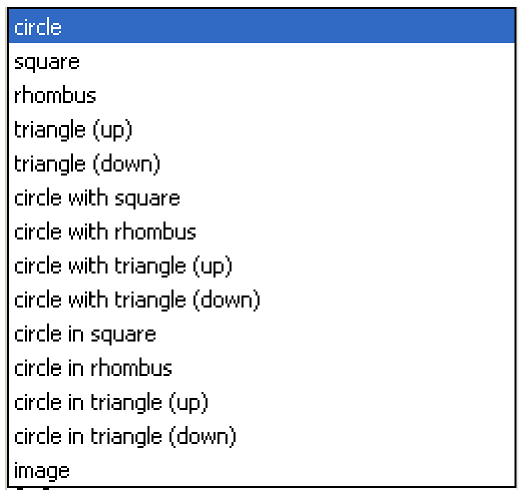


Figure 10-21. List of symbol types for displaying point objects.

The appearance of the symbol depends on several parameter settings. If the Display: Fill Style parameter is set to the "Transparent" option, the symbol is not color filled. If the parameter is set to any other option, the color used for the fill ("Opaque") or the cross-hatch lines is determined by the setting for Colors: Type: Single Symbol: Color parameter. The display size of the symbol is controlled by the Size: Default Size parameter.

When the Colors: Type parameter is set to the "Discrete Colors" or "Graduated Color" option, the color used to fill a symbol is from the current color palette. The color palette is chosen with the 'Colors' parameter in the Colors: Type: Scaling area. If the 'Type' parameter is set to the "Lookup Table" option, the 'Table' parameter in the 'Lookup Table' section will determine the fill color. The fourth option in the 'Type' parameter is "Single Symbol". In this case, the fill color used is set by the Colors: Type: Single Symbol: Color parameter.

The map view window in Figure 10-22 displays a point shape layer containing an observer location for a view shed analysis overlain on a digital elevation model (DEM) grid layer. This is a zoomed in view. The point is displayed using a rhombus symbol with the ‘Fill Style’parameter set to “Opaque”, Colors: Type: Single Symbol: Color is set to red, Display: Outline: Color is set to yellow, and Display: Outline: Size set to 2.

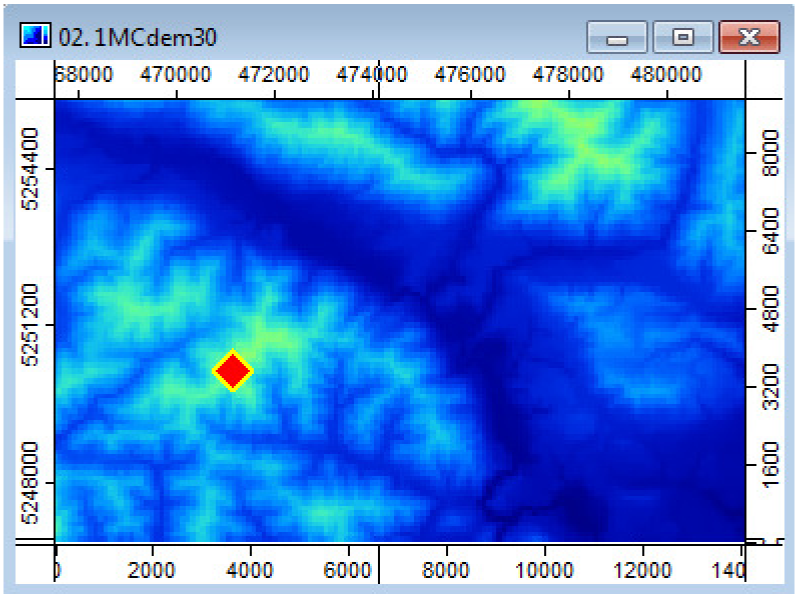
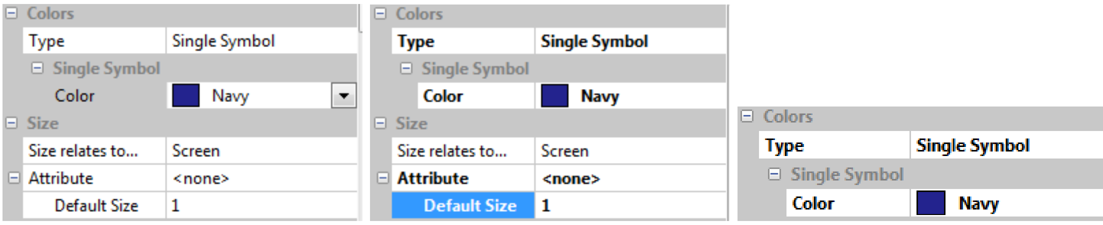


Figure 10-22. Displaying a point location using a rhombus sysmbol.

Display: Show Vertices
[lines, polygon]
This parameter is available for lines and polygon shape layers. It has been described earlier.

Display: Show Centroid
[polygon]
The toggle check box in the value field to the right of the parameter name is used to turn this display feature on or off. A check mark indicates the feature is on. When the feature is on, the “center of gravity” for a polygon or centroid displays for each polygon object. A mathematical formula involving the X and Y coordinates of vertices defining a polygon boundary calculates the centroid position. The centroid displays as a small circle. The centroid is the display location for displaying polygon labels.

Colors: Type
There are four options for the ‘Type’ parameter: Single Symbol, Lookup Table, Discrete Colors, and Graduated Colors. Each option has a group of supporting parameters. Due to inherent geometric differences between the three shape types (i.e., points, lines, and polygons), the parameters supporting each type vary.



Line Point Polygon

Figure 10-23. Colors: Type: Single Symbol parameters for shape layer types.

Colors: Type: Single Symbol: Color
[line, point, polygon]
The default option for the 'Type' parameter is "Single Symbol". The fill color used is set with the Colors: Type: Single Symbol: Color parameter in the Single Symbol area of the settings. For the example in Figure 10-25, I have set it to the dark blue color swatch.

I click the mouse in the value field to the right of the 'Color' parameter. A dropdown list of color options displays (Figure 10-24). I choose a color by moving the mouse pointer over the color swatch and clicking the mouse button. The new color takes affect after I click on the Apply button at the bottom of the Object Properties window.

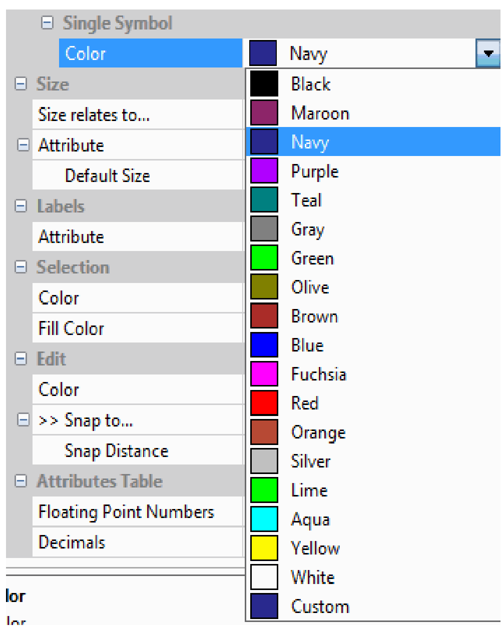


Figure 10-24. Choosing a color swatch for the "Single Symbol" option.

Figure 10-25 displays the water bodies shape polygon layer. The color "Navy" is chosen for the Colors: Type: Single Symbol: Color parameter. In addition, the selection for Display: Fill Style is "Opaque", the toggle check box parameter Display: Outline is on, the Display: Outline: Color parameter is black. The Display: Outline: Size parameter is 1.

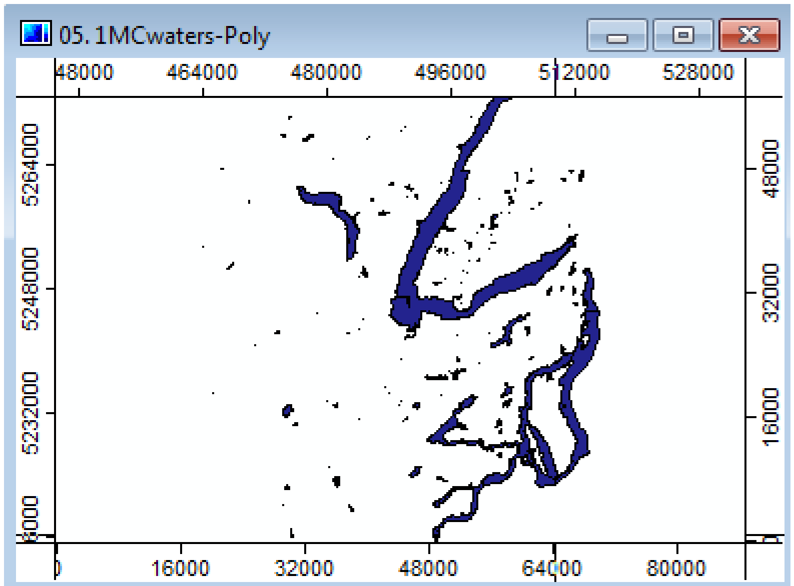


Figure 10-25. The waters polygon shape layer using the “Single Symbol” option.

The Colors: Type: Single Symbol: Color option is a one color option. All of the layer objects are filled with the single chosen color regardless of a chosen attribute and differences in attribute values. This option is not used for differentiating between layer objects based on color.

Figure 10-26 is a map displaying two layers. One of the layers is the digital elevation model (DEM) for Mason County (a grid layer) and the second one is the water bodies polygon shape layer.

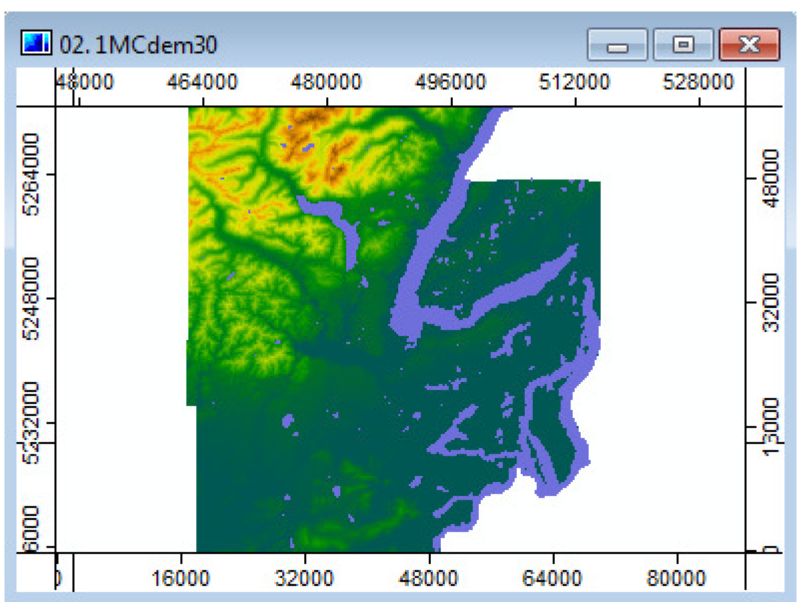


Figure 10-26. A DEM grid layer and water polygons shape layer combined for a map.

The objective for displaying the water polygons is not to differentiate any of the water bodies by characteristics or differences but to display all water bodies relative to the DEM grid layer content. The “Single Symbol” option is used for the water bodies polygons and the color used is medium blue. I used the "Custom" option to choose the color for the Colors: Type: Single Symbol: Color parameter. In addition, the selection for 'Fill Style' is "Opaque" and the toggle check box parameter 'Outline' is off.

Referring back to Figure 10-23, comparing the parameters displayed for the three shape layer types, I see that the same parameters support line and point shape layers. These parameters will be briefly discussed.

Size: Size relates to...
[line, point]
The two options for the 'Size relates to...' parameter are "Screen" and "Map Units". Screen units are in dots per inch or number of pixels (picture elements). Map units relate to the measurement units for the layer. Any units entered for the 'Default Size' parameter or any chosen attribute to provide size measurements must use the units chosen for the 'Size relates to...' parameter. If a scale bar is not displayed in the map view window, the tick marks on the bottom and right side of the view window are in map units. In my map view window displaying the '1MCrrlines' line shape layer, an entry of 20 for screen units is approximately equal to an entry of 400 for map units.

Size: Attribute
[line, point]
The default entry for this parameter is "<none>". In this case, the value used for line or point objects display thickness (or diameter in the case of point objects) is the entry for the Size: Default Size parameter. Instead of using "<none>", I can choose an attribute to provide display thickness or diameter data values. If an attribute does not exist, one can be added to the attribute table. When an attribute is chosen for this parameter, the entry for the Size: Attribute: Default Size parameter is ignored. Also, the additional parameter Size: Size Range becomes available.

Size: Attribute: Size Range, Minimum, Maximum
[line, point]
These parameters are available if an attribute is chosen as the data source for thickness or diameter data values. The entry for the 'Minimum' parameter is used for the smallest thickness value for the attribute providing the object thickness or diameter data values. If the range of data values for the attribute providing line thickness or point diameter values is from 2 to 50, and the entry for the 'Minimum' parameter for 'Size Range' is 4, the display value (thickness or diameter) for the lowest value 2 will be a thickness of 4.

The entry for the 'Maximum' parameter is used for the largest thickness or diameter value for the attribute providing the object thickness or diameter data values. If the range of data values is from 2 to 50, and the entry for the 'Maximum' parameter for 'Size Range' is 10, the display value (thickness or diameter) for the highest value of 50 is 10.

All thickness or diameter data values between the lowest and highest, e.g., 2 through 50, will be interpolated between the display values 4 through 10.

Figure 10-27 is an example using an attribute table to provide line thickness data values for a railroad line shape layer. There are 183 line objects in the layer making up three rail lines. In the attribute table linked to the '1MCrrlines' shape layer is an attribute named "LINESZ". The data values for this attribute represent line thickness and are in screen units. There is a different thickness for each of the three rail lines. The thicknesses are 10, 20, and 30.

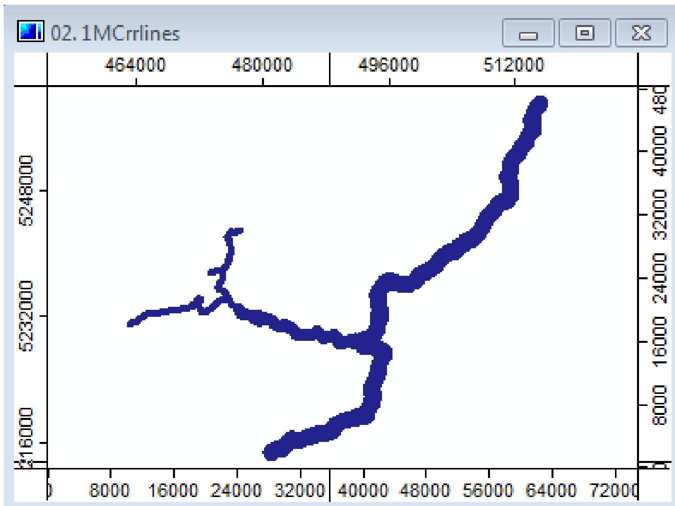


Figure 10-27. Using an attribute as the data source for the Colors: Type: Size Range parameter.

As noted above, the entry for the Size: Attribute parameter is "LINESZ". The entries for the Size: Size Range minimum and maximum parameters are 4 and 10. This means that the lowest data value in the "LINESZ" attribute, 10, is displayed using the thickness of 4 and the highest data value, 30, uses the thickness of 10. The data value 20 is interpolated to display using a thickness of 7.

Size: Attribute: Default Size

[line, point]

The entry for this parameter is used for the thickness or diameter of line or point objects of a layer if the entry for the Size: Attribute parameter is "<none>". In this case, this thickness or diameter is applied to all objects with no variation for characteristics. If there is an entry for the 'Attribute' parameter, other than "<none>", the entry for the 'Default Size' parameter is ignored.

Figure 10-28 displays a map view window for a line shape layer for railroad lines ('1MCrrlines'). The entry for the Size: Attribute parameter is "<none>". The entry for the Size: Attribute: Default Size parameter is 4.

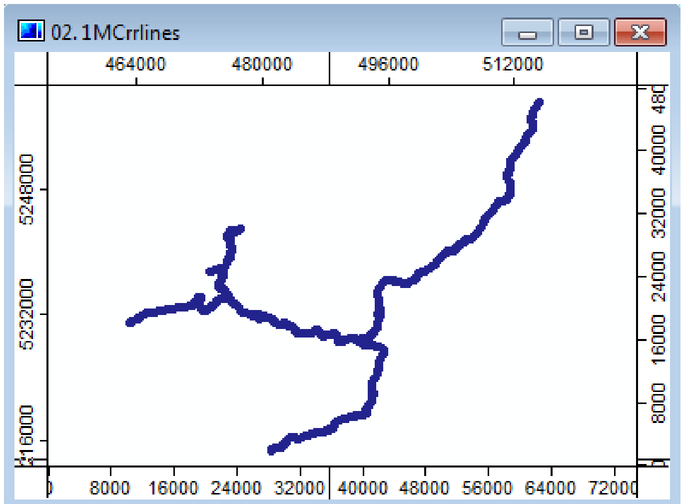
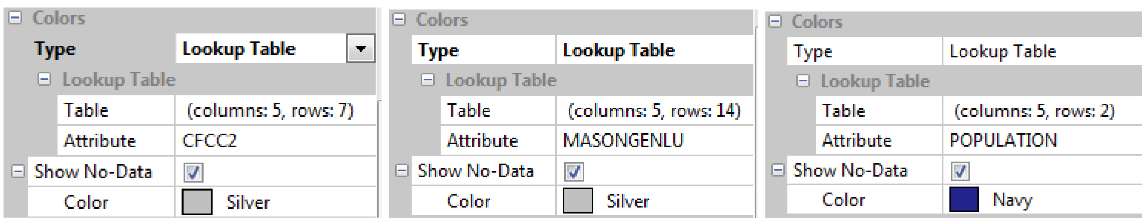


Figure 10-28. An example using the Colors: Type: Default Size parameter.



Line Point Polygon

Figure 10-29. Colors: Type: "Lookup Table" parameters for shape layer types.

Four parameters support the "Lookup Table" option for the Colors: Type parameter regardless of the layer object types.

Colors: Type: Lookup Table
[line, point, polygon]
The source of data for the “Lookup Table” are the data values of the attribute chosen for the Display: Colors: Type: Lookup Table: Attribute parameter.

Colors: Type: Lookup Table: Table
[line, point, polygon]
The default entry in the value field to the right of the Colors: Type: Lookup Table: Table parameter label is “Table (columns: 5, rows: 2)”. This indicates a default table defined as two rows and five columns. The default table is not normally the best lookup table option but, for our purposes, it is a starting point for exploring the lookup table characteristics.

If I click in the value field, on the ellipsis symbol that appears, a table view window displays. The version of the table window in Figure 10-30 is the default.

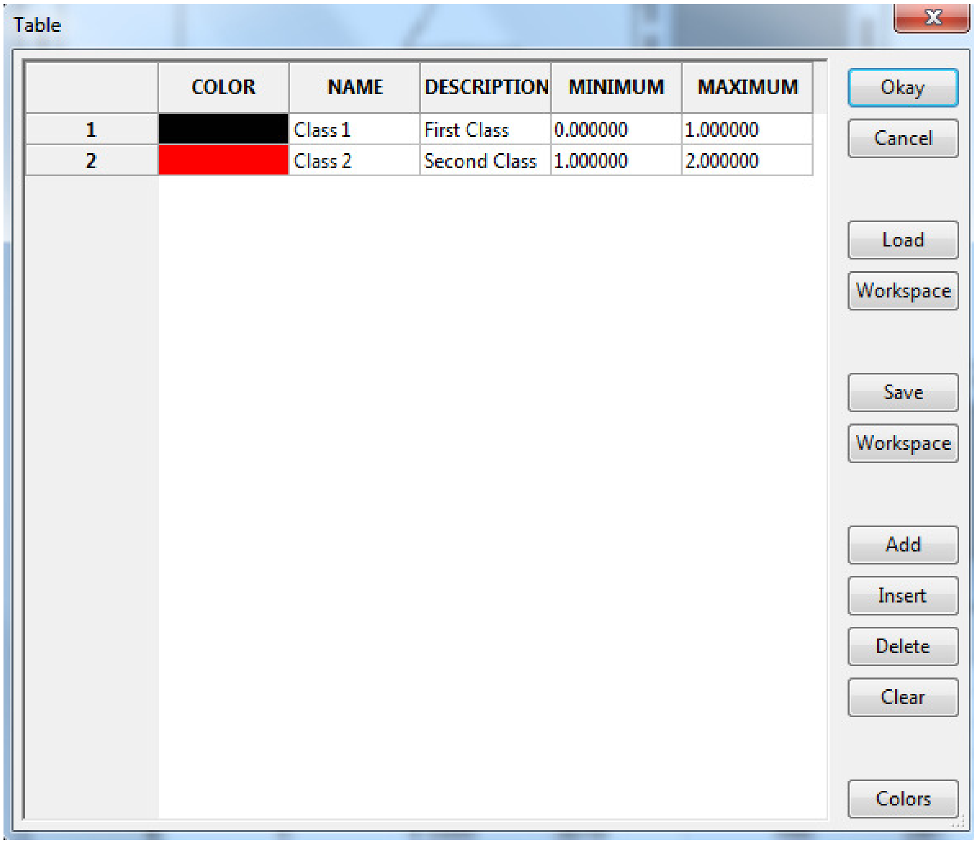


Figure 10-30. The table window for the “Lookup Table” option.

The table is arranged in rows and columns. In a lookup table, a row represents a data display class. The columns are characteristics of the class. The height of the rows and the widths of the columns are adjustable using the mouse.

There are five characteristics related to each data display class. The values I enter for the “Minimum” and “Maximum” characteristics define the class interval for the display class. These values must correspond with the data values of the choice for the Colors: Type: Lookup Table: Attribute parameter. The attribute chosen provides the data values for the display of layer objects in the map view window.

The first column in the table is for display colors. When I click on the "COLOR" column for a data display class row, a color menu similar to the one in Figure 10-31 appears. I choose a color for the selected display class in the table by clicking with the mouse pointer on the color swatch of choice in the color table. When I click on the option ‘Define Custom Colors >>’ at the bottom of the color table display, I will be able to customize a color definition. After clicking on the color swatch that I want to use, I click on the ‘OK’ button. The chosen color is assigned as the "COLOR" attribute for the data display class.

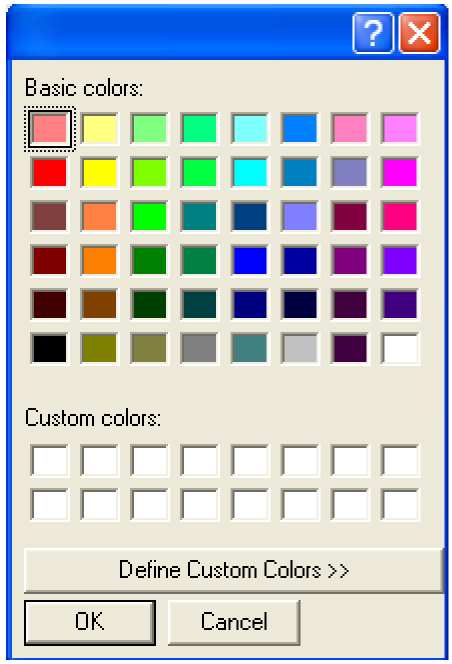


Figure 10-31. The color menu for assigning data class colors for a map display.

The next column, “NAME”, is for giving a name to the data class. The text for "NAME" is used in the layer legend and appears in the “Z” display information field at the bottom of the work area.

When the "Lookup Table" option is used for the Colors: Type parameter, as I move the mouse pointer over the shape objects for the layer in the map view window, the "NAME" entry for the display class displays at the bottom of the SAGA display window. It is displayed just to the right of the X and Y coordinate display fields. This is different from other options where the attribute data value is used.

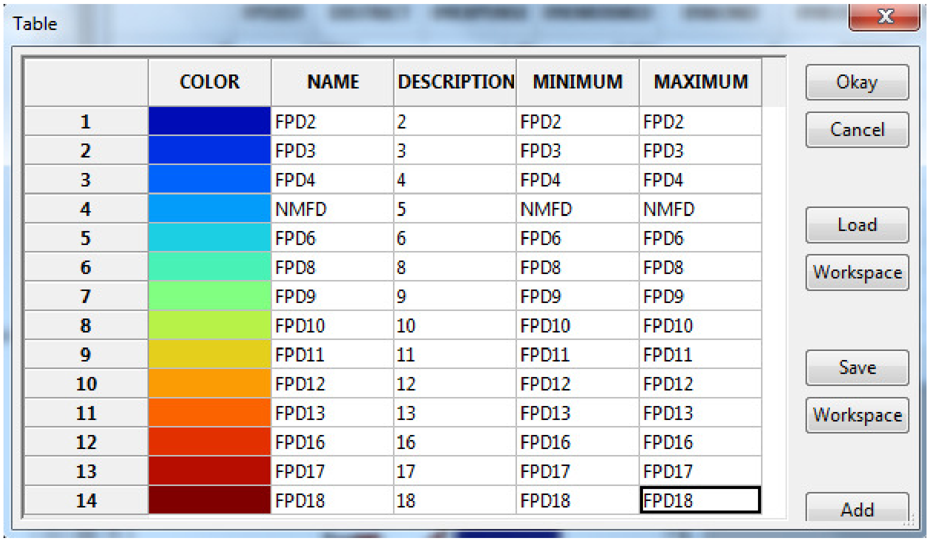
“Description” can contain text information about the data class. This field is not used anywhere by SAGA. I find it handy to keep short notes on data classes. I don't know what the limit is on the number of characters that can be entered.

The “Minimum” and “Maximum” fields define the lower and upper boundaries of the data display class. These fields were discussed earlier.

The buttons on the right include Okay for when I complete the data entry; Cancel to cancel the data entry process; and Save and Load to save a lookup table to be used later for this grid layer or other grid layers. The Workspace button below the Load button will load a table temporarily saved in the Data tab area of the Manager window. The Workspace button below the Save button will temporarily save a table in the Data tab area of the Manager.

The bottom four buttons are used with the rows. Clicking on the Add button adds a new row at the bottom of the existing rows. The Insert button inserts a new row above the currently active row. The Delete button deletes the currently active row. Clicking on the Clear button deletes all of the rows in the lookup table. The Clear button is used to erase the existing table content.

Let's look at two lookup tables for displaying county fire protection districts. Figure 10-32 displays a lookup table developed using the text attribute (string data type) "DISTRICT" for Lookup Table: Table: Attribute parameter.

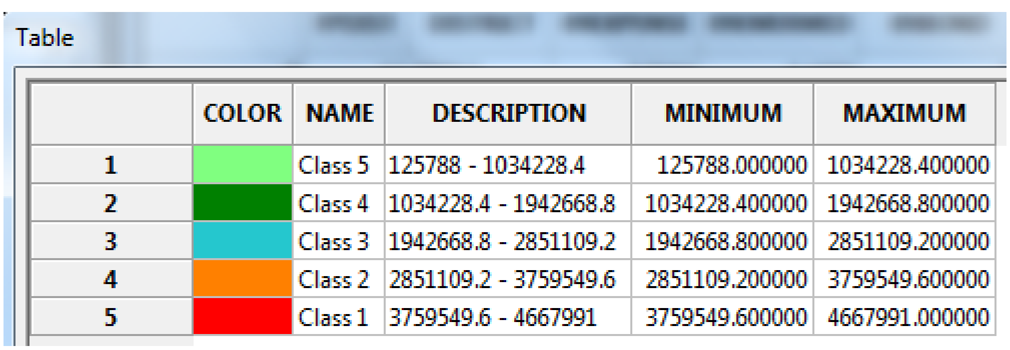


	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		FPD2	2	FPD2	FPD2
2		FPD3	3	FPD3	FPD3
3		FPD4	4	FPD4	FPD4
4		NMFD	5	NMFD	NMFD
5		FPD6	6	FPD6	FPD6
6		FPD8	8	FPD8	FPD8
7		FPD9	9	FPD9	FPD9
8		FPD10	10	FPD10	FPD10
9		FPD11	11	FPD11	FPD11
10		FPD12	12	FPD12	FPD12
11		FPD13	13	FPD13	FPD13
12		FPD16	16	FPD16	FPD16
13		FPD17	17	FPD17	FPD17
14		FPD18	18	FPD18	FPD18

Figure 10-32. A color lookup table using text attribute data entries.

The entries for the "DISTRICT" attribute are text strings. There are 14 unique values for the attribute: FPD2, FPD3, etc. Since the data values are text there is not a data value range as for numeric data. Thus, the entries for the minimum and maximum "values" for each display class are identical.

Figure 10-33 displays an example lookup table using numeric data values.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		Class 5	125788 - 1034228.4	125788.000000	1034228.400000
2		Class 4	1034228.4 - 1942668.8	1034228.400000	1942668.800000
3		Class 3	1942668.8 - 2851109.2	1942668.800000	2851109.200000
4		Class 2	2851109.2 - 3759549.6	2851109.200000	3759549.600000
5		Class 1	3759549.6 - 4667991	3759549.600000	4667991.000000

Figure 10-33. A color table modified for the "09BUDTOT" attribute for the county fire department polygon shape layer.

The "09BUDTOT" attribute identifies the fiscal year 2009 total budget for each fire protection district. I can see that the value range for the "Class 5" display class is from a minimum class boundary value of 125788 to a maximum class boundary of 1034228.4. The data values for the "09BUDTOT" attribute are continuous numeric values, dollars. There are five display classes, each with a class interval of 908440.4. The commands available on the 'Table' dialog window (see Figure 10-30) can be applied to develop this lookup table. Rather than manually calculate the class boundaries for the five classes, I used the "Create Lookup Table" option available in SAGA.

The "Create Lookup Table" option is available when I right-click with the mouse on a shape layer name in the layer list in the Data tab area of the Manager. One of the options on the popup list that displays is "Create Lookup Table". The lookup table created with this option can be edited as needed using the tools described above. I did edit the entries for the "NAME" column. As part of the process using this option, the user chooses an attribute for the source of data values on the 'Create Lookup Table' dialog window. This attribute choice automatically updates the Colors: Type: Attribute in the Settings tab area of the Object Properties window for the layer.

The "Create Lookup Table" option is a very useful capability.

Changes to a lookup table will not affect the display of the layer until the Apply button is clicked on with the mouse.

Colors: Type: Lookup Table: Attribute
[line, point, polygon]
This parameter identifies the attribute of the attribute table linked to the shape layer that supplies the data values that will display for the layer objects in a map view window. Numeric or text attributes may be used. The display classes, based on the attribute data values, need to be defined in the table available in the 'Table' parameter value field.

Figure 10-34 displays two tables. The upper one is based on a numeric attribute for population and the lower one is for school district name, a text attribute. These tables were created using the "Create Lookup Table" command discussed earlier.

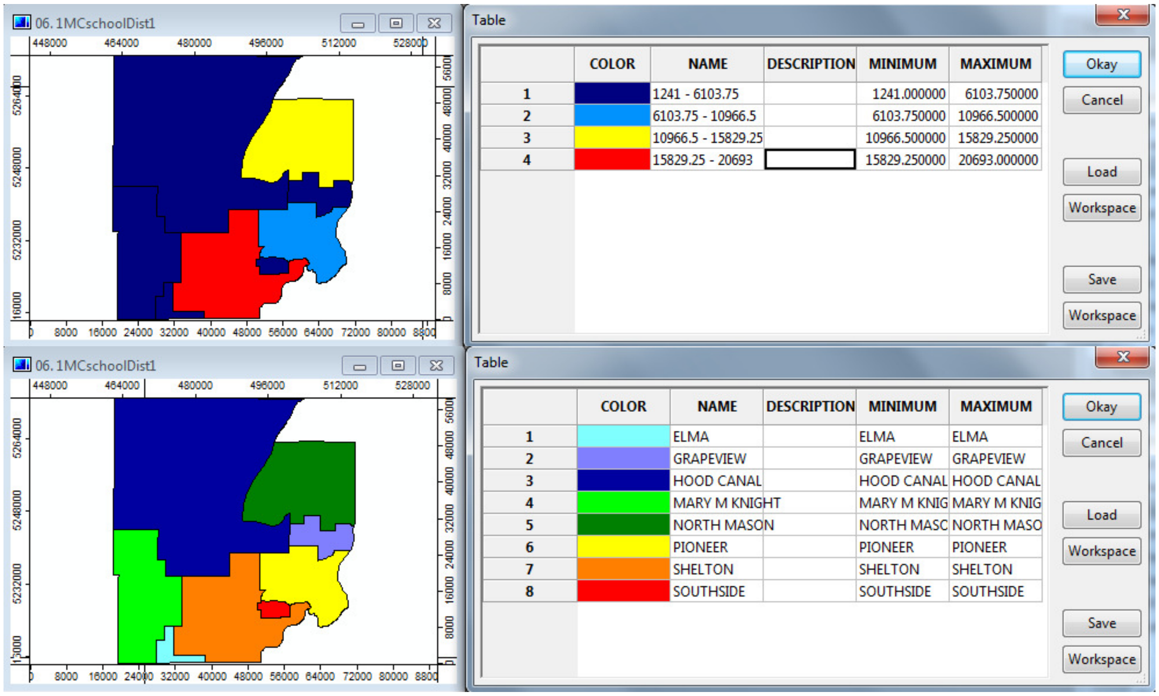


Figure 10-34. Comparing two lookup tables created with the "Create Lookup Table" option.

Colors: Show No-Data
[line, point, polygon]
Grid layers, when created or imported, have a no-data value for grid cells that do not contain valid data values. For example, grid cells traversed by a road have a valid data value for the road or a road feature. Grid cells not traversed by a road may contain a no-data value, e.g., -99999. The no-data value for a grid layer depends on whether the layer is created by a SAGA tool, and, if so, which tool. The no data value used for an output layer from one tool could be different from the no data value supported by another tool. When a raster or grid layer is imported from another program, the import tool assigns a no-data value for grid cells not containing a valid grid value.

Shape layers have no data values. If a data entry for an attribute object is the no data value, the object will display using the assigned color for the Colors: Show No-Data: Color parameter. Related to lookup tables, any data value or text entry for the attribute chosen for the 'Attribute' parameter that does not fall in a display class for numeric data classes or not specifically included as a text based display class, is interpreted for display purposes by SAGA as a no-data value or no-data text and will display using the Show No-Data: Color parameter color.

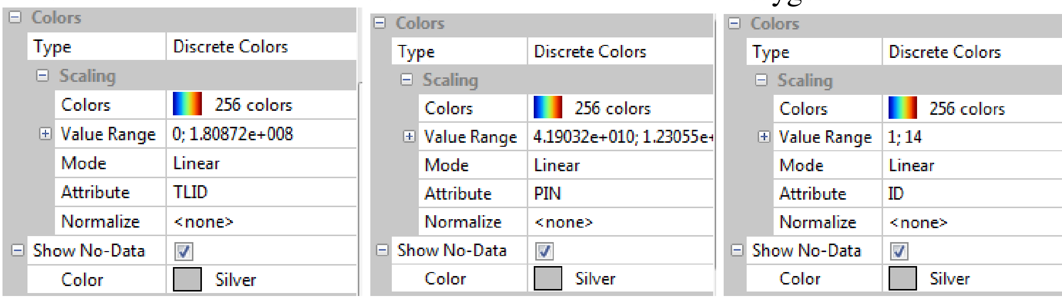
Let's look at the upper layer and table in Figure 10-34. The chosen attribute is for school district population. There is a district with a population of 1241. The color display for this district would be display class 1 (1241 to 6103.75). If the 1241 population did not fall in any of the table display classes, for example, the class interval was 1242 to 6103.75, SAGA would interpret 1241 as a no data value and the district polygon would display as a no-data area using the color for no data.

The 'Show No-Data' parameter is a toggle check box parameter. The default is for this parameter to be on. This means that objects interpreted as no-data will be displayed using the color chosen for the Colors: Type: Show No-Data: Color parameter. I can turn this parameter off by clicking with the mouse pointer in the toggle box. The boundaries of objects considered to be no-data will disappear and these areas display in white.

Colors: Show No-Data: Color
[line, point, polygon]
Objects interpreted as no-data display in the color chosen for this parameter. This parameter acts in a similar manner to other color choice options in SAGA. When I click on the triangle in the value field for the parameter, a dropdown list of color swatches appears. I choose a color by clicking on the color swatch with the mouse.

Discrete Colors

Line Point Polygon



Graduated Colors

Line Point Polygon

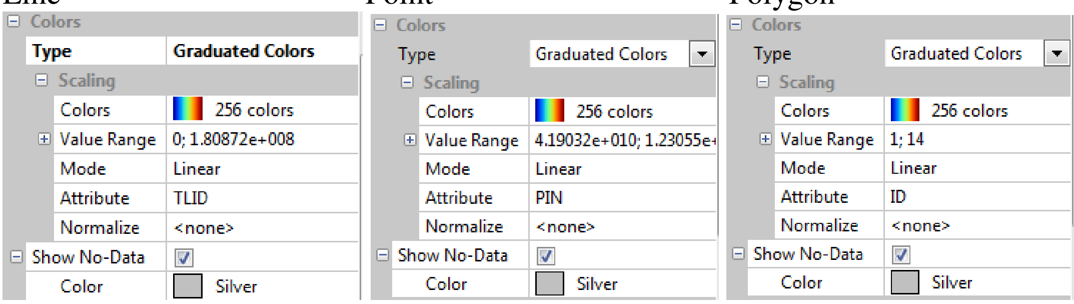


Figure 10-35. Colors: Type: "Discrete Colors" and "Graduated Colors" parameters for shape layer types.

Looking at Figure 10-35, I can see that the "Discrete Colors" and "Graduated Colors" options for the Colors: Type parameter use identical support parameters, not only for the two options, but also for all three layer object types. Many of these parameters are used in other sections and have already been explained in this chapter with the exception of the 'Mode' and 'Normalize' parameters.

Colors: Type: Discrete Colors; Colors: Type: Graduated Colors

[line, point, polygon]

The "Discrete Colors" and “Graduated Colors” type options use the data values furnished by the attribute chosen for the Colors: Type: Scaling: Attribute parameter.

Colors: Type: Scaling: Colors

[line, point, polygon]

If the ‘Type’ parameter option is the "Discrete Colors" or “Graduated Colors” option, the color used to fill a symbol or an object is determined from the chosen color palette. This palette is selected for the Colors: Type: Scaling: Colors parameter. The color used for each object depends on the data values of the chosen attribute. A color gradient is interpolated using the data range for the chosen attribute.

A color palette is chosen in the value field to the right of the Colors: Type: Scaling: Colors parameter name. A small color palette icon displays in the value field representing the currently chosen color palette. When I move the mouse pointer into the value field and click the mouse button, an ellipsis appears on the right side of the field. The 'Colors' window (see Figure 10-36) displays when I click on the ellipsis.

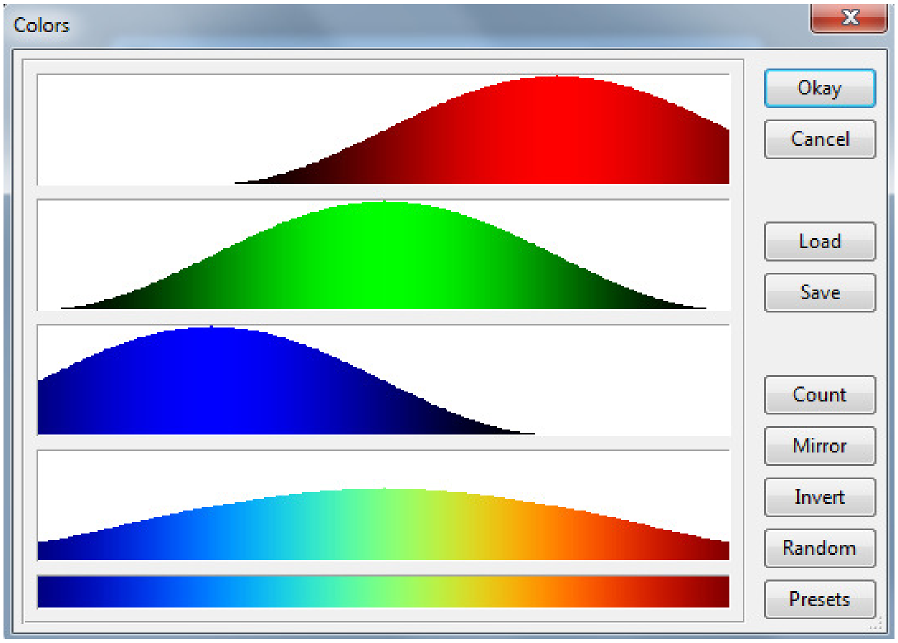


Figure 10-36. The 'Colors' window.

A new color palette can be created using the RGB windows in the 'Colors' window. I can also use the Load button to load a palette saved as a palette (.pal) file in my palette folder. In addition, I can choose one by clicking on the Presets button at the bottom of the button list on the right.

Figure 10-37 displays part of the list of available color palettes when I click on the Presets button.

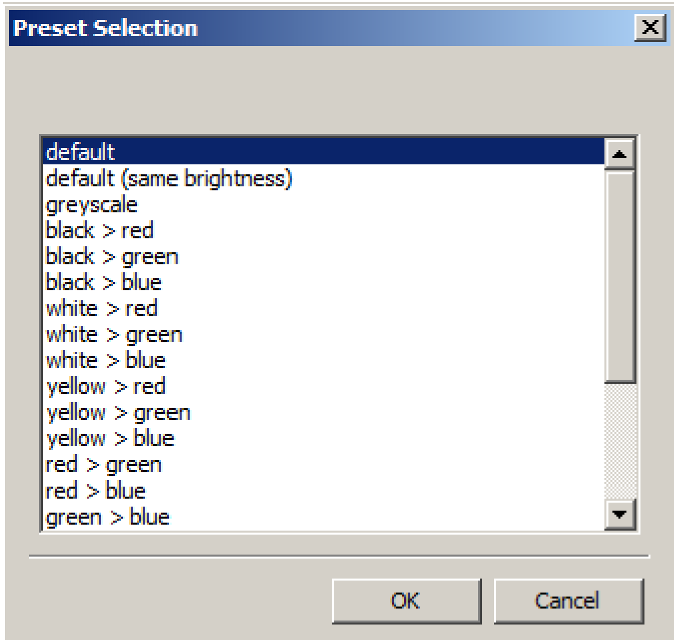


Figure 10-37. A partial list of Presets, i.e., available color palettes for choosing.

There are 23 color palettes on the presets list that I can choose. I have 47 palette files in my palette folder.

Colors: Type: Scaling: Value Range, Minimum, Maximum
[line, point, polygon]
The numbers displayed in the value field to the right of the Colors: Type: Scaling: Value Range parameter label are the entries for the ‘Minimum’ and ‘Maximum’ parameters. These parameters are visible if I click on the "+" expansion sign to the left of the parameter name. This expands the parameter and the minimum and maximum parameters display immediately below it.

The ‘Minimum’ and ‘Maximum’ parameter values are based on the data range for the attribute chosen for the Colors: Type: Scaling: Attribute parameter. When I choose a different attribute, the minimum and maximum values adjust for the new data range.

On the 'Colors' window in Figure 10-36 I see a button labeled Count. The entry for the "Count" variable sets the number of data display classes for the data value range. The count number displays adjacent to the color palette icon in the value field to the right of the Colors: Type: Scaling: Colors parameter. If the 'Value Range’ parameter has a minimum of 1 and a maximum of 200 and the "Count" variable is set to 10, there will be 10 data display classes identified, each one covering a data range of 19.9. I use the Count button to change the entry for the variable. I click with the mouse pointer on the Count button and the 'Input' dialog window in Figure 10-38 displays.

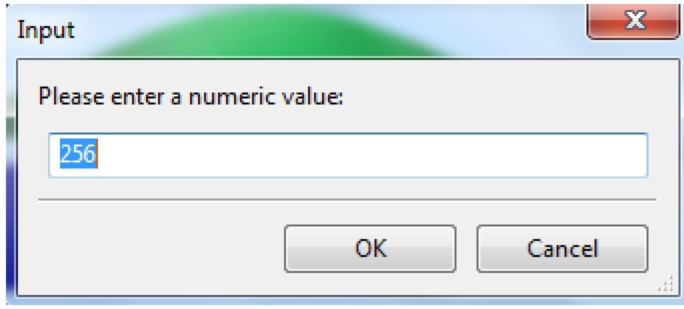


Figure 10-38. The 'Input' dialog window for changing the variable "Count".

I enter a new value and click the OK button to exit the window. I can also edit the entries for 'Minimum' and 'Maximum' if desired.

Colors: Type: Scaling: Mode
[line, point, polygon]
The Colors: Type: Scaling: Mode parameter has three options: Linear, Logarithmic (up), and Logarithmic (down). The default entry for the ‘Mode’ parameter is “Linear”. I use the “Logarithmic (up)” and “Logarithmic (down)” choices when I have a data value range that is extremely large.

The “Logarithmic Stretch Factor” is where I enter the magnitude of log stretch to be applied to the data range.

Colors: Type: Scaling: Attribute
[line, point, polygon]
The Colors: Type: Scaling: Attribute parameter is for choosing an attribute to provide a set of data values for the shape layers' objects. The layer objects will be color filled using the data values of the chosen attribute field.

The default attribute is the first attribute field of the attribute table linked to the layer. If I click in the value field to the right of the 'Attribute' name, a popup list of all the attributes in the attribute table appears. I use the mouse to highlight and choose one of them. The data values of the one I choose replace the data values of the previously chosen attribute. I must click with the mouse on the Apply button for the change to take affect.

Let's look at an example using a water bodies polygon shape layer. The '1MCwater-Poly' layer contains 119 polygon objects. The attribute table linked to the layer has 8 attributes. I click in the value field to the right of the Colors: Type: Scaling: Attribute parameter name and a popup list of the attributes displays. The list includes Ref.ID, FISH, SIZE, COUNTY, CFCC, LANDNAME, LANDPOLY and LANDNAME_L. I check the Description tab of the Object Properties window for the layer and see that five of the attributes, Ref. ID, FISH, SIZE, LANDPOLY and LANDNAME_L are numeric. They use a data type of “signed 8 byte integer”. The other three attributes are string data type. The "Discrete Colors" and "Graduated Colors" options only apply color variations to numeric attributes. If I choose a text string variable, all features are assigned a single color. String data values are interpreted as having a “0” value.

Figure 10-39 displays a zoomed in area of the water bodies shape layer using the “Discrete Colors” option and the attribute “SIZE” selected. The “SIZE” attribute is also chosen to provide labels for the water body polygons. The Legend tab content is displayed on the right.

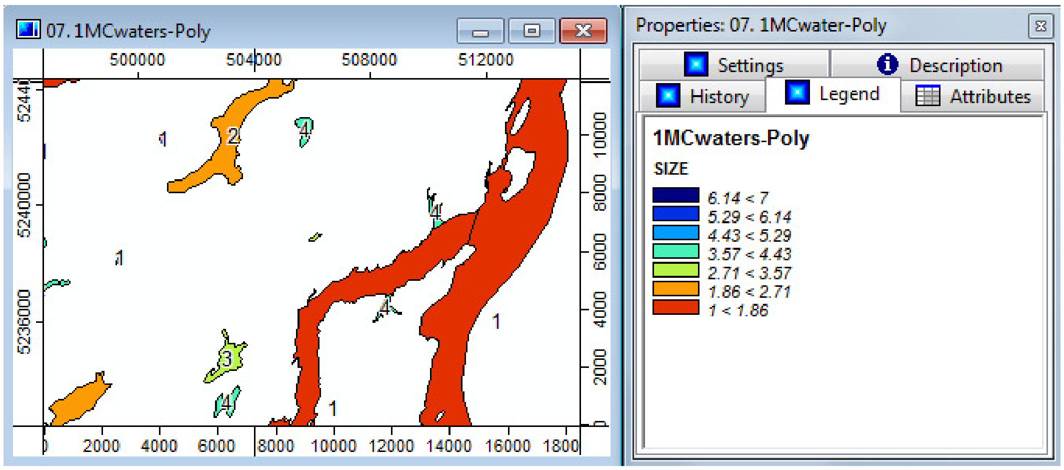


Figure 10-39. Displaying the "SIZE" attribute for the water bodies shape layer.

Looking at the legend I can see how the spectrum of colors is assigned to the range of attribute values for the "SIZE" attribute. The data values for "SIZE" are integers 1 through 7. Thus the data range is 6 (i.e., 7-1 = 6). The entry for the "Count" variable is 7. The display class interval is .857 (i.e., 6 divided by 7). This shows how the display class lower and upper boundaries are calculated.

Colors: Type: Scaling: Normalize
[line, point, polygon]
This process involves two numeric attributes. The attribute chosen for the Colors: Type: Scaling: Attribute provides data values for the numerator and an attribute is chosen for the Colors: Scaling: Normalize parameter that serves as the denominator for a division calculation. The simple division calculation produces proportion display data values.

I have a county wide school district polygon shape layer containing 8 polygon objects. The attribute table linked to this layer contains 11 attributes. The two of interest are for an historical population level ("POP1") and the current population level ("POPULATION"). I can use the 'Normalize' parameter to create a display of this ratio.

I choose the "POP1" attribute for the Colors: Type: Scaling: Attribute parameter and "POPULATION" for the Colors: Type: Scaling: Normalize parameter.

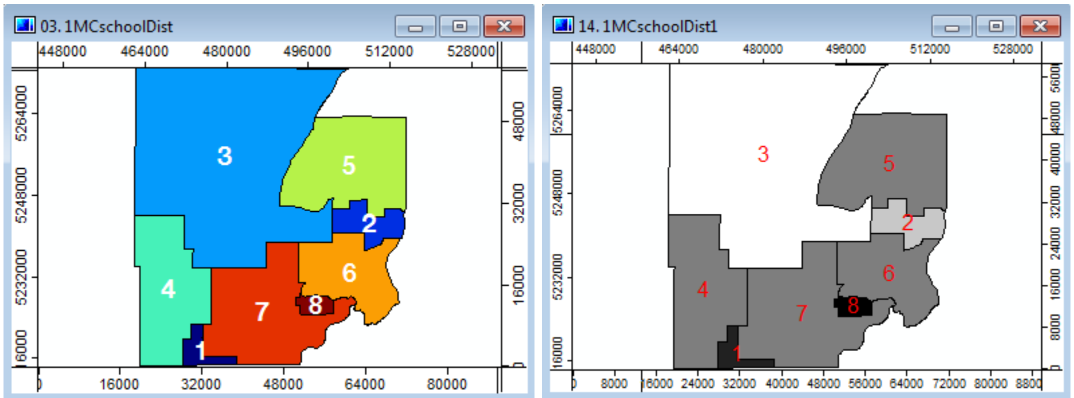


Figure 10-40. An example of using the 'Normalize' parameter.

The lower the normalize value, the more change took place from the historical population level to the current population level. The map view window on the right displays the normalize results. The darker the gray shade the greater the change.

ID	POP1	POPULATION	NORMALIZE
1	200	2000	0.1000
2	646	1753	0.3685
3	2211	4843	0.4565
4	310	1241	0.2498
5	2762	11046	0.2500
6	1987	7948	0.2500
7	5173	20692	0.2500
8	89	1954	0.0455

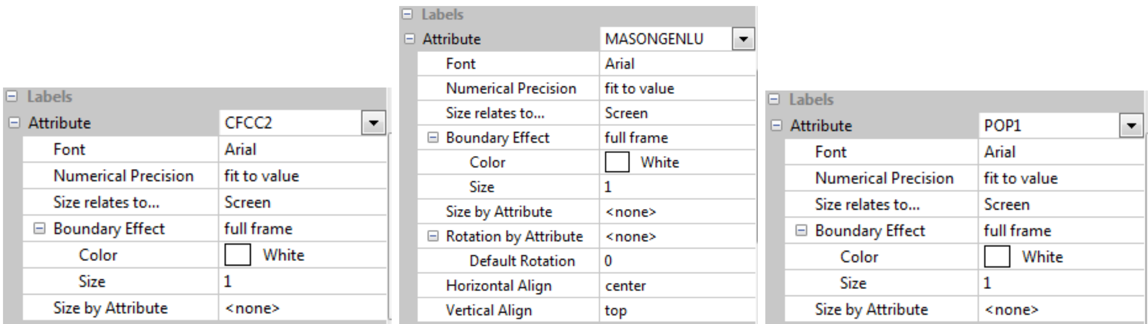
Figure 10-41. Manual calculation of normalize data values.

I can verify the normalize display results by manually calculating the normalize values between the "POP1" and "POPULATION" attributes. This manual calculation is displayed in Figure 10-41. Another approach is to create a "NORMALIZE" attribute for the attribute table using the *Table/Calculus/Field Calculator [Shapes]* tool.

Colors: Show No-Data
[line, point, polygon]
The entry for an object attribute can be the no data value for the layer. Although the no data value is entered for a particular attribute for an object, the entry is blank. If the attribute is chosen for the Colors: Type: Scaling: Attribute parameter, SAGA interprets the data value as the no data value and the object is displayed using the color assigned for the Colors: Show No-Data: Color parameter.

The 'Show No-Data' parameter is a toggle check box parameter. The default is for this parameter to be on.

Colors: Show No-Data: Color
[line, point, polygon]
This parameter acts in a similar manner to other color choice options in SAGA. When I click on the triangle in the value field for the parameter, a dropdown list of color swatches appears. I choose a color by clicking on the color swatch with the mouse.



Line Point Polygon

Figure 10-42. Labels parameters for shape layer types.

The point shape layer includes several parameters unique to point objects. These are: Rotation by Attribute, Default Rotation, Horizontal Align, and Vertical Align. These parameters are discussed after reviewing the 8 parameters that are common to all three shape layer types. These are: Attribute, Font, Numerical Precision, Size relates to..., Boundary Effect, Color, Size, and Size by Attribute.

Labels
The parameters in the "Labels" section determine the attribute that provides object labels and how the labels display. The school district shape layer in Figure 10-43 is used to illustrate these parameters.

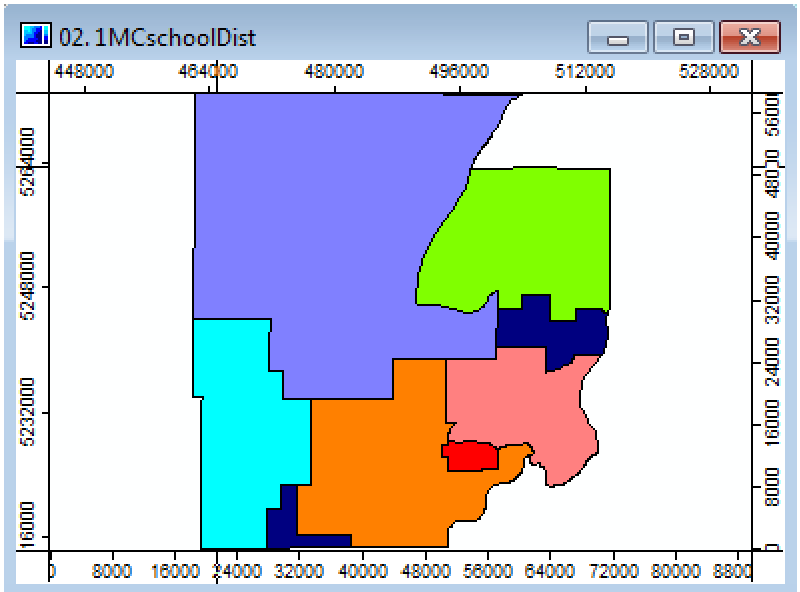


Figure 10-43. The Mason County school district shape layer.

Labels for point objects center on the symbol used for the point object location. Some additional parameters support point labels. Labels for polygon objects display at the polygon object centroid.

Displaying labels for line objects is not operational.

Labels: Attribute
[line, point, polygon]
The default setting for the ‘Attribute’ parameter is “<none>”. This turns off the display of labels for a shape layer. The other options for the 'Attribute' parameter are the attribute fields for the layer. When I choose an attribute field, numeric or text string data type, its’ data values will be used as labels for the objects.

For the school district polygon shape layer, when I click in the value field to the right of the Label: Attribute parameter, the popup list of attribute names displayed in Figure 10-44 appears. Notice that the last item in the list is the default entry “<none>”. If I had been displaying labels and wanted to turn the label display function off, I would choose the “<none>” option.

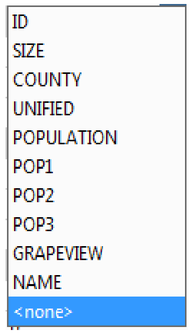


Figure 10-44. The popup list for the ‘Attribute’ parameter value field.

Figure 10-45 shows our example with the “ID” attribute field selected and the other label support parameters using their default entries.

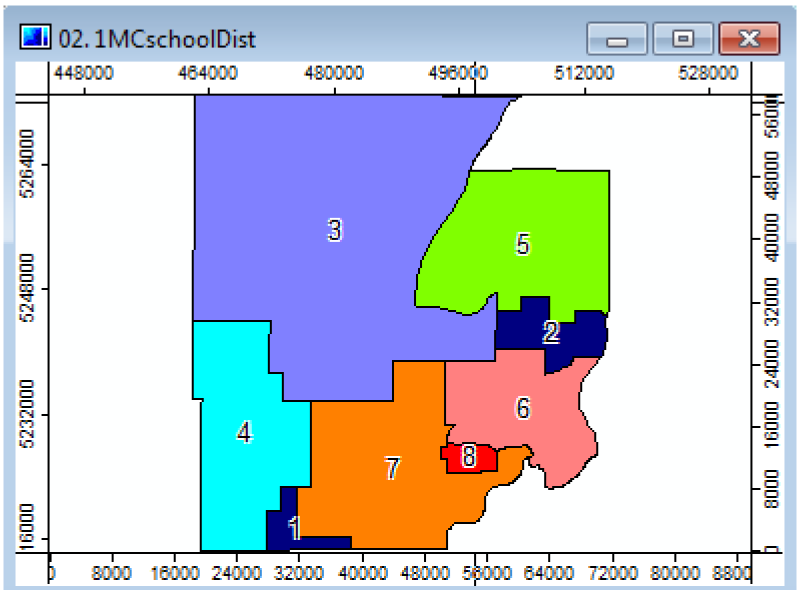


Figure 10-45. The “ID” labels displayed using default settings.

Labels: Attribute: Font
[line, point, polygon]
The default entry in the value field to the right of the ‘Font’ parameter is “Arial”. I click on the ellipsis symbol that displays in the value field. A ‘Font’ dialog window displays (Figure 10-46).

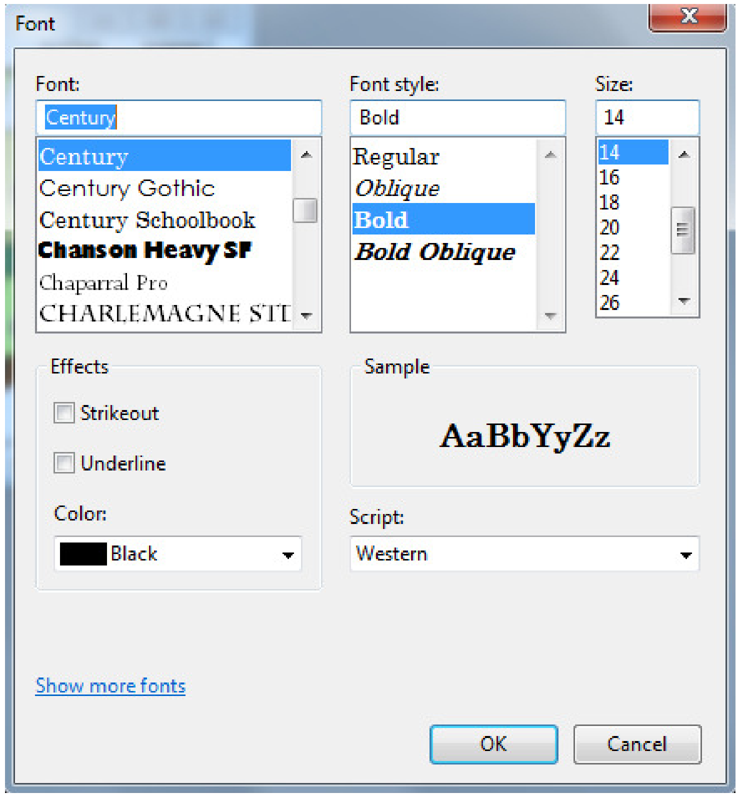


Figure 10-46. The 'Font' dialog window.

I can choose from a full range of available fonts, font styles, and sizes. The map view window in Figure 10-47 shows the result with my choices of the Font "Century", Font style "Bold", and 14 for "Size".

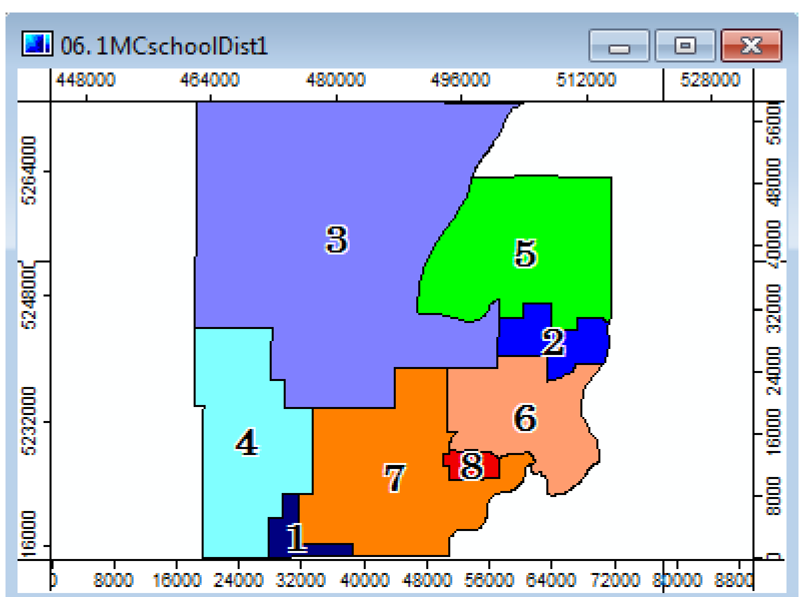


Figure 10-47. Using the Century font, bold font style, and size 14.

Labels: Attribute: Numerical Precision
This attribute is used with attributes containing floating point numeric data types, such as 4 or 8 byte floating point number types. It affects how these data values display in a map view window.

I click the mouse pointer in the value field to the right of the Labels: Attribute: Numerical Precision parameter. A popup list of options displays (Figure 10-48).

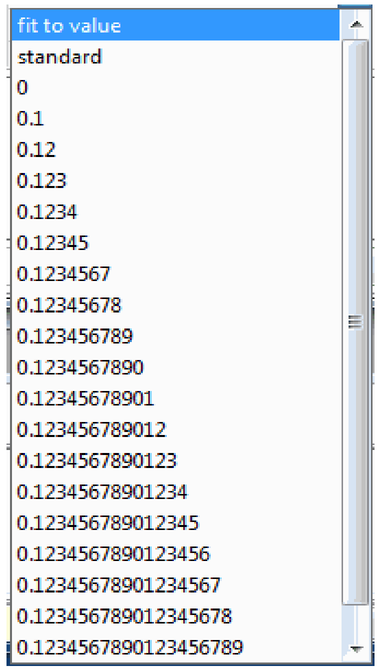


Figure 10-48. Options for the 'Numerical Precision' parameter.

The default entry for this parameter is "fit to value". This option produces rounded values to hundredths for floating point numbers. The "standard" option displays numbers rounded to the nearest tenth. Using the "0" option results with floating point numbers displayed with six places past the decimal; e.g., 1.1 as 1.100000 and 3.111 as 3.111000. Choosing a specific option, e.g., .012345678, results in the display of floating point numbers to 8 places past the decimal.

Labels: Attribute: Size relates to…
[line, point, polygon]
The two options for the Labels: Attribute: Size relates to... parameter are "Screen" and "Map Units". Screen units are dots per inch or number of pixels (picture elements). Map units relate to the measurement units for the layer. The numeric values at the tick marks on the bottom and right sides of the map view window are in map units (unless the "Scale Bar" option is active in the map window, in which case, the ticks are labeled by X and Y map coordinates).

Each of the two options uses a different process to calculate label size. Here is how it appears to operate when "Screen" is the choice for the Labels: Attribute: Size relates to...' parameter. If the entry for the Labels: Attribute: Size by Attribute parameter is "<none>", label size is determined by the choice of font size made in the 'Font' dialog window. When an attribute is chosen for the 'Size by Attribute' parameter, the attribute data values are used for font size. It is, therefore, important that the attribute data values of the attribute relate to logical font sizes.

The other option for the 'Size relates to...' parameter is "Map Units". When this option is chosen, the parameter Labels: Attribute: Size by Attribute: Default Size is available. If the entry for the 'Size by Attribute' parameter is "<none>", label size is determined by the entry for the 'Default Size' parameter. This number must be in map units. I use the map unit tick marks on the bottom or right side to estimate an entry for the 'Default Size' parameter. For example, I enter 4000 for an equivalent size of a font size 14.

The 'Size by Attribute' is used if the attribute table includes an attribute containing label size values. Remember the data values must correspond to the choice for the Labels: Attribute: Size relates to...' parameter. The entry for the 'Default Size' parameter acts as a multiplier for the attribute data values. When I enter a 0, no labels display. If I enter a 1, the data values in the attribute determine the label size. If I enter a 2, the data values in the attribute are multiplied by 2, the labels are double the size compared to using 1.

Let's look at a couple examples using the '1MCschoolDist1' polygon shape layer.

I choose the "ID" attribute for the Labels: Attribute' parameter. This attribute will provide the labels for each polygon object. I select the "Screen" option for the Labels: Attribute: Size relates to... parameter and "<none>" for the Labels: Attribute: Size by Attribute parameter. I click with the mouse pointer in the value field to the right of the 'Font' parameter name. When the 'Font' dialog window displays I choose the "Basic Sans SF" font, "Bold" for font style, and 16 for font size. I click on the 'OK' button. The map view window in Figure 10-49 displays the result.

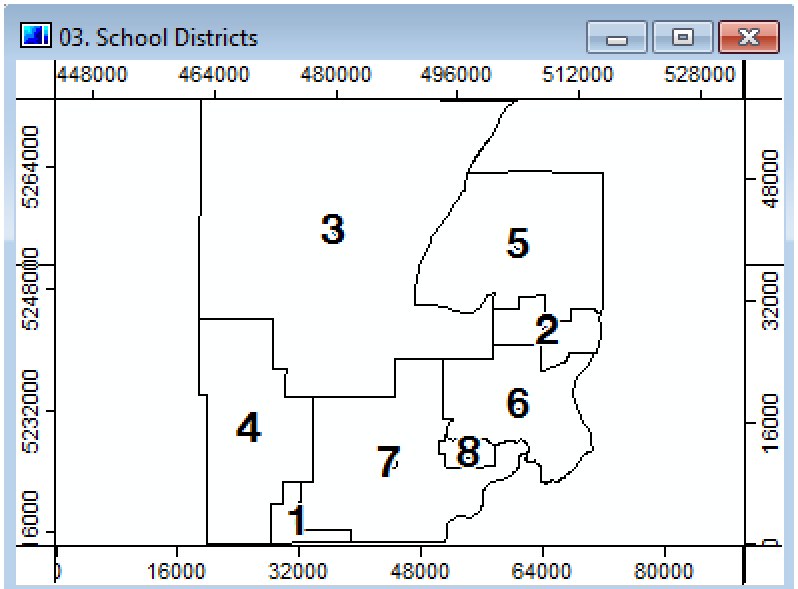


Figure 10-49. An example of labels for school district polygon objects.

The numeric labels appear to be around a size 16 and bold. Here is a **3** at size 12 and bold and here is a **3** at size 16 and bold.

For this second example, I choose the "ID" attribute for the 'Attribute' parameter. This attribute will provide the label for each polygon object. I select the "Screen" option for the 'Size relates to...' parameter and "SIZE2" for the 'Size by Attribute' parameter. I click with the mouse pointer in the value field to the right of the 'Font' parameter name. When the 'Font' dialog window displays I choose the "Basic Sans SF" font and "Bold" for font style. I ignore the font size option as the font size is furnished by the data values for the "SIZE2" attribute. I click on the OK button.

The data values for the "SIZE2" attribute are all the same, 20. This means that each label will display using a font size of 20. Figure 10-50 displays the map view window with the results.

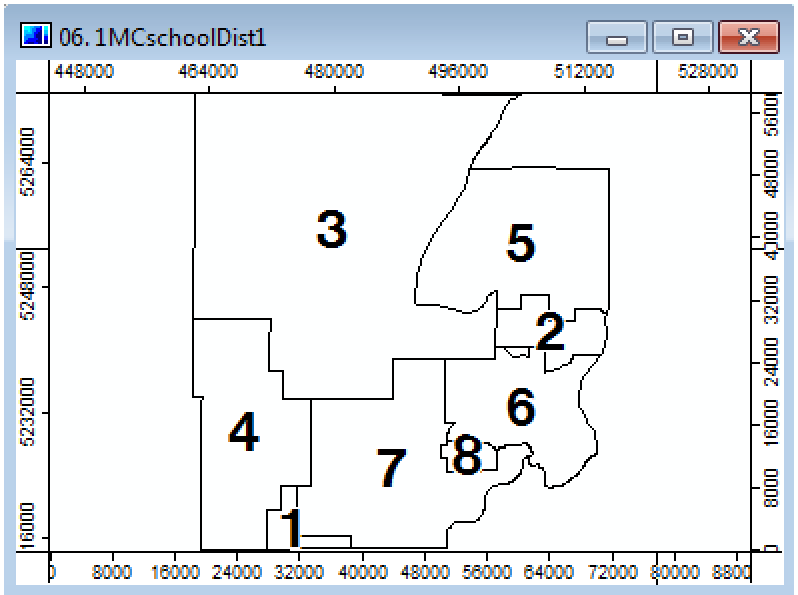


Figure 10-50. An example of labels using an attribute to provide font size.

The numeric labels appear to be around a size 20 and bold. Here is a **3** at size 12 and bold and here is a **3** at size 20 and bold.

Let's take a look at a couple examples using the "Map Units" option for the Labels: Attribute: Size relates to... parameter. I choose the "ID" attribute for the 'Attribute' option. This attribute will provide the labels for each polygon object. I select the "Map Units" option for the 'Size relates to...' parameter and "SIZE2" for the 'Size by Attribute' parameter. I click with the mouse pointer in the value field to the right of the 'Font' parameter name. When the 'Font' dialog window displays I choose the "Basic Sans SF" font and "Bold" for font style. I ignore the font size entry as this approach does not use it. I click on the OK button. I enter 400 for the 'Default Size' parameter. This is the value that will be a multiplier for the data values of the "SIZE2" attribute to determine label heights. The data values for the "SIZE2" attribute are all 20. This means that the calculated label height, in map units, is 8000. Figure 10-51 displays the map view window with the results.

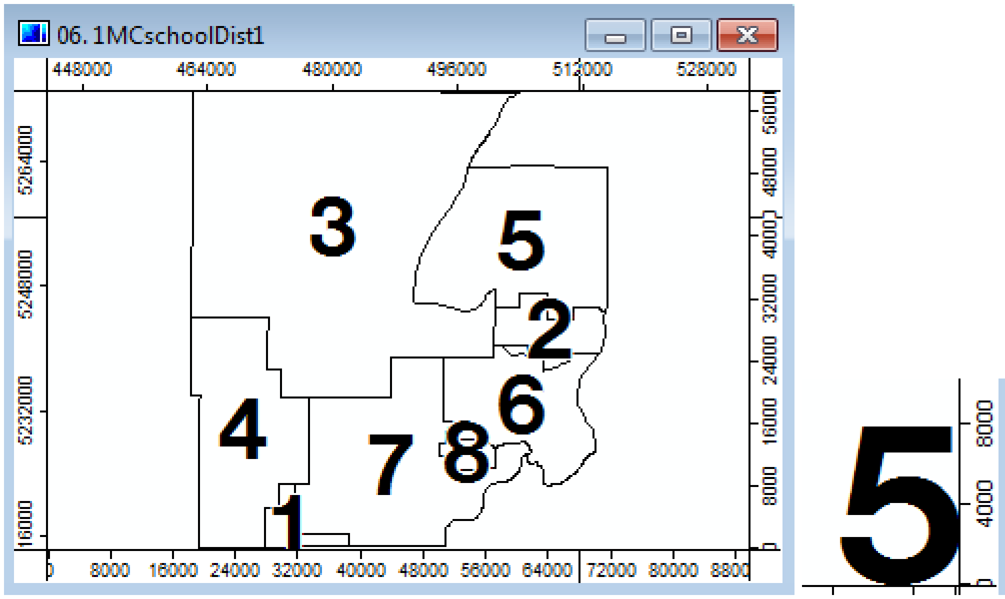


Figure 10-51. An example of label height calculated in map units.

I can verify the label height by moving a label adjacent to the right side of the map view window. Just to the right of the map view window in Figure 10-51 is a zoomed in area showing the label 5 adjacent to the map distance scale. The starting number at the bottom for the map distance scale is 0 and at the top in the zoomed in area is 8000.

Labels: Attribute: Boundary Effect
[line, point, polygon]
This parameter, and the next two (Color and Size), are used to provide an emphasis for the edges of label characters. The 'Boundary Effect' parameter has choices for a directional effect. The default entry is "<none>". There are nine other choices ranging from "full frame" for an effect from all directions to top, top left, top right, etc.

Labels: Attribute: Boundary Effect: Color
[line, point, polygon]
This parameter supports the 'Boundary Effect' parameter. A color choice can be made for the effect. I click with the mouse pointer in the value field to the right of the parameter name and a dropdown list of colors displays. I can click on a color swatch to select it or select the "Custom" option at the bottom of the list to create a color that does not appear on the list.

Labels: Attribute: Boundary Effect: Size
[line, point, polygon]
This parameter supports the 'Boundary Effect' parameter. The entry value sets the width of the boundary effect. The entry value is in number of pixels. The default entry for this parameter is 1. This means that the effect is 1 pixel wide. I can change the effect to be 3 pixels wide by entering a 3 for this parameter.

Labels: Attribute: Size by Attribute
[line, point, polygon]
The Labels: Attribute: Size by Attribute parameter is for choosing an attribute that provides numeric values for font height or one that contains data values that can be used to determine label height along in combination with a numeric entry for the Labels: Attribute: Size by Attribute: Default Size that serves as a multiplier for the data values. Using the "Screen" option for the 'Size relates to...' parameter is when the 'Size by Attribute' parameter furnishes the data values for font height (thus ignoring the entry for font height in the 'Font' dialog window).

When the "Map Units" option is chosen for the Labels: Attribute: Size relates to... parameter, the numeric entry for the 'Default Size' parameter serves as a multiplier with the data values for the chosen attribute for calculating label height in map units. The entry for font height in the 'Font' dialog window is ignored.

The attribute chosen for this parameter should contain numeric data values related to object characteristics that also can serve for sizing labels or the attribute may be created specifically for determining label size. Using an attribute to determine label size can also serve to vary the label height based on some characteristic. Displaying different sized labels allows for relative visual interpretation of some characteristic of the objects.

The default entry for the ‘Size by Attribute’ value field is "<none>". I can choose an attribute by clicking the mouse pointer in the value field to the right of the parameter name. A popup list of the attributes in the attribute table linked to the layer displays. I move the mouse pointer down over the attribute I want to choose and press the left mouse button. Then I click on the Apply button at the bottom of the window.

Labels: Attribute: Size by Attribute: Default Size
[line, point, polygon]
This parameter is available when an attribute is chosen for the Labels: Attribute: Size by Attribute' parameter.

The numerical entry for this parameter serves as a multiplier for calculating label height. If the choice for the Labels: Attribute: Size relates to...' parameter is "Map Units" and an attribute is chosen for the 'Size by Attribute' parameter, the numeric entry for the 'Default Size' parameter serves as a multiplier with the data values of the chosen attribute. The numeric entry for this parameter must consider the data values of the attribute chosen for the 'Size by Attribute' parameter.

Labels: Attribute: Rotation by Attribute
[point]
The default entry for the Labels: Attribute: Rotation by Attribute parameter is "<none>". An attribute in the attribute table linked to a point shape layer can be chosen to provide rotation angles for point object labels. Rather than all labels having the same amount of rotation applied, using an attribute value for each label provides control over how each

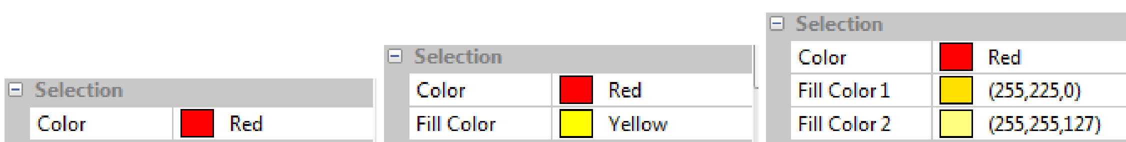
object label is rotated around the point object. When an attribute is chosen to provide label rotation angles, the 'Default Rotation' parameter is not available.

I click with the mouse in the value field to the right of the parameter and a dropdown list of the attributes for the layer displays. I choose an attribute by moving the mouse pointer over the attribute name and clicking the mouse button.

The data values for the chosen attribute provide the label rotation angle for the displayed labels. It is important that the numeric data values represent angles for rotation.

Labels: Attribute: Rotation by Attribute: Default Rotation
[point]
This parameter is only available if "<none>" is entered for the Labels: Attribute: Rotation by Attribute' parameter. The amount, in degrees, to rotate labels is entered in the value field to the right of the ‘Default Rotation’ parameter. The default is 0 for no rotation. Positive degree values rotate the labels in a counter-clockwise direction; negative degree values rotate in a clockwise direction. The rotation point will depend on the settings for the horizontal and vertical alignment parameters. This parameter affects all labels in the same manner.

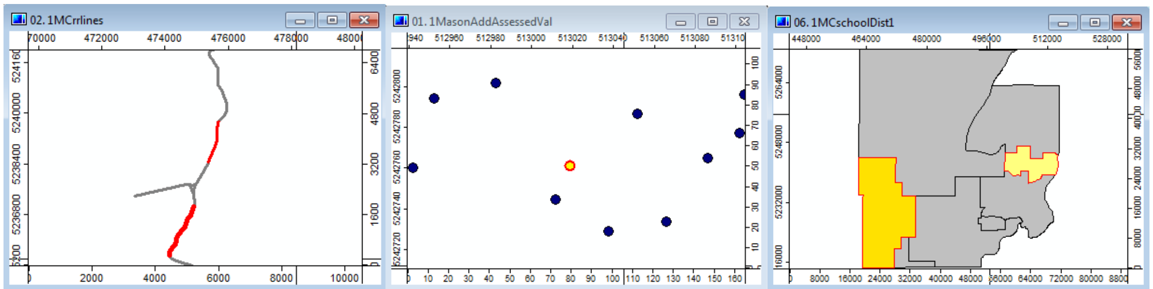
Labels: Attribute: Horizontal Align; Labels: Attribute: Vertical Align
[point]
These parameters have three options for positioning the label horizontally to the left, center, or right or vertically top, center, bottom of the point symbol. The default entries are "center" and "top". These parameters only effect the position of the label, not the appearance, size, or color.



Line Point Polygon

Figure 10-52. The Selection parameters for the three shape layer types.

Selection: Color
[line, point, polygon]
The default color for this parameter is red. The color affects objects that have been selected, e.g., by using the Action tool available on the toolbar. There are other ways an object can be selected, e.g., by a tool search. If the object chosen is a line object, the line display changes from its non-selected color (gray in Figure 10-53) to red. Point objects represented by symbols and polygon objects, when selected, their outlines change to the selection color and there fill color changes. Figure 10-53 displays an example for each shape layer type.



Line Point Polygon

Figure 10-53. Selection examples for each shape layer type.

The 'Single Symbol' option for the Colors: Type parameter is used for each of the shape layers in the map view windows in Figure 10-52. The line shape layer is the '1MCrrlines' layer for rail lines. The point shape layer is for address points ('1MasonAddAssessedVal') and the polygon shape layer is for school district boundaries.

In each of the three map view windows I see objects either outlined in red or lines displaying in red. The red indicates these objects are in selection status. A couple differences can be observed in the map view windows for line and polygon objects.

Two line segments display in red. The most recent selected line object is emphasized by extra line thickness. A prior selected line object, that is still selected, displays as a thinner line. In the polygon shape layer map view window, two polygon objects display in two shades of yellow. The most recent selected polygon object is filled with the darker yellow shade.

The selection color can be changed. I click the mouse pointer in the value field to the right of the Selection: Color parameter. A dropdown list of color named color examples displays. I can select a color on the list using the mouse pointer. This is the same approach for choosing a color for any of the fill parameters.

I can see that point and polygon objects have area and use red outlines. The yellow color is a fill color.

Selection: Fill Color
[point]
Point object locations display using symbols because a point location is defined by a single X, Y coordinate location and does not have any area. Symbols have area. This parameter identifies a color that serves as the fill color for a symbol area of a selected point object.

Selection: Fill Color 1, Fill Color 2
[polygon]
Polygon objects have area. The 'Fill Color 1' fill color is used to fill the current selected polygon object. If this is one of multiple polygons selected, other selected polygon objects use the color for the 'Fill Color 2' parameter.

Edit	
Color	Black
>> Snap to...	1 object (1MCrrlines)
Snap Distance	10

Line

Edit	
Color	Black
>> Snap to...	1 object (1MasonPoints2)
Snap Distance	10

Point

Edit	
Color	Black
>> Snap to...	1 object (1MCschoolDist)
Snap Distance	10

Polygon

Figure 10-54. Shape layers Edit parameters.

Edit

The Settings tab in the Object Properties window for a shape layer has three parameters in the "Edit" section supporting on-screen digitizing. They are 'Color', '>> Snap to...', and‘Snap Distance'. Figure 10-54 displays this portion of the Setting tab area for each shape layer type.

Edit: Color

[line, point, polygon]

The role of on-screen digitizing is to develop a new layer or update an object or objects of an existing layer. It is often the case that for these purposes, a feature or features on one or more other shape layers are used as guides to precisely define an object edit or a new object.

When an object on a shape layer is in selection status, using the Action tool from the toolbar, the "Edit selection" option can be chosen. The object outline, vertices, and/or edges then display with the color chosen for the Edit: Color parameter. This is a layer parameter and does not affect other layers.

I can change the color for this parameter by clicking the mouse pointer in the value field to the right of the Edit: Color parameter. A dropdown list of colors with color names displays. I choose a color with the mouse. I click on the Apply button at the bottom of the window for the new color to take effect.

Edit: >> Snap to...

[line, point, polygon]

The ‘>>Snap to…’ parameter identifies one or more shape layers that will serve to providing precise object positioning, relative to objects of other layers, for new objects on the edited layer that meet the snap distance criteria. As with other parameters, you must click on the Apply button at the bottom of the window for changes in these parameters to take effect.

Edit: >> Snap to...: Snap Distance

[line, point, polygon]

The ‘Snap Distance’ parameter value field sets a distance radius for snapping a point of an object, on a layer being updated, to a point of an object on another layer. If the digitized point on the layer being updated is within the snap distance to a point of an object on another layer, location of the new digitized point is set the same as the point location on the other layer. Snap distance units are screen pixels.

Here is an example that provides more explanation of the on-screen digitizing support parameters and how they are used in an on-screen digitizing process.

In this example, I create a map view window displaying the point shape layer '1ObservLoc' and the ‘1MCroadsAll’ line shape layer. I intend to update the '1ObservLoc' layer and want a new point object to snap to an existing road line object. The new point will snap to a location on a road object of the '1MCroadsAll' line shape layer. Figure 10-55 displays the map view window showing a zoomed in area of the two layers.

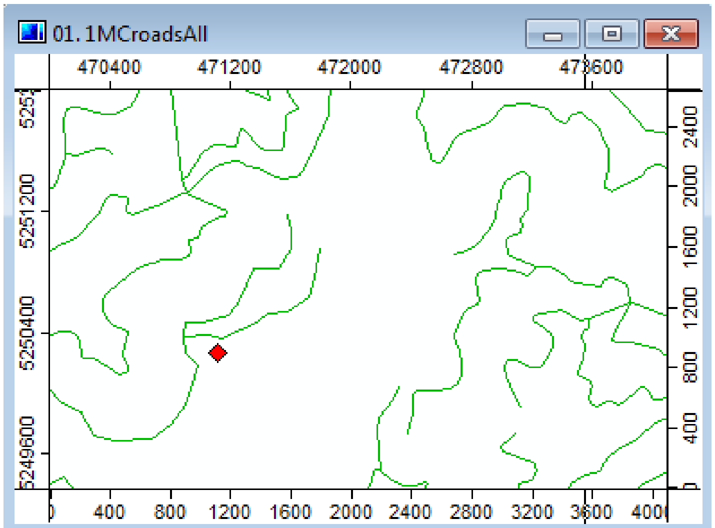


Figure 10-55. Map 1 displaying the ‘ObservLoc’ and ‘MCroadsAll’ shape layers.

The green lines in the map view window represent roads. The red rhombus is a viewing point.

I click on the ‘1ObservLoc’ layer in the Data tab of the Manager window and display its parameter entries in the Settings tab of the Object Properties window. In the value field to the right of the ‘>>Snap to…’ parameter, I click on the ellipsis symbol. The ‘Snap to…’ dialog window in Figure 10-56 displays.

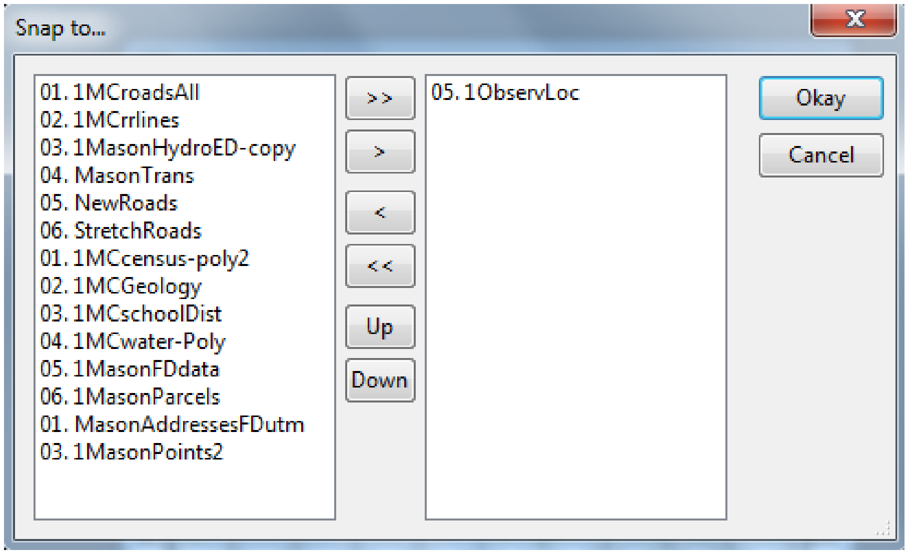


Figure 10-56. The ‘Snap to…’ dialog window.

The default entry for the 'Snap to...' parameter is for the layer to snap to itself. In this case I do not want to use the default. I want to use the '1MCroadsAll' line shape layer. I click the mouse pointer on the '1ObservLoc' layer name in the right panel. I then click on either the single (<) or double (<<) arrow keys to move the layer to the left panel. Now I select the roads layer.

Using the mouse cursor, I click on the ‘1MCroadsAll.shp’ layer name that appears in the list of shape layers on the left. Once it is highlighted, I click on the '>' button in the middle of the window to move the layer name to the area on the right. I could have chosen more than one layer by pressing the Ctrl key at the same time as clicking on additional layers. They all could be moved at the same time by clicking on the ‘>>’ button. Next, I click on the Okay button on the right. I leave the ‘Snap Distance’ parameter set at 10 and click on the Apply button at the bottom of the Object Properties window.

I have selected black for the 'Color' parameter, the '1MCroadsAll' layer for the '>> Snap to...' parameter, and am using the default 10 entry for the 'Snap Distance' parameter.

I make sure the '1ObservLoc' point shape layer is the active layer. Before I can add an object to it, I must choose the Action () tool from the toolbar or the Menu Bar Map dropdown menu. Next, I move the mouse pointer within the map view window and press the right mouse button. A popup list of five edit options displays. The 'Add Shape' option is one of the two that are available. I choose the ‘Add Shape’ option. I am now in on-screen digitizing mode. I notice a circle displayed in the upper left corner of the map view window that graphically displays the ‘Snap Distance’ parameter value.

I locate in the map view window the road intersection where I want to define a new observation point. Once the mouse pointer is near the intersection (visually within the circle distance), I click the mouse button. Since I am editing a point shape layer, a single mouse click defines a point object. After I click the left mouse button, I click the right button to end the data entry. A box with a point in the middle appears where I clicked. Since I was within 10 screen pixels of the road intersection, the point was snapped to the same location as the road intersection. It looks correct, so I right-click with the mouse pointer in the map view window. A popup list of options displays, I choose the 'Edit Selected Shapes' mode option (which is the only one of the three that is active). A message displays asking if I want to save the feature I just added. I click on the 'Yes' button.

The map view window is now updated with a second viewing point (Figure 10-57).

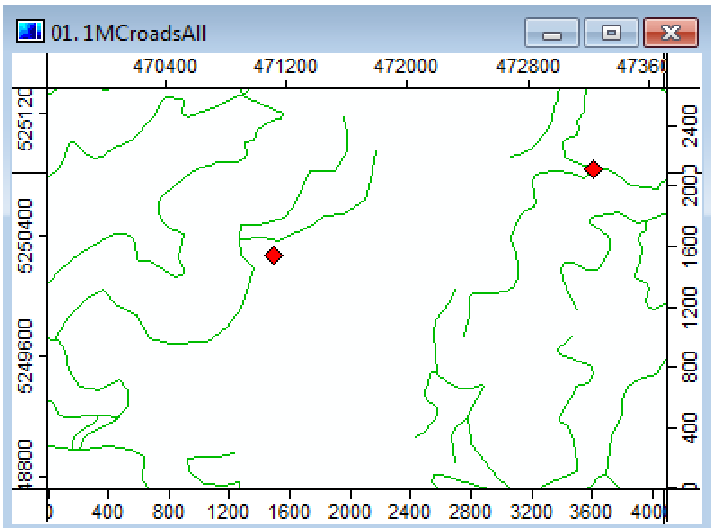


Figure 10-57. The updated '1ObservLoc' point shape layer.

This process for adding objects to a shape layer and adjusting feature locations to features on other layers is very easy to use.

The snapping capability supported in SAGA is a powerful on-screen digitizing feature. Before using it, plan your on-screen digitizing process. Using more than one layer as the snapping to layer can create a very complicated edit situation. You can move in and out of this feature. For example, you may have a series of points that you want to snap to locations of objects on another layer and have a series of points that are totally independent of any other features. When you get to new objects in the latter group, update the 'Snap to…' parameter by removing the previously identified layer.

Snapping is disabled to layers if you re-select the '>>Snap to …' parameter and move layers in the list on the right back over to the left side list. A second way to disable the snapping option is to enter a zero for the 'Snap Distance' value field.

A more detailed discussion of on-screen digitizing is in Chapter 7.

The Object Properties Tabs: Description, Legend, History and Attributes
In addition to the Settings tab, there are four other tabs at the top of the Object Properties window. These are Description, History, Legend and Attributes.

The Description Tab of the Object Properties Window
Figure 10-58 displays the upper portion of the Description tab area of the Object Properties window for a county school district polygon shape layer. The lower portion, "Table Description", is displayed in Figure 10-59. Users cannot directly edit data displayed in the Description tab window.

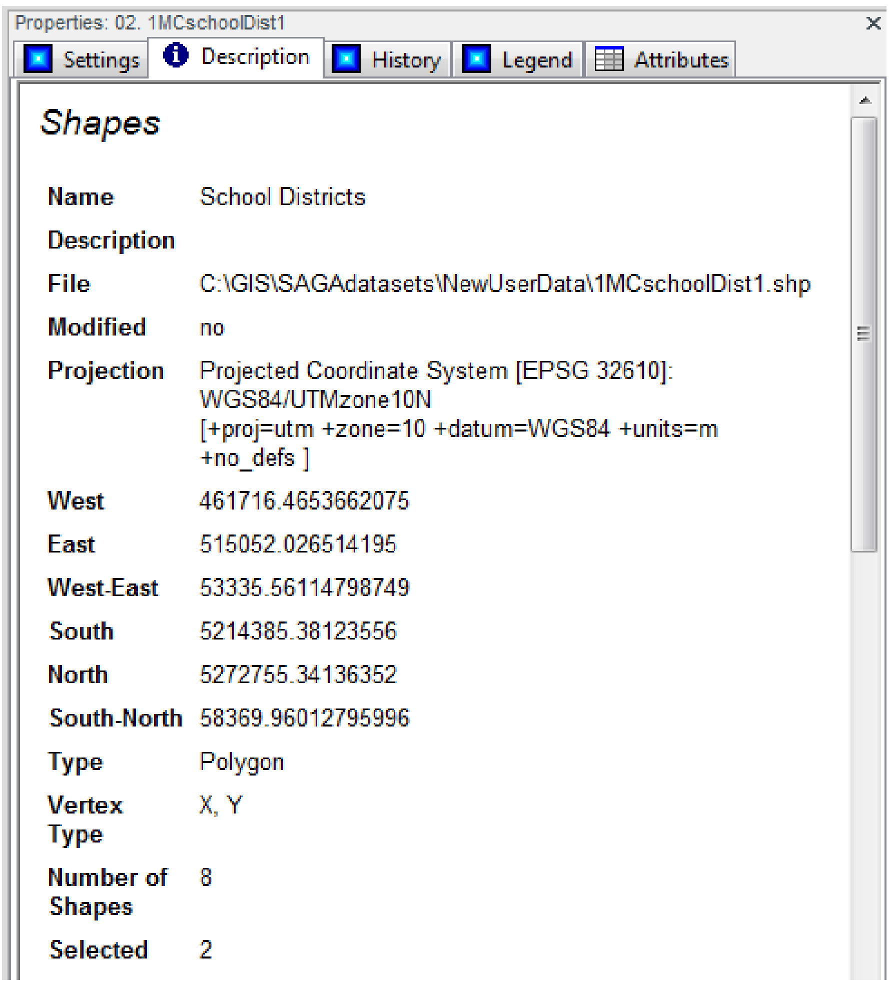


Figure 10-58. The Description tab area for a shape layer in the Object Properties window.

The Description area provides information for a layer. The entry for the "Name" field is the entry for the 'Name' parameter in the Settings tab area of the Object Properties window. Immediately under the "Name" field is a "Description" field. Information entered for the 'Description' parameter displays for this field. If no information is entered, this field is blank. Below it is the path and file name of the layer data file as stored on the desktop system. In this example, the name used for the 'Name' parameter is "School

Districts" and the data file name is "1MCschoolDist1.shp". I usually use the layer file name for the 'Name' parameter. The exception is when I use the layer in a layout view window and want a more explanatory title for the legend that describes the layer.

The "Modified" field variable identifies whether the layer has been edited in the work session. In this case the entry is “no” meaning the layer has not been changed.

The "Projection" information identifies the projected coordinate system. Projected coordinate system information is stored in a .prj file. If the layer file set includes a .prj file, the coordinate information is displayed in the Description area. When a .prj file does not exist, this information is entered using the 'Spatial Reference' parameter available for the layer in the Data tab area of the Manager window or using the *Projection - Proj.4/Set Coordinate Reference System* tool. This information can be updated or changed using the tools available in the Projection library. In the absence of a .prj file, "Undefined Coordinate System" displays.

The next several variables relate to the map extent. Map extent is a rectangle shaped envelope or box that encompasses the objects of the layer.

The West, East, South, and North information fields list the coordinates for the sides of a bounding rectangle. The West value is the western coordinate or X value of the furthest west located object of the layer. The East value is the eastern coordinate or X value of the furthest east located object of the layer. The North value is the north coordinate or Y value of the furthest north located object of the layer. The South value is the southern coordinate or Y value of the furthest south located object of the layer. The West-East and South-North identify distances in meters across the bounding rectangle. These distances are calculated by subtracting the West coordinate from the East coordinate and the South coordinate from the North coordinate.

The "Type" field identifies the kind of objects contained in the shape layer. The choices are Polygon, Line, Multipoint or Point.

The "Number of Shapes" field lists the number of objects (i.e., shapes) contained in the layer.

The "Selected" field identifies whether any objects of the layer are in selection status.

The next section of the Description is the "Table Description". This relates to the linked attribute table. The Table Description provides some limited documentation for the attributes that are characteristics for the layer objects. Figure 10-59 shows the table description for the school district polygon shape layer ('1MCschoolDist1').

Table Description

Field	Name	Type	Minimum	Maximum	Mean	Standard Deviation
1	ID	signed 8 byte integer	1	8	4.5	2.291288
2	SIZE	signed 8 byte integer	1	8	4.25	2.487469
3	SIZE2	signed 4 byte integer	20	20	20	0
4	COUNTY	string				
5	UNIFIED	string				
6	POPULATION	signed 8 byte integer	1241	20692	6434.625	6304.704076
7	POP1	signed 8 byte integer	89	5173	1672.25	1636.124976
8	POP2	signed 8 byte integer	631	6346	2681.25	2166.281708
9	POP3	signed 8 byte integer	211	9173	2081.5	2805.783001
10	GRAPEVIEW	signed 8 byte integer	0	1	0.125	0.330719
11	NAME	string				

Figure 10-59. The Table Description portion of the Description tab area of the Object Properties for the '1MCschoolDist1' layer.

The “Field” column identifies the column position for the attribute in the attribute table. The “Name” column shows the name of the attribute and the “Type” column shows the type of data values. Text attributes are identified with the type “string” notation. Numeric attributes are described according to their numeric format. The remaining four columns are descriptive statistics for numeric variables. These columns are blank for string attributes.

Below is a list of numeric formats used in SAGA layers. The reference that SAGA uses for each type is in quotes.

"unsigned 1 byte integer"; integer values from 0 to 255
"signed 1 byte integer"; integer values from –128 to 127
"unsigned 2 byte integer"; integer values from 0 to 65535
"signed 2 byte integer"; integer values from –32768 to 32767
"unsigned 4 byte integer"; integer values from 0 to 4294967295
"signed 4 byte integer"; integer values from -2147483648 to 2147483647

"unsigned 8 byte integer"; integer values from 0 to 18,446,744,073,709,551,515
"signed 8 byte integer"; integer values from + or - 9,223,372,036,854,775,808
"4 byte floating point number"; real values with seven digits precision
"8 byte floating point number"; real values with fifteen digits precision
"binary"; values of 0 and 1

The History Tab of the Object Properties Window
A history file for a shape layer is stored using the .mshp format. The History tab of the Object Properties window for a layer accesses information on how the layer evolved. Figure 10-60 displays the History tab area for a polygon shape layer for land parcels. The layer is named '1MasonParcels'.

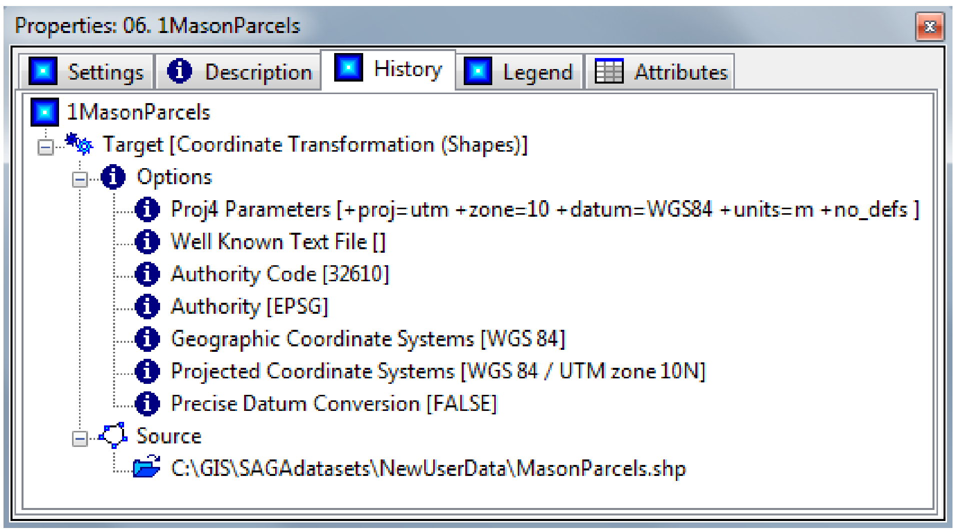


Figure 10-60. The History tab area for the "1MasonParcels" polygon shape layer.

The "Source" entry in the History tab area indicates the path to the folder where the input data files for the *Coordinate Transformation (Shapes)* tool are stored. The tool converted the coordinate reference system of the source shape layer to Universal Transverse Mercator, Zone 10 North. Some of the parameter values are listed.

The .mshp file content can be viewed with Notepad ++ and other text editors. Figure 10-61 displays a portion of the .mshp file for the "1MasonParcels" polygon shape layer.

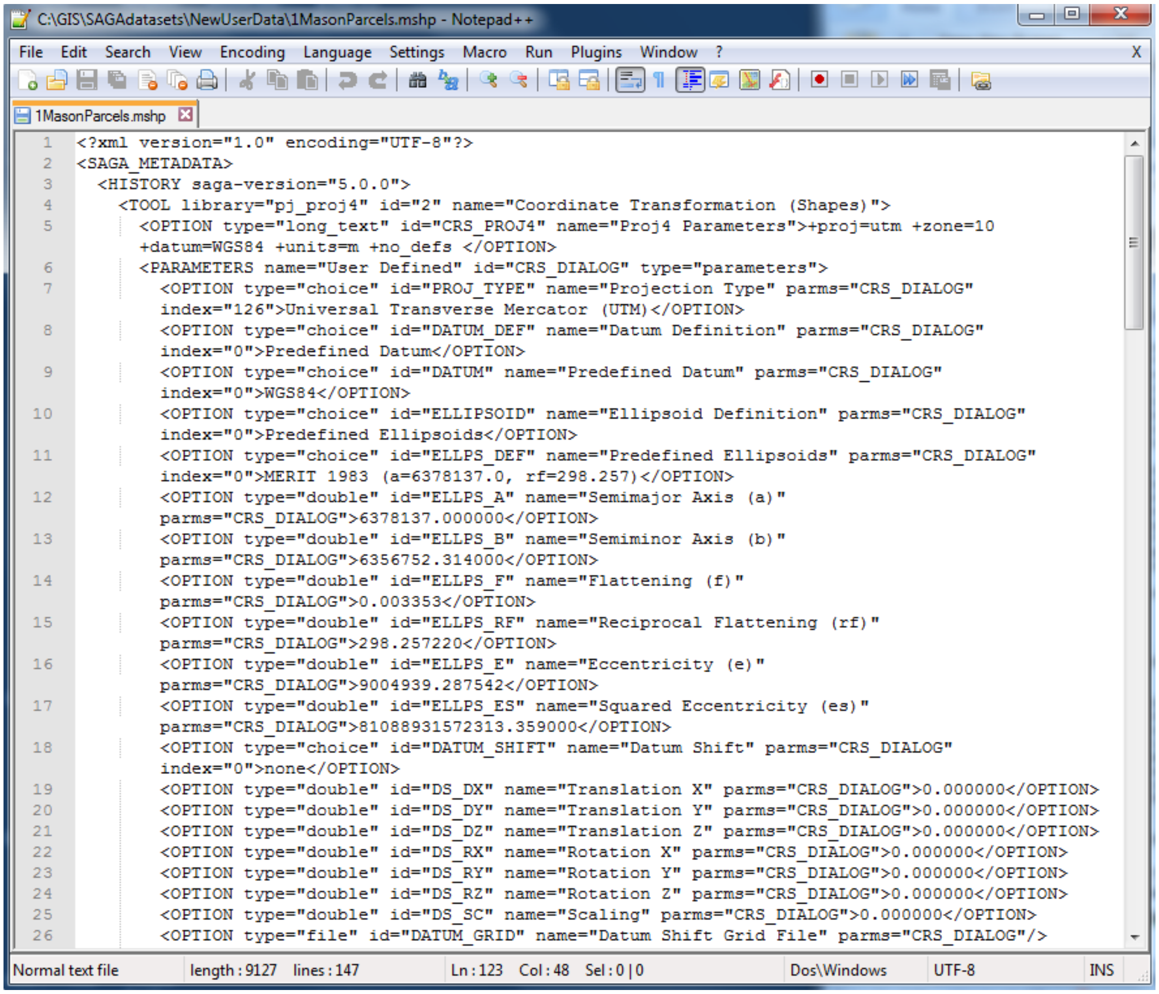


Figure 10-61. Display of a portion of the '1MasonParcels.mshp' history file using Notepad++.

I can see that the .mshp file contains a lot of information, much more than what displays for the 'History' tab.

The Legend Tab of the Object Properties Window

The next tab is ‘Legend’. The legend for a shape layer depends on three factors. First, the obvious one, the legend depends on a selected attribute. Secondly, not so obvious, the legend will vary depending on the Display: Colors: Type parameter. And third, the ‘Count’ variable in the Discrete Colors: Colors and Graduated Colors: Colors parameter settings.

Let's look at how the options for the Colors: Type parameter affect the legend. Figure 10-62 shows the legend for the water bodies polygon shape layer with the ‘Type’ parameter set to the default, “Single Symbol”.

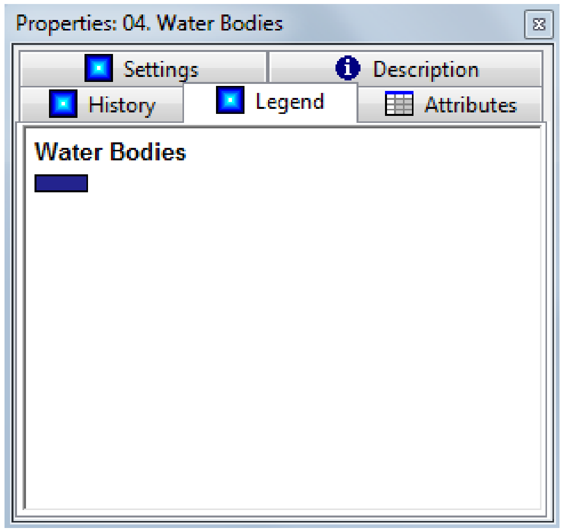


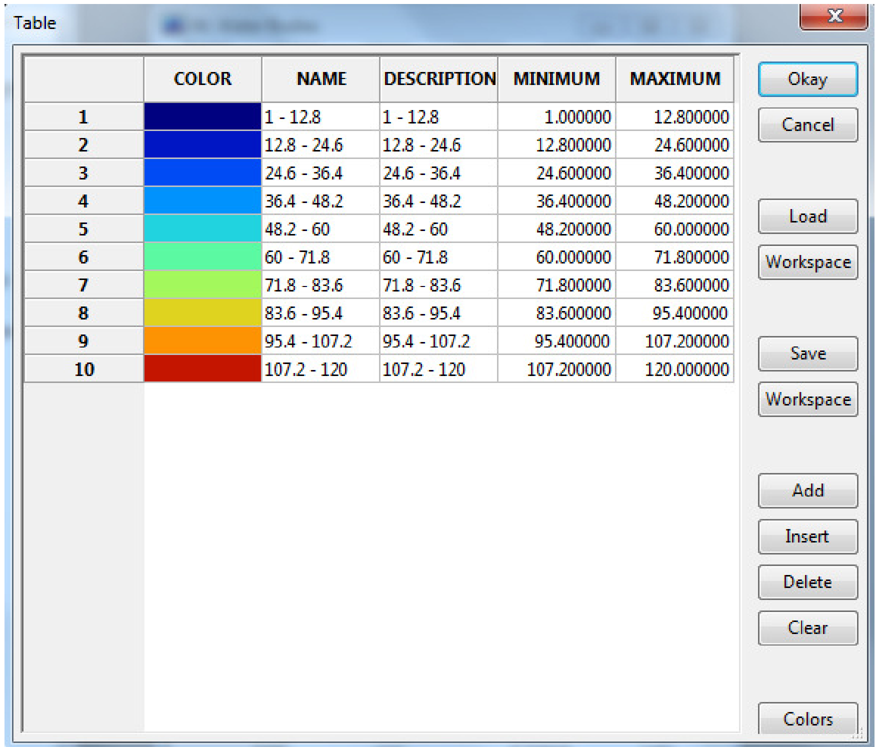
Figure 10-62. The water bodies shape layer legend using "Single Symbol" for the Colors: Type parameter.

A single color is assigned for all object attribute values. There is no visible differentiation for object data values based on color differences. There is not a parameter available for selecting an attribute for use with "Single Symbol". I use this option to display the presence and location of objects of a layer relative to the display of other features.

The title for the legend in Figure 10-62 is "Water Bodies". The text "Water Bodies" is entered for the 'Name' parameter for the '1MCwaters-Poly' polygon shape layer. I chose the navy blue color for the Colors: Type: Single Symbol: Color parameter. I would use these settings for displaying the water bodies of Mason County as a layer in a map view window that also displays other layers content.

The second option for the Colors: Type parameter is "Lookup Table". Recall the discussion earlier in this chapter related to the "Lookup Table" option. An example using the "Create Lookup Table" option was also presented.

I used the "Create Lookup Table" option to create a lookup table for the "ID" attribute of the '1MCwaters-Poly' polygon shape layer. I chose the "equal intervals" option for the 'Classification Method' parameter and entered 10 for the 'Count' variable. Figure 10-63 displays the table view window showing the resulting lookup table.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		1 - 12.8	1 - 12.8	1.000000	12.800000
2		12.8 - 24.6	12.8 - 24.6	12.800000	24.600000
3		24.6 - 36.4	24.6 - 36.4	24.600000	36.400000
4		36.4 - 48.2	36.4 - 48.2	36.400000	48.200000
5		48.2 - 60	48.2 - 60	48.200000	60.000000
6		60 - 71.8	60 - 71.8	60.000000	71.800000
7		71.8 - 83.6	71.8 - 83.6	71.800000	83.600000
8		83.6 - 95.4	83.6 - 95.4	83.600000	95.400000
9		95.4 - 107.2	95.4 - 107.2	95.400000	107.200000
10		107.2 - 120	107.2 - 120	107.200000	120.000000

Figure 10-63. A "Lookup Table" for the "ID" attribute for water polygons.

Figure 10-64 shows the legend created based on the "Lookup Table" in Figure 10-63.

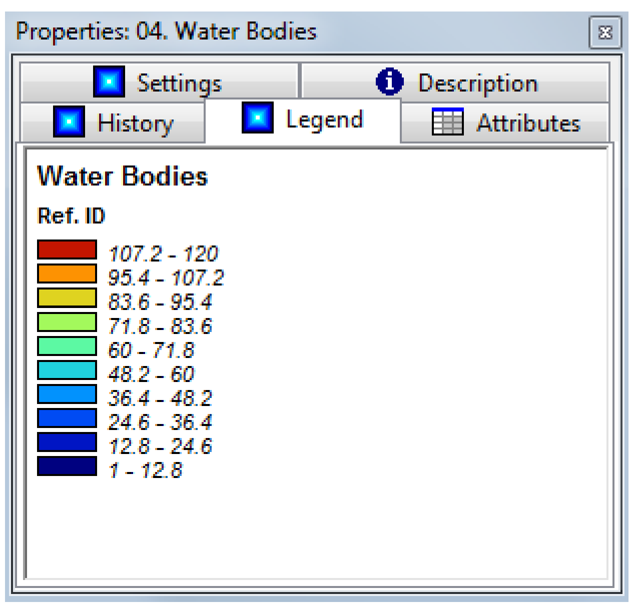


Figure 10-64. A legend from a "Lookup Table" for water bodies.

The overall title for the legend is "Water Bodies". The line below "Water Bodies" displays the name of the attribute providing the data values. In this case what shows is

"Ref. ID". The original attribute name was "ID" but I wanted to clarify what the data values represented and changed the attribute name to "Ref. ID" for purposes of the legend.

I will use the Mason County school district polygon shape layer ('1MCschoolDist1') in these last two examples. This layer includes 8 polygon objects, each represents a school district. The linked attribute table contains 11 attributes. I am going to use the "POP1" attribute. These data values represent the population of each school district at a certain point in history. The lowest value is 89 and the highest value is 5173. The data range is 5084.

I am using the "Discrete Colors" option for the Colors: Type parameter and 8 for the "Count" variable. This means that the data values will be displayed using a set of 8 display classes. Since the data range is 5084 and the number of classes is 8, the display class interval is 635.5. Figure 10-65 displays the legend created using these parameter entries.

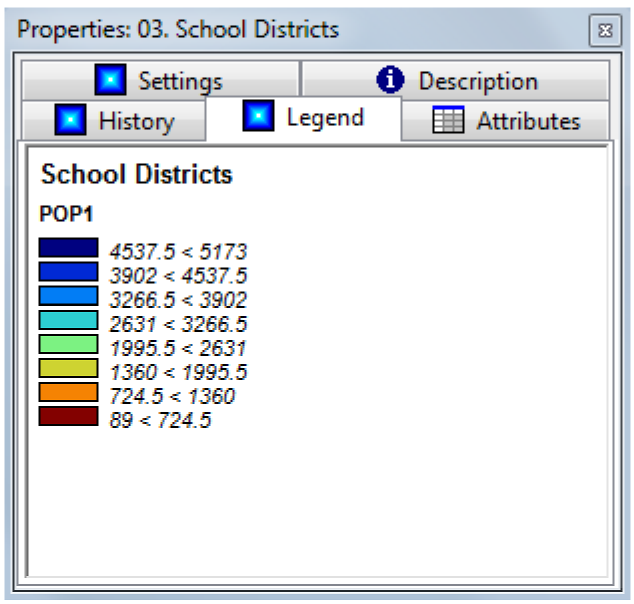


Figure 10-65. A legend with 'Type' set to "Discrete Colors" and a "Count" variable of 8.

The legend in Figure 10-65 has 8 display classes. The class interval is 635.5. The lowest class has a minimum class boundary of 89. Adding 635.5 to 89 and you have the maximum or upper class boundary of 724.5.

This last example legend, in Figure 10-66, uses the "Graduated Colors" option for the Colors: Type parameter and 8 for the "Count" variable. The "POP1" attribute is used. The "Graduated Colors" option, rather than defining display classes, applies a color ramp of a gradient of colors from a color associated with the lowest data value to a color associated with the largest data value. Data values in between are displayed with interpolated colors between the two. The entry for the "Count" variable is ignored since display classes are not involved.

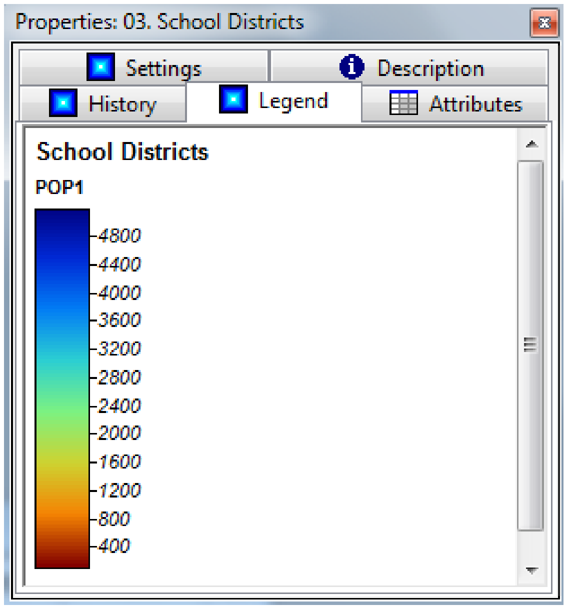


Figure 10-66. A legend with 'Type' set to "Graduated Colors".

A continuous gradient of colors from red to blue defines the color display legend. The lowest data value, 89, is equated to red at the bottom of the legend and the largest data value, 5173, is equated to blue at the top of the legend. Other data values are interpolated to color gradients between the minimum and maximum.

The Attributes Tab of the Object Properties Window

The Attributes tab area of the Object Properties window for a shape layer displays output from using the Action tool on the toolbar to select a specific object on a shape layer. The values for the attributes in the attribute table linked to the layer for the selected object update the Attributes tab area of the Object Properties window.

Figure 10-67 displays an empty Attributes tab area. No objects are selected on the '1MCwaters-Poly' layer.

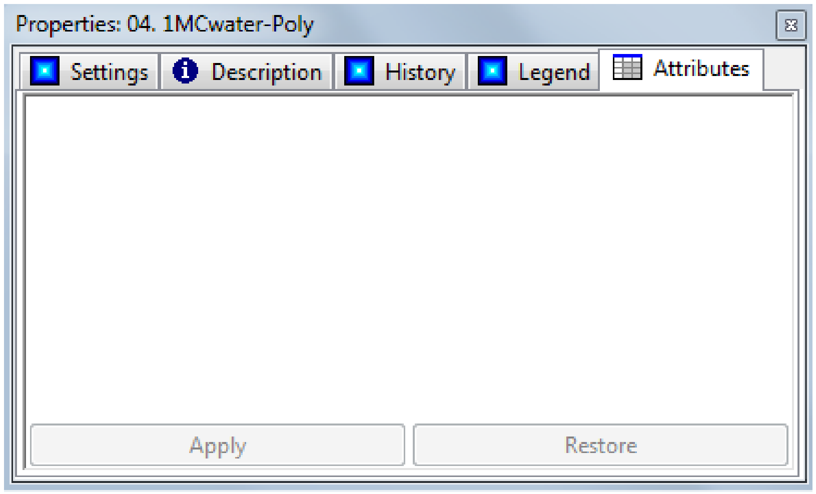


Figure 10-67. The empty Attributes section for a water body polygon shape layer.

Using the Action tool, I select one of the water polygons that appear in the water bodies layer map view window. The object is now highlighted. The highlighted water feature displays filled in yellow with a red outline for its boundary in Figure 10-68.

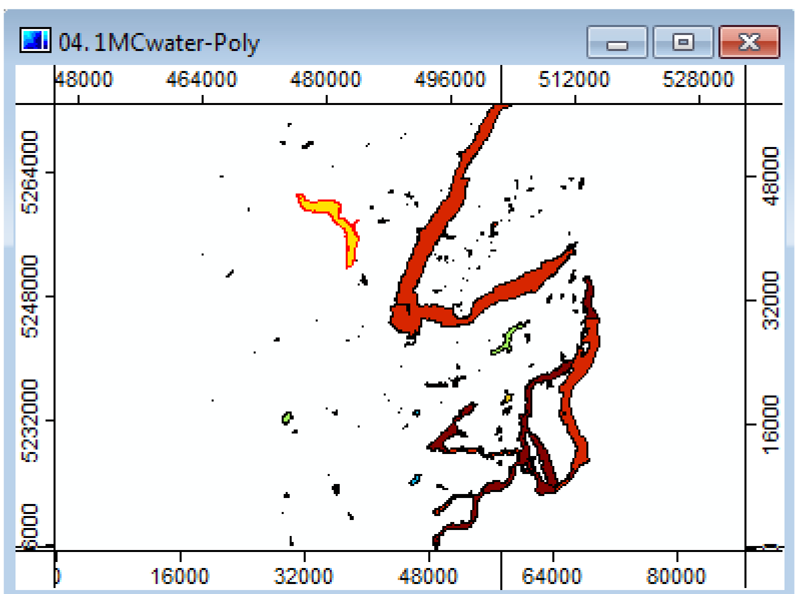


Figure 10-68. The red-outlined water body polygon is selected and highlighted.

As soon as a polygon is selected, the attributes for the polygon object display in the Attributes section of the Object Properties window (Figure 10-69).

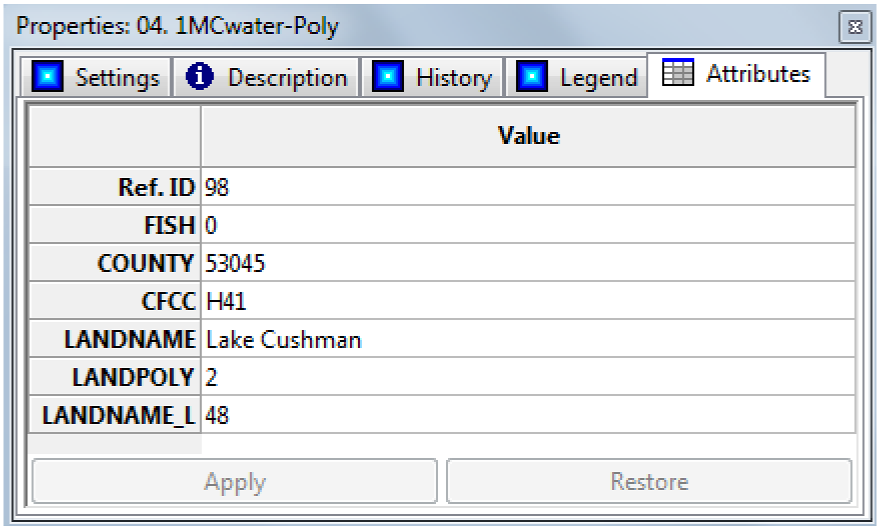


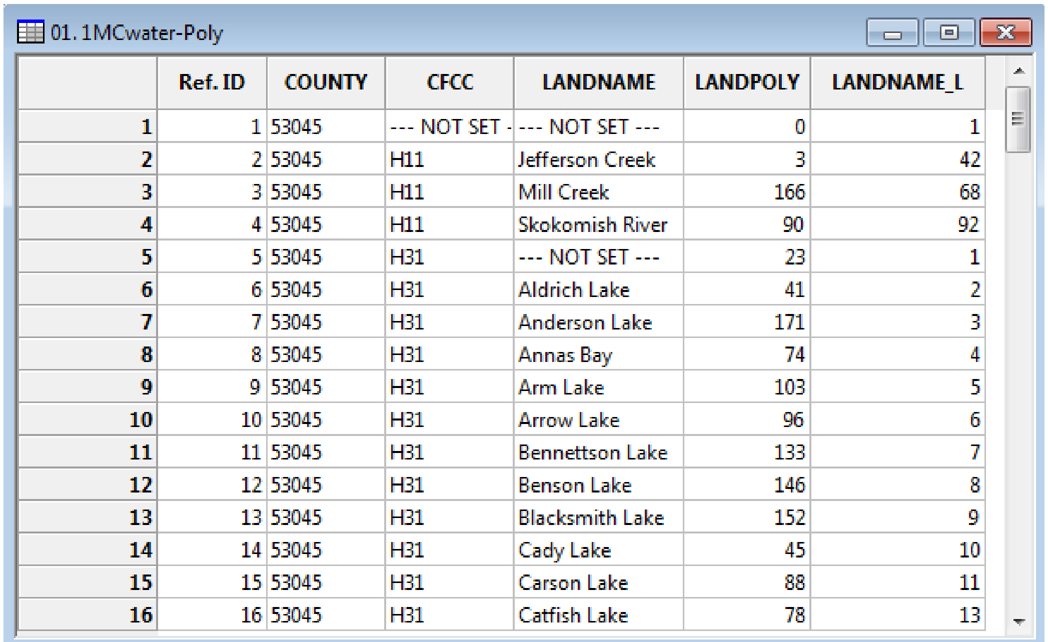
Figure 10-69. The attributes for the selected water body polygon.

The selected water polygon is Lake Cushman located on the Olympic Peninsula in Mason County, Washington.

The capability to select a shape object, display its attributes in the Attributes tab area of the Object Properties window, can also be used to edit existing attributes or even to add a completely new attribute and enter attribute values for it.

I will use the ‘1MCwaters-Poly’ shape layer as an example. First, I display the attribute table linked to the ‘1MCwaters-Poly’ layer. I move the mouse pointer over the layer name in the Data tab area of the Manager and right-click. A popup list of options appears. I expand the list for the ‘Attributes’ title by moving the mouse pointer over the triangle to its’ right. Another popup list of options displays and I choose ‘Show'.

Figure 10-70 displays a portion of the ‘MCwaters-Poly’ attribute table.



01. 1MCwater-Poly

	Ref. ID	COUNTY	CFCC	LANDNAME	LANDPOLY	LANDNAME_L
1	1	53045	--- NOT SET -	--- NOT SET ---	0	1
2	2	53045	H11	Jefferson Creek	3	42
3	3	53045	H11	Mill Creek	166	68
4	4	53045	H11	Skokomish River	90	92
5	5	53045	H31	--- NOT SET ---	23	1
6	6	53045	H31	Aldrich Lake	41	2
7	7	53045	H31	Anderson Lake	171	3
8	8	53045	H31	Annas Bay	74	4
9	9	53045	H31	Arm Lake	103	5
10	10	53045	H31	Arrow Lake	96	6
11	11	53045	H31	Bennettson Lake	133	7
12	12	53045	H31	Benson Lake	146	8
13	13	53045	H31	Blacksmith Lake	152	9
14	14	53045	H31	Cady Lake	45	10
15	15	53045	H31	Carson Lake	88	11
16	16	53045	H31	Catfish Lake	78	13

Figure 10-70. A portion of the attribute table for the 'MCwaters-Poly' shape layer.

On the Menu Bar, I click on the Table menu and choose the "Add Field" option from the dropdown list of options. The 'Add Field' window in Figure 10-71 displays.

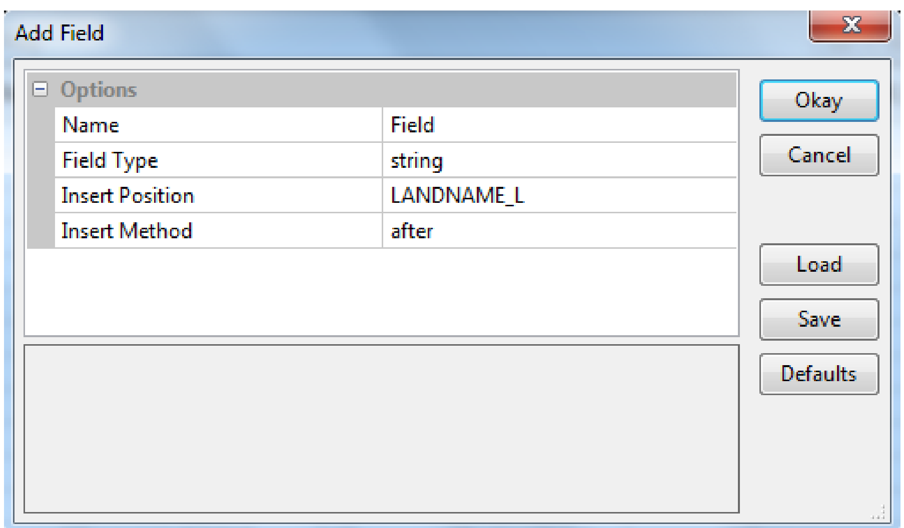


Figure 10-71. The 'Add Field' window.

I use this window to add a new, numeric field after the existing "Ref. ID" attribute in the table. The new attribute is named "FISH". It will contain ratings for fishing success, 1 through 10, with 10 being best.

Figure 10-72 displays my entries for creating my new "FISH" attribute.

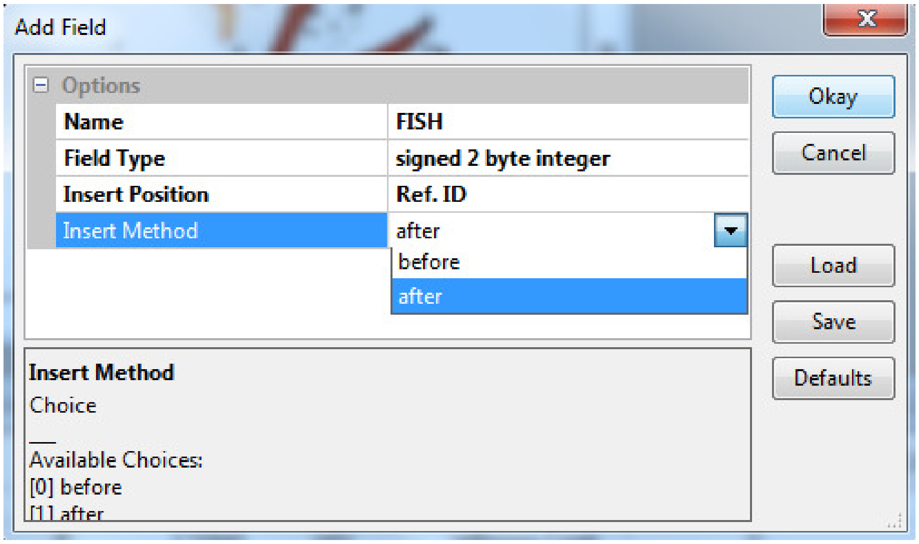


Figure 10-72. Creating the "FISH" attribute for the 'MCwaters-Poly' shape layer.

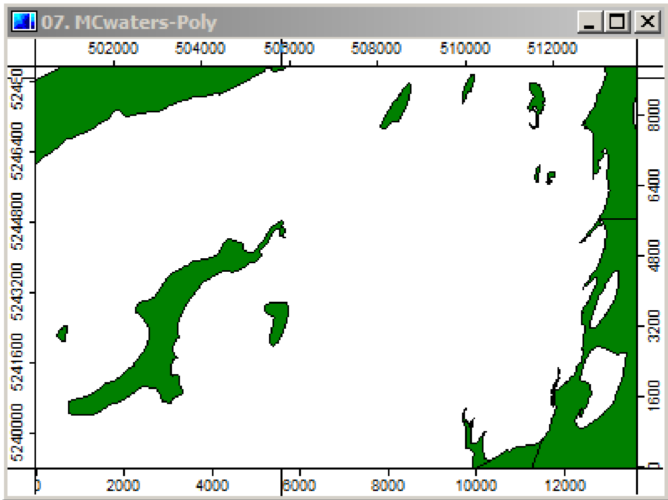
The modified attribute table for the 'MCwaters-Poly' shape layer appears in Figure 10-73.

01. 1MCwater-Poly

	Ref. ID	FISH	COUNTY	CFCC	LANDNAME	LANDPOLY	LANDNAME_L
1	1	0	53045	--- NOT SET --	--- NOT SET -	0	1
2	2	0	53045	H11	Jefferson Cre	3	42
3	3	0	53045	H11	Mill Creek	166	68
4	4	0	53045	H11	Skokomish Ri	90	92
5	5	0	53045	H31	--- NOT SET -	23	1
6	6	0	53045	H31	Aldrich Lake	41	2
7	7	0	53045	H31	Anderson Lak	171	3
8	8	0	53045	H31	Annas Bay	74	4
9	9	0	53045	H31	Arm Lake	103	5
10	10	0	53045	H31	Arrow Lake	96	6
11	11	0	53045	H31	Bennettson L	133	7
12	12	0	53045	H31	Benson Lake	146	8
13	13	0	53045	H31	Blacksmith La	152	9
14	14	0	53045	H31	Cady Lake	45	10
15	15	0	53045	H31	Carson Lake	88	11
16	16	0	53045	H31	Catfish Lake	78	13

Figure 10-73. The revised attribute table for the 'MCwaters-Poly' shape layer.

The "FISH" attribute is the one in the second column and has zeroes for values. I could directly enter my values for the "FISH" attribute in the table. When finished, I would choose the "Save Shapes" option that is available when I right-click on the layer name in the Data tab area of the Manager window. I do not have a rating to enter for most of these water bodies. I do want to enter one for Benson Lake (line 12 in the table).



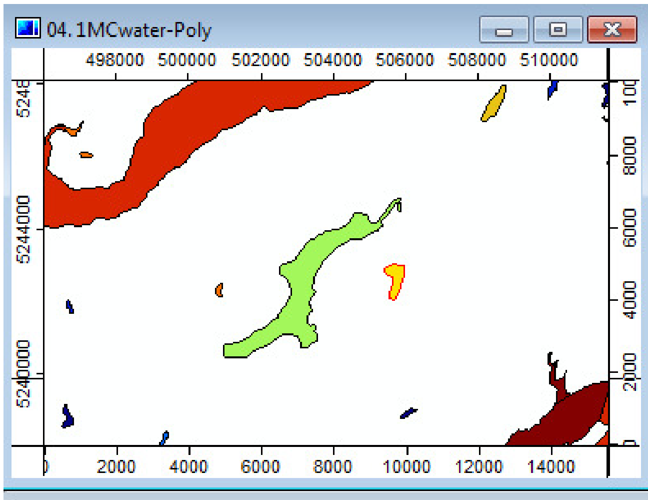
01. MCwaters-Poly

	ID	FISH	COUNTY	CFCC	LANDNAME	LANDPOLY	LANDNAME_L
1	1	0	53045	--- NOT SET ---	--- NOT SET ---	0	1
2	2	0	53045	H11	Jefferson Creek	3	42
3	3	0	53045	H11	Mill Creek	166	68
4	4	0	53045	H11	Skokomish River	90	92
5	5	0	53045	H31	--- NOT SET ---	23	1
6	6	0	53045	H31	Aldrich Lake	41	2
7	7	0	53045	H31	Anderson Lake	171	3
8	8	0	53045	H31	Annas Bay	74	4
9	9	0	53045	H31	Arm Lake	103	5
10	10	0	53045	H31	Arrow Lake	96	6
11	11	0	53045	H31	Bennettson Lak	133	7
12	12	0	53045	H31	Benson Lake	146	8
13	13	0	53045	H31	Blacksmith Lake	152	9
14	14	0	53045	H31	Cady Lake	45	10

Figure 10-74. A zoomed in area of the 'MCwaters-Poly' shape layer.

Benson Lake is the small lake just below the center of the map view window. It looks like a comma.

I select the Action tool on the toolbar and click and highlight Benson Lake.



01. 1MCwater-Poly

	Ref. ID	FISH	COUNTY	CFCC	LANDNAME	LANDPOLY	LANDNAME_L
1	1	0	53045	--- NOT SET --	--- NOT SET -	0	1
2	2	0	53045	H11	Jefferson Cre	3	42
3	3	0	53045	H11	Mill Creek	166	68
4	4	0	53045	H11	Skokomish Ri	90	92
5	5	0	53045	H31	--- NOT SET -	23	1
6	6	0	53045	H31	Aldrich Lake	41	2
7	7	0	53045	H31	Anderson Lak	171	3
8	8	0	53045	H31	Annas Bay	74	4
9	9	0	53045	H31	Arm Lake	103	5
10	10	0	53045	H31	Arrow Lake	96	6
11	11	0	53045	H31	Bennettson L	133	7
12	12	0	53045	H31	Benson Lake	146	8
13	13	0	53045	H31	Blacksmith La	152	9
14	14	0	53045	H31	Cady Lake	45	10
15	15	0	53045	H31	Carson Lake	88	11
16	16	0	53045	H31	Catfish Lake	78	13

Figure 10-75. Updated view of the 'MCwaters-Poly' shape layer and attribute table.

Three actions take place as a result of this selection. First, Benson Lake (the polygon object) is highlighted in yellow with a red outline in the map view window. Second, record 12, for Benson Lake, in the attribute table linked to the layer, is selected. Figure 10-76 displays the third action.

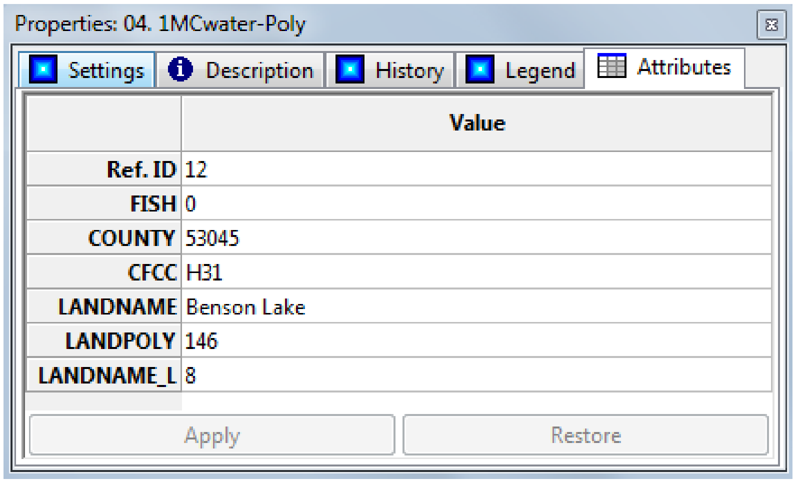


Figure 10-76. The Attributes tab area of the Object Properties window.

You can see in Figure 10-76 that the information displayed is the same attribute information available in the attribute table for Benson Lake.

I now have two options for entering a 10 for the “FISH” attribute. I am going to enter the new value using the Attributes tab area of the Object Properties window. The other option is to enter the value into the attribute table directly.

I move the mouse pointer into the data field to the right of the “FISH” attribute name and double-click to select the current value (which is “0”). With the old value highlighted, I enter 10 to replace it. Then I press the Enter key on the keyboard. The Apply button is now active. I click on the Apply button at the bottom of the Attribute tab area to have the edit take effect.

I can verify that the edit occurs by closing the attribute table and then re-displaying it using the ‘Show' command.

At this point, my edit is only good for this work session. In order to make it permanent, I need to re-save the ‘MCwaters-Poly’ shape layer. I use the ‘Save Shapes As…’ command to do that. I right-click with the mouse on the layer name in the Data tab area and choose the ‘Save Shapes As…’ command and follow the instructions.

Chapter 11 – Parameter Settings for Point Cloud Layers

The focus of this chapter is the point cloud layer, in particular, as derived from airborne laser scanning or the application of a LIDAR (light detection and ranging) remote sensor. Keep in mind that SAGA includes tools that support the creation of point clouds from a SAGA grid layer or from a point shape layer. Tools also support the creation of a grid or point shape layer from a point cloud.

A Point Cloud is a set of points in a three-dimensional coordinate space. The X and Y coordinates define horizontal position and Z coordinates are values for vertical position.

The .las file exchange format is a binary format that supports information specific to airborne Light Detection and Ranging (LIDAR) sensors. The SAGA module *Import/Export-LAS/Import LAS Files* imports the.las exchange format into a SAGA work session. Once a .las file is in a work session, it can be saved as a SAGA compressed point cloud layer (.sg-pts-z) or uncompressed point cloud layer (.sg-pts, .spc). The compressed point cloud layer is a zip file.

The *Point Clouds* library tools in SAGA support creating point clouds from grid layers, shape layers, or tables. An important capability of the SAGA point cloud format is its' efficiency for processing datasets with millions of points.

Numeric attributes imported as part of the .las format or as additional columns in attribute tables are stored as point attributes in the SAGA point cloud layer file. I think of a SAGA point cloud as a table with columns for X, Y, and Z columns and additional optional columns containing numeric attributes. The 'Load Point Cloud' option loads a SAGA point cloud layer (.spc, .sg-pts, .sg-pts-z). These files can be extremely large in size.

There is an excellent slide presentation (available as a .pdf file) created as part of Geostat 2012. Volker Wichmann is a co-author. It is titled: LIDAR Point Cloud Processing with SAGA. The reference for the document is:

Wichmann, V., Conrad, O., Jochem, A. "LIDAR Point Cloud Processing with SAGA GIS", Hamburger Beitrage zur Physischen Geographie und Landschaftsokologie 20, S 81-90.

Dr. Wichmann's slide presentation is available in the download area of the SAGA website (www.saga-gis.org): Downloads/SAGA - Documentation/Tutorials/ Geostat_2012/pc_processing_with_saga.pdf.

The Import/Export - LAS/Import LAS Files Tool

The American Society of Photogrammetry and Remote Sensing has been instrumental in establishing a LIDAR exchange format referred to generically as LAS. The SAGA tool *Import/Export - LAS/Import LAS Files* supports .las exchange formats 1.0, 1.1, and 1.2. Figure 11-1 displays the 'Import LAS Files' dialog window used to import 1 or more .las files.

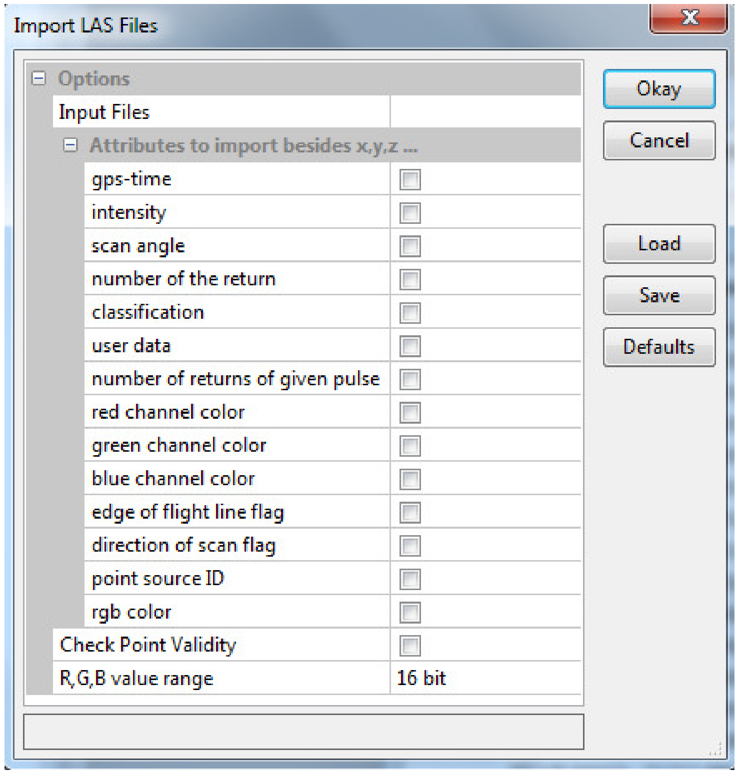


Figure 11-1. The 'Import LAS Files' dialog window.

The value field to the right of the 'Input Files' parameter is for identifying 1 or more .las files to import. I move the mouse pointer into the value field and press the left mouse button. An ellipsis appears on the right side of the value field. I click with the mouse on it and the 'Open' dialog window in Figure 11-2 displays.

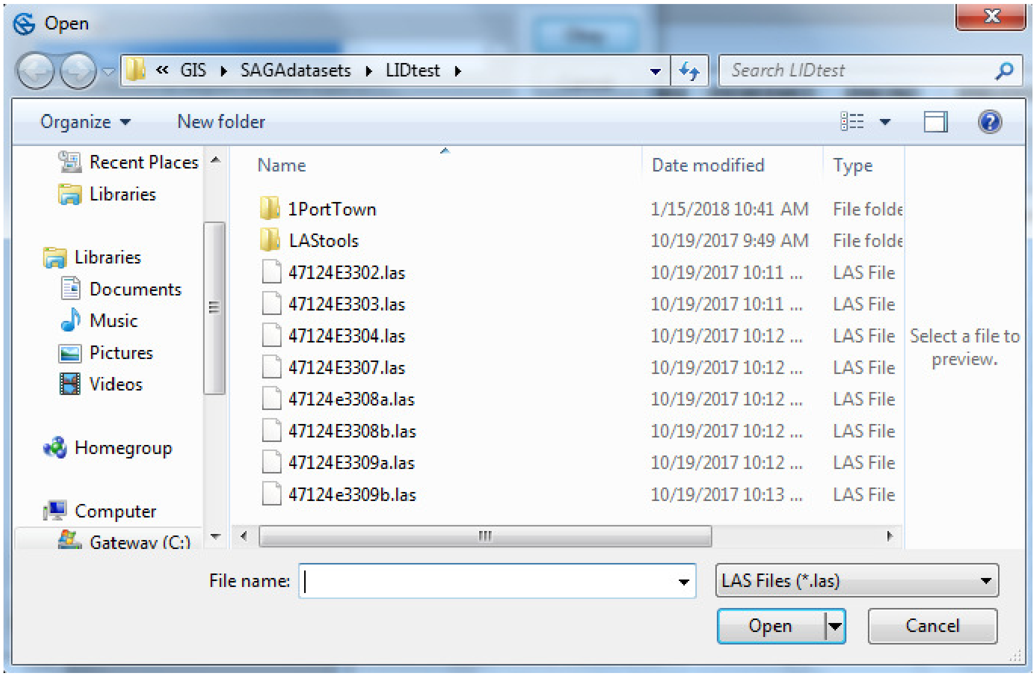


Figure 11-2. The 'Open' dialog window.

I navigate to where the .las file is stored. Viewing the 'Open' dialog window I can see that I have several .las files stored in a folder named "LIDtest". I am going to import the '47124E3304.las' file. I click the mouse on the file name and the name displays in the "File name:" information field near the bottom of the dialog window. I click with the mouse on the Open button and return to the 'Import LAS Files' dialog window.

The .las file, in addition to X, Y coordinates and Z values for vertices (or points), also includes 14 attributes. These attributes are part of the exchange format. These attributes are toggle check box attributes listed on the left side of the dialog window (Figure 11-1). I am going to import the following attributes: gps-time, intensity, number of the return, classification, number of returns of given pulse, and rgb color. I move the mouse pointer into the check box to the right of each of these attributes and press the left mouse button. A check mark appears in the box indicating the attribute is in on status for being imported. When I finish identifying attributes to import, I click on the Okay button. The tool imports the .las file including the selected attributes.

I check in the Data tab area of the Manager. The new point cloud layer '47124E3304' is listed in the "Point Cloud" section of the Data tab area. I edit the default entry for the 'Name' parameter in the Settings tab area of the Object Parameters window. I change it to '1pc47124E3304'. I next click with the mouse on the layer name in the Data tab area and choose the "Save as ..." option on the popup list of options. I save the renamed new point cloud layer as '1pc47124E3304' to a storage area.

The Settings Tab of the Object Properties Window for Point Cloud Layers
The parameter entries for a point cloud layer are viewed in the Settings tab of the Object Properties window the same way as parameter settings for grid and shape layers. I display the Object Properties window in the work area and click on the Settings tab. I navigate to the Data tab in the Manager window and click with the mouse on the name of a point cloud layer. The parameter entries in the Settings tab area of the Object Properties window update with the parameter settings for the active point cloud layer '1pc47124E3304'.

Figure 11-3 shows the properties for a point cloud layer named ‘pc47124E3304’.

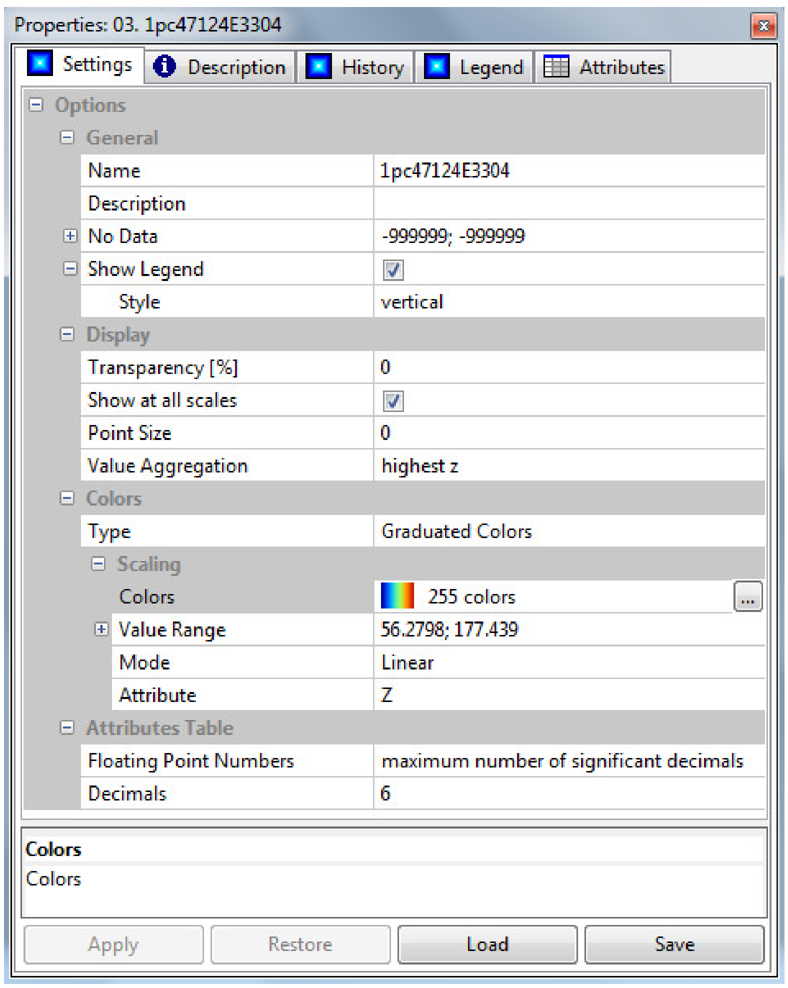


Figure 11-3. The property settings for Point Cloud layer '1pc47124E3304'.

The Settings tab area for a point cloud layer has four sections: General, Display, Colors, and Attribute Table.

The Settings tab area buttons appear at the bottom of the window: Apply, Restore, Load, and Save. The Apply and Restore buttons are dimmed and not available until I make a change to a parameter. I can make a change to a parameter by moving the mouse pointer into the value field to the right of the parameter name and press the left mouse button. The text identifying the Apply button becomes undimmed and the button is available. I must click with the mouse on the Apply button for a change to take effect. If the parameter is one requiring me to key information into the value field, e.g., a number, after I key in the information I press the Enter key on the keyboard. The Apply button then becomes active. Clicking on the Apply button updates any parameter changes.

The Restore button acts like a cancel button. If I have made changes to parameters, have not used the Apply button to enable them, and decide that I do not want them to take effect, I click on the Restore button and the parameters return to their pre-change condition.

The Save button is used to save a layers' parameter settings in a data file for future use. The data file is in the .sprm file format. Once a parameter .sprm file exists, the Load button loads it back into a work session. The content of the .sprm file is identical to the layer content saved as part of a configuration (.cfg) or project file (.sprj).

In Figure 11-3 I notice, on the left side of the parameter list, "-" and "+" symbols in boxes for some of the options listed. A "+" means additional parameters can be viewed by clicking on the "+" symbol. For example, in Figure 11-3 there is a "+" to the left of the 'No Data' parameter. I click on the "+" with the mouse pointer and two additional parameters display: 'Minimum' and 'Maximum'.

The first group of parameters are in the General category. Similar named parameters exist for grid and shape layers.

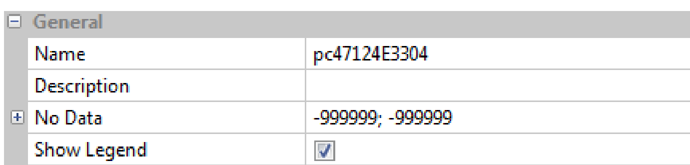


Figure 11-4. Parameters in the General category.

General: Name
This parameter is the alias SAGA uses for the layer. The default for the 'Name' parameter, for a new point cloud layer, is the storage file name of the imported .las file. I usually rename and resave an imported layer, regardless of the type of layer, using the same name for both the 'Name' parameter and the storage file name.

The entry for the 'Name' parameter is used in many areas of SAGA as the reference to the layer itself. For example, this is the name for the layer that appears in the Data tab area of the Manager window where available layers for the work session are listed. It is the name for the layer appearing in the lists tools use for choosing input layers.

The ‘Name’ parameter also serves as the title of the legend title whenever the legend for the layer displays. When I click on the Legend tab at the top of the Object Properties window, the legend displays and the title for it is the entry for the 'Name' parameter. It is also the title for the legend when I use the ‘Show Print Layout’ option. If I want to change the title used for a legend, I change the entry for the 'Name' parameter. For example, if I want "Elevation" to display rather than a point cloud layer name, I replace "1pc47124E3304" with the text "Elevation".

The value field to the right of the ‘Name’ parameter is where the layer name displays and where it can be changed. If I click in the value field with the mouse and highlight the name, I can enter a different name or edit the current one. If I change the name, I must press the Enter key on the keyboard and then click with the mouse on the Apply button at the bottom of the window in order for the change to take effect. Changing the name does not change the storage name of the saved layer.

General: Description
I can enter free-form text that displays in the value field to the right of the 'Description' parameter name. I click with the mouse in the value field and an ellipsis displays. I move the mouse pointer over the ellipsis on the far right and press the left mouse button. The 'Description' entry form in Figure 11-5 displays.

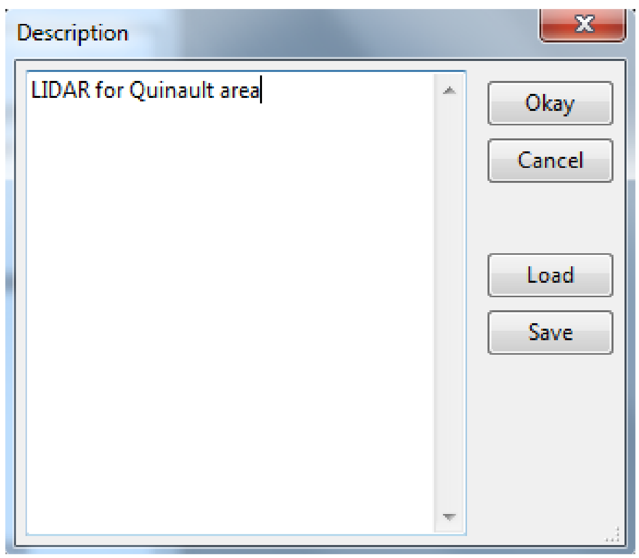


Figure 11-5. The 'Description' entry form.

I move the mouse pointer into the form and press the left mouse button. I can now enter text from the keyboard. In the example, I have entered text describing this layer. I could also enter keywords. The amount of text I can enter in the entry form appears unlimited. I have tested using up to 1000 characters. I click on the Okay button with the mouse pointer and the text I entered displays in the 'Description' value field.

The information entered for the 'Description' parameter is searchable. In addition, the names for the attributes in the attribute table are searchable. SAGA has a search function (described in Chapter 2 of this User Guide) that searches for selected text in the

'Description' and 'Name' parameters and attribute names in attribute tables linked to shape layers. The search function works with layers available in the current work session.

The search function is found in the Data and Maps tab areas of the Manager window. Move the mouse pointer over the word "Data" or "Maps" title near the top of the Manager window and press the right mouse button. At the bottom of the popup list of options is one named "Search for...". I click on it with the mouse. The 'Locate...' dialog window displays. I enter "LIDAR" into the value field to the right of the 'Search for...' parameter. I click on the toggle check box for the 'Description' parameter and a check mark appears in the box. Next, I click on the 'Okay' button. A second 'Locate...' window displays listing the names of layers in the current work session meeting the search criterion. In this example, the name of the '1pc47124E3304' point cloud layer is the only one on the found list.

General: No Data, Minimum, Maximum
Information for no data values does not display as information fields in the Description tab area of an Object Properties window for a point cloud layer. However, no data values serve the same purpose in point cloud layers as they do in grid layers. The Settings tab area for point cloud layers, includes parameters for no data values.

General: Show Legend
This parameter affects the "Show Print Layout" option available on the Menu Bar Map dropdown menu when a map view window displays in the work area. The default is for this toggle check box parameter to be on. This means when I choose the "Show Print Layout" option the legend for the point cloud layer displays to the right of the layer in the layout view window. The on or off setting of this parameter does not affect the Legend tab area. However, the related General: Show Legend: Style parameter affects an existing Layout view window and the Legend tab area.

General: Show Legend: Style
This parameter becomes available when the General: Show Legend parameter is in on status. The two options for the parameter control the orientation of the legend in an existing Layout view window and in the Legend tab area of the Object Properties window. The two choices are "vertical" and "horizontal".

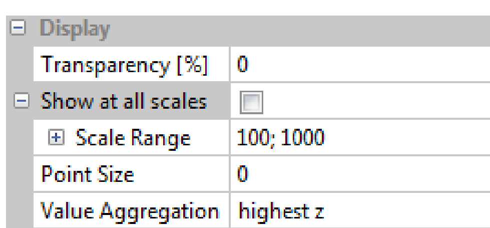


Figure 11-6. Parameters in the "Display" section.

Display: Transparency [%]
This parameter can come in handy when two or more layers display in the same map view window and the top layer is blocking the view of information displayed on the

bottom layer. I can adjust the ‘Transparency [%]’ parameter (a numeric value) for a layer or layers if I want to emphasize or de-emphasize the visual display of one layer versus others in the map view window.

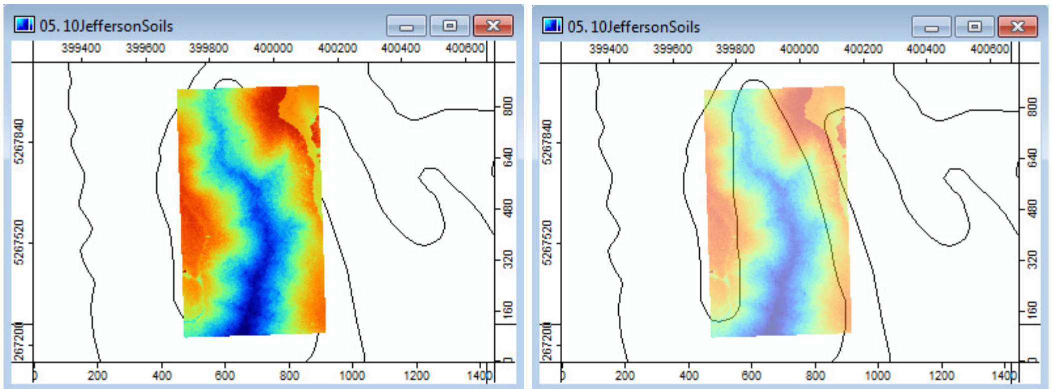


Figure 11-7. Comparing the use of the ‘Transparency [%]’ parameter with a Point Cloud layer.

Both map view windows in Figure 11-7 display a point cloud layer and the corresponding portion of the Jefferson County soil map. Soil polygon boundaries are in black. I use an entry of 0 for the ‘Transparency [%]’ parameter of the point cloud on the left and 50 for the same point cloud on the right. An entry of 0 does not change the opaqueness of the layer whereas an entry of 50 reduces it by 50 percent.

Display: Show at all scales
This is a toggle check box type parameter. The default is for this parameter to be in on status. The point cloud layer will display at any scale when this parameter is on (has a check in the box). I can change this parameter to off status by moving the mouse pointer into the box and pressing the left mouse button. The check mark in the box disappears and three additional parameter rows display just below the 'Show at all scales' parameter.

Display: Show at all scales: Scale Range, Minimum, Maximum
One of the additional parameters is 'Scale Range'. Supporting 'Scale Range' are parameters for setting the minimum scale range ('Minimum') and the maximum scale range ('Maximum'). The values entered for the 'Minimum' and 'Maximum' parameters define the scale range (the minimum map scale and the maximum map scale) for a map view window within which the layer displays. The layer does not display if the scale of the map view window is outside the defined scale range.

The values entered for these parameters are in map distance units. If the scale bar available on the tool bar is not active in the map view window, the bottom and right sides of a map view window display map distance unit tics. A layer will display in the map view window if the range for either the bottom or right scales (the lesser of the two) is greater than the minimum and less than the maximum.

For example, I have a map view window displaying a grid layer. The map distance range for the bottom side of the window is 72000; the range for the right side is 62000. The map distance range of 62000 is the lesser of the two. I enter 15000 for the 'Minimum' and 70000 for the 'Maximum'. I zoom out changing the map distance range to over 89000. The map does not display in the window. I choose the "Zoom to Previous Map Extent" option. Now I zoom in. When the map distance range reaches less than 15000, the map should not display. I have zoomed in a couple times, the current map distance range is 18000. I zoom in one more time, the range changes to 8800, less than 15000. The map does not display in the window.

Display: Point Size

This parameter controls the display size of point cloud points. The default value is 0. Increasing the value for this parameter increases the display size of each point cloud point. Figure 11-8 displays a zoomed in area of the '1pc47124E3303' point cloud layer. The map view window on the left uses the default value of 0 for this parameter while the map view on the right uses a value of 2.

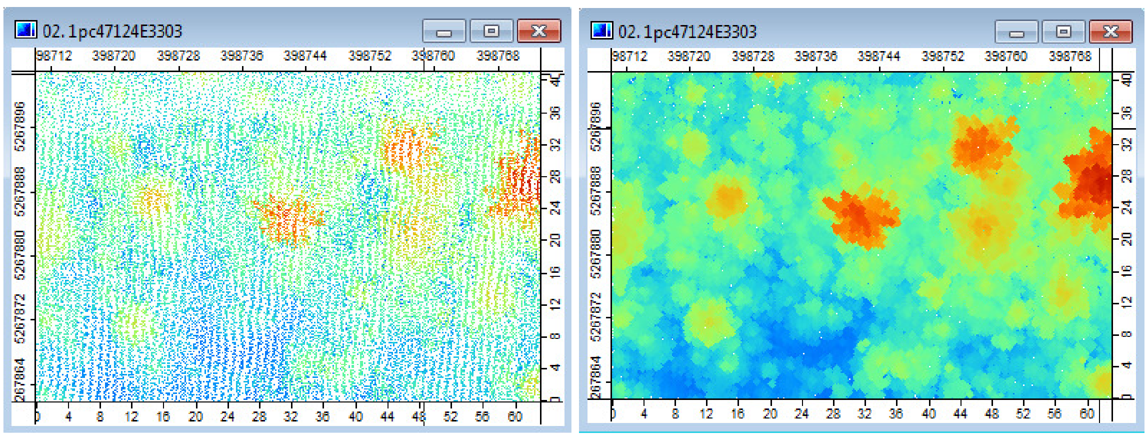


Figure 11-8. Comparing the results of using two different point size values.

Display: Value Aggregation

One of the possible attributes to import as part of a .las import is return number. This is a number 1 through 4 and identifies the number of a return from a pulse transmission. Often the first return is equated to the highest object or tree canopy ("highest z"). If this is the only return from a pulse it will be for bare ground. The last return, 4, is usually for bare ground or "lowest z".

Depending on a pixel or cell size, multiple points of a point cloud can fall in the pixel or cell area. Related to multiple points, the "first value" option is for the first (according to the GPS clock) value falling in the cell; the "last value" option is for the last chronological point in the cell. The "lowest z" is for the point having the lowest z value and the "highest z" is for the point having the highest z value.

Colors: Type
When I move the mouse pointer into the value field to the right of the 'Type' parameter and press the left mouse button, a dropdown list of five options displays. The options are: Single Symbol, Lookup Table, Discrete Colors, Graduated Colors and RGB. Each option has a set of supporting parameters. The support parameters for the "Discrete Colors" and "Graduated Colors" options are identical.

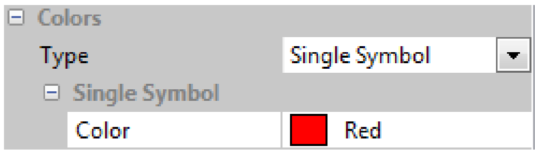


Figure 11-9. The parameter supporting the "Single Symbol" option.

Colors: Type: "Single Symbol"
The "Single Symbol" option is chosen for the 'Type' parameter.

Colors: Type: Single Symbol: Color
The “Single Symbol” option is available for grid, shape and point cloud layers. When I choose it for a point cloud layer, all data values of the point cloud layer will display using the single color chosen in the Colors: Type: Single Symbol: Color parameter value field. All visual differentiation between point data values is lost.

I click the mouse in the value field to the right of the ‘Color’ parameter. A dropdown list of color options displays (Figure 11-10). I choose a color on the list by moving the mouse pointer over the color swatch and clicking the left mouse button. The new color takes affect after I click on the Apply button at the bottom of the Object Properties window.

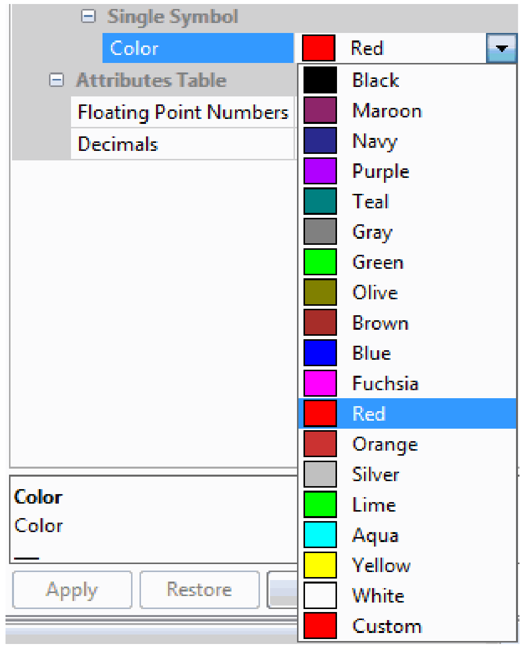


Figure 11-10. Choosing a color swatch for point cloud layer data values.

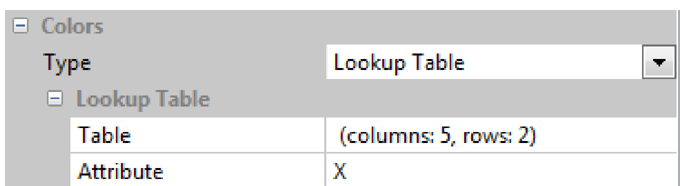


Figure 11-11. The parameters supporting the "Lookup Table" option.

Colors: Type: "Lookup Table"
The "Lookup Table" option is chosen for the 'Type' parameter.

Colors: Lookup Table: Table
One of the approaches for assigning colors to data values is using a “lookup table”. A lookup table is a way of transforming the data range into a range of colors. This approach is implemented in point cloud layers using the ‘Table’ parameter.

The default entry in the value field to the right of the ‘Table’ label is “(columns: 5, rows: 2)”. This text describes a default table having 2 rows and five columns.

Using a “lookup table” does not change the data values stored in the grid cells. It will change how they display. I can define display class boundaries and assign colors to each display class. The data values falling in each display class will display in a map view window using the color assigned to the display class.

If I click in the value field and on the ellipsis symbol that appears, a ‘Table’ view window displays. Figure 11-12 displays the default ‘Table’ for a point cloud layer. This happens to be the same default table used with grid and shape layers.

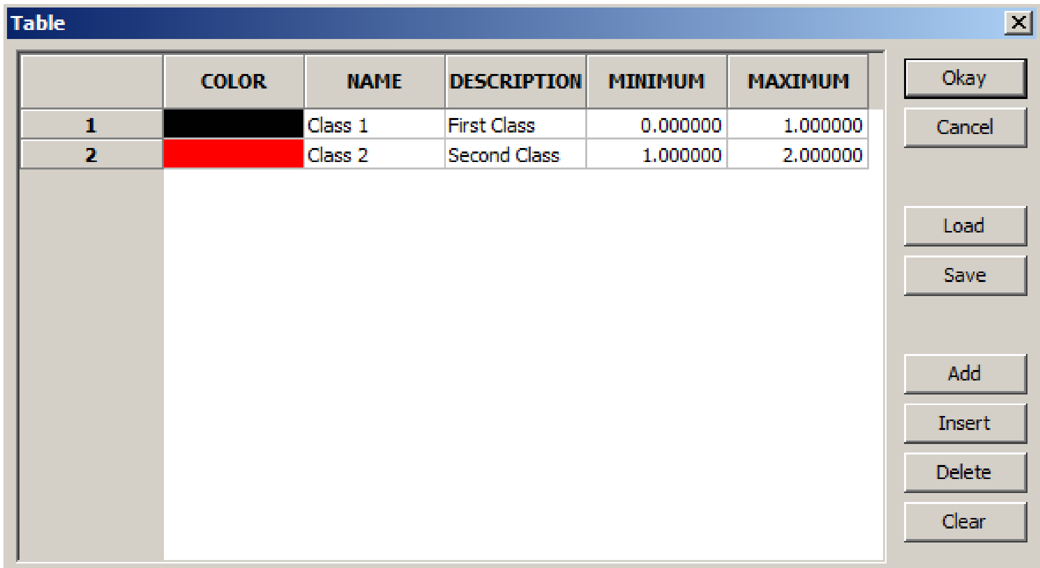


Figure 11-12. The default ‘Table’ for a point cloud layer.

A row represents a data display class. The columns are characteristics of the display class. The height of the rows as well as the widths of the columns can be adjusted using your mouse. I can see that there are five characteristics related to each data class. The first one is “COLOR”.

When I click with the mouse in the color column for a data class, a color table of color swatches like the one in Figure 11-13 appears. I identify a color for the selected data display class in the ‘Table’ by clicking with the mouse pointer on the color swatch in the color table that I want to use. When I click on the option ‘Define Custom Colors >>’ at the bottom of the color table display I can customize a color definition. After clicking on the color swatch that I want to use, I click on the OK button. The chosen color is assigned as the "COLOR" attribute for the data display class and appears in the “COLOR” column for the display class.

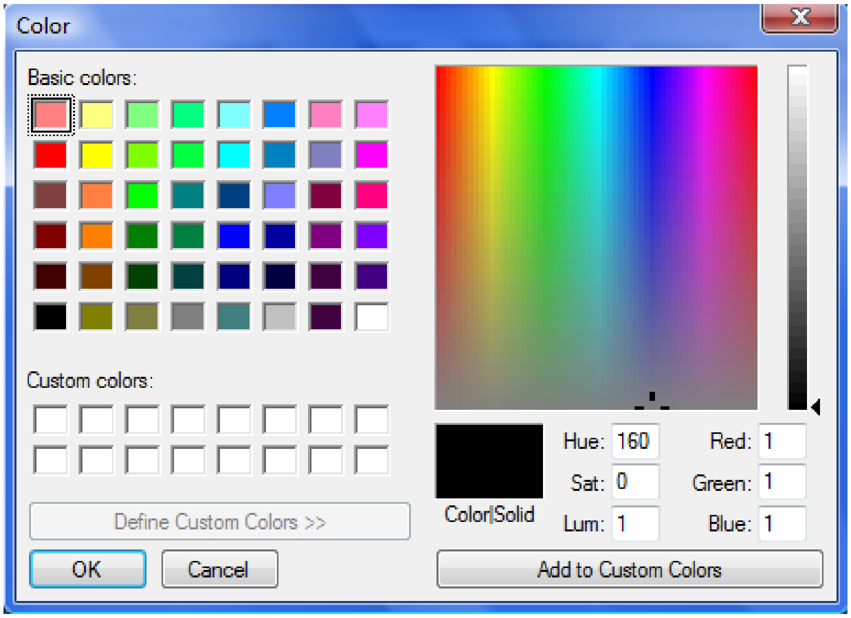
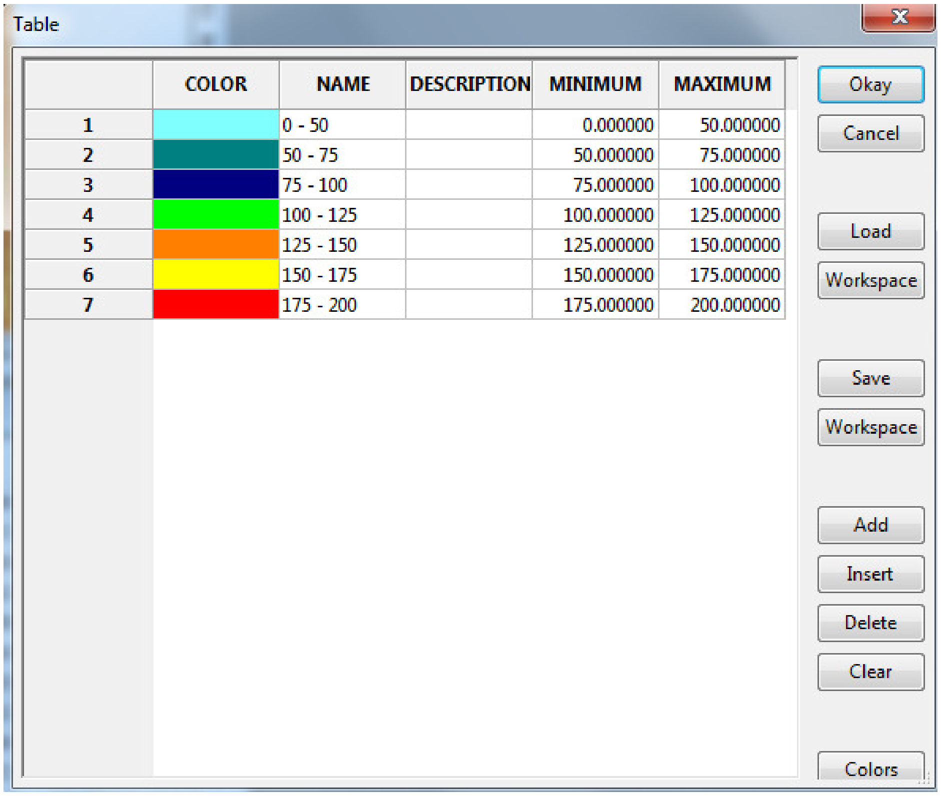


Figure 11-13. The color swatch table for assigning data class colors for grid data values.

The next column, “NAME”, is for assigning a name to the data display class. The text I enter, rather than the actual data value, will display in the Z information field at the bottom of the workspace window. I move the mouse pointer over the points of the layer in the map view window. The display class “NAME” for the data values displays in the Z information field to the right of the X and Y coordinate information fields. The text entered in the “NAME” field also serves as display class names for the layer legend. Figure 11-14 displays an example “Lookup Table” for a point cloud layer.



	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		0 - 50		0.000000	50.000000
2		50 - 75		50.000000	75.000000
3		75 - 100		75.000000	100.000000
4		100 - 125		100.000000	125.000000
5		125 - 150		125.000000	150.000000
6		150 - 175		150.000000	175.000000
7		175 - 200		175.000000	200.000000

Figure 11-14. The ‘Table’ for the ‘1pc3304sub’ point cloud layer.

“DESCRIPTION” can contain text information about the data class. This field does not appear to be used anywhere by SAGA. I use it to keep notes on data classes. The “Minimum” and “Maximum” fields define the lower and upper boundaries of the data display class.

The buttons on the right include Okay for when I complete the data entry; Cancel to cancel the data entry process; and Load and Save to save a lookup table to be used later and to load a saved table file. The Workspace button below the Save button is used to temporarily save the lookup table as a file in the Data tab area of the Manager window. The Workspace button below the Load button is used to reload a text table that has been temporarily saved to the Data tab area of the Manager using the Workspace button below the Save button.

The group of four buttons near the bottom are used with rows. Clicking on the Add button adds a new row at the bottom of the existing rows. The Insert button inserts a new row above the currently active row. The Delete button deletes the currently active row. Clicking on the Clear button deletes all of the rows in the lookup table.

Rather than manually calculate and enter the class boundaries for the classes, I can use the "Create Lookup Table" option available in SAGA.

This option is available when I move the mouse pointer over a point cloud layer name in the layer list in the Data tab area of the Manager and press the right mouse button. One of the options on the popup list that displays is "Create Lookup Table". The lookup table created with this option can be edited as needed using the tools described above.

As part of the process of using the "Create Lookup Table" option, I choose an attribute for the source of data values on the 'Create Lookup Table' dialog window. This attribute choice automatically updates the Colors: Type: Attribute in the Settings tab area of the Object Properties window for the layer.

A modified lookup table will not affect the display of the layer until I click with the mouse on the Apply button.

Colors: Lookup Table: Attribute
Point cloud layers are multi-dimensional, somewhat like shape layers, whereas grid layers have a single dimension. The multi-dimensional aspect of shape layers is provided by an attribute table file linked to the layer. Normally this file is either in dBase or text format. Point clouds store attributes as part of the layer file. A minimum of three attributes are stored in a point cloud layer file: X, Y, and Z. The attributes represent technical information collected for each point during the data collection process.

The .las exchange file format for point clouds supports the exchange of more attributes in addition to the minimum three above. These attributes are:

Gps-time
Intensity
Scan angle
Number of the return
Classification
User data
Number of returns of given pulse
Red channel color
Green channel color
Blue channel color
Edge of flight line flag
Direction of scan flag
Point source ID
RGB color

During the .las import process using the SAGA *Import/Export – LAS/Import LAS Files* tool, the user has the opportunity to choose from a list, which attributes to import, if any. These are in addition to the X and Y (horizontal) coordinates and Z (vertical) elevation values that import by default.

Using the Colors: Lookup Table: Attribute parameter in the point cloud layer Settings tab area of the Object Properties window, I specify a set of attribute data values for the X, Y, and Z points for display. The default attribute for display is Z or elevation.

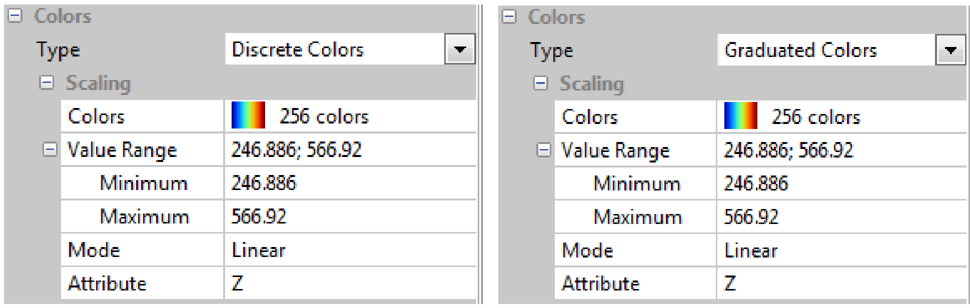


Figure 11-15. The parameters supporting the "Discrete Colors" and "Graduated Colors" options.

Colors: Type: "Discrete Colors" or "Graduated Colors"
These two options for the 'Type' parameter are supported by the same sets of parameters.

Colors: Scaling: Colors
When the 'Type' parameter option is "Discrete Colors" or "Graduated Colors", attribute data values and an assigned color palette determine how points display. The color palette is assigned using the Colors: Scaling: Colors parameter. Using the color palette and the value range for the chosen attribute, a color gradient is used to determine a display color for each point. The attribute chosen for the Colors: Scaling: Attribute parameter is the source of data values.

A small icon depicting the currently chosen color palette displays in the value field to the right of the 'Colors' parameter. When I move the mouse pointer into the value field and click the mouse button, an ellipsis appears on the right side of the field. The 'Colors' window (see Figure 11-16) displays when I click on the ellipsis.

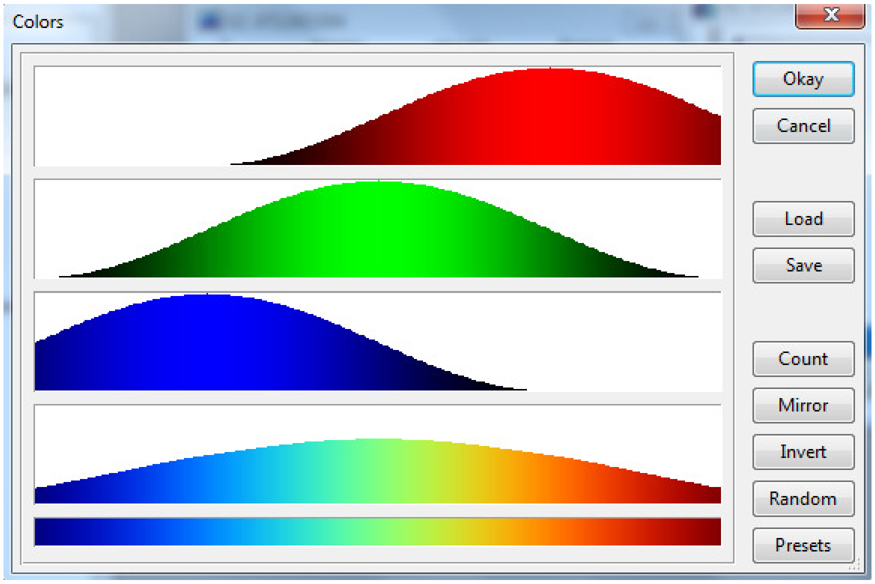


Figure 11-16. The 'Colors' window.

A new color palette can be created using the RGB windows in the ‘Colors’ window. I could also choose a palette using the Presets button at the bottom of the button list on the right. There are 27 palettes available that are built-in to the SAGA program. In addition I can use the Load button to load a palette saved as a palette (.pal) file in my palettes folder. There are 45 .pal files stored in the folder.

When I click on the Presets button, a popup list of pre-defined color palettes displays. This list displays in Figure 11-17.

Figure 11-17. List of preset color palettes.

The first choice in the list is the "default" color palette SAGA automatically chooses for a point cloud layer. The easiest way to gain familiarity with the pre-defined color palettes is to select them and view the results with different point cloud layers.

There are 27 color palettes on the presets list.

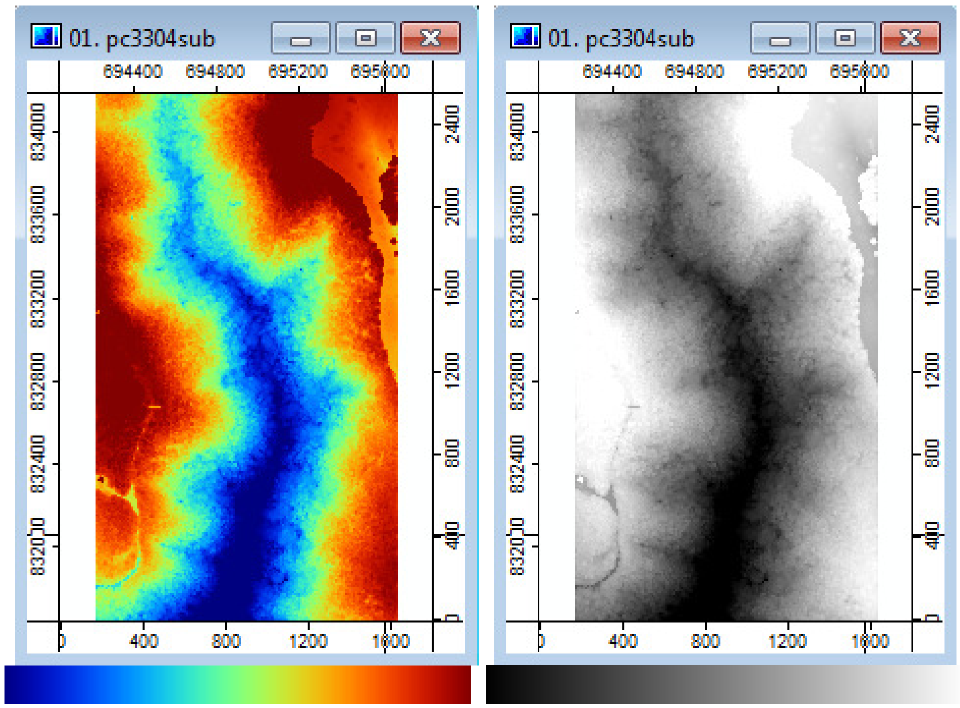


Figure 11-18. Comparing a point cloud layer using two different color palettes.

The two map view windows in Figure 11-18 display the same point cloud layer; each view uses a different color palette. The color range for the layer displays below each one. The color range displays are not part of the map view windows. I can see that the one on the left is assigning a dark blue color to the minimum elevation and the highest elevation dark red. All the various elevations in between receive an "interpolated" color. The example on the right is a traditional gray-scale palette going from black to white with shades of gray in-between. Interpolated shades of gray are assigned to elevations between the minimum and maximum elevation entries.

Let's take a closer look at how colors are handled in SAGA with point clouds.

I can interactively create, save, and load my own color custom color palettes. Whichever color palette is chosen for the Colors: Scaling: Colors parameter is the one used for displaying the point cloud layer points when the 'Type' parameter is set to either "Discrete Colors" or "Graduated Color".

Color palettes are managed using the Colors: Scaling: Colors parameter. When I click with the mouse in the value field to the right of the 'Colors' parameter, an ellipsis appears in the field. Clicking on the ellipsis symbol displays a 'Colors' window (see Figure 11-19).

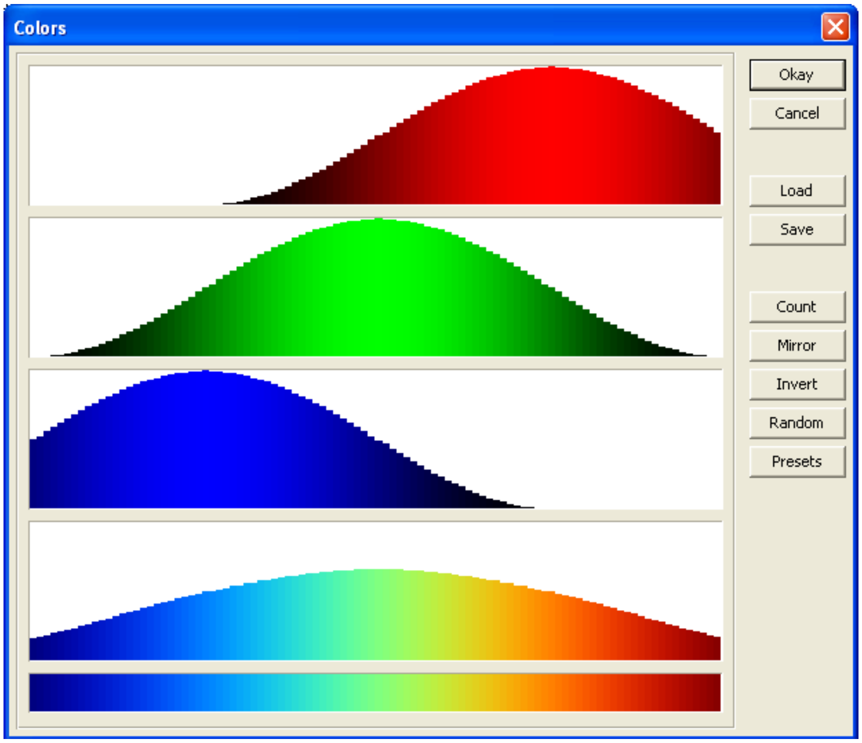


Figure 11-19. The 'Colors' window used with color palettes.

This 'Colors' window is also an editor. The graphic in Figure 11-19 displays the settings in the window used to generate the point cloud map view window on the left side in Figure 11-18.

The three upper color boxes represent the standard RGB or red, green, blue color components or channels. I can adjust any of the individual RGB curves by clicking and dragging with the mouse. Any change in any of the RGB boxes causes a corresponding change in the fourth and fifth boxes. The fifth color box displays the color palette that results from the RGB curves settings. The fourth box can be used to adjust the brightness of the palette. When I make an adjustment in this box, the resulting color palette in the bottom box and the three RGB curves is lightened or darkened accordingly. Exploring on your own to make changes to the components is a good approach to becoming familiar with the 'Colors' window.

The default number of color classes is 255. I can change the number of classes by clicking with the mouse on the Count button on the right side of the window. An 'Input' dialog window displays (see Figure 11-20).

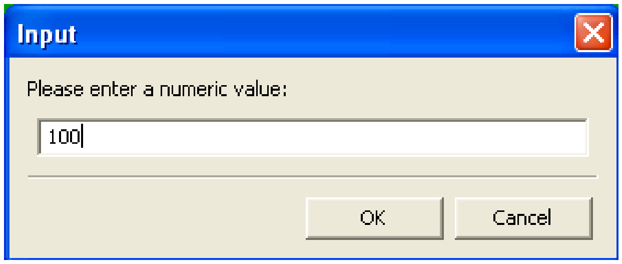


Figure 11-20. The ‘Input’ dialog window for changing the number of color palette classes using the Count button.

I can change the number in the data entry field. After making the change, I click on the OK button. The smaller the number, the more change is visible in the ‘Colors’ window. If the number is reduced significantly, for example from 100 down to 50, the curves will lose their smoothness and exhibit a stair-step appearance. The smaller the count number the wider the stair-steps appear in the curves; the larger the number, the smoother the curves appear. Figure 11-21 shows how the ‘Colors’ window appears after changing the "Count" number from 255 to 16.

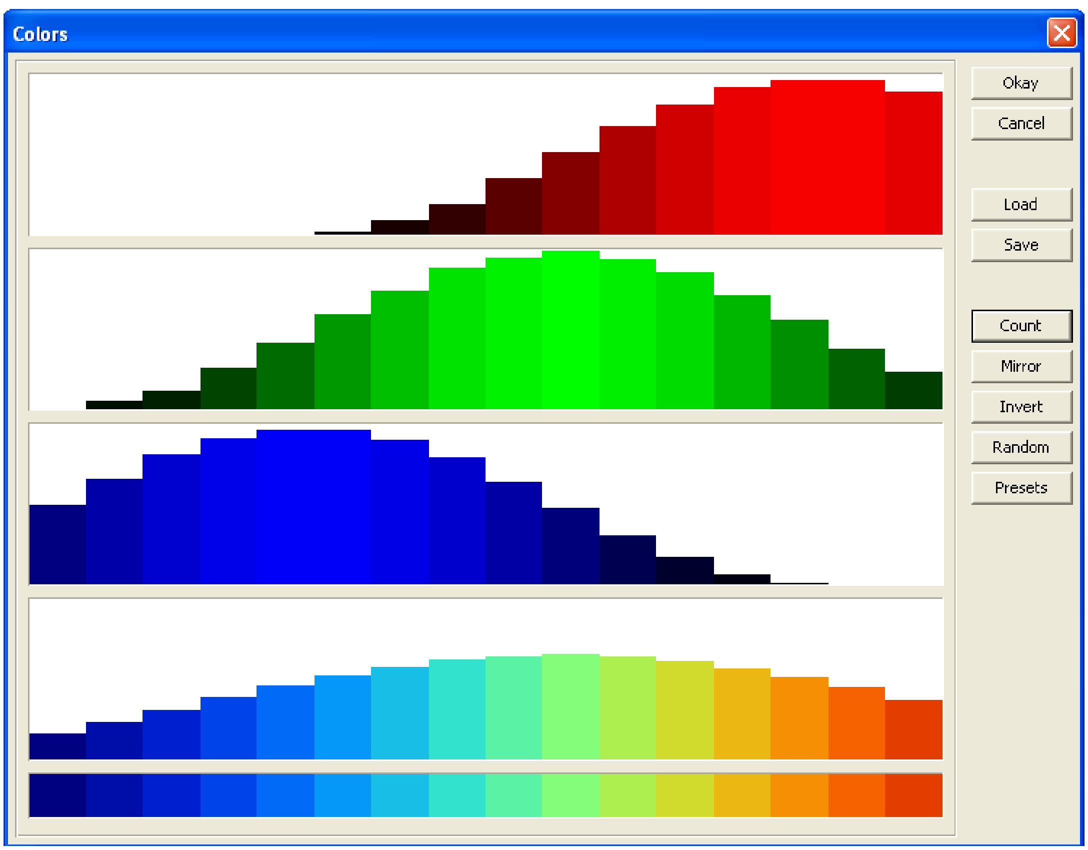


Figure 11-21. The ‘Colors’ window using a value of 16 for the "Count" variable.

The Mirror button will flip or reverse the existing color palette horizontally. The color palette displayed in Figure 11-21, in this case, would reverse and go from orange on the left to blue on the right. Using the Invert button replaces each color with its complimentary color. The Random button defines a random distribution of color classes. Rather than a rainbow effect, as in the example in Figure 11-21, the colors will be randomly chosen and not follow any particular color pattern.

I can create my own color palette by adjusting the individual RGB color curves in the upper three boxes or the composite box with my mouse. If I want to use a color palette I have customized in a future work session, there are two options supporting this. First, I can save the project the layer is associated. When I save or re-save a project, the display parameter settings are saved along with references to the layers as part of the project environment. Secondly, I can save the color palette independent of the project environment using the Save button located on the right side of the 'Colors' window. When I click on the Save button, a 'Save Colors' dialog window appears (Figure 11-22).

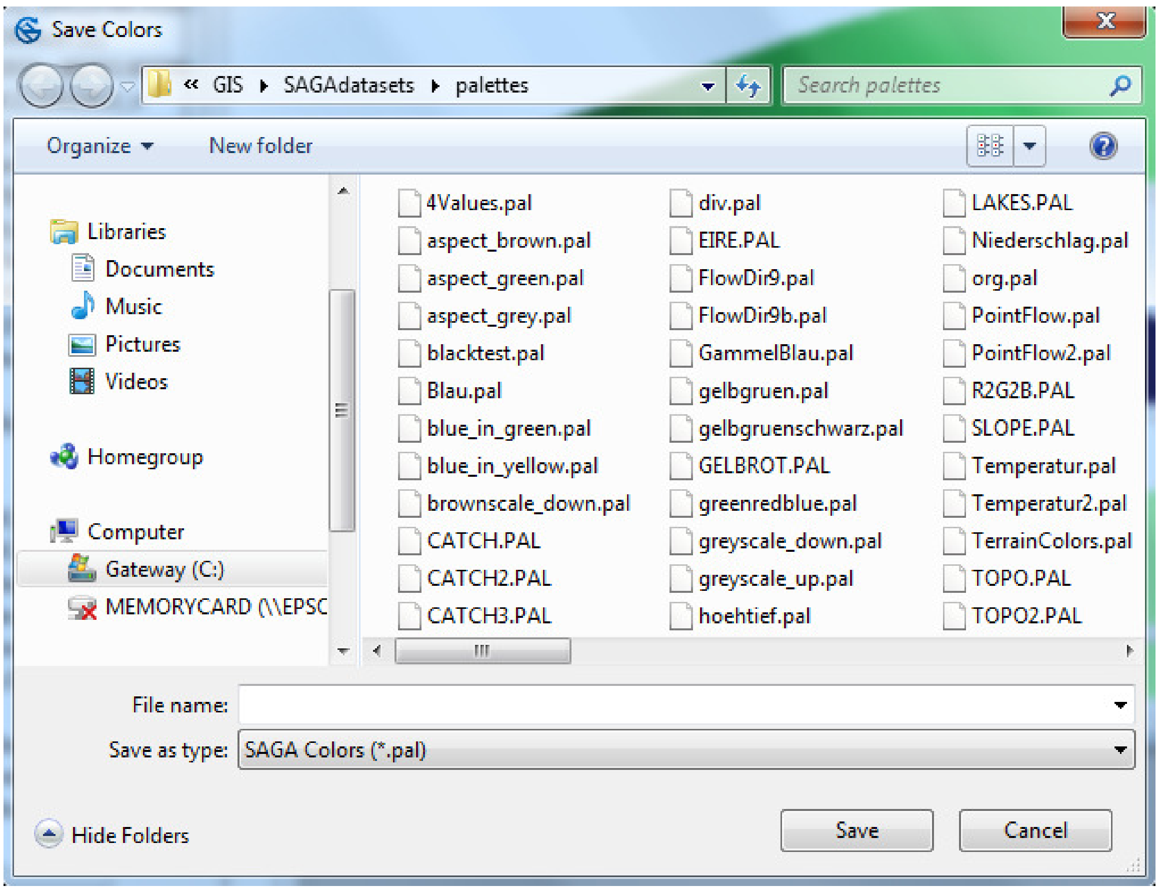


Figure 11-22. The 'Save Colors' dialog window.

A color palette is saved as a palette (*.pal) file type. When the dialog window appears, I browse to the folder I want to save the color palette file in, enter a name for it, and click the 'Save' button.

When SAGA loads a point cloud layer, a default color palette is assigned. If I have saved a customized color palette that I want to use, I can re-load it using the Load button on the 'Colors' window.

The option of saving and loading the saved palette is not working in SAGA Version 5 but it has been fixed in SAGA Version 6..

Remember, as discussed above, a customized color palette is associated with a point cloud layer if I update a project definition the layer is a part. After making changes to a color palette for a point cloud layer, if I save the current project, the new color palette will remain associated with the point cloud layer it was developed. Any time I change a color palette and re-save the project before exiting the work session, the changed color palette is associated with its point cloud layer. This process applies to each of the parameter settings. The customized color palette, however, is not saved as part of the layer when I save the layer.

Colors: Scaling: Value Range, Minimum, Maximum
The range of data values provided by the attribute chosen for the Colors: Scaling: Attribute parameter define the default entries for the two parameters Colors: Scaling: Value Range: Minimum and Colors: Scaling: Value Range: Maximum. The entries for the 'Minimum' and 'Maximum' parameters serve as the entries for the Colors: Scaling: Value Range value field. The two entries, separated by a semi-colon, display in the value field to the right of the 'Value Range' parameter name.

When I load a point cloud, e.g., '1pc3304sub', into a work session, I can determine the actual minimum and maximum data values for attributes by viewing the information displayed for the Description tab for the layer. I see that the minimum data value for the Z attribute (elevation) for this point cloud layer is 47.65 and the maximum data value is 214.12. These are not the values I see for the Colors: Scaling: Value Range Minimum, and Maximum parameters in the Settings tab area of the Object Properties window. These values are 75.31 and 172.82. These two values represent the minimum and maximum of a data range defined by plus or minus 2 standard deviations around the arithmetic mean for the attribute data values.

Chapter 4 discussed functions and commands available in the Data tab area of the Manager window. One of the options described for point cloud layers is "Classification". This option has three choices for defining the minimum and maximum parameters for value range. They are: Set Range to Minimum/Maximum, Set Range to Standard Deviation (1.5), and Set Range to Standard Deviation (2.0).

The 'Value Range' is the data range for which SAGA assigns display colors. The data range can be for the actual range of the data values of a chosen attribute or the entries for the 'Minimum' and 'Maximum' parameters can be changed to emphasize a portion of the data range.

I can edit the values displayed in the value field to the right of the 'Value Range' parameter directly. I move the mouse pointer into the value field and press the left mouse button. The entries displayed are selected and highlighted. I can enter two new values or a new value for one of them from the keyboard. I must make sure that I separate the two values with a semi-colon. I press the Enter keyboard key. I need to click on the Apply button for any edits to take effect.

The other approach is to edit the entries for the 'Minimum' and 'Maximum' parameters. They appear in the two rows immediately below the 'Value Range' parameter. I click the mouse (using the left mouse button) in either value field. This selects and highlights the entry. I enter a new value from the keyboard. I press the Enter keyboard key. I need to click on the Apply button for any edits to take effect.

Any changes I make to the ‘Value Range’ parameters are temporary. If I close and re-load the layer, SAGA resets the values to the defaults. The default entry for the 'Attribute' parameter is Z that is the elevation data for points. The default entries for the 'Minimum' and 'Maximum' parameters are the minimum and maximum values for the Z coordinate defined by plus or minus 2 standard deviations around the arithmetic mean of the Z data values (see earlier paragraph).

When a layer is loaded into a work session using a load command, the defaults for the parameters are restored. If a layer is loaded into a work session as part of a project, the parameters for the layer at the time the project was created are restored. When SAGA is starting up, if I choose the "[last state]" option, the configuration file created for the last exit from SAGA, restores layer parameters that were in effect when the configuration file was created. Let's look at these several options for restoring parameters.

I can save the parameter values for the active layer whose parameter values currently display in the Settings tab of the Object Properties window using the Save button, at the bottom of the window. The parameter values are saved in a .sprm file. This is the only way to explicitly save a set of modified parameters for a layer independent of a project environment or configuration file. This means that when I use the point cloud layer in a future work session, I can restore the parameter settings using the Load button on the Object Properties window when the point cloud layer is the active layer. The Load button is used to load the .sprm file.

Parameter values for all layers and tables of a work session can also be stored in a project definition file, a .sprj file. Whenever the project is re-loaded, the parameter values for the layers and tables at the time the project was saved, are restored.

The third way layer parameter values are saved is upon exiting from a SAGA work session. In addition to non-layer parameter values, parameter values for all available layers in the work session are saved as part of a configuration file (.cfg). The next time I start SAGA, if I choose the "[last state]" option on the opening 'Select Startup Project' display window, the existing parameter settings for the last work session are re-stored via the .cfg file. However, if I choose the "[empty]" option on the opening 'Select Startup

Project' display window, the existing parameter settings for the last work session are lost. Parameters for any layers brought into the new work session using a load command will use the defaults for the parameters.

The 'Value Range' parameter is convenient for exploring display colors to use for the data values of a point cloud layer. I might manipulate the value range to identify recoding possibilities for a completely new point cloud layer. Sometimes a .las import includes what I call extraneous data; data values that are probably errors and of extreme value and not actual elevation values. This can result in a selection of colors for displaying point cloud data that does not adequately portray the data values. Changing the 'Minimum' parameter can often improve the visual picture. A smaller value range allows for a better assignment of colors.

Colors: Scaling: Mode
When I click in the value field to the right of the 'Mode' parameter, a triangle appears. A popup menu containing three options displays. The options are: Linear, Logarithmic (up), and Logarithmic (down). The default entry for the 'Mode' parameter value field is "Linear".

The log options are used if the data value range for the point cloud chosen attribute is extremely large. The number entered for the 'Logarithmic Stretch Factor' parameter is applied when the 'Mode' option selected is either "Logarithmic (up)" or "Logarithmic (down)".

Colors: Scaling: Attribute
Point cloud layers are multi-dimensional, somewhat like shape layers, whereas grid layers have a single dimension. The multi-dimensional aspect of shape layers is supported by the use of linked attribute files usually either in dBase or text format. Point clouds store attributes as part of the layer file. A minimum of three attributes will be stored in a point cloud layer file: X, Y, and Z. Additional attributes represent technical information collected for each point during the data collection process.

The .las exchange point cloud file format supports the exchange of attributes in addition to the minimum three above. These attributes are:

Gps-time
Intensity
Scan angle
Number of the return
Classification
User data
Number of returns of given pulse
Red channel color
Green channel color
Blue channel color
Edge of flight line flag

Direction of scan flag
Point source ID
RGB color

The attribute named “RGB color” is supported and it is not part of the .las format. This is a SAGA option for converting .las RGB column values to the format used by the Point Cloud ‘Color Classification: RGB’ parameter.

During the .las import process using the SAGA *Import/Export – LAS/Import LAS Files* tool, the user has the opportunity to choose from a list, which, if any, attributes they wish to import in addition to the X and Y (horizontal) coordinates and Z (vertical) elevation values.

Using the Colors: Type: Scaling: Attribute parameter on the point cloud parameter page, I specify a set of attribute data values for the X, Y, and Z points to be color displayed using the Color: Type: Scaling: Colors entry. The default attribute for display is Z or elevation.

Colors: Type: "RGB"
When I click with the mouse pointer in the value field to the right of the ‘Type’ parameter, a small triangle will appear along with a popup list of five options. The options are: Single Symbol, Lookup Table, Discrete Colors, Graduated Colors and RGB. The "RGB" option is chosen for the 'Type' parameter. There is one support parameter for the "RGB" option.

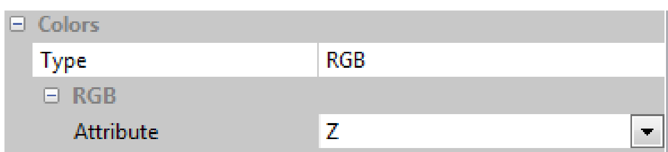


Figure 11-23. The parameter supporting the "RGB" option.

Colors: Type: RGB: Attribute
The 'Attribute' parameter is the single parameter that supports the "RGB" option for the 'Type' parameter. The assigned colors for data value display are converted to their numeric RGB code. The Z data value display for a point becomes the RGB code for the display color. So, rather than the data value displayed in the Z information field at the bottom of the work area, the numeric RGB code displays.

I explored several point cloud layers having varying sets of imported .las characteristics. Consistently, using the "Z" and "intensity" options produced a rendering using black and shades of red to display point cloud points. These two attributes had a larger range of data values than other attributes. This is probably why they produced map view windows with varying shades of red. Other attributes resulted in single color displays not allowing any visual differentiation of data values.

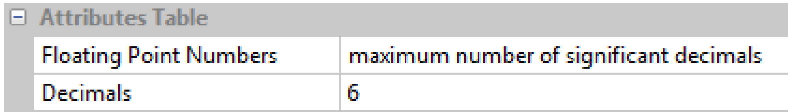


Figure 11-24. The two 'Attributes Table' parameters.

Attributes Table: Floating Point Numbers
This parameter affects how floating point numbers in the point cloud attribute table display. This parameter has three options. The default option is "maximum number of significant decimals". The other two options are "system default" and "fix number of decimals".

When the "maximum number of significant decimals" option is used, the number of digits past the decimal for a data value truncates at the number entered for the 'Decimals' parameter. For example, I have entries 5.123456 and 10.123. These values display as entered when the entry for 'Decimals' is 6. The first number uses six places past the decimal. However, if the entry for the 'Decimals' parameter is 4, the first number will display as 5.1235. The second number display will not change.

The number of places past the decimals when the "system default" is chosen is 6. The entry for the 'Decimals' parameter is ignored when this option is used.

The entry for the 'Decimals' parameter determines the number of places past the decimal when the "fix number of decimals" option is chosen. If the data value only has 2 places past the decimal if the entry for the 'Decimals' parameter is larger than 2, the data value will include following zeros. For example, if the data value is 5.12 and the entry for the 'Decimals' parameter is 4, the data value 5.12 becomes 5.1200 in the table.

Attributes Table: Decimals
This parameter provides the value for the number of digits past the decimal for the option chosen for the Attributes Table: Floating Point Numbers parameter. The value for this parameter is used with the "maximum number of significant decimals" and "fix number of decimals" options. It is not used with the "system default" option.

There are four other tabs displayed at the top of the Object Properties window. These are Description, History, Legend, and Attributes.

The Description Tab Area of the Object Properties Window
Figure 11-25 displays the upper portion of the Description tab area of the Object Properties window. Users cannot edit data displayed in the 'Description' window.

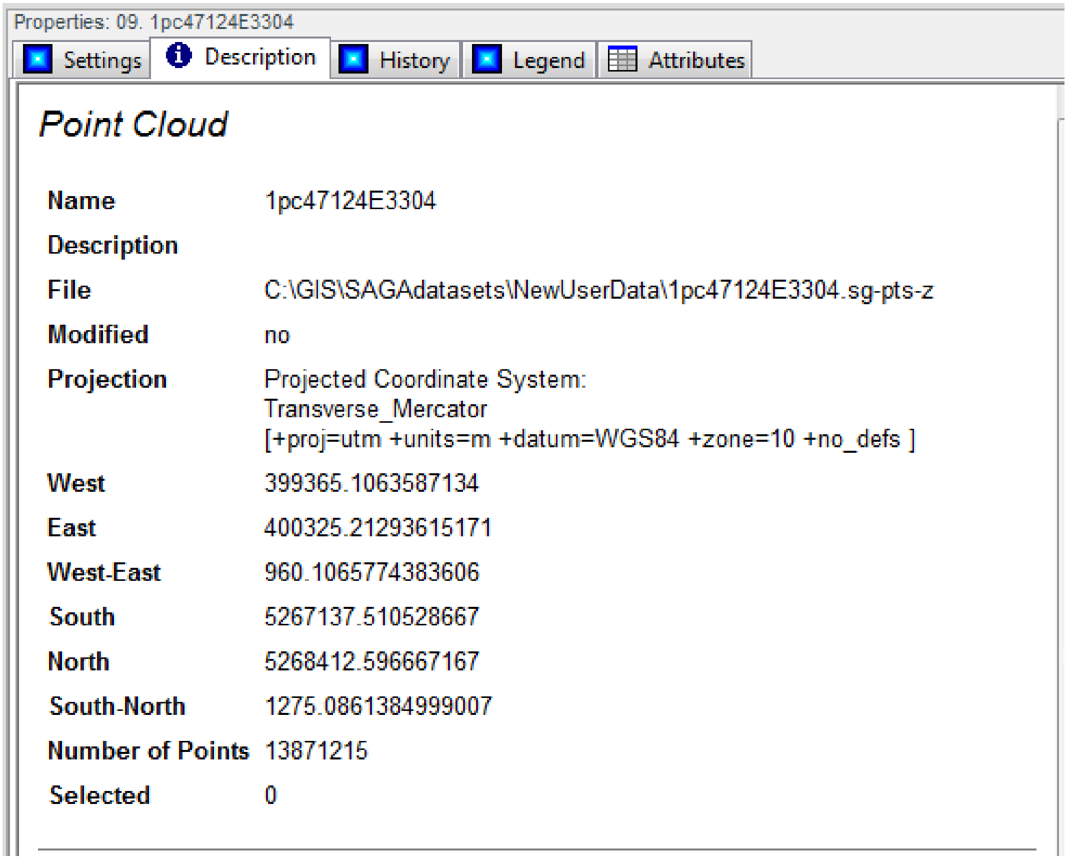


Figure 11-25. The upper portion of the Description tab area for the '1pc47124E3304' Point Cloud layer.

The name entered for the layer in the 'Name' parameter in the 'Settings' area of the Object Properties window is displayed on the "Name" line. Below it, the "File" information field shows the name of the layer (this can be different from the entry for the 'Name' parameter) and where the path to where the layer files are stored on the desktop system. In this example, the name used for the 'Name' parameter is "1pc47124E3304" and the data "File" name is "1pc47124E3304.sg-pts-z". If I do not change the 'Name' parameter in the settings area, its' default is the data file name. In that case, the "Name" and the "File" name will match in the Description tab area. It is not necessary that they be identical.

The next piece of information is for "Projection". The Universal Transverse Mercator coordinate reference system is used for the '1pc47124E3304' point cloud layer. Characteristics of the system are summarized as information for "Projection".

The next several variables relate to the spatial extent of an envelope that bounds the objects of the layer.

The West, East, South, and North information fields list the metric coordinates for the sides of a bounding rectangle. The West value is the western coordinate or X value of the furthest west located object of the layer. The East value is the eastern coordinate or X value of the furthest east located object of the layer. The North value is the north coordinate or Y value of the furthest north located object of the layer. The South value is the southern coordinate or Y value of the furthest south located object of the layer. The West-East and South-North identify distances in meters across the bounding rectangle. These distances are calculated by subtracting the West coordinate from the East coordinate and the South coordinate from the North coordinate.

The “Number of Points” for this point cloud layer is listed at 13,871,215. If any points were in selection status the number to the right of "Selected" would identify that number.

The "Table Description" portion of the Description tab displays in Figure 11-26.

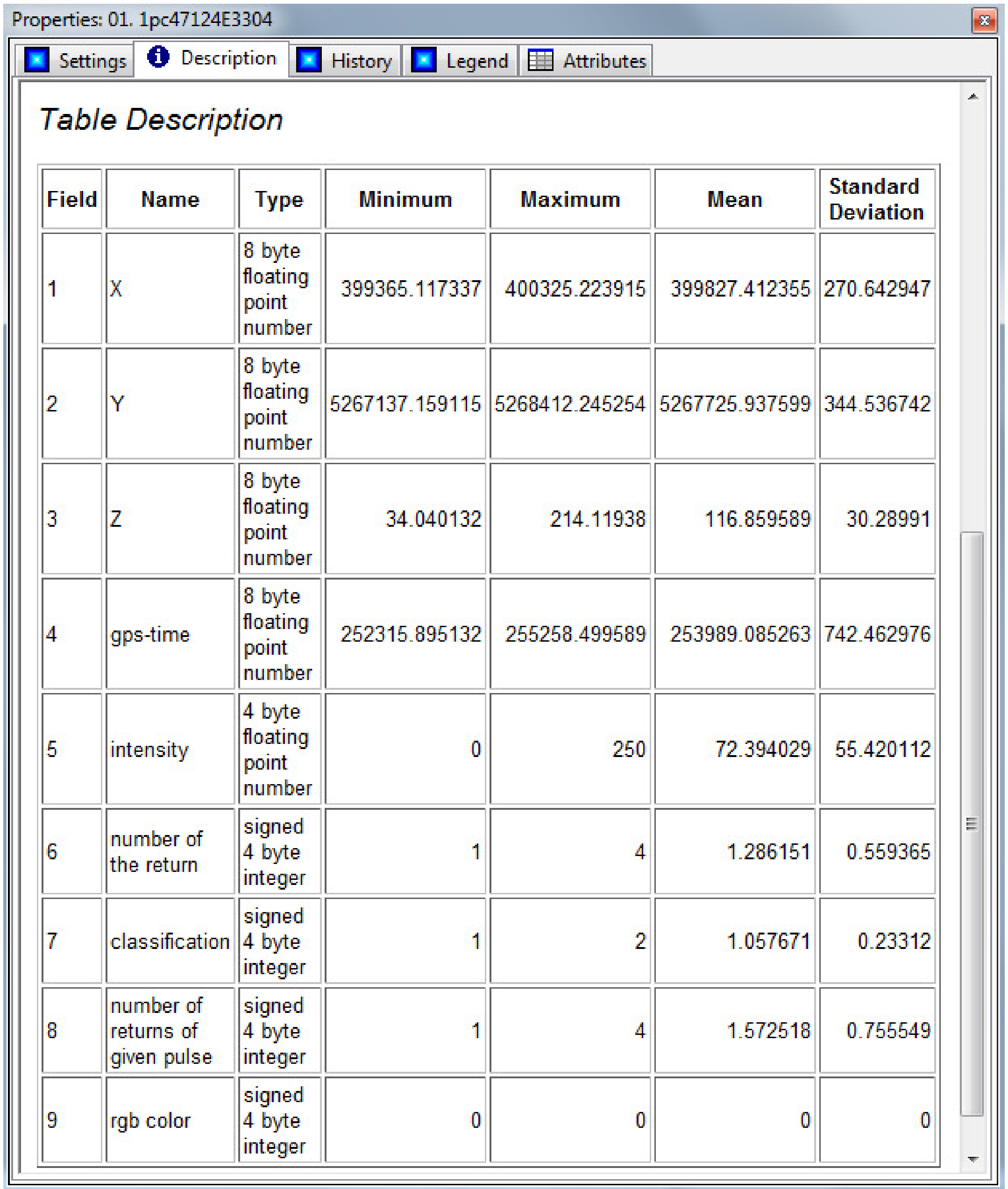


Table Description

Field	Name	Type	Minimum	Maximum	Mean	Standard Deviation
1	X	8 byte floating point number	399365.117337	400325.223915	399827.412355	270.642947
2	Y	8 byte floating point number	5267137.159115	5268412.245254	5267725.937599	344.536742
3	Z	8 byte floating point number	34.040132	214.11938	116.859589	30.28991
4	gps-time	8 byte floating point number	252315.895132	255258.499589	253989.085263	742.462976
5	intensity	4 byte floating point number	0	250	72.394029	55.420112
6	number of the return	signed 4 byte integer	1	4	1.286151	0.559365
7	classification	signed 4 byte integer	1	2	1.057671	0.23312
8	number of returns of given pulse	signed 4 byte integer	1	4	1.572518	0.755549
9	rgb color	signed 4 byte integer	0	0	0	0

Figure 11-26. The "Table Description" portion of the Description tab for the '1pc3304sub' point cloud layer.

Attribute information is saved as part of the data file. The row and column display is a description of the attributes stored in the data file for the points. There are nine attributes. They include X, Y, and Z where X and Y are the horizontal and vertical coordinates and Z is for elevation. These three attributes are always stored as part of a point cloud layer. Additional fields depend on what, if any, attributes were chosen for import when the .las LIDAR file was imported to SAGA. I chose to add attributes gps-time, intensity, number of the return, classification, number of returns of given pulse, and rgb color when importing the .las LIDAR file.

The data type displays in the “Type” field. I can see that four of the attributes use the “8 byte floating point number” type and five use the "4 byte floating point number" type. Simple descriptive statistics display for each attribute for the “Minimum”, “Maximum”, “Mean”, and “Standard Deviation”.

The History Tab Area of the Object Properties Window

Usually the History tab area displays information from the history file for the layer about how the layer evolved as it is used in SAGA. Grid and shape layers include a history file as one of the several files stored when a layer is saved. The history file for a grid layer is in the .mgrd file format. The history for a shape layer is in the .mshp file format.

The .sg-pts-z point cloud file format is a zip file. It includes a .sg-pts file (the point cloud points) and a metafile .sg-info. A history is part of the metafile.

Figure 11-27 displays the History tab area for the point cloud layer named ‘1pc47124E3304’.

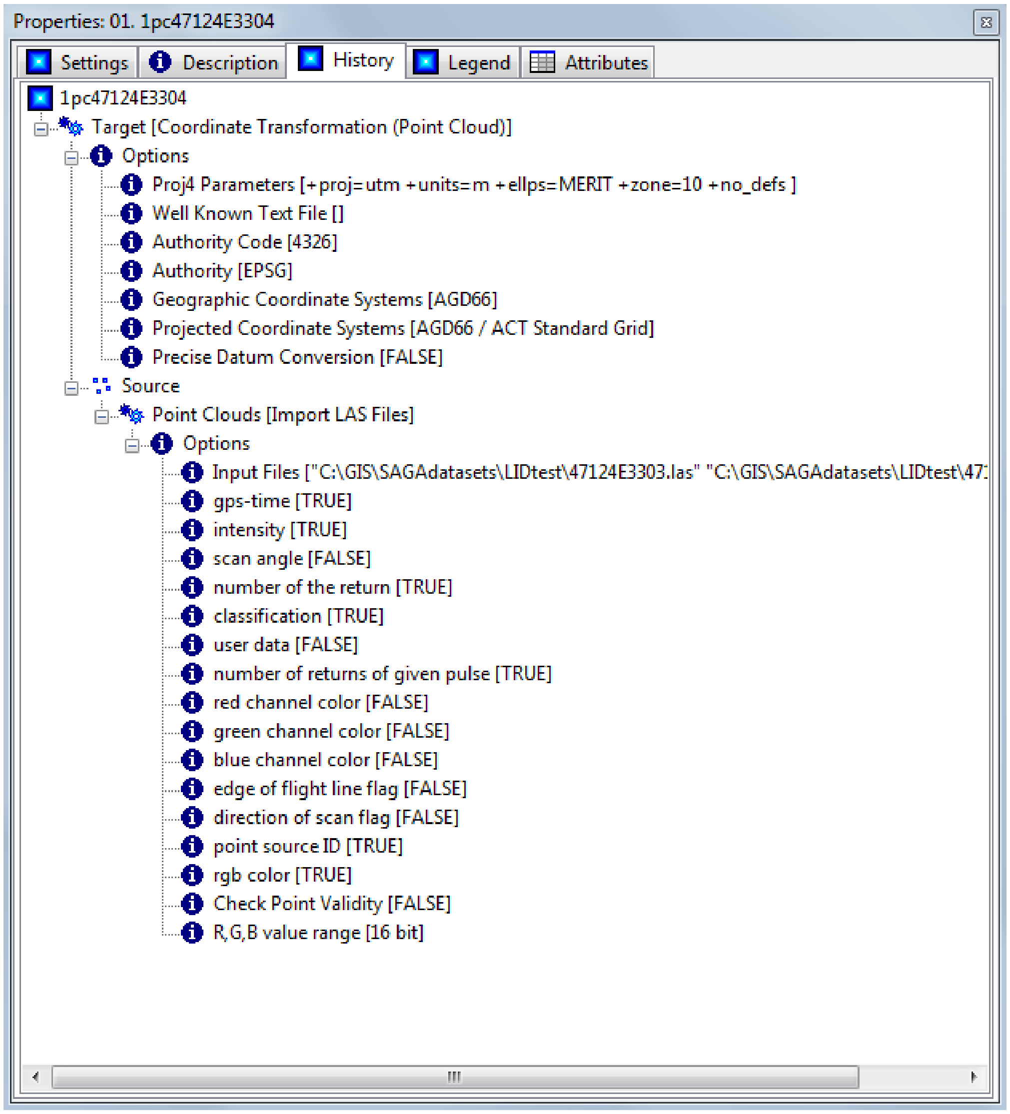


Figure 11-27. The History tab area for the '1pc47124E3304' point cloud layer.

The history indicates that a LIDAR exchange file named ‘47124E3304.las' was imported using the *Import/Export – LAS/Import LAS Files* tool. Seven of 16 attributes are selected to import along with the X, Y, and Z point coordinates. I can see that the seven attributes chosen for import are appended with "[TRUE]" while those not chosen to be imported display "[FALSE]".

The history also shows that I executed a coordinate transformation using the *Projection - Proj4/Coordinate Transformation (Point Cloud)* tool. The imported .las coordinate reference system is the Washington State Plane Coordinate System, South Zone. I transformed the coordinates to Universal Transverse Mercator Zone 10. This history is visible in the upper part of the History tab area.

The Legend Tab Area of the Object Properties Window
The next tab at the top of the Object Properties window is ‘Legend’. Figure 11-28 displays the Legend tab area for the ‘1pc47124E3304’ point cloud layer. The "Z" attribute is chosen for the Colors: Scaling: Attribute parameter. The legend, therefore, is defined for the data values provided by the "Z" attribute. The range of elevations for this attribute is from 34.040 to 214.119 meters.

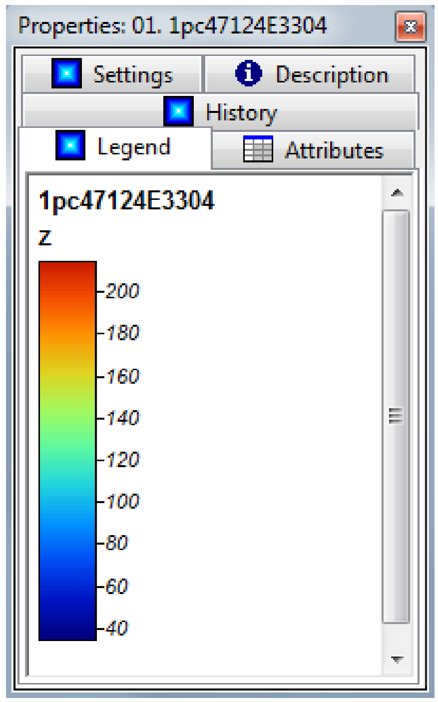


Figure 11-28. The Object Properties Legend tab area for the ‘1pc47124E3304’ point cloud layer.

The Attributes Tab Area of the Object Properties Window
The tool bar Action selection tool is used to select a point cloud point. The attributes of a selected point update the Attributes tab display for the point cloud in the Object Properties window. Here is an example.

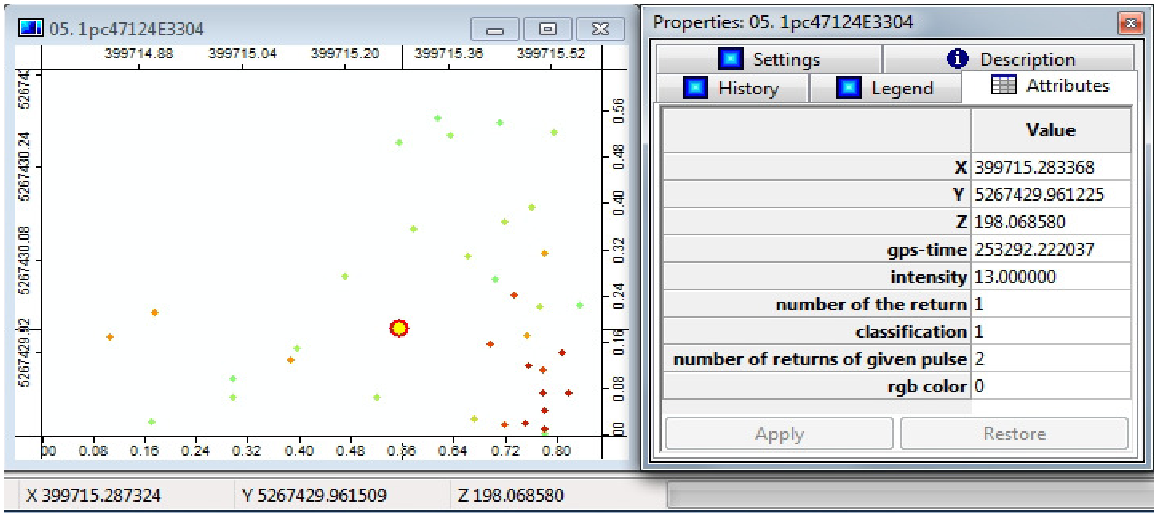


Figure 11-29. A selection on the '1pc47124E3304' layer.

The map view window displays a zoomed in area of the '1pc47124E3304' point cloud. The Attribute tab area of the Object Properties window is on the right. The entry for the 'Point Size' parameter is 2. This point size provides a better view and interpretation of the points.

A point was selected using the Action tool. The point is identified by a small yellow filled, red outlined circle. The attribute values for this point updated the attribute values displayed in the Attributes tab area of the Object Properties window for the layer.

The screen graphic in Figure 11-29 also shows the X, Y, and Z data display fields at the bottom of the work area. I can see that the data displayed in the three display fields is a close match for the data displayed for the X, Y, and Z attributes in the Attributes tab area.

The display of the points of the '1pc47124E3304' point cloud layer somewhat resembles the display of a very dense point shape layer. There is not an attribute table file linked to the point cloud, the attributes are stored as attributes in the point cloud file.

I can see some similarities between the role of the Attribute tab area for the point cloud layer and the shape and grid layers. One difference is that I cannot change a data value for an attribute displayed in the Attribute tab area of the Object Properties window. Nor can I change a data value in the point cloud attribute table.

Puget Sound LIDAR Consortium

The LIDAR data I use in this User Guide has been downloaded from the Puget Sound LIDAR Consortium website: http://pugetsoundlidar.ess.washington.edu/index.htm.

The .las file used here was created as part of the "2011 Quinault River Basin Lidar Project", 2011.

All of the LIDAR data I have used in past SAGA User Guides and tutorials has been downloaded from the Puget Sound LIDAR Consortium website. Most of the files I download have been either .e00 or .las format. I have not experienced any issue with the data or importing the data into SAGA.