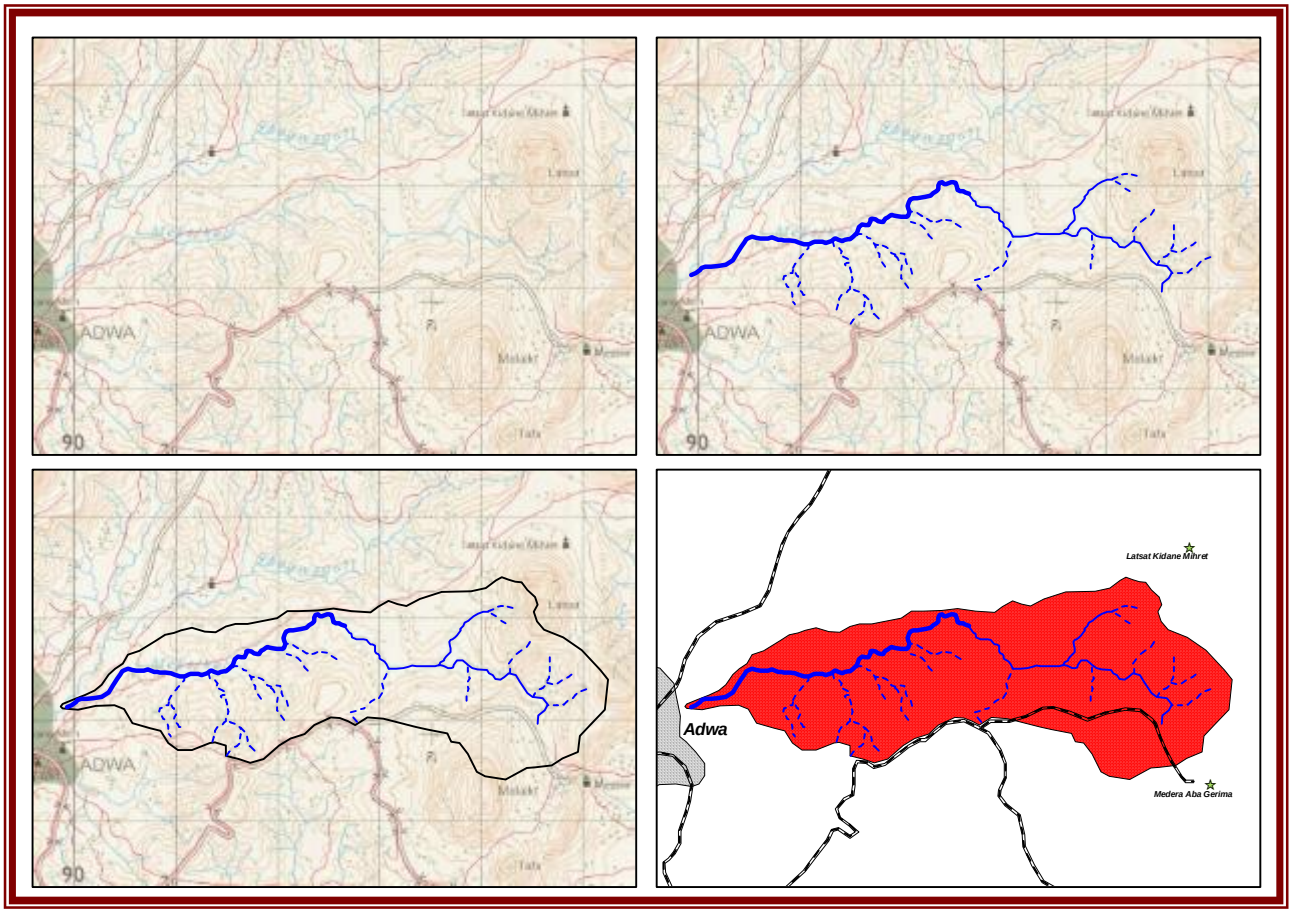
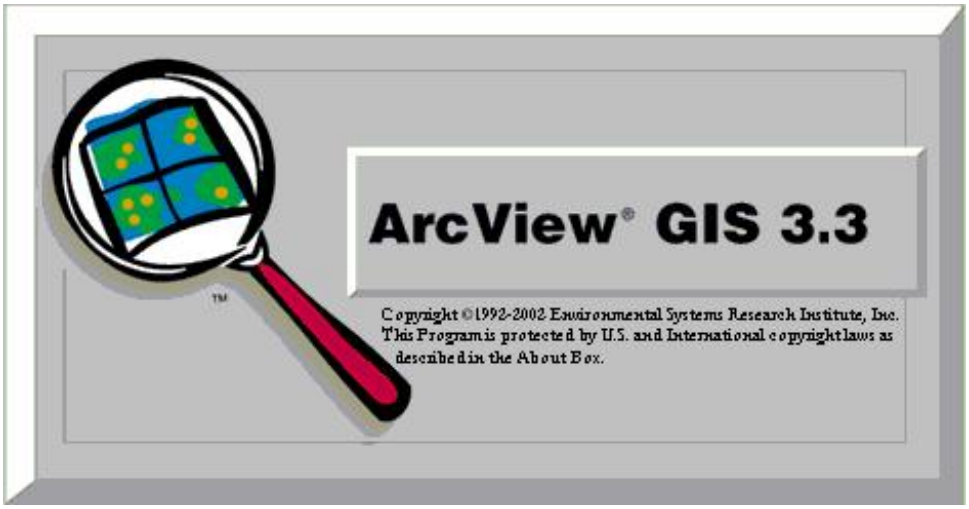
GIS

& mapping with **ArcView® GIS 3.x**



Training module July 2007 by

ded-SUN
Jens Steuernagel



ArcView gives you the power to visualize, explore, query, and analyze data geographically. In no time you'll be working with your data in a completely new way, seeing patterns you couldn't see before, understanding geographic relationships that were hidden, gaining insights, solving problems, and achieving new results for yourself and your business.

Extract from ArcView® GIS user handbook, 1996

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List of Abbreviations

.jgw	Wordfile format (of JPEG image data)
.shp	Shapefile
DBF	dBase data format
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
ID	Identification (class, number, figure etc.)
UTM	Universal Transverse Mercator (Projection, Grid)
WS	Watershed
WSM	Watershed Management

1 Introduction

ArcView 3.x is one GIS software product of the ESRI (ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE) family. There are several manufacturers offering a multitude of GIS products; ESRI is the leading enterprise in GIS technology. Most users, in business, research or private utilize ESRI products when creating or editing geographical maps.

ArcView® GIS 3.x already is an aged GIS technology. However, this software line is still considered to be the best known as well as most utilized geographic information system product worldwide, thus this basic GIS training manual merely makes use of ArcView® GIS 3.3 (in the following named as ARCVIEW 3.3).

The new generation of GIS software is dominated by ESRI as well. The newest line of ESRI GIS products is called ArcGIS 9.x. The new version is completely different software and differs from ArcView GIS 3.x not only in its appearance but also in its handling. Nevertheless, learning on ArcView 3.3 is helpful, not only to produce and edit basic maps, but also for finding a first introduction into ESRI GIS software.

2 Welcome to ArcView 3.x

2.1 Basics about ArcView 3.3

ArcView 3.3 uses specific terms which have prior to be clarified for a better technical reading. Not all terms ArcView 3.3 is using are explained, merely those termini technici which are essential for the basic understanding, all other terms which are not explained in this context can be verified under the menu '*Help'* in ArcView 3.3.

Projects

All the components of your ArcView session: views including themes, tables, charts, layouts, and scripts are conveniently stored in one file called a project. In fact all maps you are creating in a ArcView session, under normal circumstances, are called project. ArcView's Project window shows you the contents of your project and makes it easy to manage all your work. The term Project can be interpreted as the main data folder under wich different Views and Themes can be stored, respectively their data paths.

Views

With ArcView you work with geographic data in interactive maps called Views. View can be explained as theme-map where different and various Themes are compiled to reach that information status the user intends to have. The term View also can be interpreted as a flat-box where several foils (layers) can be piled up one on top the other until a expressive theme-map has been formed.

Themes

Themes are single pieces of information which are mostly represented by shapefiles (.shp) or topo-maps or digitalized maps (.bmp, .jpg etc.). The term can also be described as layers which piled up gives a View – a theme-map. A theme can be digitized rivers, roads, buildings, farmland or whatever for spatial data (chapter 3.2).

Layouts

ArcView's layouts let you create high quality, full color maps by first arranging the various graphic elements on-screen the way you want them.. Layouts are smart because they have a live link to the data they represent. When you print a layout, any changes to the data are automatically included, so you know everything on your map will be up-to-date.

2.2 Open the Program

Under normal conditions ArcView 3.3 can be opened by double click the shortcut button on the desktop or under the following path:

C:\ESRI\AV_GIS30\ARCVIEW\BIN32

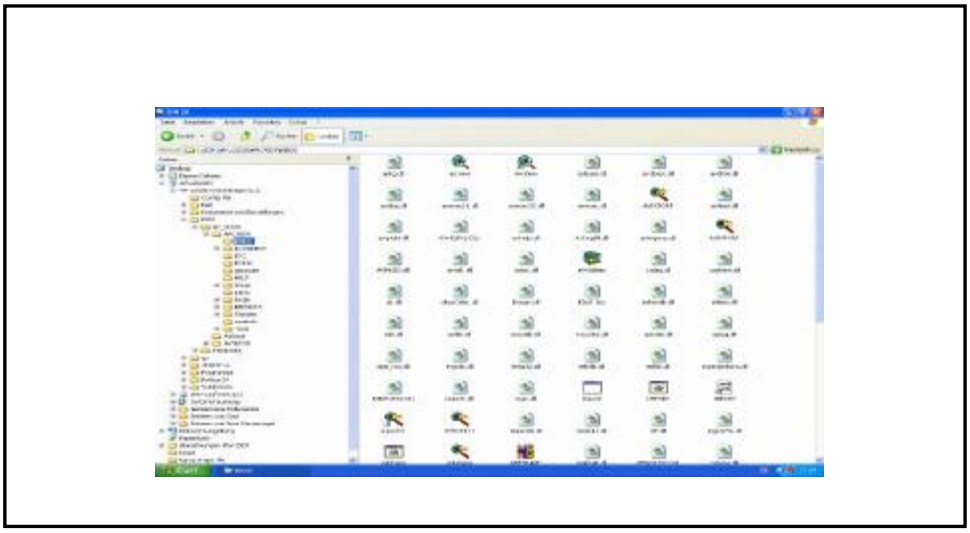


Fig. 1: Explorer bar

Start\Programmes\ESRI\ArcView 3.3

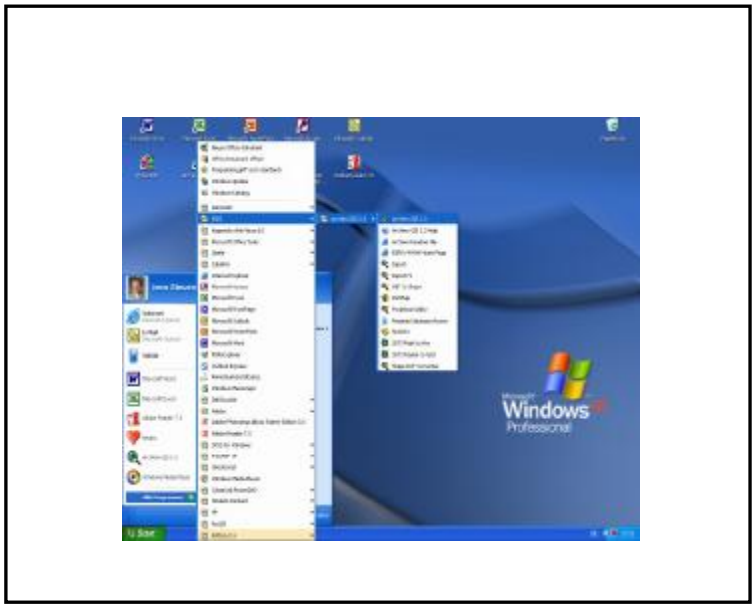


Fig. 2: ArcView under Start

2.3 Start the Program

When ArcView 3.3 were installed correctly and found and opened under the above mentioned path the following window appears. If you want to start a new project, mark the field '**with a new View'** and click '**OK**'.

If you already have created a project and you intend to open that project, and then mark the field *'Open an existing project'* and click *'OK'*. Click in the following dialogue field the path where you stored the project data. It is very important to store the data in a strict hierarchy and not to rename the data and respective folders after having them saved under a certain path; otherwise ArcView 3.3 is not able to find the data and folders which are required to show the project maps[1].

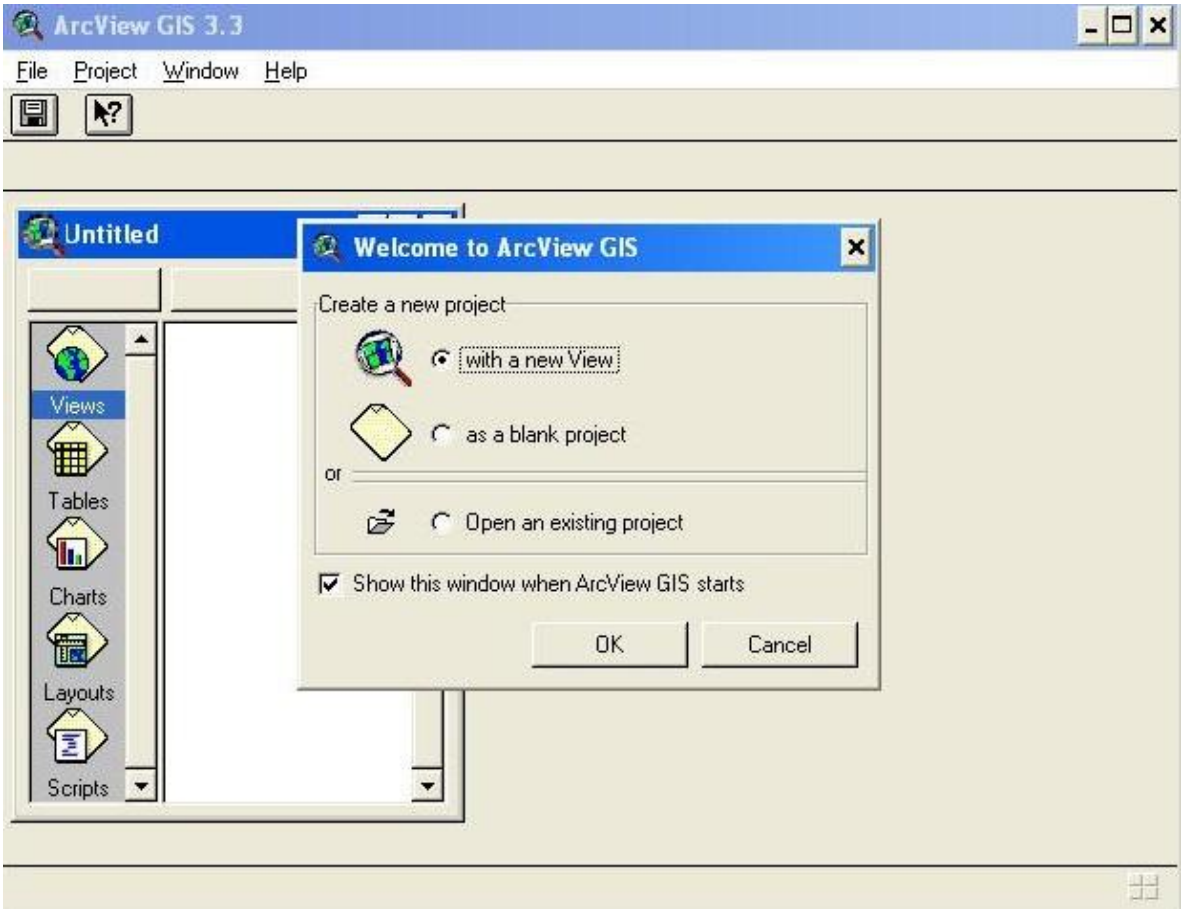


Fig. 3: Starting ArcView I

[1] One has to realize that Projects in ArcView 3.3 do not store the respective data (.jpg, .bmp etc.) as absolute data in folders or anywhere, ArcView 3.3 merely save the data paths where the respective data are stored. That means in fact, when data of a Project are renamed ArcView 3.3 is unable to find the data and cannot display the demanded map.

If you do not want to open an existing Project click as described in the first break of the prior page. ArcView 3.3 asks whether you want to add any kind of data to the View. Since the existing digital topographic maps are in JPEG format[2] you have to press the button '**No'**.

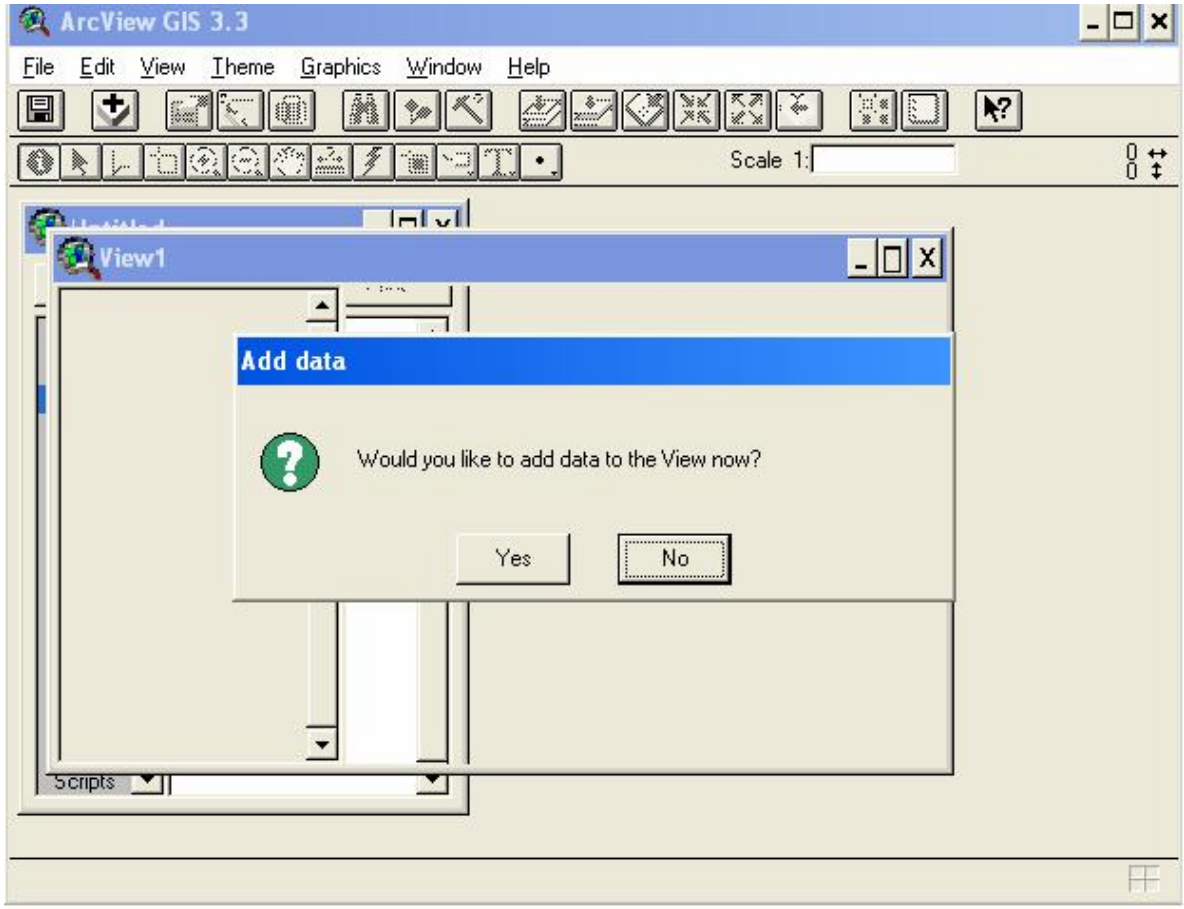


Fig. 4: Starting ArcView II

[2] In ArcView 3.x JPEG formatted pictures merely can be loaded when prior the loading process the JPEG extension is activated, otherwise only data in bmp. format can be loaded.

Before loading data in JPEG format, the JPEG extension has to be activated under menu *'File\Extensions…'*. Mark the Extension field **'JPEG image support'** and click **'OK'.** Now any JPEG data can be added to the View.

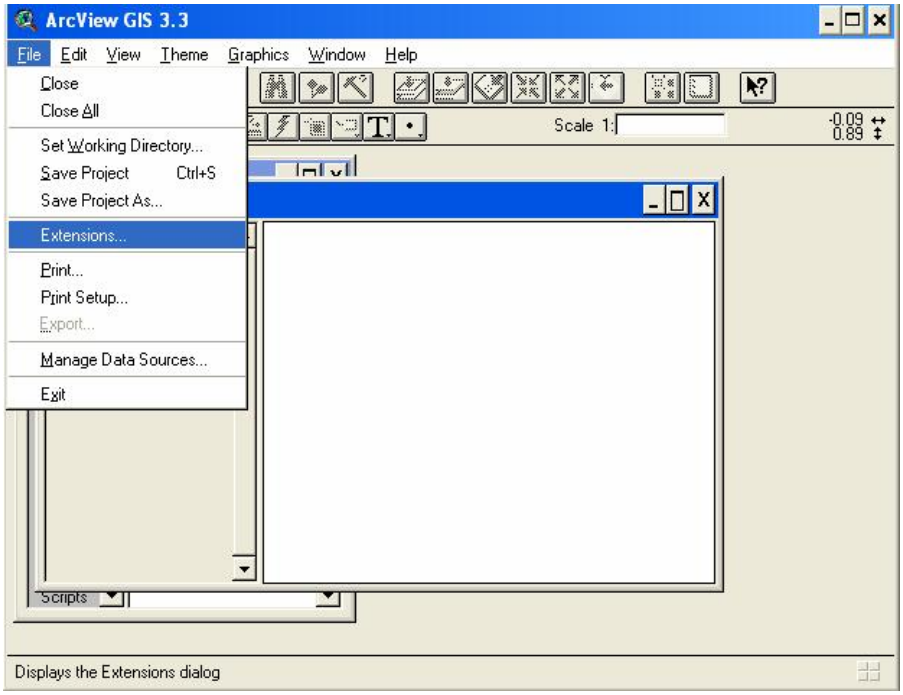


Fig. 5: Starting ArcView III

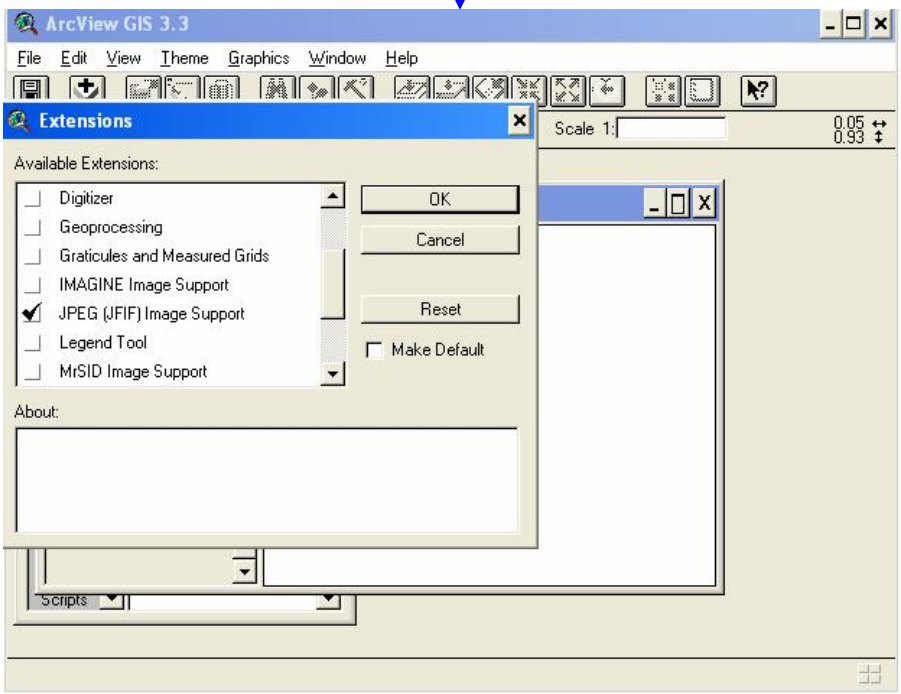


Fig. 6: Starting ArcView IV

Choose the topographic map of Adwa (adwa.jpg) and click '**OK'**. The map will appear as one Theme in the View. The View is named View1 unless it is renamed under menu '*View\Properties'*.

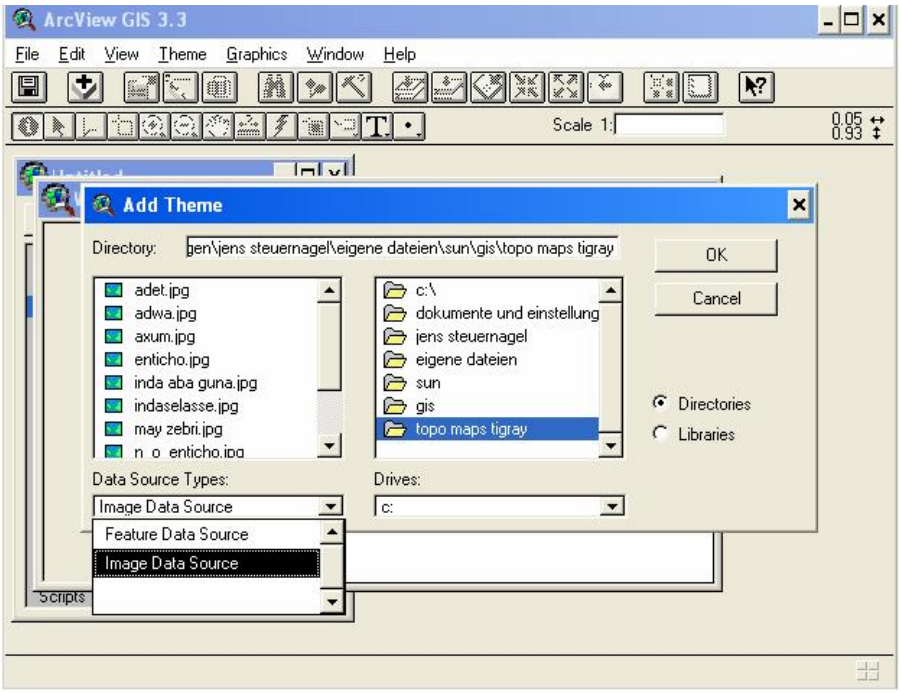


Fig. 7: Loading images

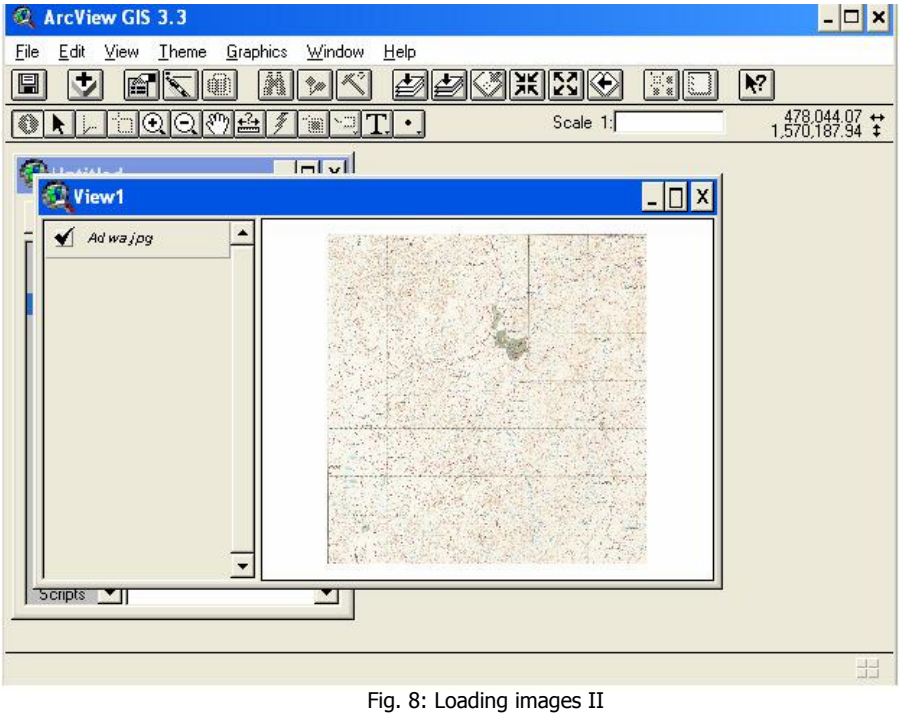


Fig. 8: Loading images II

3 Working with ArcView 3.3

3.1 What can you do with ArcView 3.3

ArcView 3.3 is multifunctional geographic mapping software. You can simply create printing layouts of already existing maps or you do comprehensive spatial analysis within self created specific theme maps. In this training course merely the basics of working on topo maps and creating specific thematic '*shapefiles'* to illustrate special subjects shall be taught.

Before working on an own map safe the loaded maps and data respectively prepare data paths. It is important to safe the data package under a certain track/path where you are able to find it at anytime, since the path –under normal conditions- cannot be renamed or removed (as described in chapter 1). Create a main folder under My Documents and name it *GIS projects*. Divide the folder into two subfolders, name one *ENABERED* and the other one *OTHERS*. Install under *ENABERED* two additional folders, name one *MYDATA*, another *MAPS and PIX* and the last one *PROJECTS*.

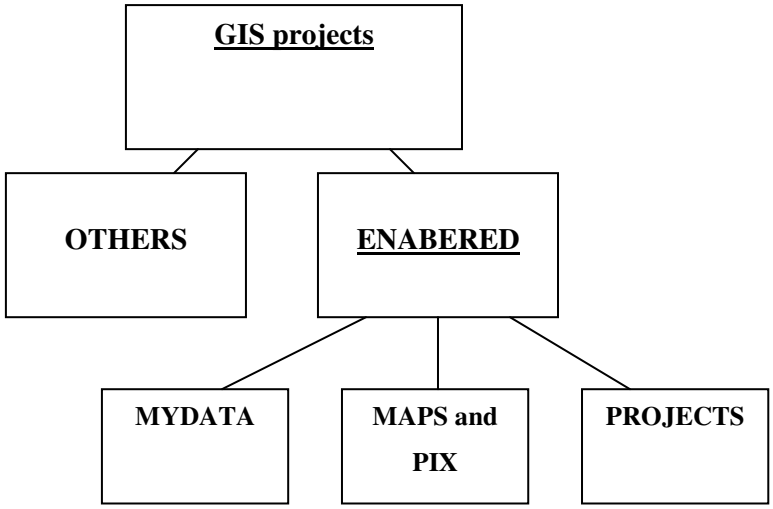


Fig. 9: Data path

3.2 Creating & Editing my Thematic Map

After having installed a strict and fix data path within the data hierarchy the work on the maps can start. First rename View1 into the name you want to have and write the creator of the map as well as define the map and distance unit (meters or kilometers). Click under View the Symbol Properties and fill out the blank fields as shown below in figure 11.

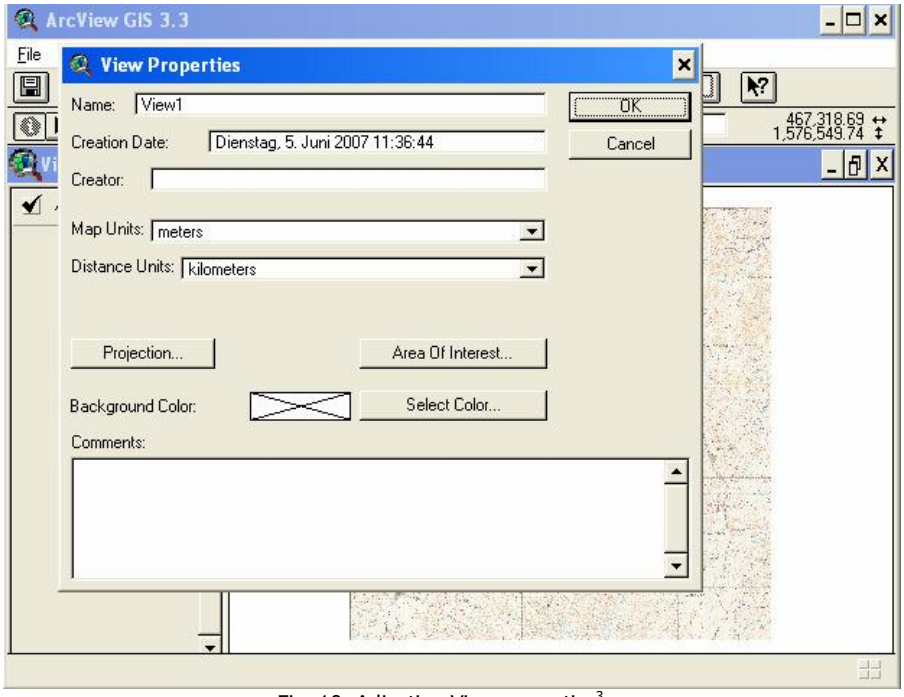


Fig. 10: Adjusting View properties[3]

After having the View changed the title View1 will disappear and be substituted by the name you entered in View\Properties\Name.

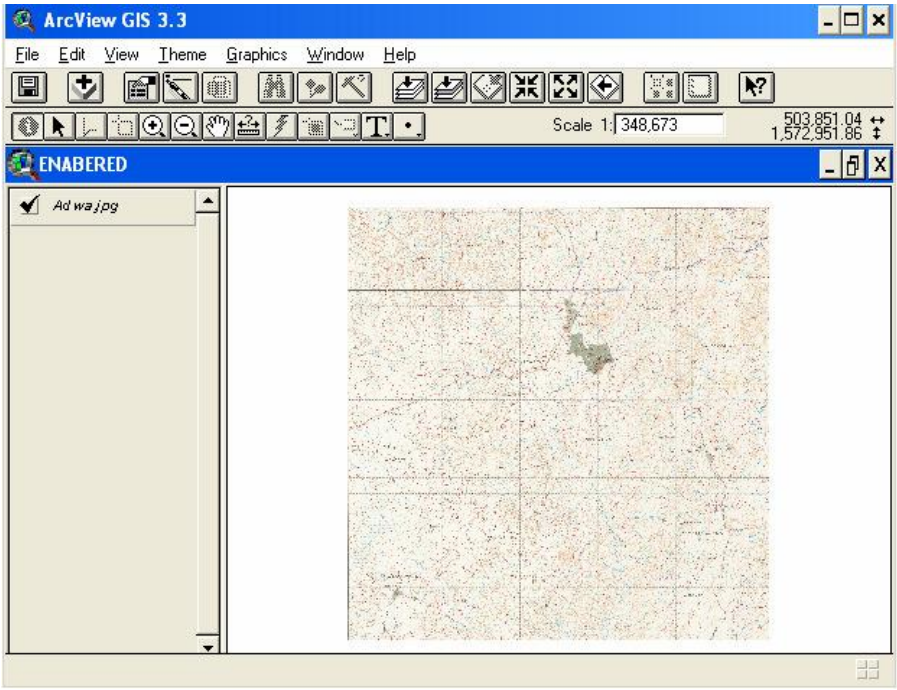


Fig. 11: The View

[3] Note that the projection of the given maps are pre-adjusted, do not try to adjust the projection yourself and note, that you always are in need of a *worldfile* (.jgw) if you want to open a *.jpg* map, the *worldfile* guarantees the correct display of image data, or image data without georeferenced wordfiles cannot be displayed properly.

The next step is to Zoom into the map to enable a more detailed view of the topographic map. Click the magnifying glass (+) in the tool/symbol bar as shown below.

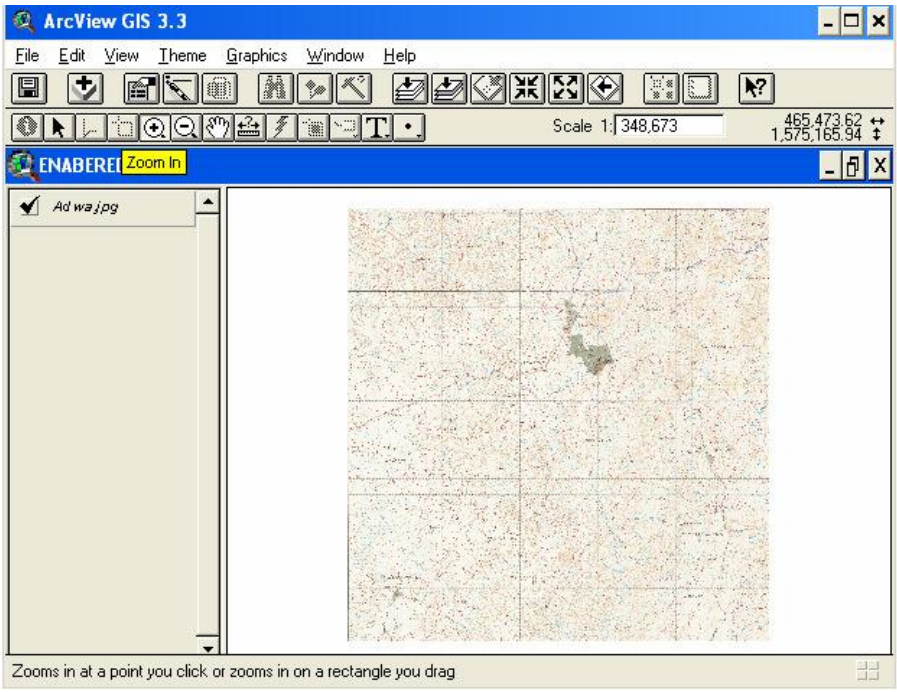


Fig. 12: Zooming tools

The detail you extracted by the magnifier from the map will be illustrated and one can start to do further steps to work on the map.

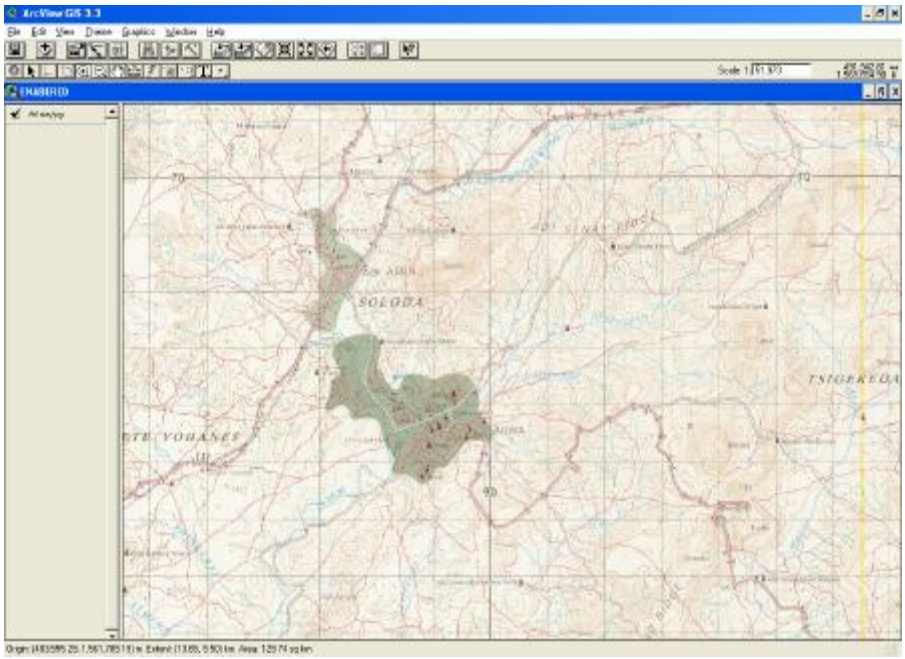


Fig. 13: Zooming tools II

3.3 Creating Point, Line or Polygon Themes

Creating new data such as point, line, or polygon themes, the shapefile you are going to create will be stored in the same projected units as the existing data sources. That means further, the data you create will merely be displayed correctly with themes based on data sources that are also stored in the same projecting units (here: UTM meters); and additionally it means, there is no necessity to adjust the projection of any new theme if the new theme is added to an already existing data.

3.3.1 Creating Point Themes

Creating point themes is necessary if you want to add e.g. important buildings (churches, schools etc.) to a map for a better orientation. Peaks of mountains can also be displayed as point themes. When creating a map of a certain catchment area, where erosion control activities takes place, also a single checkdam or microbasins can be displayed as point themes. To create a point theme click '*View*' '*New theme*', choose the feature type you want (here: *point*) and confirm your choice by clicking '*OK*'. Store the theme under *GIS projects\Enabered\MyData* and name it '*Buildings*'. Then, choose at the tool bar the very right symbol for digitizing point themes and click where you want to have displayed any kind of building, no matter if schools, churches or other buildings[4] (See figures 15 – 20).

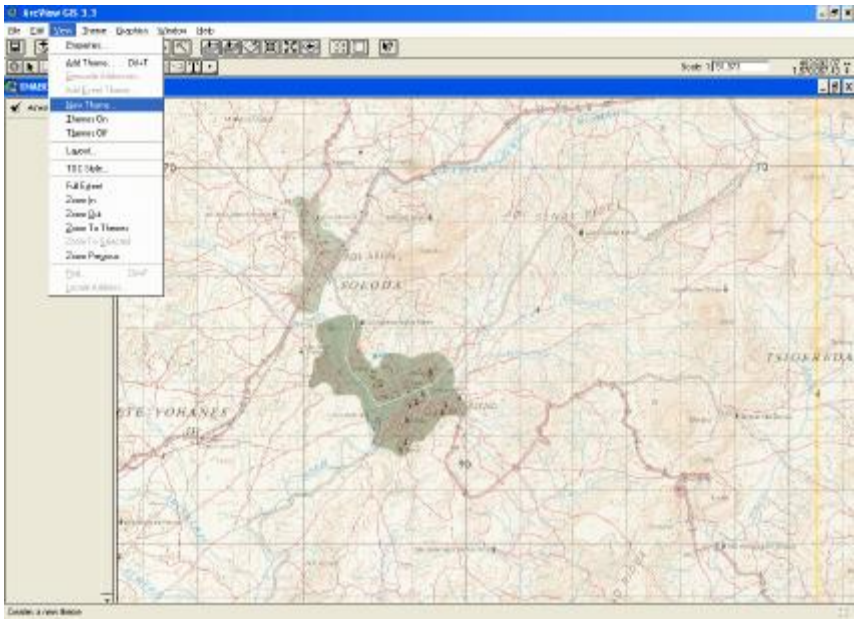


Fig. 14: Point themes

[4] The buildings can be categorized later (chapter: 3.3).

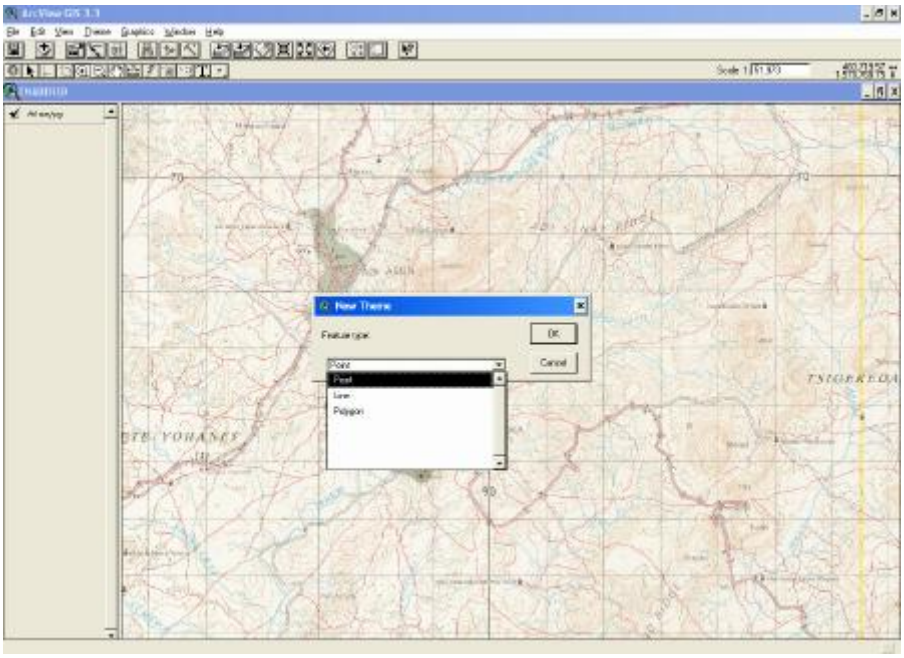


Fig. 15: Point themes II

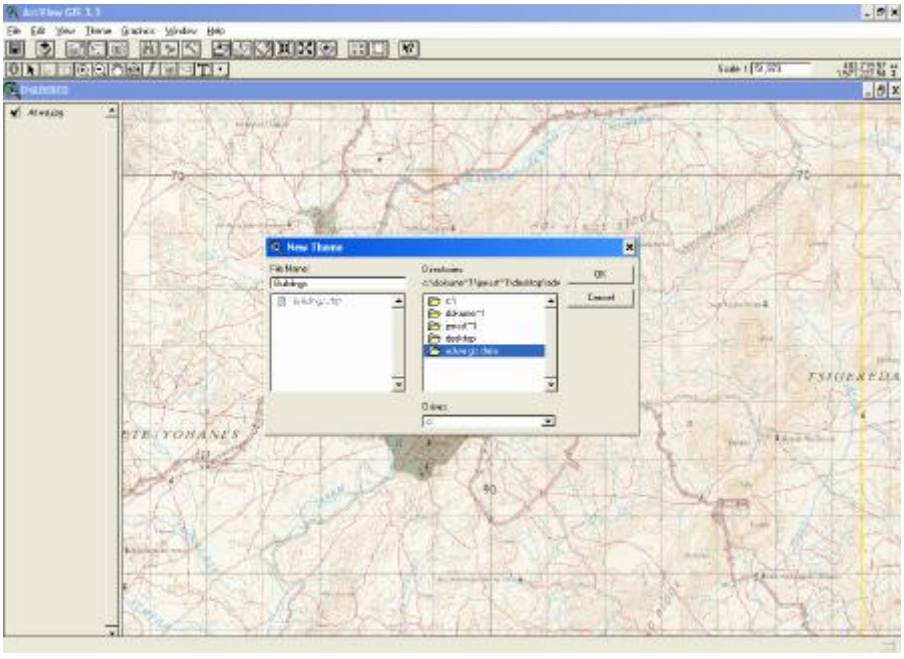


Fig. 16: Point themes III

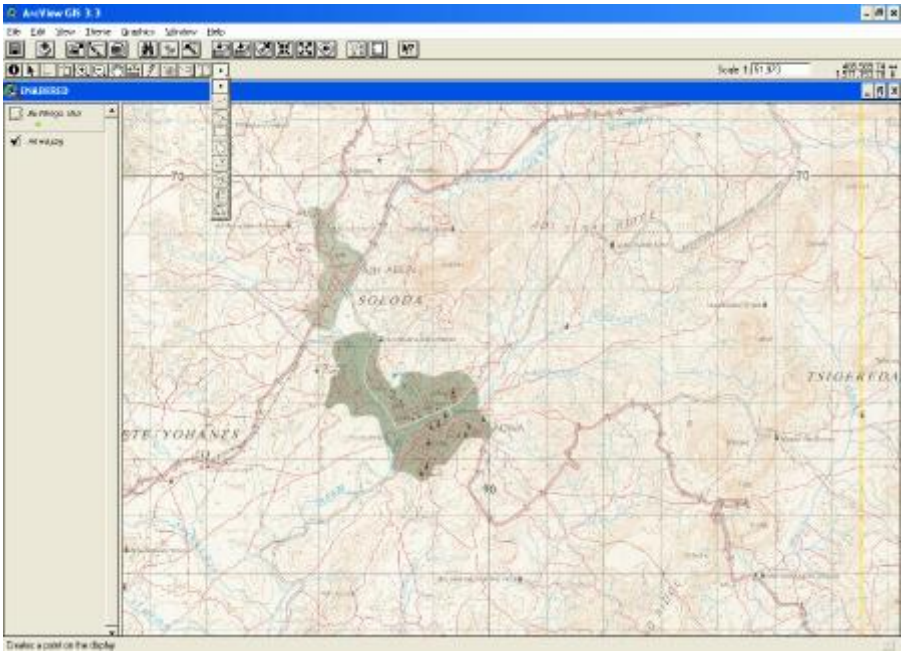


Fig. 17: Point themes IV

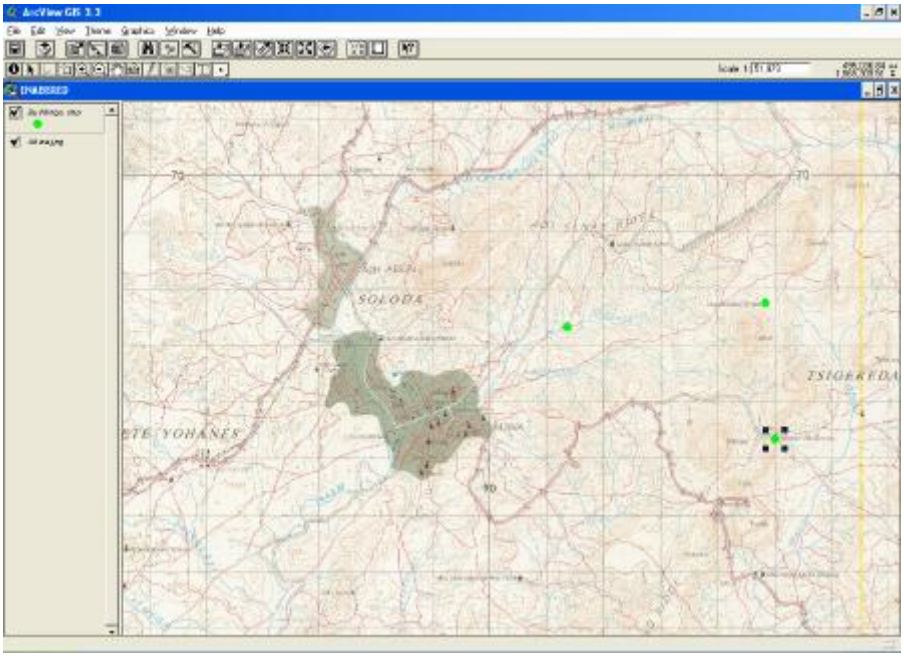


Fig. 18: Point themes V

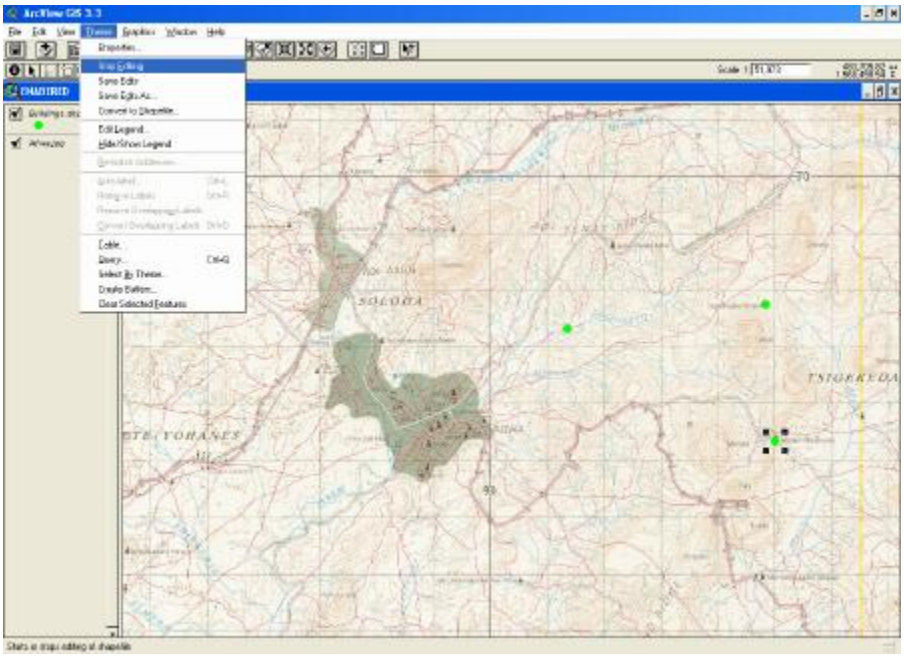


Fig. 19: Point themes VI

After having finalized digitizing buildings you want to have displayed on your own map click *Theme\Stop editing* and confirm that the changes in the shapefile are stored.

3.3.2 Creating Line Themes

If you want to add a new line theme do the same steps as described before, instead of choosing create point theme choose line theme. Click the tool bar and choose '*Draw line'*. Now a line shaped feature such as roads or rivers can be drawn. But before start drawing a line feature in the map you should adjust the '*snapping'* feature. It is important that all line features belonging to the same feature class, such as rivers resp. gullies, share the same endpoint, and for there to be overshoots or undershoots. The most comfortable snapping tool is the '*interactive'* snapping environment. To activate that, first make the new line theme active and click under *Theme\Properties\Editing* the field '*interactive'*(Fig. 21).

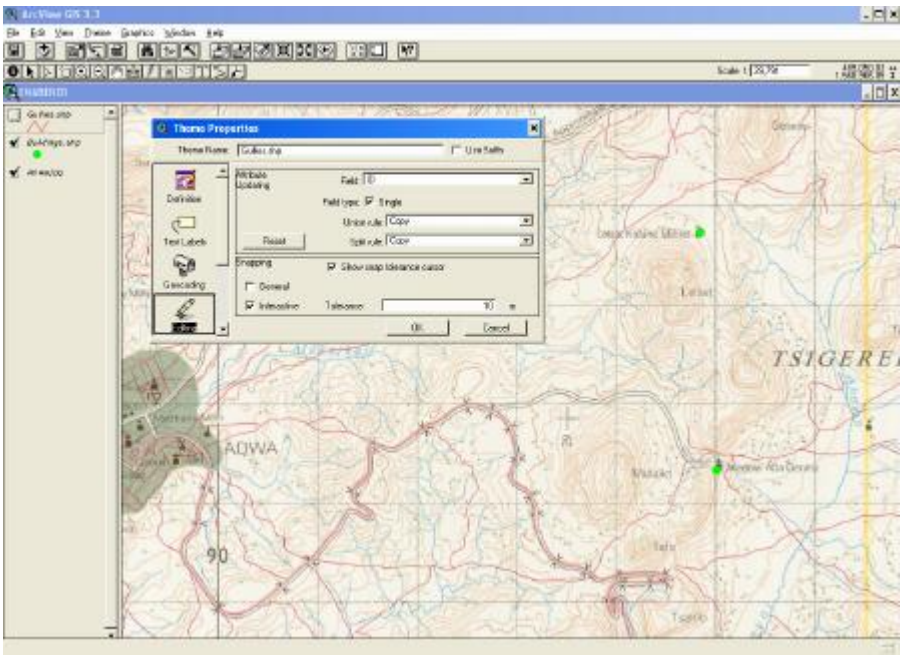


Fig. 20: Line theme

If you have set the interactive snap enyironment as described above, then while you are adding your line you can hold down the right mouse button to display the popup menu, and choose one of the following snapping options to control how the next vertex shall snap to the existing line:

- **Snap to Vertex:** Snaps the next vertex to the nearest vertex in an existing line,
- **Snap to Boundary:** Snaps the next vertex to the nearest line segment in an existing line,

The other options are of negligible importance, since they are covered by the option '*snap to vertex'*.

After having activated the entire necessary fields the lines can be drawn with clicking with the left mouse button at the starting point and set other vertices along the line where it is needed to draw the line. To end the line feature double click at the endpoint. When different lines have a shared endpoint click, before you reach the endpoint respectively the end line or boundary to set the last vertex, the right mouse button an choose '*Snap to Vertex*', then click as near as possible to the vertex at the endpoint you want to end the line[5] (Fig. 22).

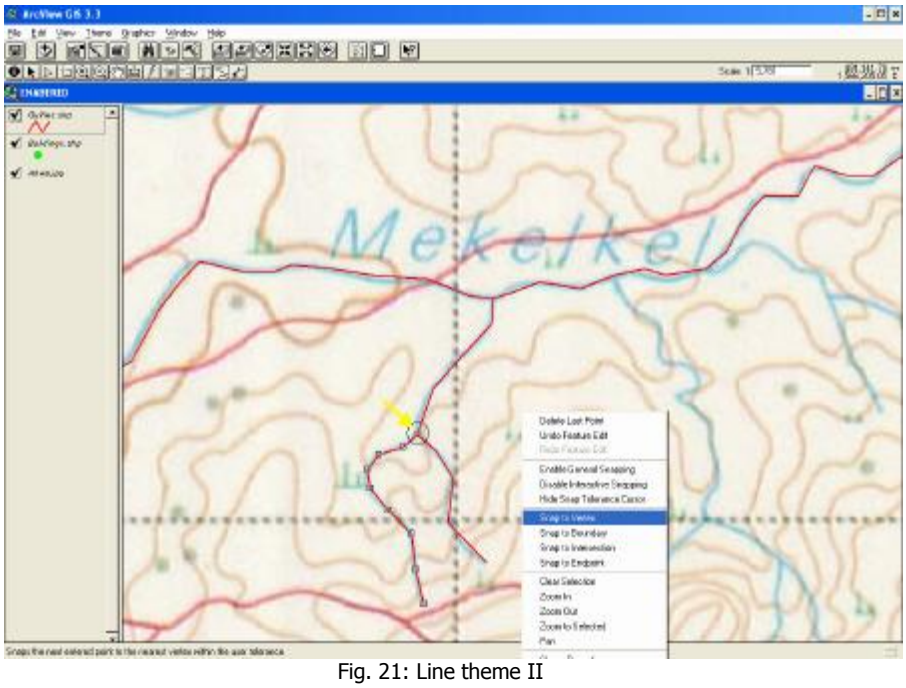
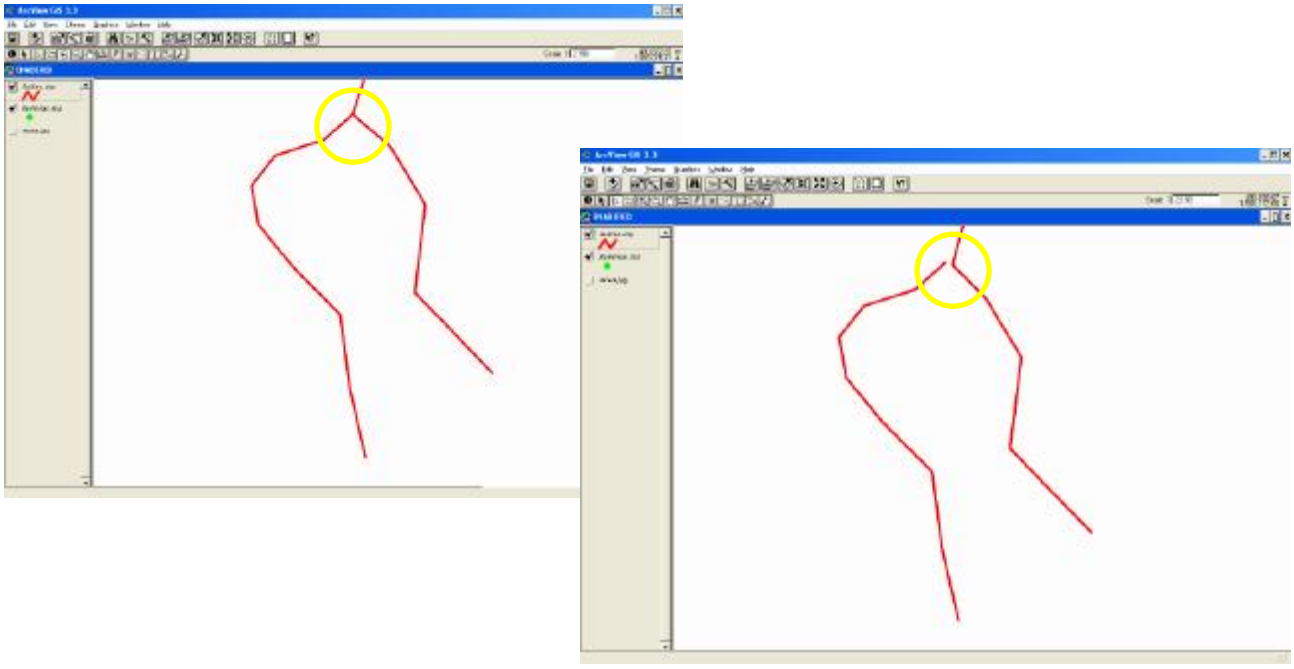


Fig. 21: Line theme II

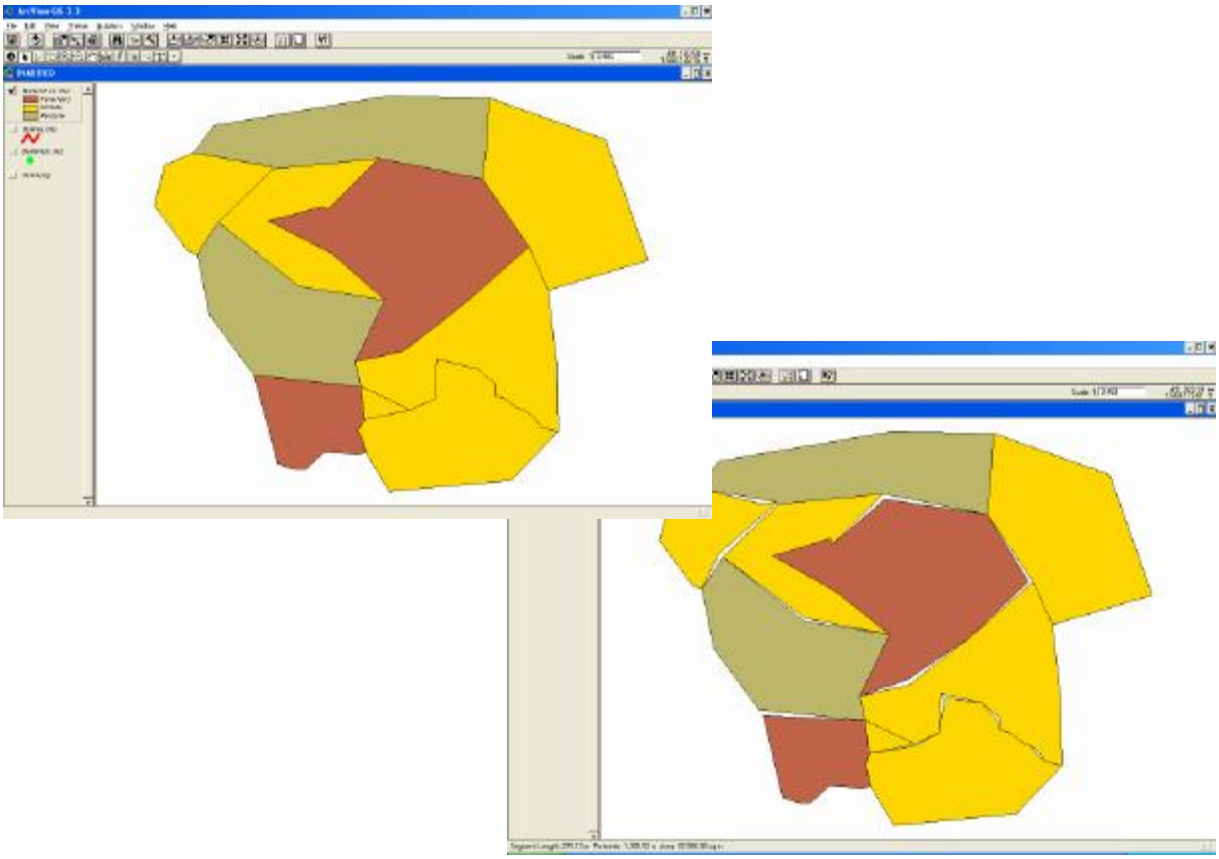


[5] If the snapping environment is not activated it may happen that the endpoints are not precisely at the same place (Fig. ??) which falsify further calculations and looks extremely unprofessional.

3.3.3 Creating Polygon Themes

When creating polygon themes the snapping tool should be used to guarantee correctness as well as to prevent gaps and overlaps (see figures below). Follow the steps as described in the chapter before and define if you want general snapping or the interactive snapping environment. Especially when creating polygons, snapping is essential if one wants to utilize maps for further analyses, otherwise calculations will not be correct.

Note that snapping is possible merely if you work within one theme. Snapping within and between two different themes is not possible. Thus, generalize in the beginning of creating maps as much as possible. E.g. if you want to create a map which shows the existing land use types of one area you better digitize the different land use types of one area in one theme and divide them later on by marking them with the single marking tool (tool bar) and convert them into shapefiles (*Theme\Convert to Shapefile*)[6]instead of creating single land use type themes from beginning on.



[6] Consider that you are supposed to follow the strict hierarchy when storing data as described before.

4 Editing & Analyzing Data

If you have created your own map you have two possibilities now. Either you create a Layout (described in the following chapter 5), or you use your map for further analyses. The term analysing data means in this context more or less simple calculation of length, width and areas. Beyond that, ArcView 3.3 offers various features to do further specific spatial analyses. Spatial analyses are not subject of this training module. To receive information about that issue use help in ArcView 3.3.

4.1 Editing Maps & Data

If you want to analyse maps you need to describe the features of your created maps more exact. E.g. if you have created a map with different land use types you can name the different types and you can categorize them which is a precondition for further calculations. Instead of one symbol or color you can choose various symbols or colors for the respective land use types.

To come to the *Attribute Table* click *Theme\Table* or use the tool bar to reach the *Attribute Table*. When you are working in the *Attribute Table* window, then click *Table\Start Editing* (Fig. 23).

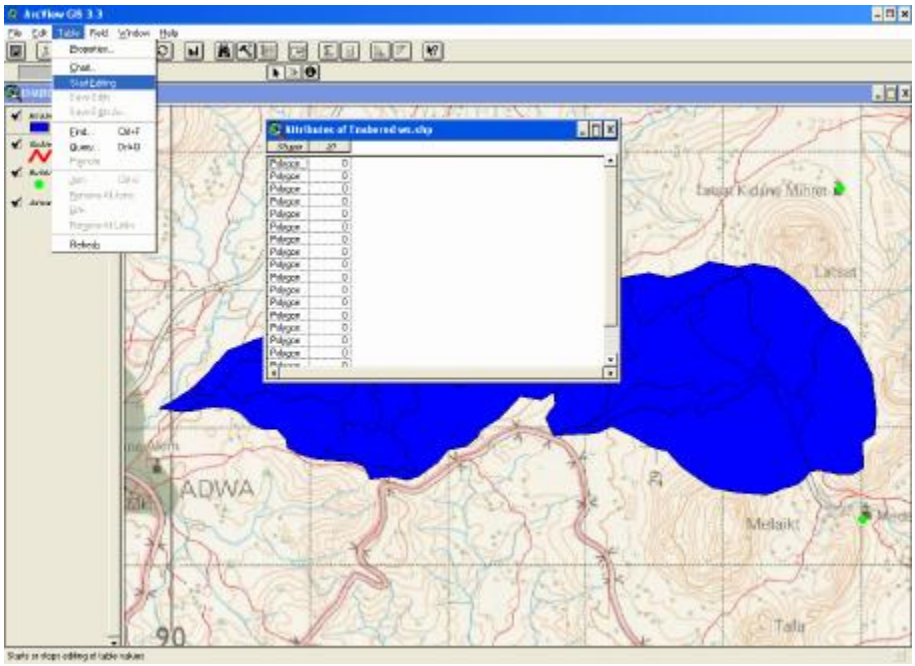


Fig. 22: Editing data in Attribute Table

To be sure that you are able to edit the *Attribute Table* check the column headers, they appear normal and not italic anymore. Use the marking/writing tool and write the ID numbers (Fig. 25), then click *Field\Stop Editing* and safe the edits by confirming the *YES* button. Cancel the *Attribute Table* and check the different polygons you have created by the Info button to find in the tool bar (Fig. 24). Note on paper the IDs and the respective land use types.

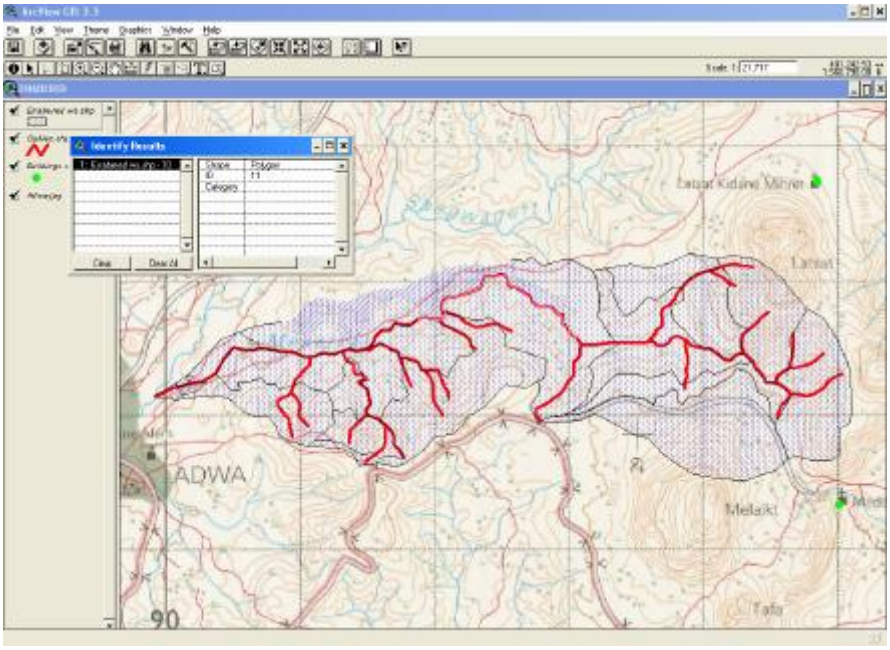


Fig. 23: Editing polygon themes

Then return to the *Attribute Table* and add a field (*Edit\Add Field*). Define whether the field shall be a number field or a field for words/terms and determine the width of each field (Fig. 25, 26)[7].

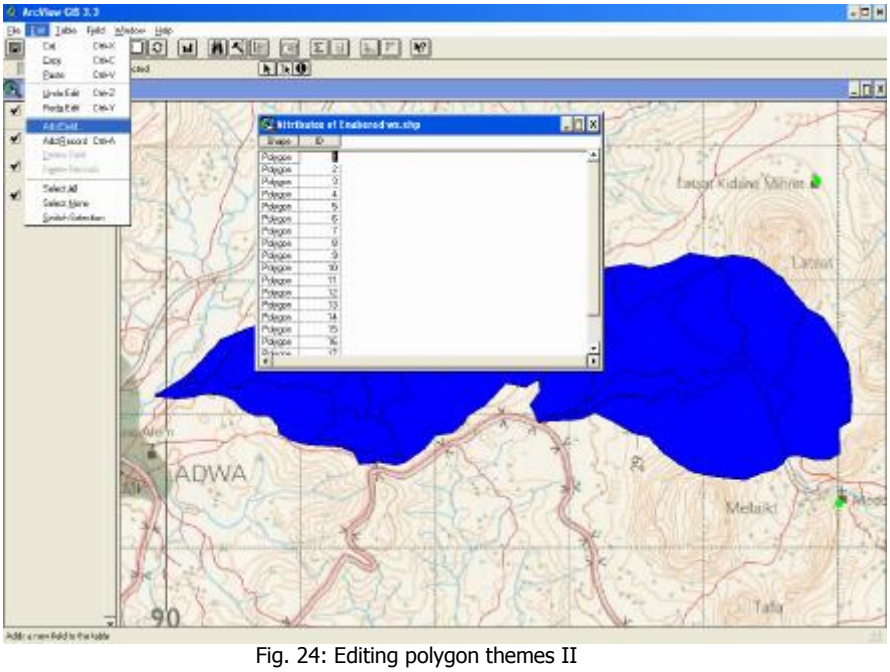


Fig. 24: Editing polygon themes II

[7] Note that Number fields should have a width of around 10 and a term field of about 24.

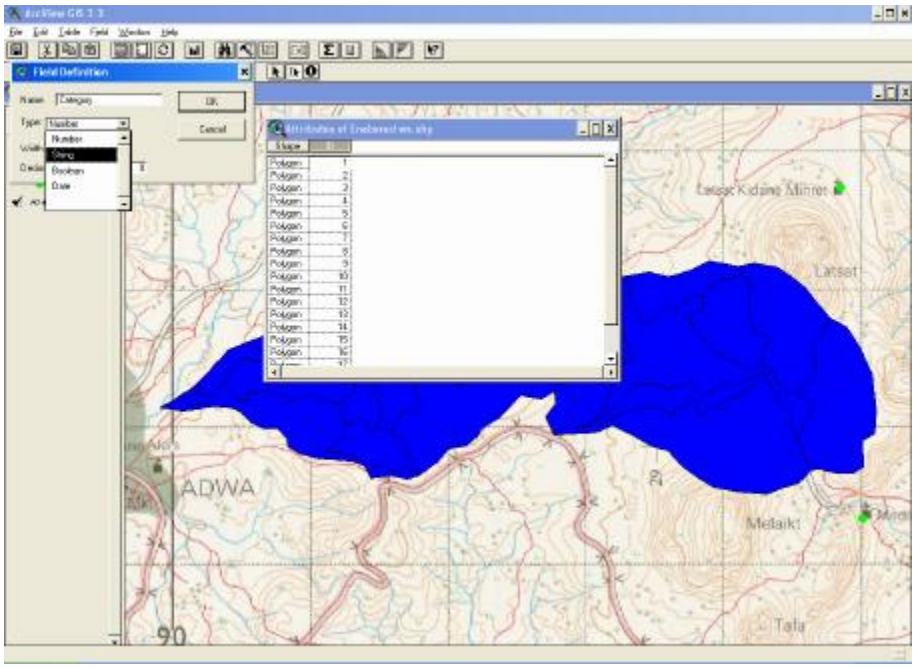


Fig. 25: Editing polygon themes III

Now write the category names of the respective land use type in the field and safe the edits as described before (Fig. 27).

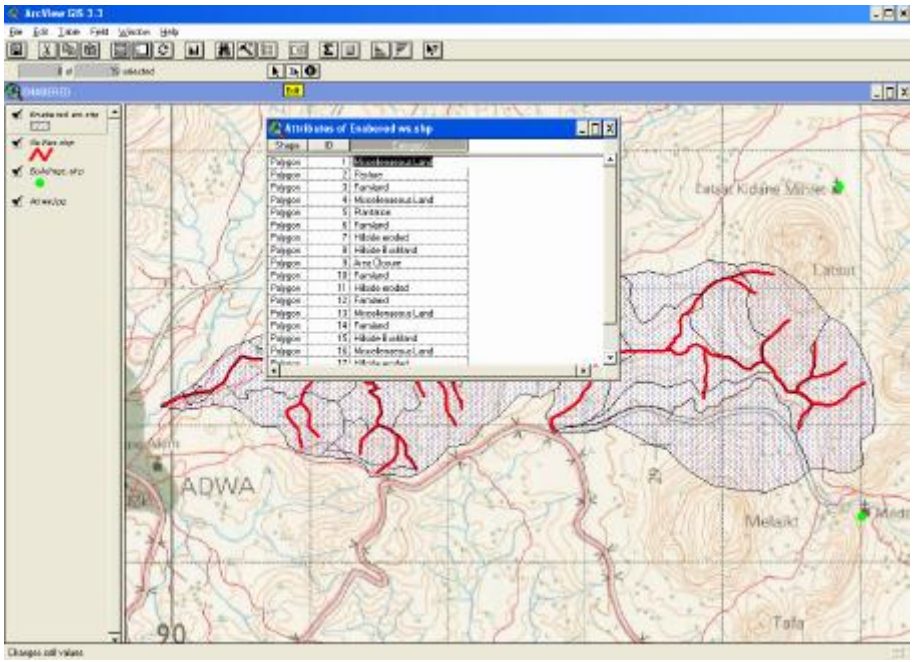


Fig. 26: Editing polygon themes IV

After having done the edits the land use pattern can be displayed. Double click the polygon Theme (here: Enabered WS) and choose under *Legend Type Unique Value* and define the *Value Field* as Category (or however you have named the new field under the Attribute Table). Confirm with *Apply* and the different land use types will appear in various colors, which can be modified as well by double clicking the symbol color of the respective land use type (Fig. 28, 29).

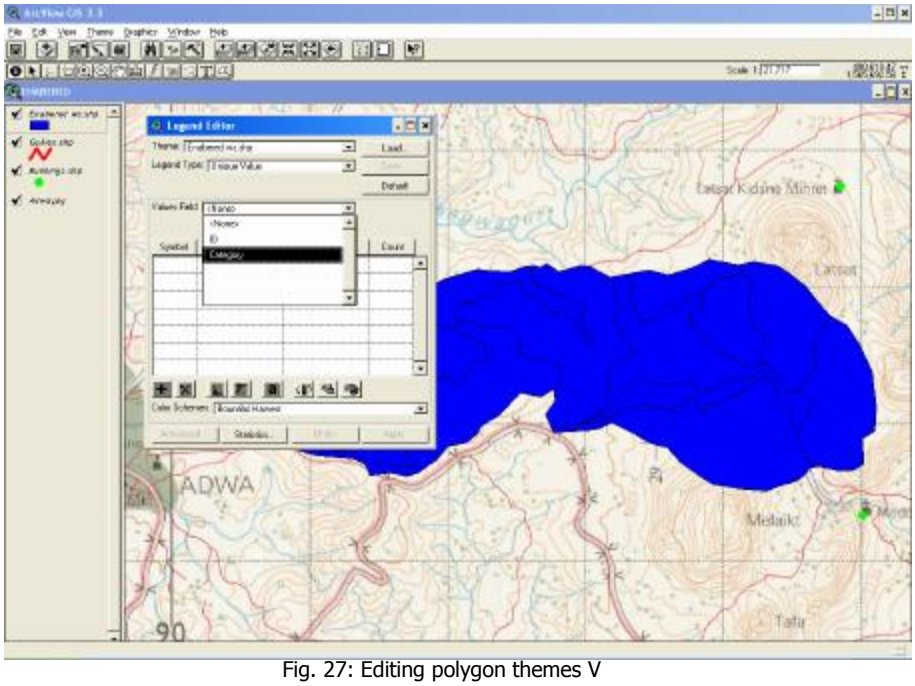


Fig. 27: Editing polygon themes V

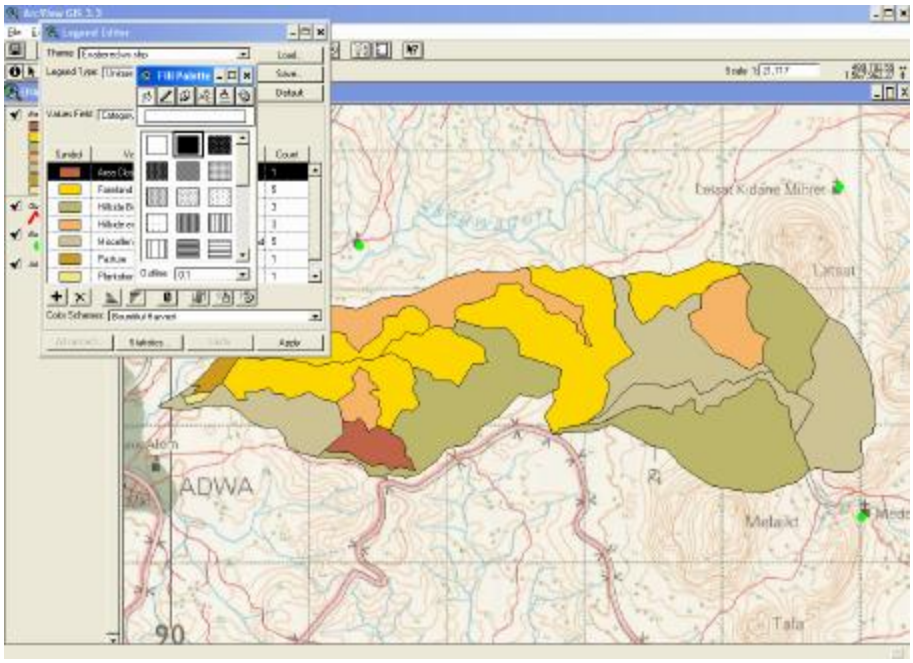


Fig. 28: Editing polygon themes VI

4.2 Calculating & Co.

Calculations can be performed in the Attribute Table surface. Activate the Theme you want to analyse and click to the Attribute Table. Start editing under menu Table and add a new field under menu Edit[8]. Define that you want to have a number field and determine the field width.

Then activate the new field (it appears dark grey instead of light grey), here: Area, and click the calculator. Enter the formula *[Shape].ReturnArea* and confirm with *OK*[9] (Fig. 30).

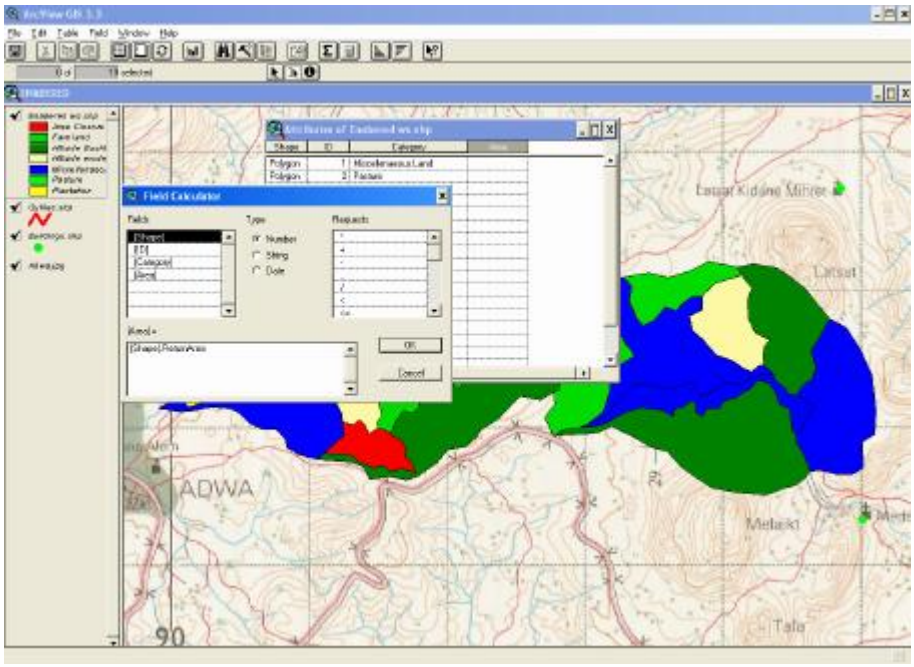


Fig. 29: Calculations on spatial data

Precondition for any calculation is that the map is adjusted in correct map units. Adjust under *View\Properties* and define maps units, which should be *meters*.

[8] All Stepps of editing are described in the chapter before. Follow up to here the same steps.

[9] To calculate the length of a line theme simply change the formula from [Shape].ReturnArea to [Shape].ReturnLength.

5 GPS Data Import

If there are no specific shapefiles about your area respectively about your certain field of interest you want to deal with, it is needed to create an own shapefile. To realize a spatial link of data, the positions of specific locations have to be transferred to a GIS system. The most comfortable and mostly most exact way to get spatial data in the field is the utilization of GPS. To invert GPS data into GIS systems different steps have to be followed.

1) Verify the projection of your digital topo map and make sure that your GPS device shows the same grid data[10]. **2)** Measure the points by GPS device in the field, safe them as waypoints or note them on paper. It is needed to have two figures for each point, one for the latitude and also one for the longitude. **3)** Create a simple table in Excel (three columns, first for ID, the second for latitude and the last for longitude) (Fig. 31 & 32). Enter your measured data in this table, mark the partition of the excel spread sheet where your data are drawn and safe it as *dBASE IV* (DBF 4) and confirm the following requests by clicking 'OK'.

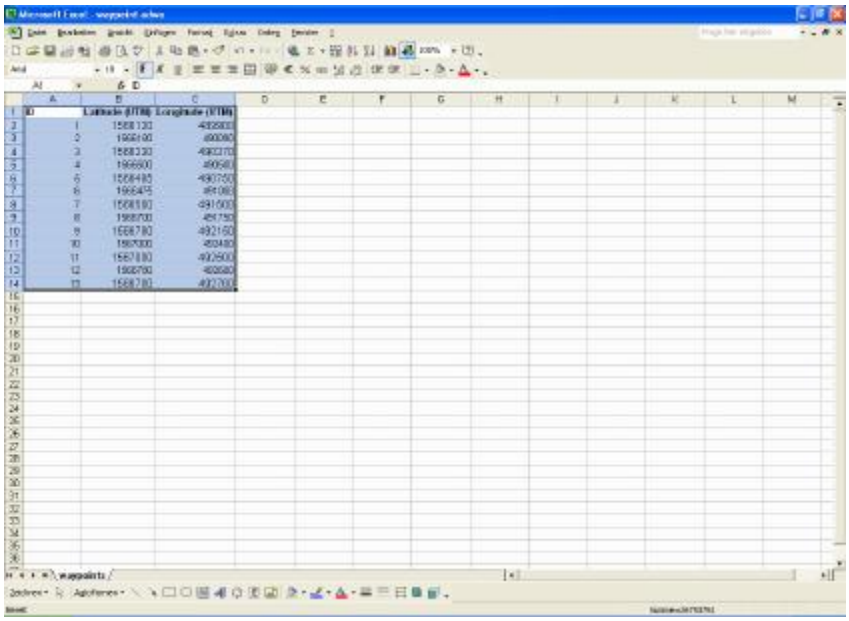


Fig. 30: GPS data import

[10] In Ethiopia most of geographical data are given in UTM (**U**niversal **T**ransverse **M**ercator grid); Ethiopia lies in Zone 37.

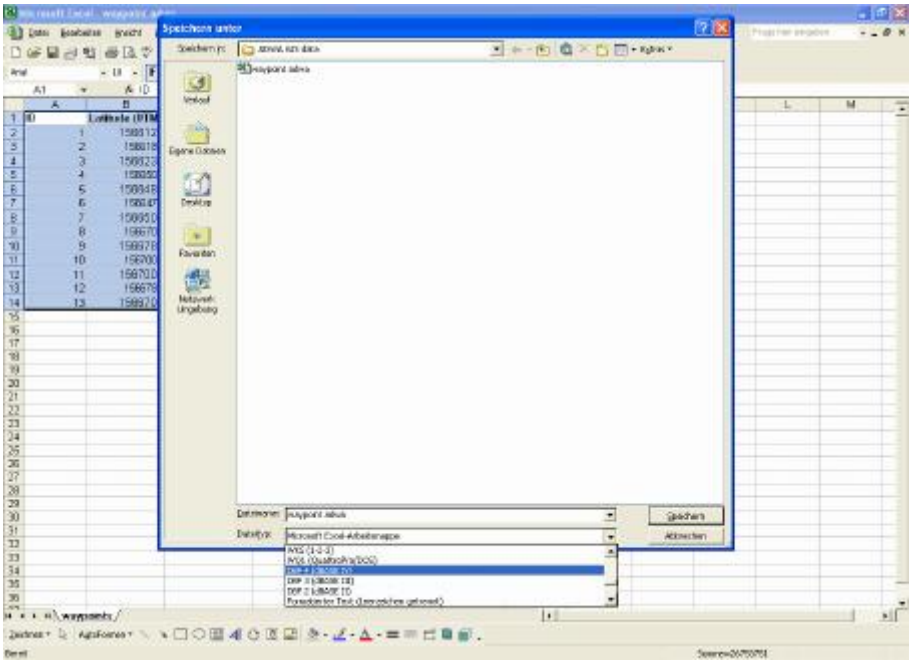


Fig. 31: GPS data import II

4) Open ArcView 3.3, load the adwa topo map (…\gis training june 2007\topo map) and choose the suitable part of the map by the magnifier tool, make the Project window active and click in the right bullet list to *Tables* and click '*Add*' and follow the path where you have stored the data (here: …\gis training june 2007\data\waypoints) and confirm by clicking 'OK' (Fig. 33) – now, the Table is inverted into ArcView 3.3.

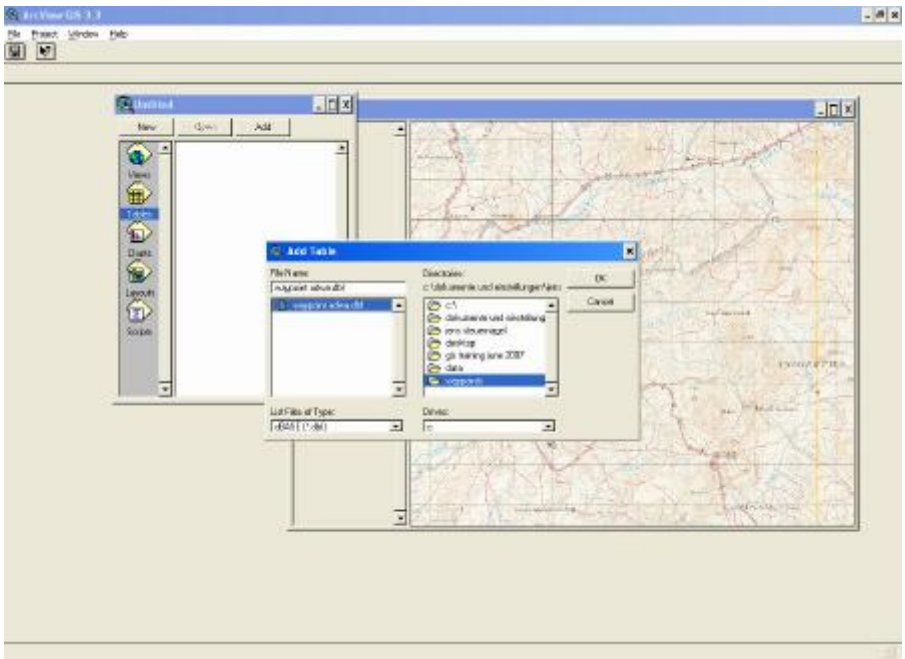


Fig. 32: GPS data import III

5) To make use out of the data, they have to be loaded as theme into the View. Click under menu View '*Add Event Theme'* by choosing the table '*waypoints*', the *x-field* must be longitude and the *y-field* latitude (Fig. 34 - 36).

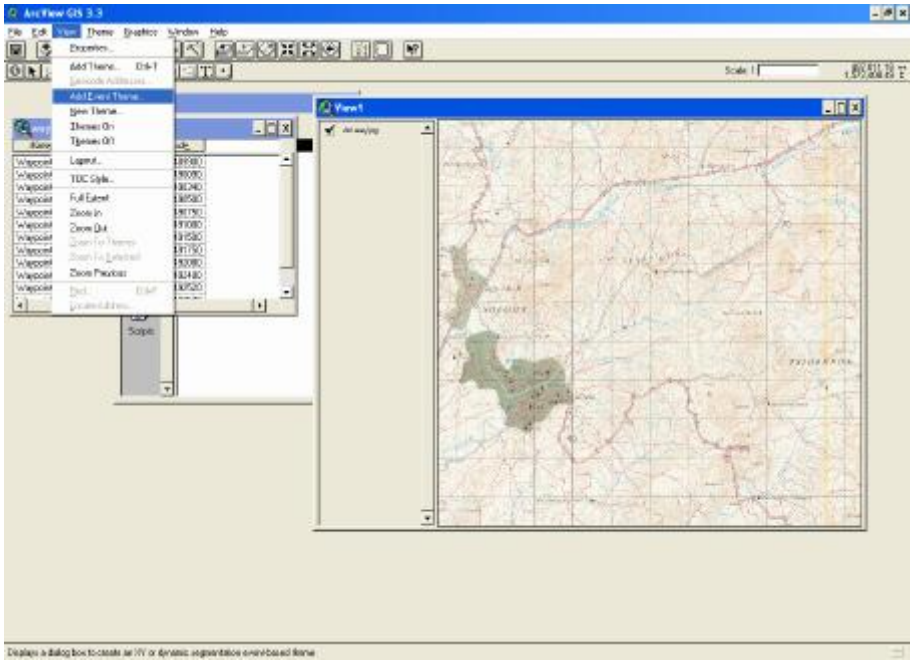


Fig. 33: GPS data import IV

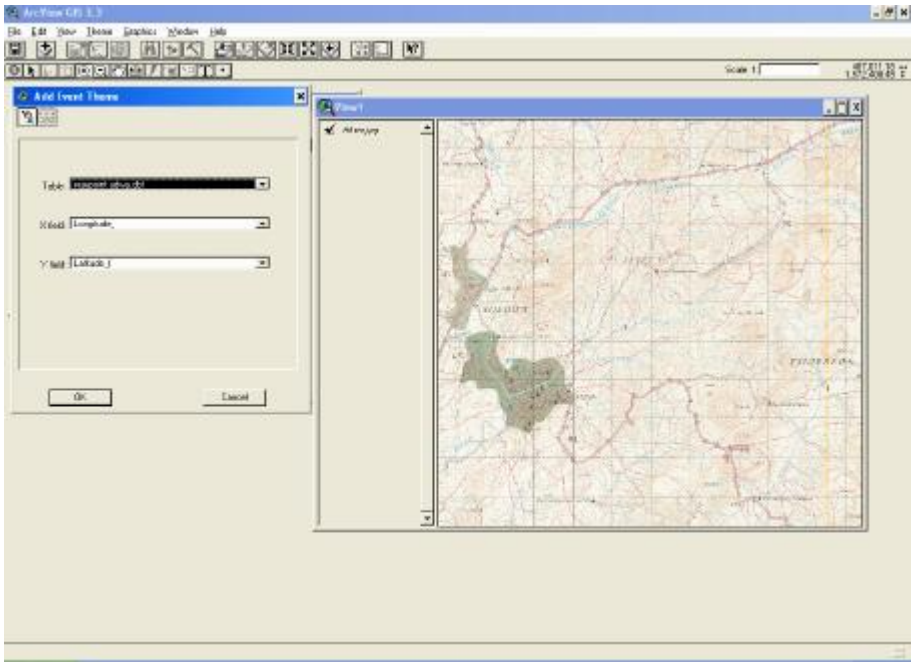


Fig. 34: GPS data import V

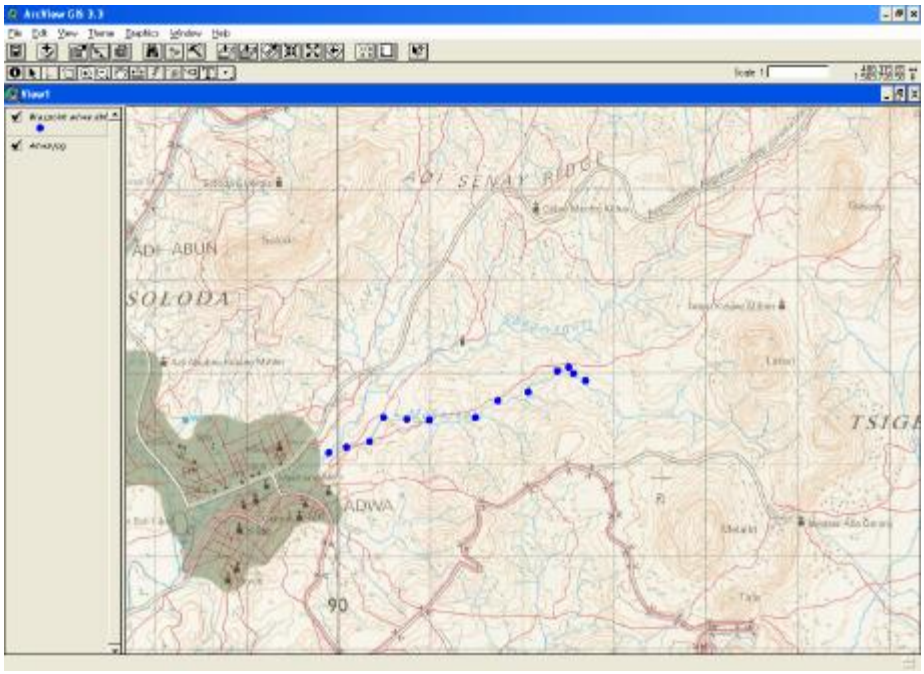


Fig. 35: GPS data import VI

6 Layout

Last but not least self created maps have to be presented, for that reason they can be printed out. Print outs of maps need certain features to be considered to be complete. When creating a (printed) map, the north indication arrow and a scale (indicator) have to be added. Additionally, one can affix also the grids of a map and the legend. To create a map which can be printed out ArcView 3.3 has the feature '*Layout'*, to find under menu View. Decide if you want to have portrait or landscape format and confirm with 'OK' (Fig. 37).

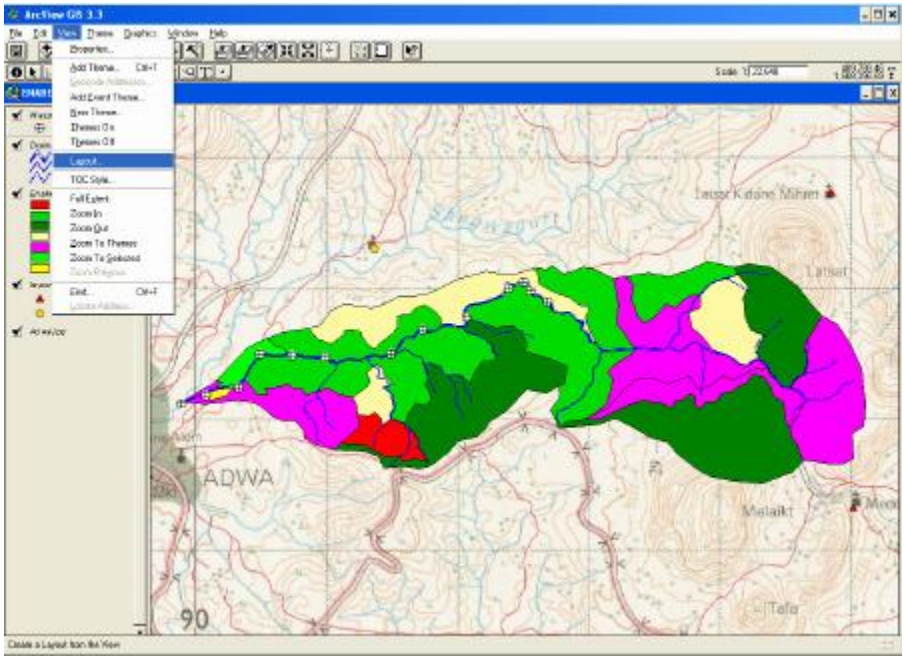


Fig. 36: Layout

In the Layout window you can change the display of the different icons like the north arrow and the scale bar by double click the respective symbols. You can simplify also the legend box to arrange it in the way you want. Click with the right mouse button on the legend icon and choose '*Symplify'*.

Before you can add the map grids you have to activate the extension '*Graticules and Grids'* to find under '*File\Extension*', confirm with 'OK' as usual. Double click the new icon in the tool bar and follow the steps and choose the features you want (Fig. 38 – 40).

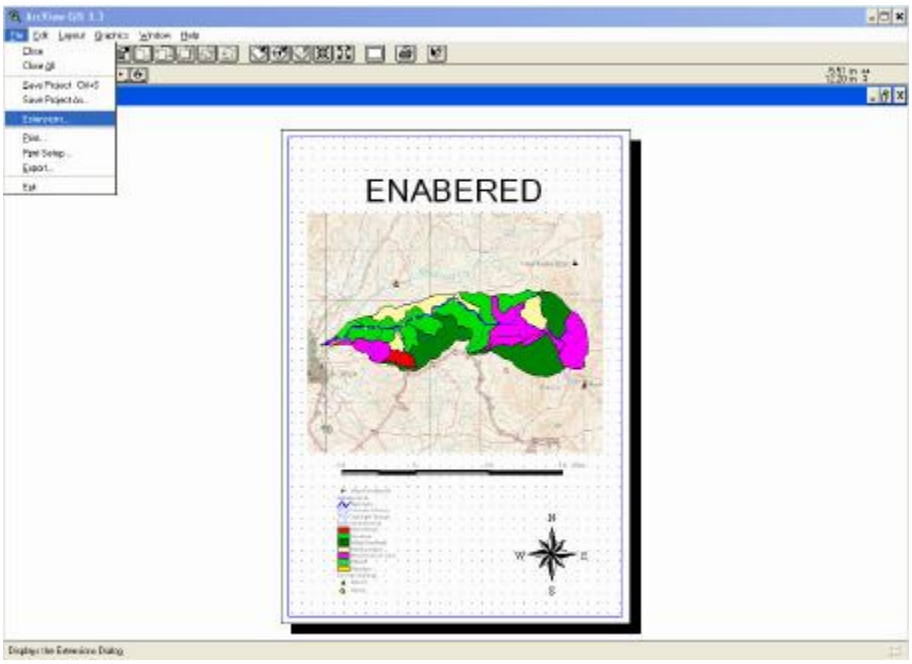


Fig. 37: Layout II

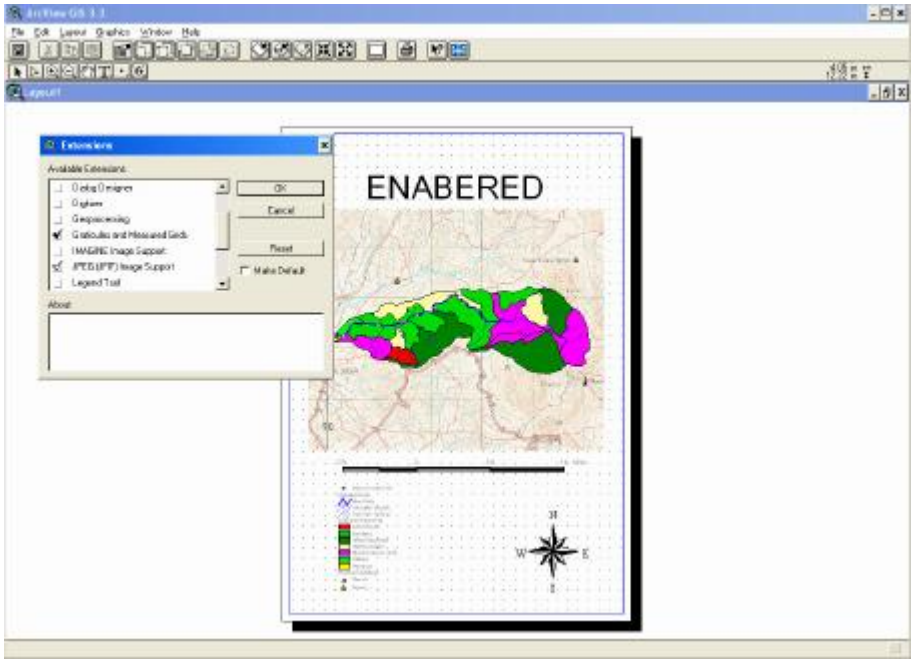


Fig. 38: Layout III

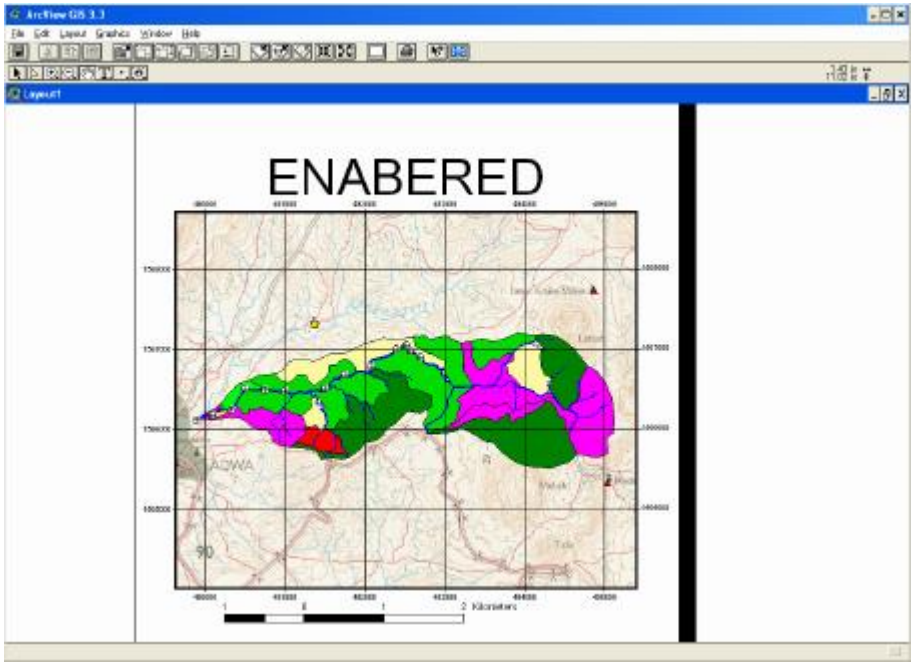


Fig. 39: Layout IV

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