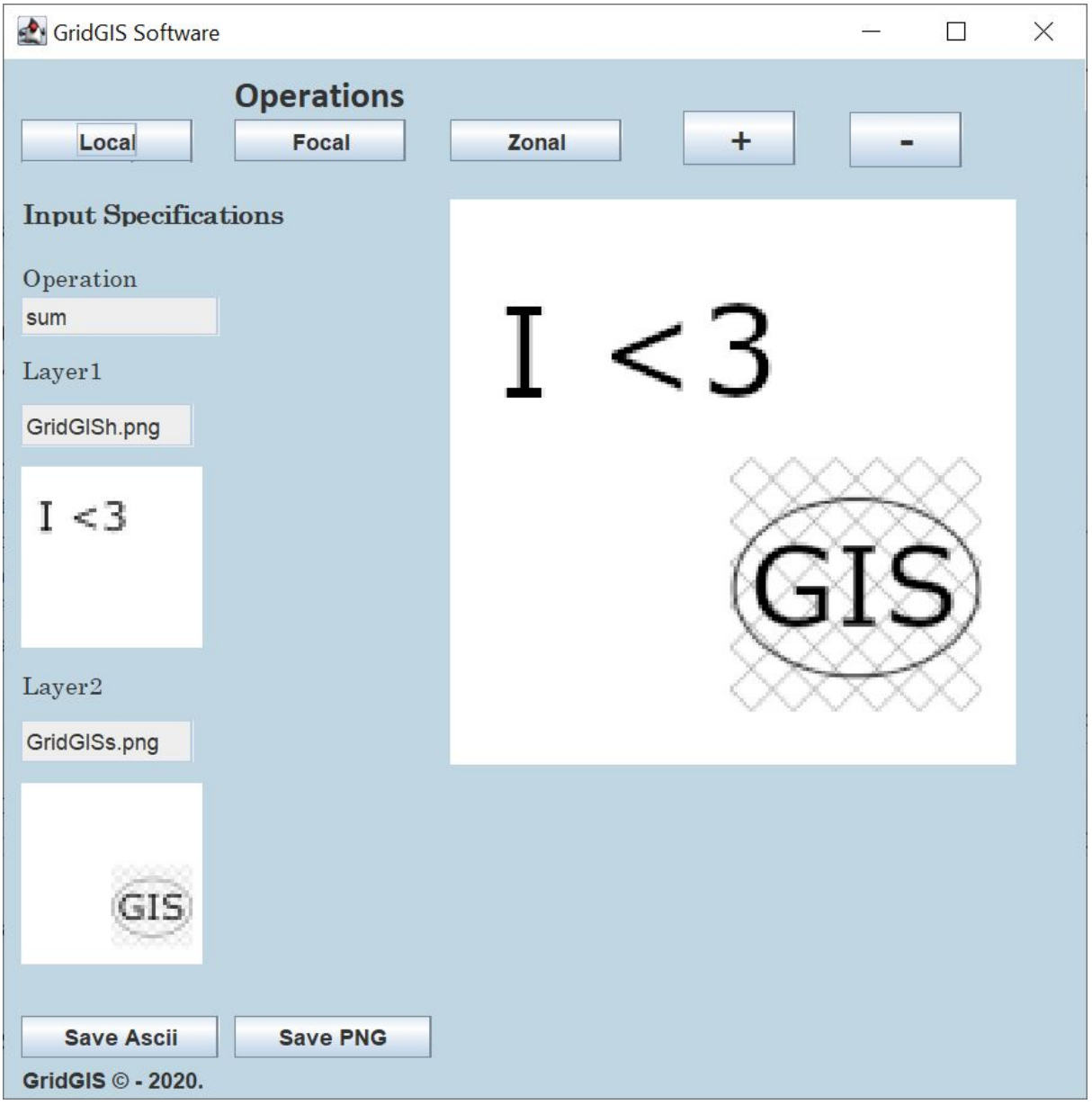
GridGIS - a Raster Based GIS



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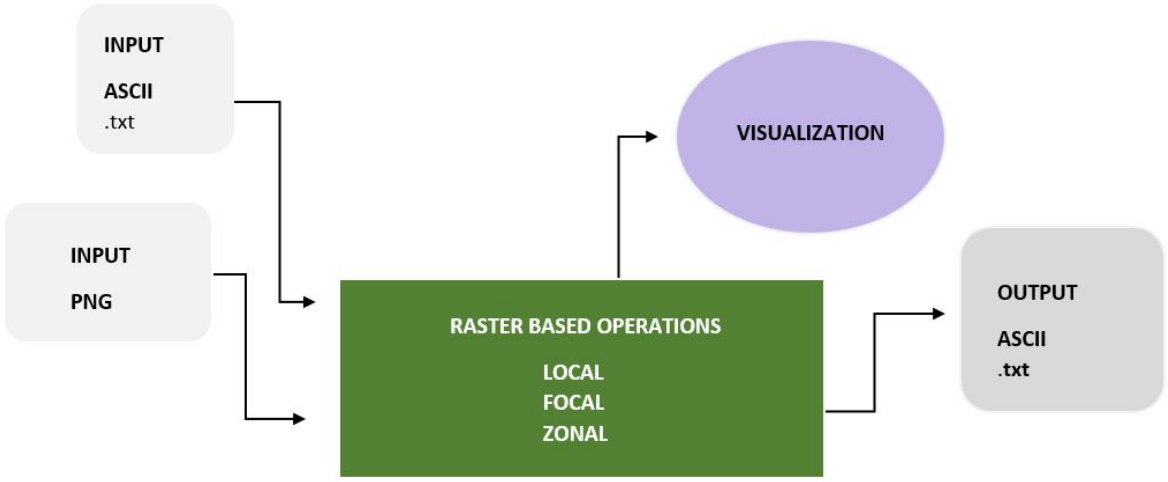
Greetings to the User

While developing GridGIS, the goal was to create an easily used GIS competent enough to do everything the basic GIS user is desiring, while not complicating it. This is why GridGIS is based on Map Algebraic operations and an uncomplicated interface. The range of operations provided in GridGIS are enough to provide all GridGIS users with a versatile tool, which operations you after reading this manual will know how to use. The user will be provided with examples of usage of the operations in chapter 7. The processed input files can be visualized as a map image and the output files can be saved, as described by the flow chart of GridGIS is figure 1.



Conceptual model of the functionality in GridGIS.

The Development team wants to thank You for choosing GridGIS as the software for your future geographical work, and hope you will enjoy using it. The GridGIS development team is not interested in your money, which is why the software will be open source to be available for the greater public. All users are however very welcome with feedback to improve the areas of usage and the user friendliness of our software.

Happy GIS:ing!

Best regards,

the Development Team

Yang Mu
Jonas Bylerius
Micael Makenzius
Ann-Sofi Lenander

Chapter 1 - GridGIS Set Up

The GridGIS is offered as a .jar file. The user is recommended to keep the files to be used in the software (.txt and .png) in a separate folder, thar for example can be called *data*. The user is also recommended to have a separate folder for saving GridGIS output results in. This folder could for example be called *result*. An example of a folder set up can be seen in figure 2.

Figure 1.0. Example of a set up of folder structure that may be helpful for the user.

Chapter 2 - Acceptable Types of Input Files

GridGIS is able to process ASCII text files (.txt) and PNG files as input. If the user has access to convert other file types into text files, the user has the ability to process a great deal of data in GridGIS. It is important that the input files have the , otherwise the user will receive an error message. How to import files into GridGIS is described in chapter 5.1 to 5.3.

The user can import both PNG images exported from GridGIS but also images acquired from other sources. Image files produced through GridGIS have an associated meta-data file which contains information to scale the image to the correct values. Images from other sources do not contain such information and will be scaled to a value between 0 and 255.

Chapter 3 - Output File Types

The GridGIS software is able to save the processed input files into ASCII text files (.txt) and into PNG files. The user is able to select the desired type of output after running a selected operation. How to save output of the software is covered in Chapter 6. The result of the software will also show the output of the processed data as an image, so the user can see the result of the operation.

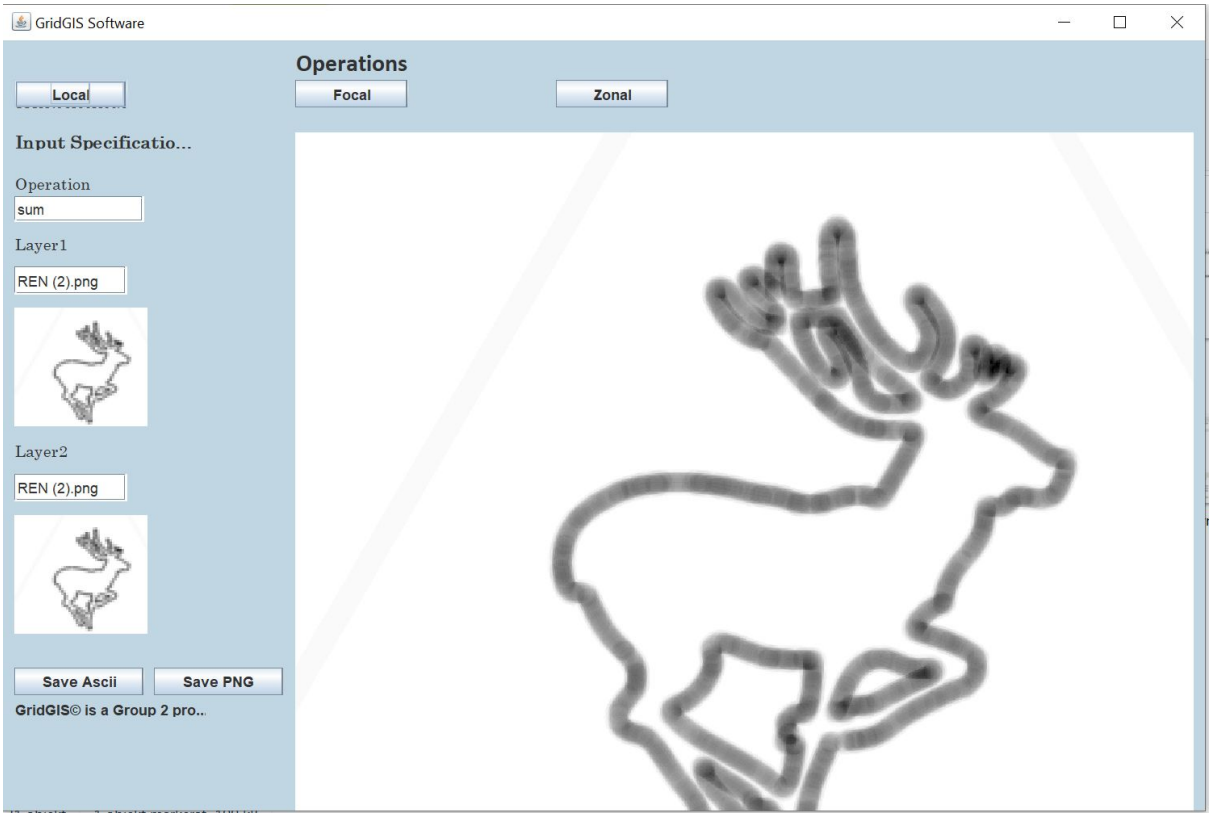


Figure 3.0. GridGIS will show the user a picture of the operation output. After running an operation, the user is given the opportunity of saving the output as a text file or a PNG file.

Chapter 4 - Operation Documentation

The types of operations provided by GridGIS are raster based and uses map algebra, meaning that the operations are done to all cells using one or two raster layers. The operations of GridGIS are either based on local, focal or zonal operations, described under the chapters 4.1 to 4.3. How to select operations and set file inputs will be covered in chapter 5.

GridGIS can perform one operation at the time. Should the user be interested in performing several operations, the user is able to do so by saving the output result of one operation, and using the same output for the next operation.

4.1 Local Operations

The tools based on local operations in GridGIS require two input files to work properly. The local operations will be performed using the same cell position of the two input files as described in figure 3. The positions of the input files will be processed according to the selected operation until all positions have been processed.

If any of the two layers imported for local operation contain a null value, the returned value will be null and the null value will be colored red in the visualization of the output.

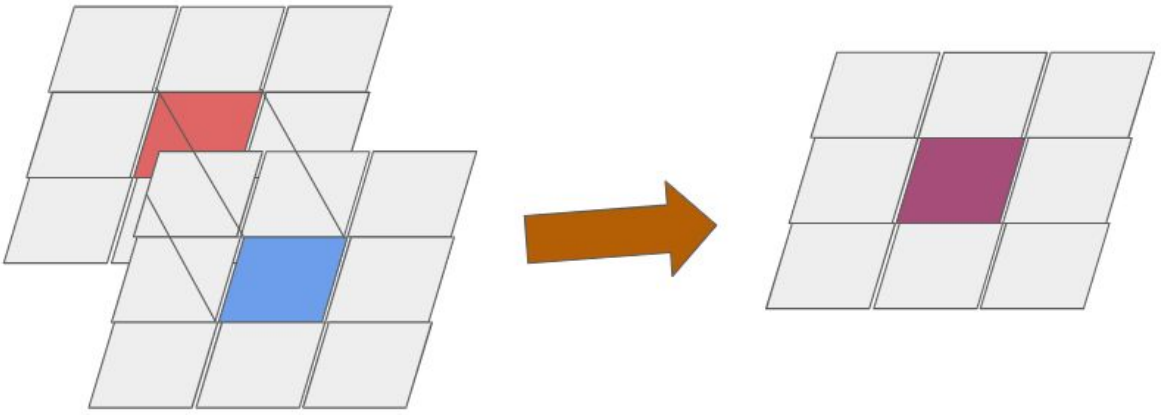
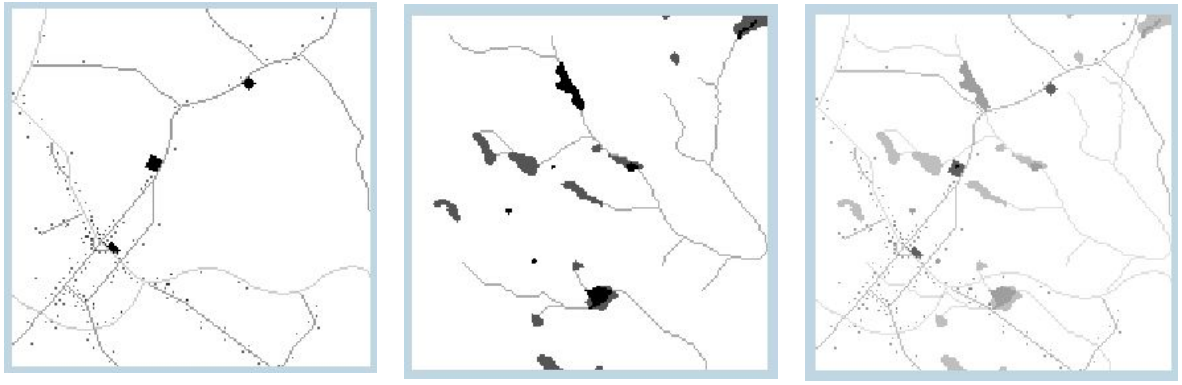


Figure 4.1. Local operations will perform the selected operation type on all positions in the two input file layers. The operation will perform the operation on the corresponding positions in each grid.

4.1.1 Local Sum

The Local sum operation will calculate the sum of the values of the same position of the two input files.

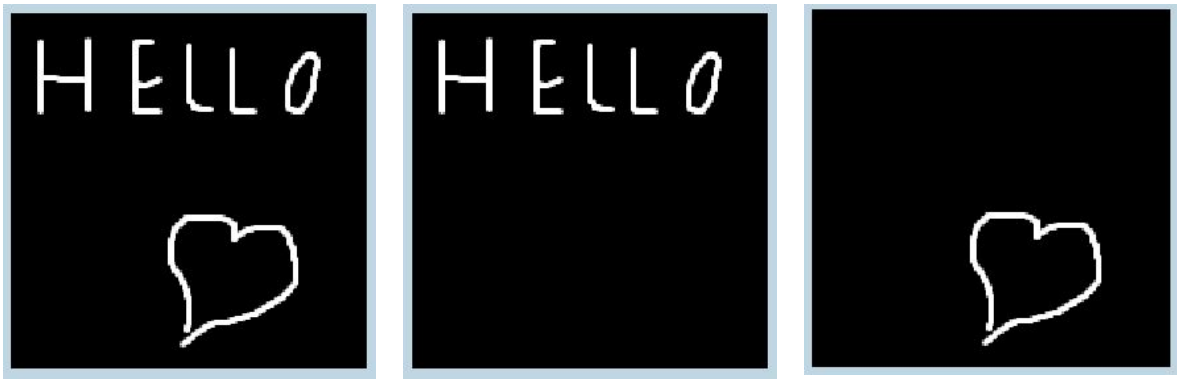


Input file 1 Input file 2 LocalSum Result

Figure 4.1.1. A result of the Local sum operation.

4.1.2 LocalSubstraction

The local subtraction operation will calculate the difference of the two input files. The second input file layer is subtracted from the first input file layer.

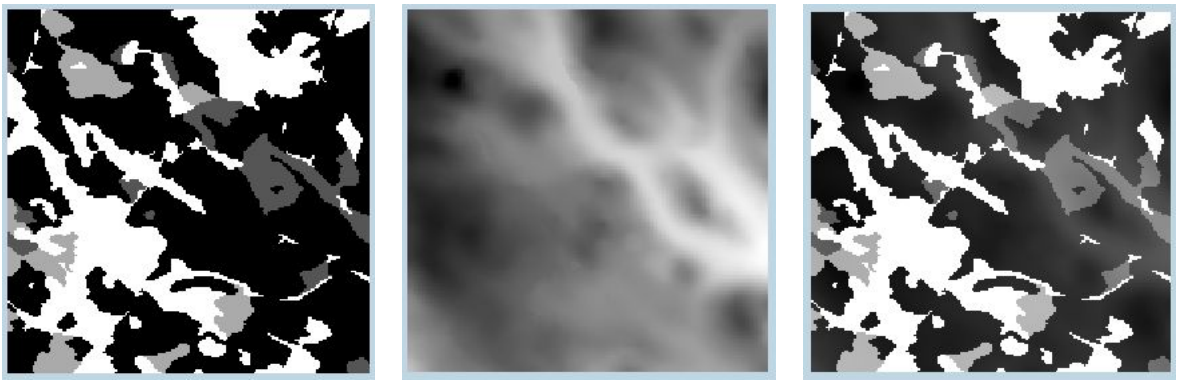


Input file 1 Input file2 LocalSubstraction Result

Figure 4.1.2. A result of the LocalSubstraction operation using PNG-files.

4.1.3 LocalMultiplication

The local multiplication operation will calculate the product of the values that have the same position in the selected input files.

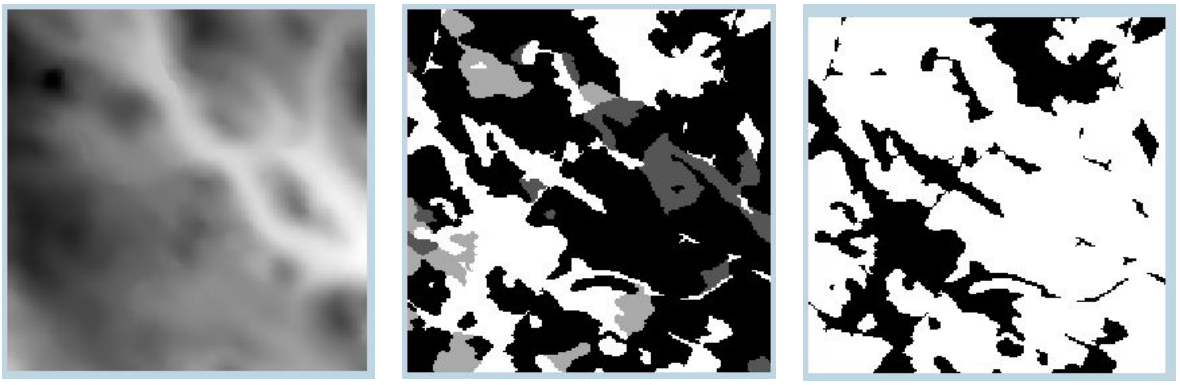


Input file 1 Input file 2 LocalMultiplication Result

Figure 4.1.2. A result of the LocalMultiplication operation.

4.1.3 LocalDivision

The local division operation will calculate the quotient of the values of the same position of the two selected input files. The dividend file (input file 1) will be the numerator and the divisor file (input file 2) will be denominator. If the input file 2 contains zero, the result will be a null value. If the input file 1 contains zero, the output result will be zero.

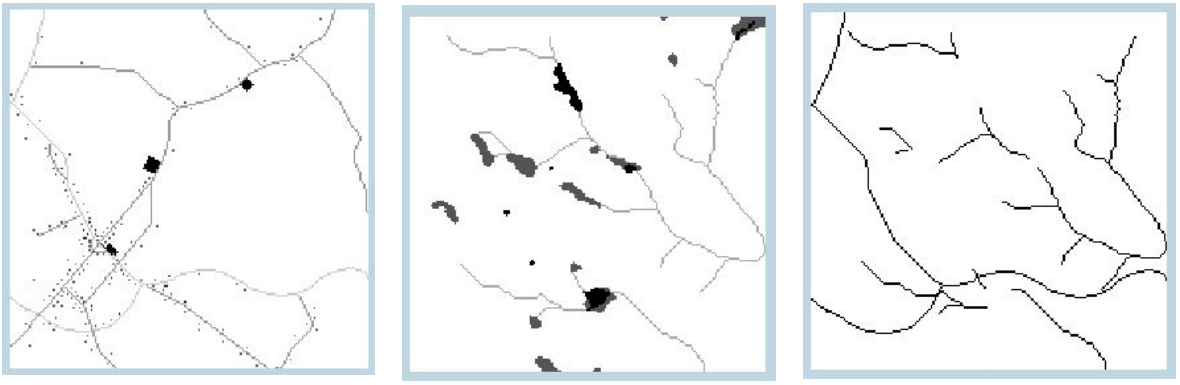


Input file 1 Input file 2 LocalDivision

Figure 4.1.3. A result of the LocalDivision operation.

4.1.4 LocalBinary

The local binary operation is a search function that will search for all positions of the value selected to be searched for in both of the input layers. If any of the input file layers contain the applied search value ("Search (Binary)" in figure 4.1.4.2), the position will return the value of applied search value. If none of the input file values contains the applied search value, the output file layer will return a zero for the position. If the user is only interested in searching for a value in one input layer, the user may input the same file layer as input file 1 and input file 2. How to select input values and search values will be covered in chapter 5.



LocalBinary
Search value: 1

Figure 4.1.4.1. A result of the LocalBinary operation using two different input files. The operation will search for all values of "1" in both input files.

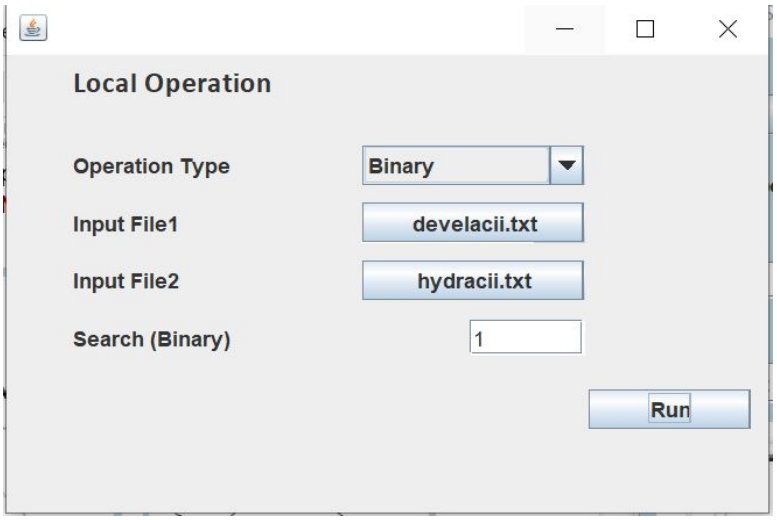
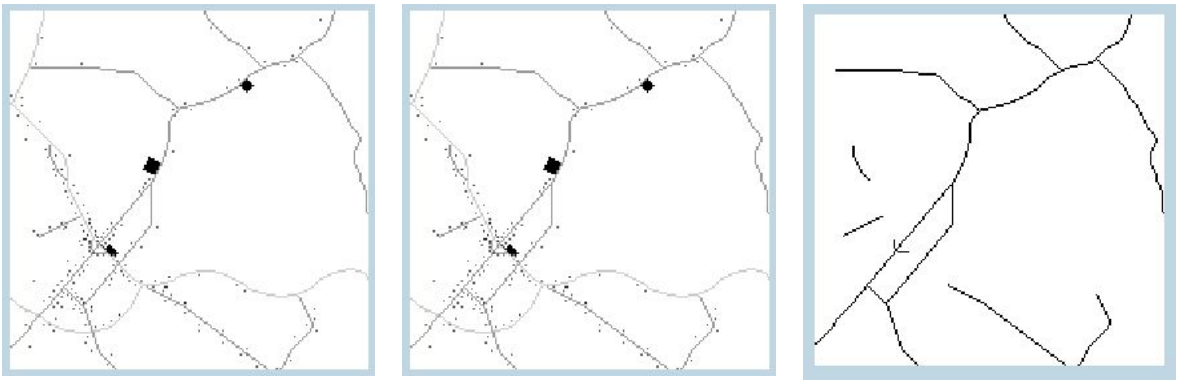


Figure 4.1.4.2. When selecting the Binary operation type, the user must give GridGIS a "Search (Binary)" value. In the example, the value is 1.

OBS! If the applied search value represents different properties in the two input file layers, the user is responsible for usability of the result. If the user however input the same input file layer twice, the user is able to search for the desired property value.

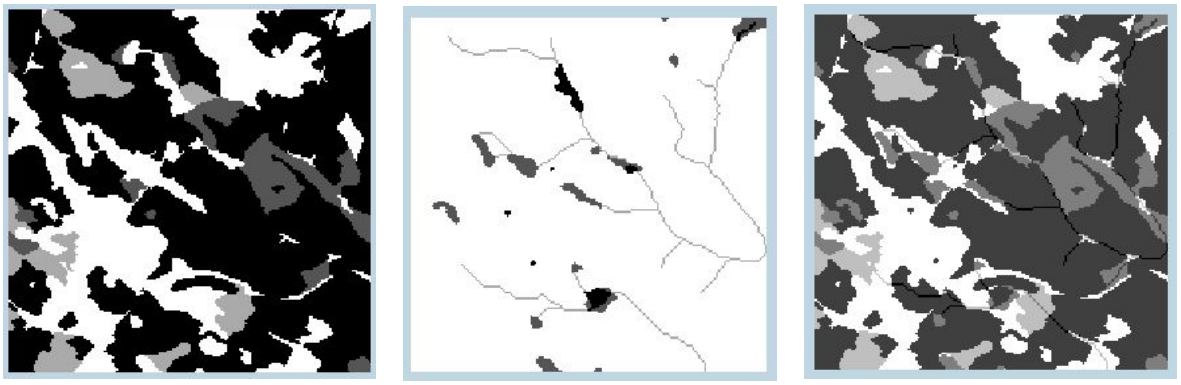


Input file 1 | Input file 2 (same as Input file 1) | LocalBinary, Search value: 2

Figure 4.1.4.3. The user may input the same input file twice. Like this, the user is able to search for eaxmple, all roads of Search value "2".

4.1.5 LocalMean

The local mean operation will calculate the mean value of the values that have the same position in the selected input files.

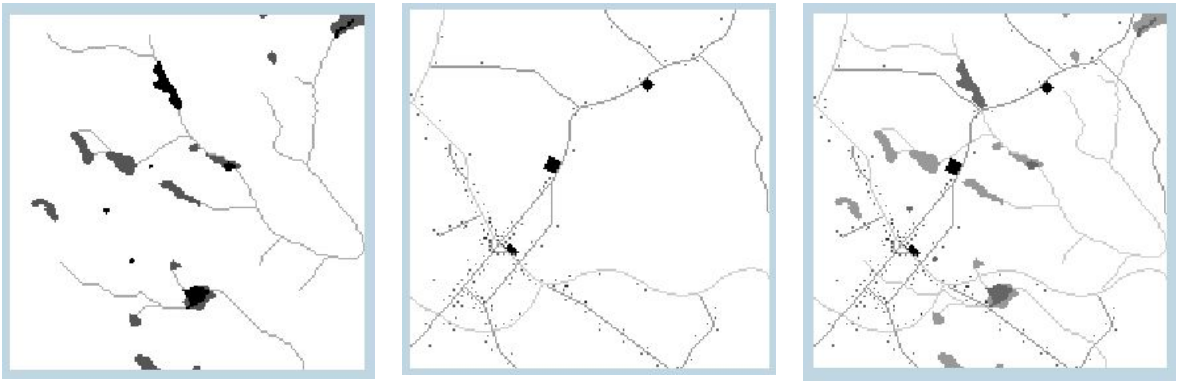


Input File 1 Input File 2 LocalMean

Figure 4.1.5. A result using the LocalMean Operation.

4.1.6 LocalMax

The local max operation will return the maximum value of the two values that have the same position of the selected input files.



Input File 1 Input File 2 LocalMax

Figure 4.1.6. A result using the LacalMax operation.

4.1.7 LocalMin

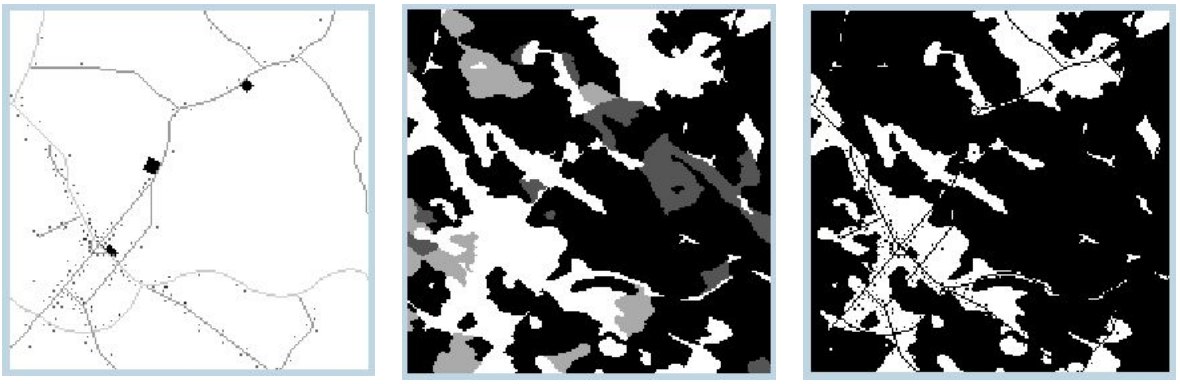
The local min operation will return the minimum value of the two values that have the same position in the two selected input files.

Input file 1 Input file 2 LocalMin

Figure 4.1.7. A result using the LocalMin operation.

4.1.8 LocalVariety

The local variety operation will return the count of the values of the same position in the two input files. If the two files contain exactly the same value for the same position in both of the input files, the ouitput value will be 1. If the two input files contain dissimilar values of the same position in the two input files, the returned output value will be 2.



Input file 1 Input file 2 LocalVariety

Figure 4.1.8. A result using the Local Variety operation.

4.2 Focal Operations

Focal operations require one input file and perform the operation over a neighborhood to the cell in the selected input file. The operation will be performed on the neighborhood of all positions of the input file, and the operation result of a neighborhood will be the returned result. The two types of neighborhoods that are available in GridGIS are “Square” and “Circle”, see figure 4.2. The radius of these will be decided by the user. The radius of 1 will correspond to the size of one cell. The radius can only be integers in GridGIS. If the user forgets to give a radius or if the radius is typed in an unsupported format, the user will get an error message.

If a neighborhood contains a null value, the returned value for the focal operations will return a null value and the null value will be colored red in the visualization of the output.

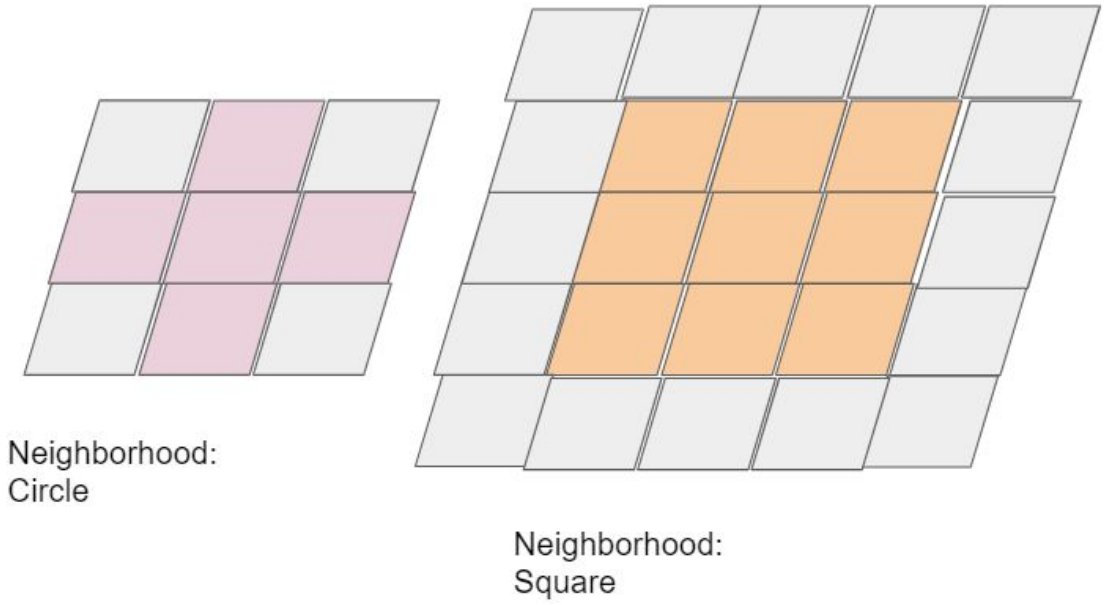
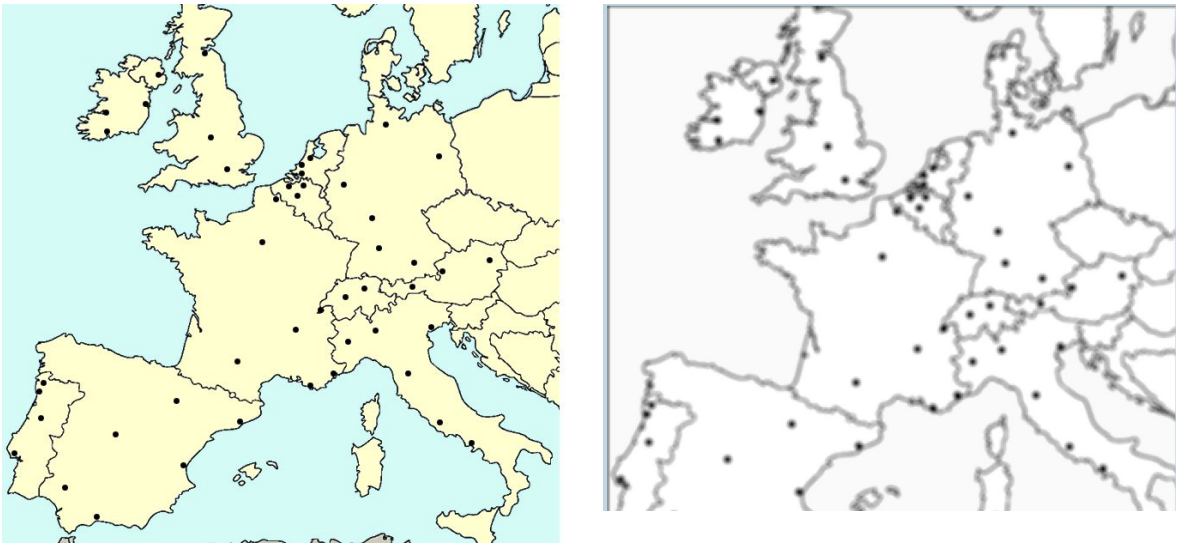


Figure 4.2. Description of available neighborhood shapes.

4.2.1 FocalSum

The focal sum operation will return the sum of all values in the neighborhood of each position in the selected input file.



Input File FocalSum

Figure 4.2.1. A result using the FocalSum operation.

4.2.2 FocalBinary

The focal binary will search for the same value as the user gives as input of the binary operation in each neighborhood of the selected input file. If the neighborhood of the cell position contains the applied search value, the cell position will return the applied search value. If the neighborhood does not contain the applied search value, the returned output of the cell will return 0. Changes of the radius will change the size of the neighborhood area. As the operation will be performed on all cell positions of the input grid, the effect of using the focal binary operation will be a buffered area. This effect can be seen in figure 4.2.2.1.

Input File 1

FocalBinary.
Search value: 1, Radius 8

Figure 4.2.2.1. A result using the FocalBinary operation. As the user increase the radius, the result will look like a buffered zone around the searched for value.

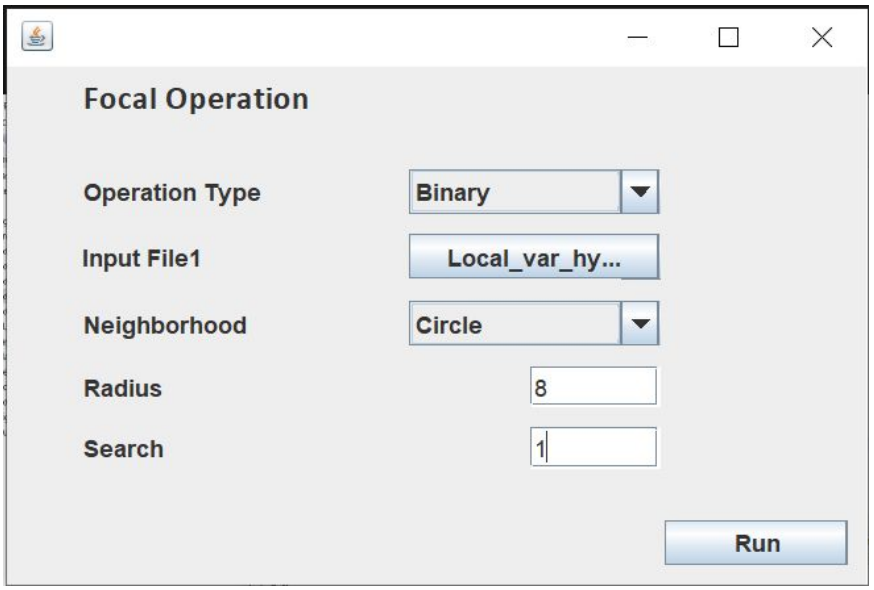
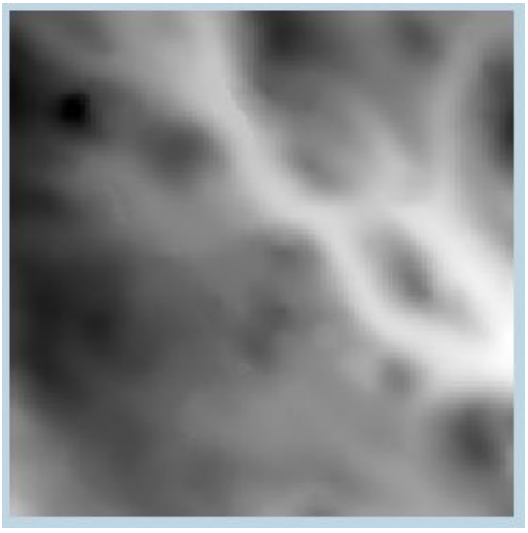


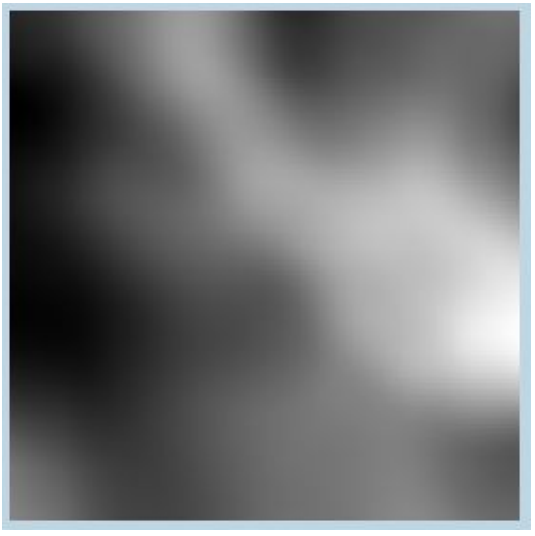
Figure 4.2.2.2. The user must give the GridGIS software a Search (Binary) value while running the FocalBinary operation.

4.2.3 FocalMean

The focal mean operation will return the mean value of all values in the neighborhood for all positions in the selected input file.



Input File 1

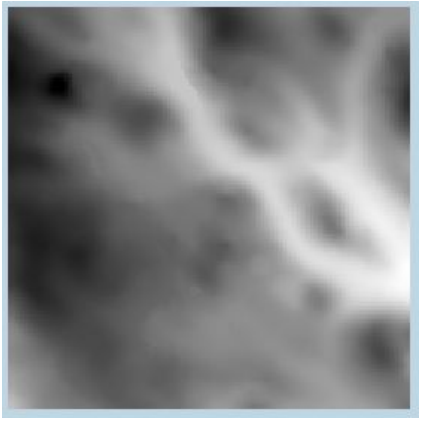


FocalMean
Radius: 20

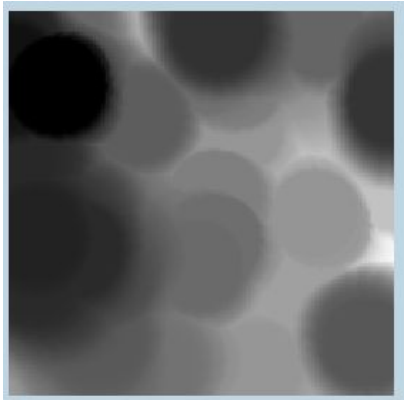
Figure 4.2.4. A result using the FocalMean operation.

4.2.5 FocalMax

The focal max operation will return the maximum value found in the neighborhood, in all positions in the neighborhood. The operation will be performed for the neighborhood of all positions in the selected input file.



Input file 1

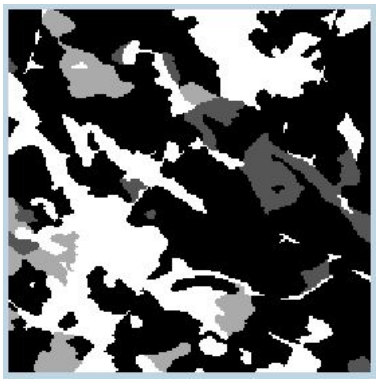


FocalMax
Radius: 20

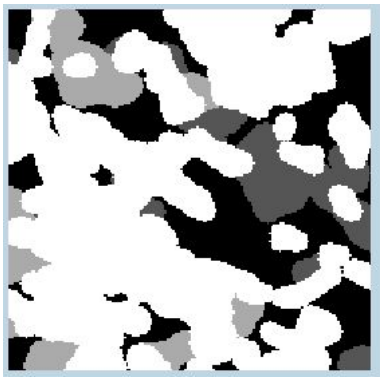
Figure 4.2.5. A result running the focalMax operation.

4.2.6 FocalMin

The focal min operation will return the minimum value found in the neighborhood, in all positions in the neighborhood. The operation will be performed for the neighborhood of all positions in the selected input file.



Input File 1

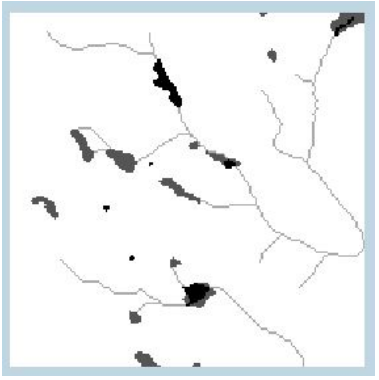


FocalMin

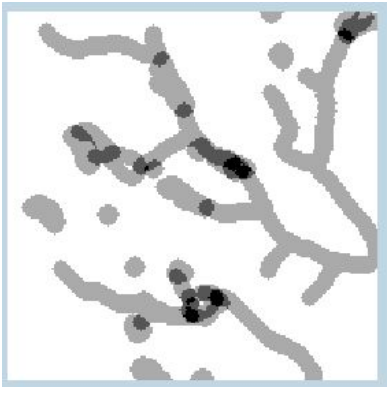
Figure 4.2.6. A result using the FocalMin operation.

4.2.7 FocalVariety

The focal variety operation will return the count of values in the neighborhood, in all positions in the neighborhood, The operation will be performed for the neighborhood of all positions in the selected input file.



Input File 1



FocalVariety
Radius: 4

Figure 4.2.7. A result using the FocalVariety operation.

4.3 Zonal operations

Zonal operations require two input files, of which one input file will function as the zone layer, and one will function as the value layer, as seen in figure 5. The operation will be performed on all the values in the value input file that are within each zone from the zone input file layer. Zones are created from the zone input file layer by grouping up all the values from the zone input file layer that are the same. The operation will result in one output file where within each zone all the values are the same, and the zones will be of the same positions as of the zone input file layer.

If any value within a zone contains null, the returned values of that zone will be null and the null value will be colored red in the visualization of the output.

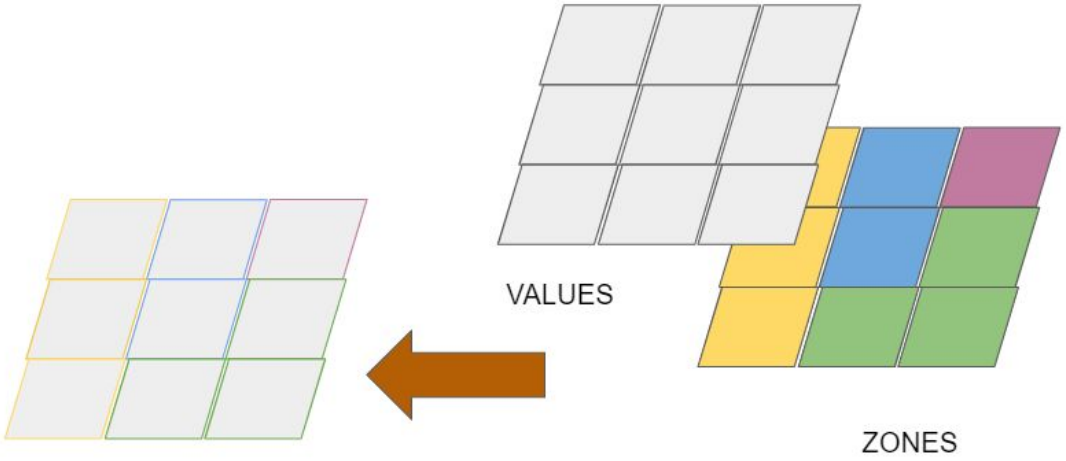
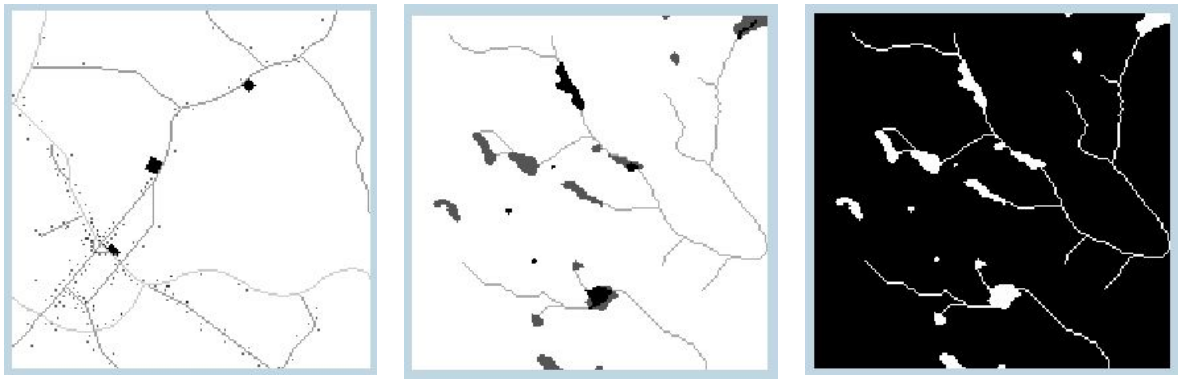


Figure 4.3.0. The concept of Zonal operations. The operation will find the zones (the colored layer to the right) of the zone input file, and perform the operation on all values to the positions corresponding to a zone in the zone input file.

4.3.1 ZonalSum

The zonal sum operation will return the sum of all values in a zone. The zones are determined by the zone layer, and the values are determined by the value layer.



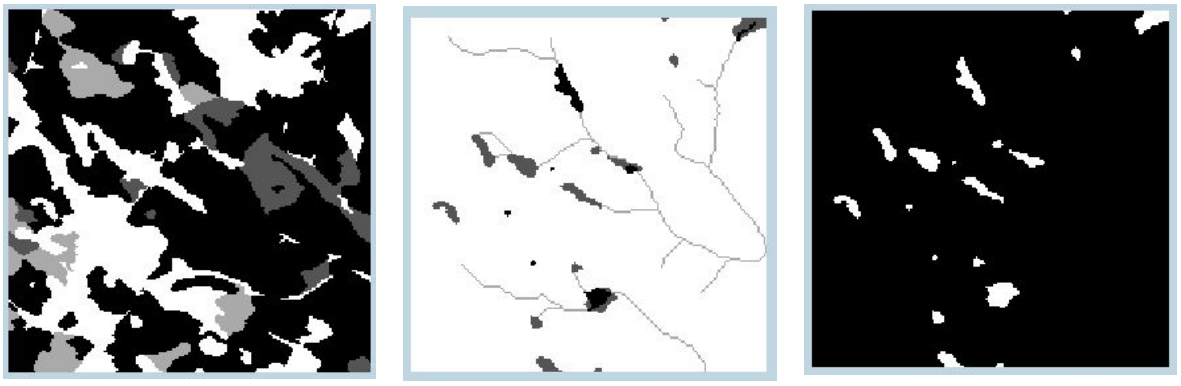
Value file | Zone File | ZonalSum output

Figure 4.3.1. A result using the ZonalSum operation.

4.3.2 ZonalBinary

The zonal Binary will search for the applied search value in each zone of the zone input file. If the applied search value can be found in a zone corresponding to the cell position of the zones in the zone input file, all positions in that zone will return the applied search value. If the applied search value cannot be found in corresponding positions to a zone, that zone will return the value 0.

CAUTION: If all zones contain at least one cell position in the value input file of the applied search value, the whole returned output file will return all cell positions of the same value.



Value file | Zone File | ZonalBinary
Search value: 308.4576

Figure 4.3.2.1. A result using the Zonal Binary operation. The operation will return each zone containing the applied search value.

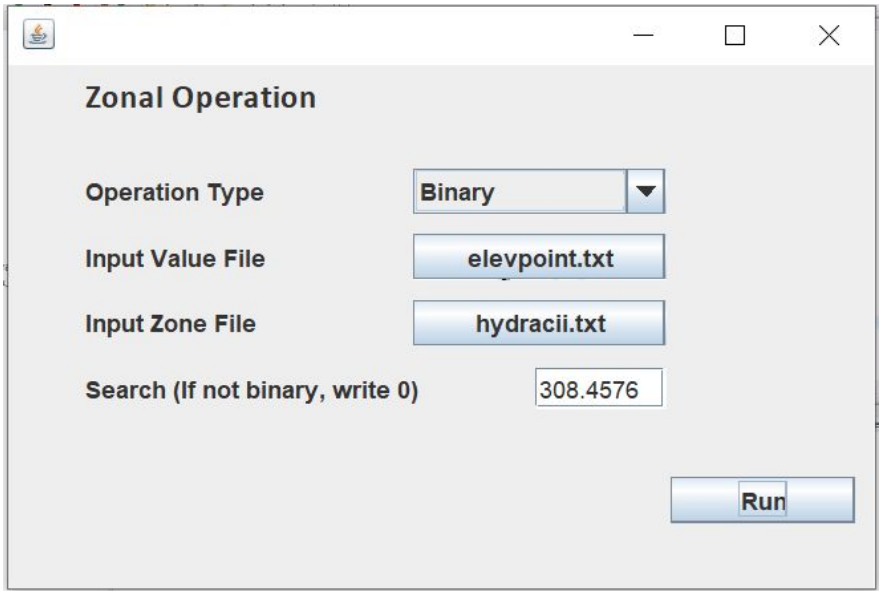
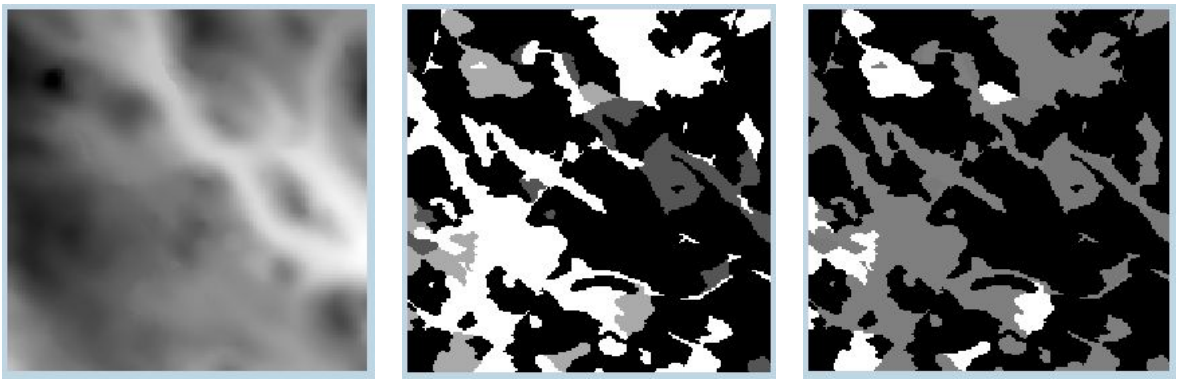


Figure 4.3.2.2. For zonal binary operations, the user must give GridGIS a Search (Binary) value.

4.3.3 ZonalMax

The zonal max operation will return the maximum value of all values in a zone. The zones are determined by the zone layer, and the values are determined by the value layer.

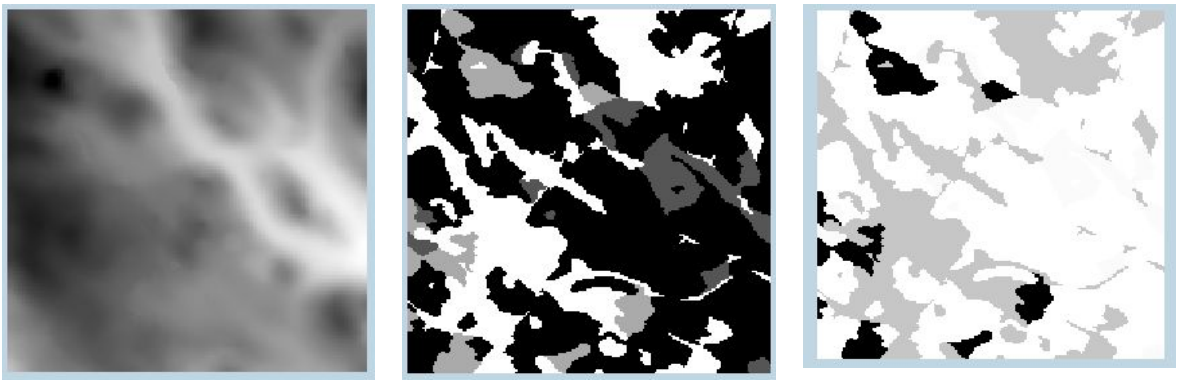


Value file Zone File ZonalMax

Figure 4.3.3. A result using the ZonalMax operation.

4.3.4 ZonalMin

The zonal min operation will return the minimum vof all values in a zone. The zones are determined by the zone layer, and the values are determined by the value layer.

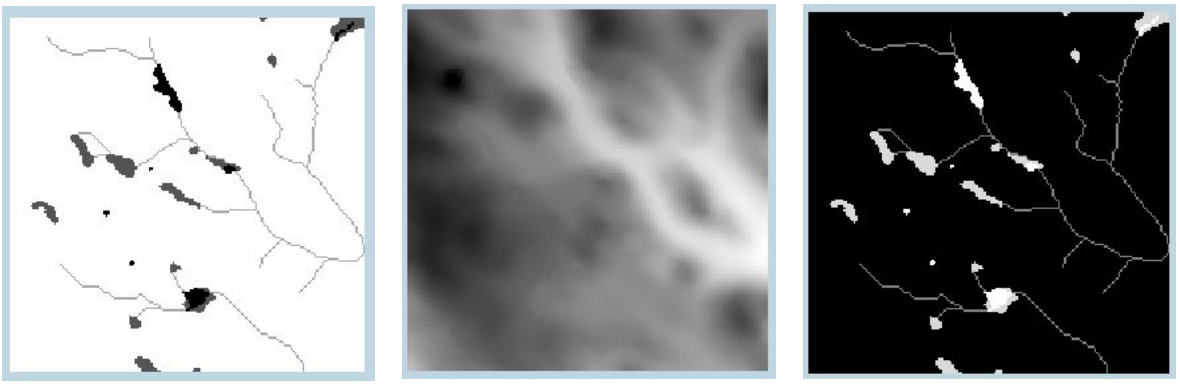


Value file Zone File ZonalMin

Figure 4.3.4. A result using the zonalMin operation.

4.3.5 ZonalVariety

The zonal variety operation will return the count of all values in a zone. The zones are determined by the zone layer, and the values are determined by the value layer.



Value file Zone File ZonalVariety

Figure 4.3.5. A result using the zonalVariety operation.

CAUTION! ZonalVariety requires long running time.

Chapter 5 - Description of User Input

When opening the GridGIS software, the user is greeted by the interface seen in figure 5.0. The user can choose from three different types of operations, described in the fourth chapter. To the left of the user interface, there is a Input specification list, showing selected operation and all files that can or have been inputted. In the lower left corner, the saving options can be found, and used after getting an operation output, as described in chapter 6. The user can use the “+” and a “-” button in the upper right corner to zoom in and out in the output result.

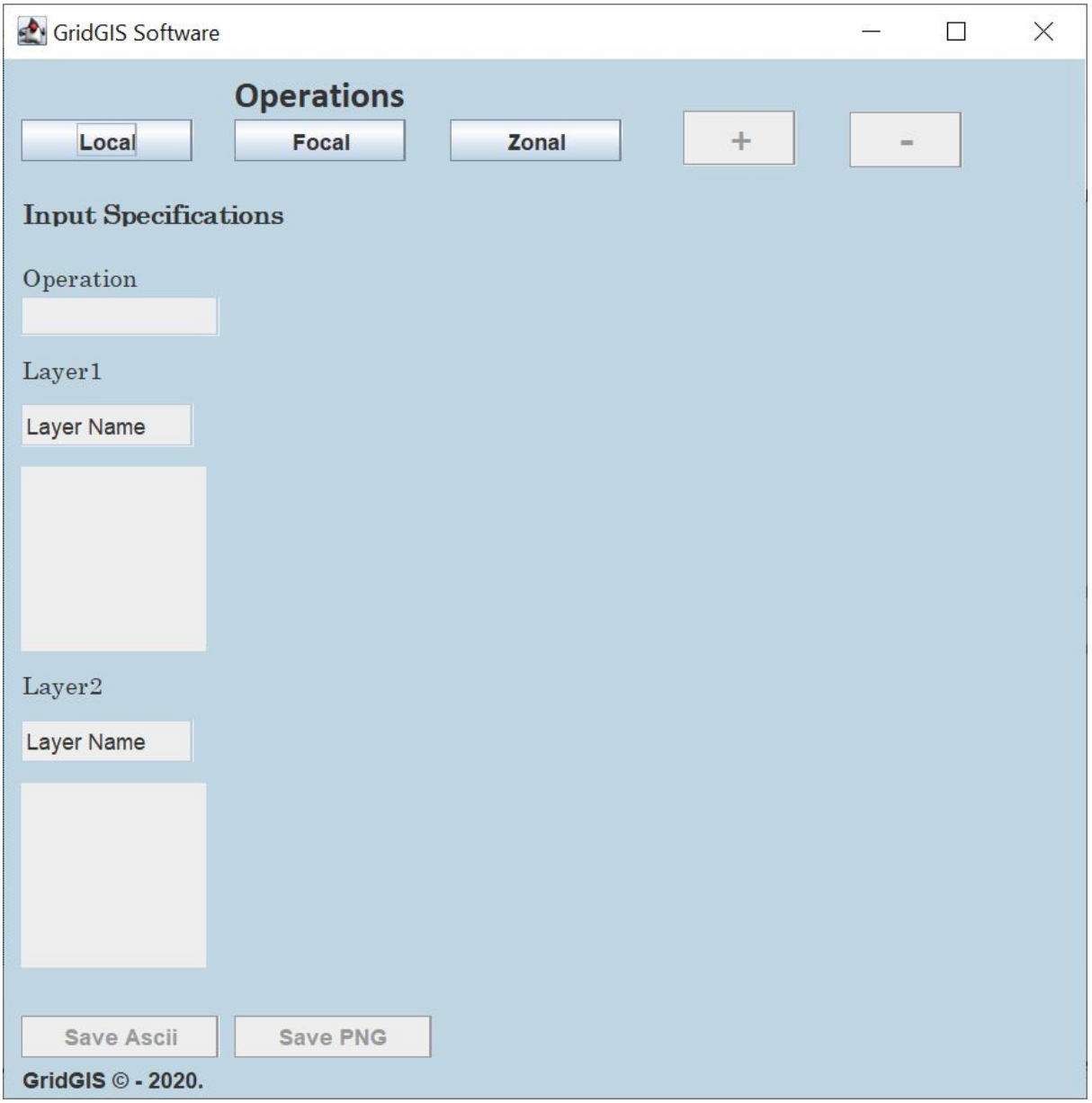


Figure 5.0. The user is welcomed by this interface when opening GridGIS.

The following part of this manual will teach the user how to select the desired operations, how to choose files to work with to the “input specification” and how to save the input.

5.1 Input - Local Operations

By clicking the “Local” button in the GridGIS software window (figure 5.0), the user will see a new dialogue window called “Local Operation”, figure 5.1. Local operations require two input files.

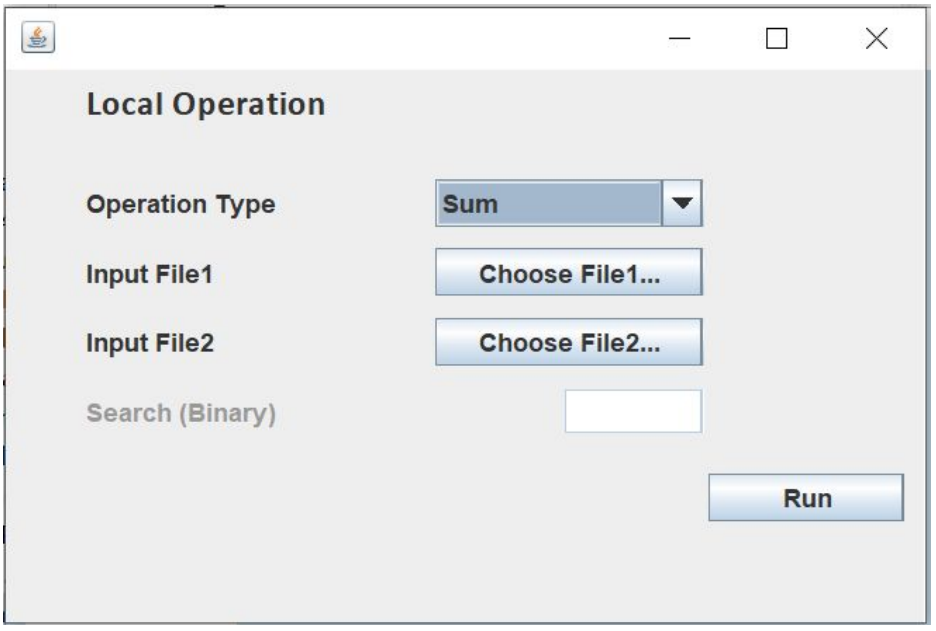


Figure 5.1. The Local Operation dialogue window,

The operation type is selected from the “Operation Type” dropdown menu.

The first input file is selected by clicking “Choose File1...”, and navigating to the first desired input file. the second input file is selected by clicking “Choose File2...”, and navigating to the second desired input file.

If the user selects the local operation “LocalBinary”, the user must input a value in the input box “Search (Binary)”. This value must be found in the input files for the operation to be useful.

After all required input has been done, the user clicks “Run”, and the operation result will be visualized in the “GridGIS Software” window, see figure 5.1.2.

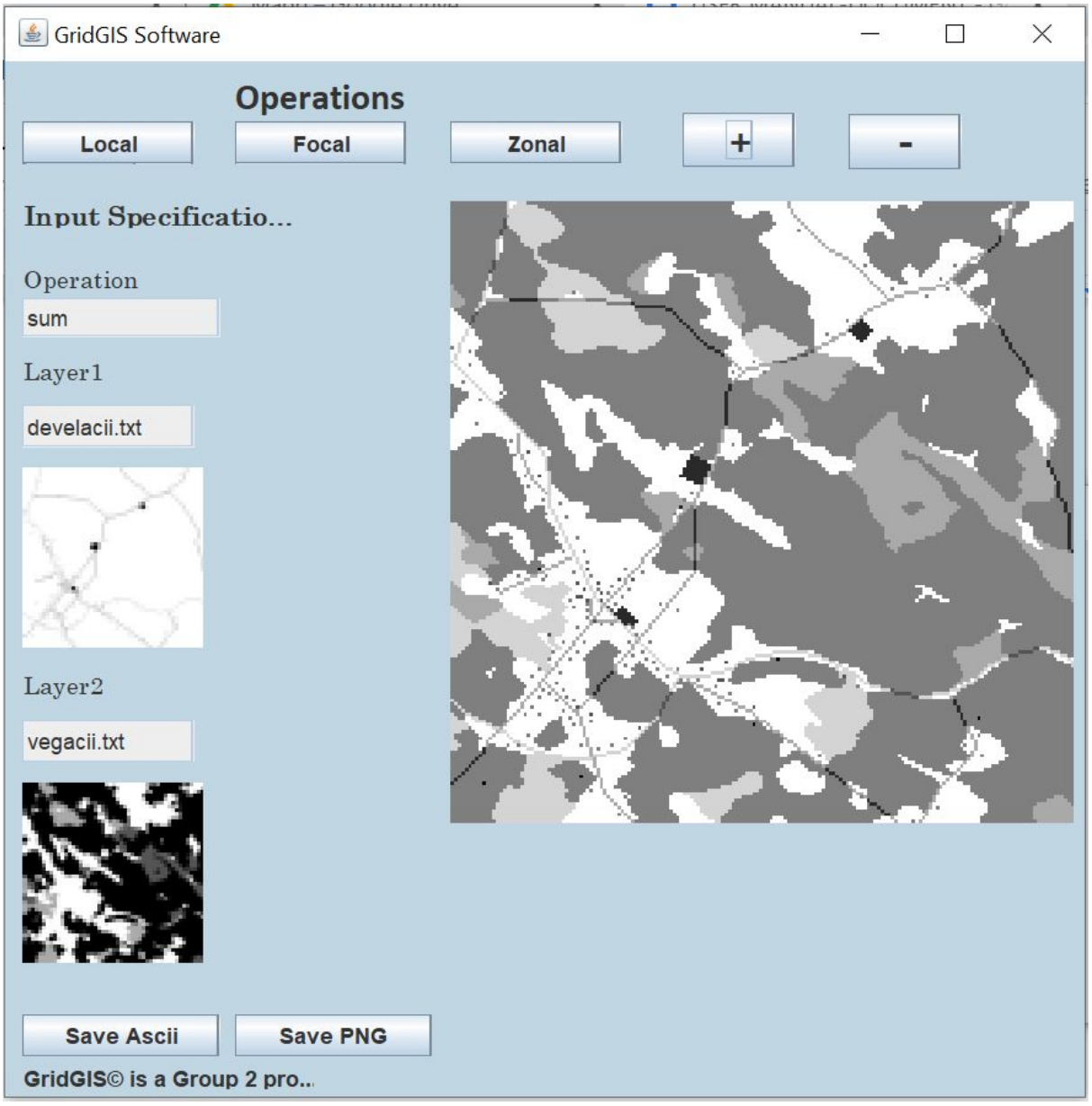


Figure 5.1.2. The output will be visualized after running an operation. By clicking "+" and "-", the user can zoom in and zoom out.

5.2 Input - Focal operations

By clicking the button “Focal” in the “GridGIS Software” window (figure 5.0), the user will receive the Focal Operation window, figure 5.2.1. The focal operations require one input file.

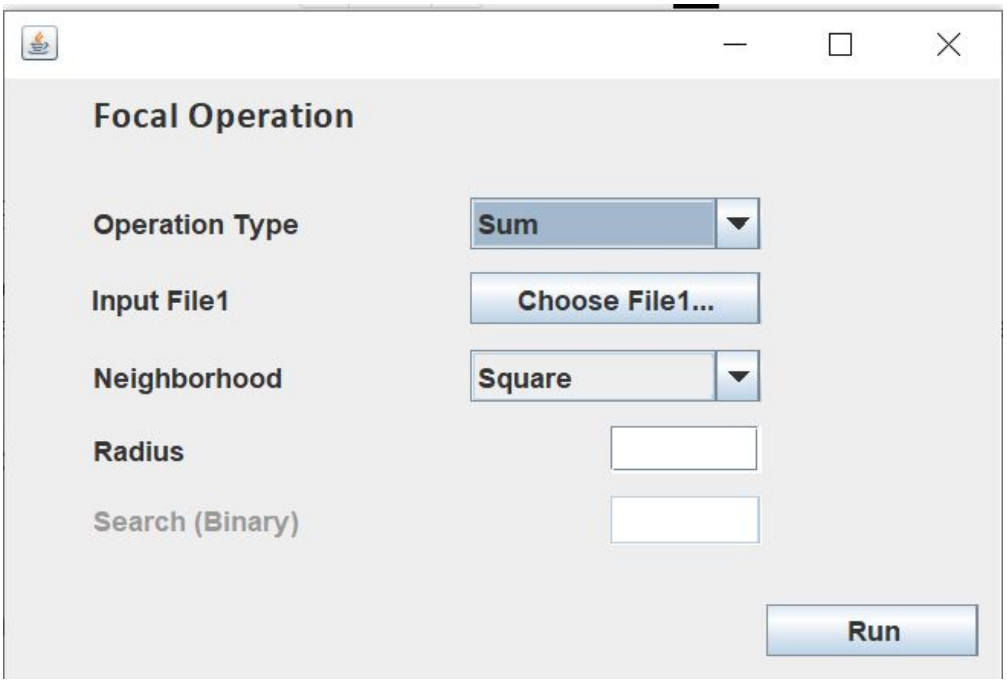


Figure 5.2. 1. The Focal Operation dialogue window.

In the “Operation Type” drop down menu, the user selects the desired focal operation type.

By clicking the “Choose File1...” button, the user can navigate to the desired input file.

In the Neighborhood dropdown menu, the user can select the desired type of neighborhood: Square or Circle.

In the Radius input box, the user can select the desired radius of the neighborhood, where every integer represents a radius of one cell. The radius can only be integers.

If the user selected FocalBinary, the user must input a value in the “Search (Binary)” input box. For the output to be useful, the number should be found in the input file.

After filling in all input, the user should press “Run”, in order to receive the output visualized in the “GridGIS Software” window, see figure 5.2.1.

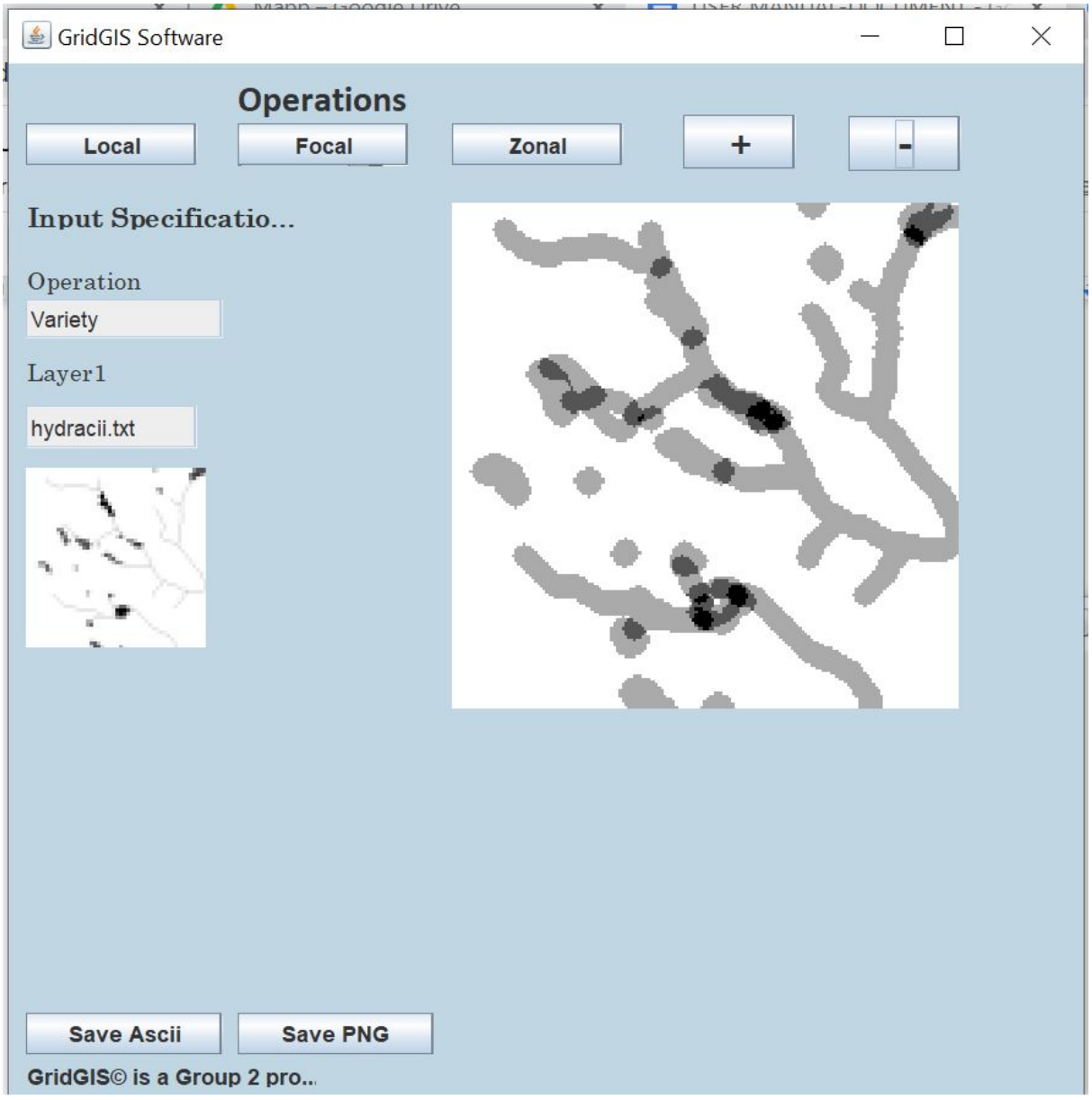


Figure 5.2.2. The result after running a FocalOperation will be visualized. By clicking "+" and "-", the user can zoom in and zoom out.

5.3 Input - Zonal Operation

By clicking the button “Zonal” in the “GridGIS Software” window (figure 5.0), the user will recieve the “Zonal Operation” dialogue window. In this window, the user may select input files, operation types and run the operation

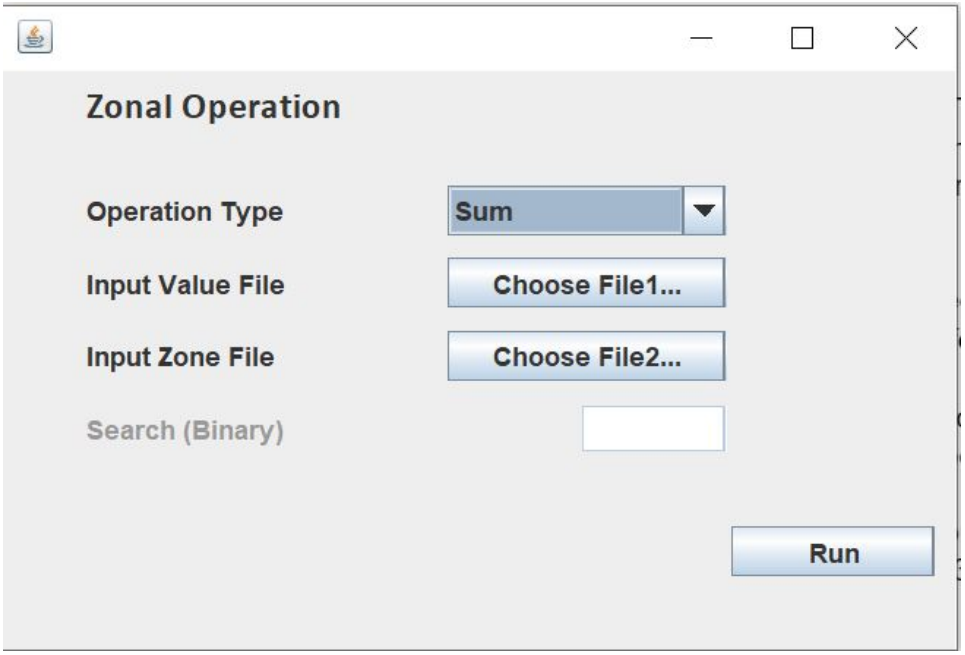


Figure 5.3.1 The zonal operation dialogue window.

The operation type is selected from the “Operation Type” dropdown menu. The input value file will contain the values that will be used in the selected operation type. This file is selected by pressing the “Choose File1…” button and navigating to the desired input file for values..

The zone File will decide the zones of the operation. The zone file is selected by pressing the second “Choose File2…” button and navigating to the desired input file for zones.

If the operation type “ZonalBinary” is selected, the user should fill the “Search (Binary)” input box. This value should be found in the Input Value File for the operation to be useful.

After filling in all required information, the user should press the “Run” button, after which the result will be visualized on the “GridGIS Software” window, see figure 5.3.2.

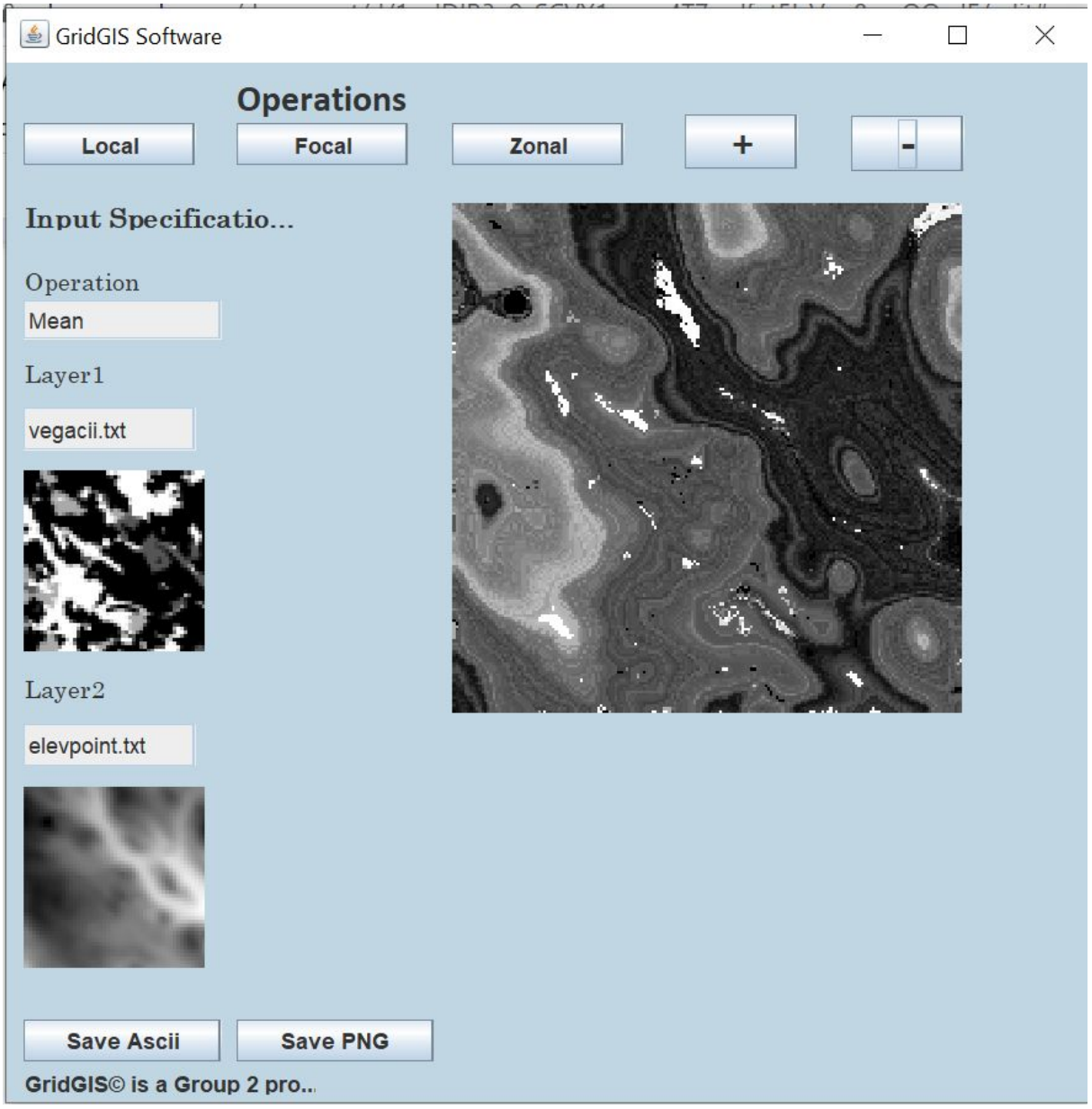


Figure 5.3.2. After running a ZonalOperation, the output will be visualized. By clicking "+" and "-", the user can zoom in and zoom out.

Chapter 6 - Saving a File

After running a desired operation, the user may want to save the output file. The user is able to do so either by saving it as a text file or as a PNG file.

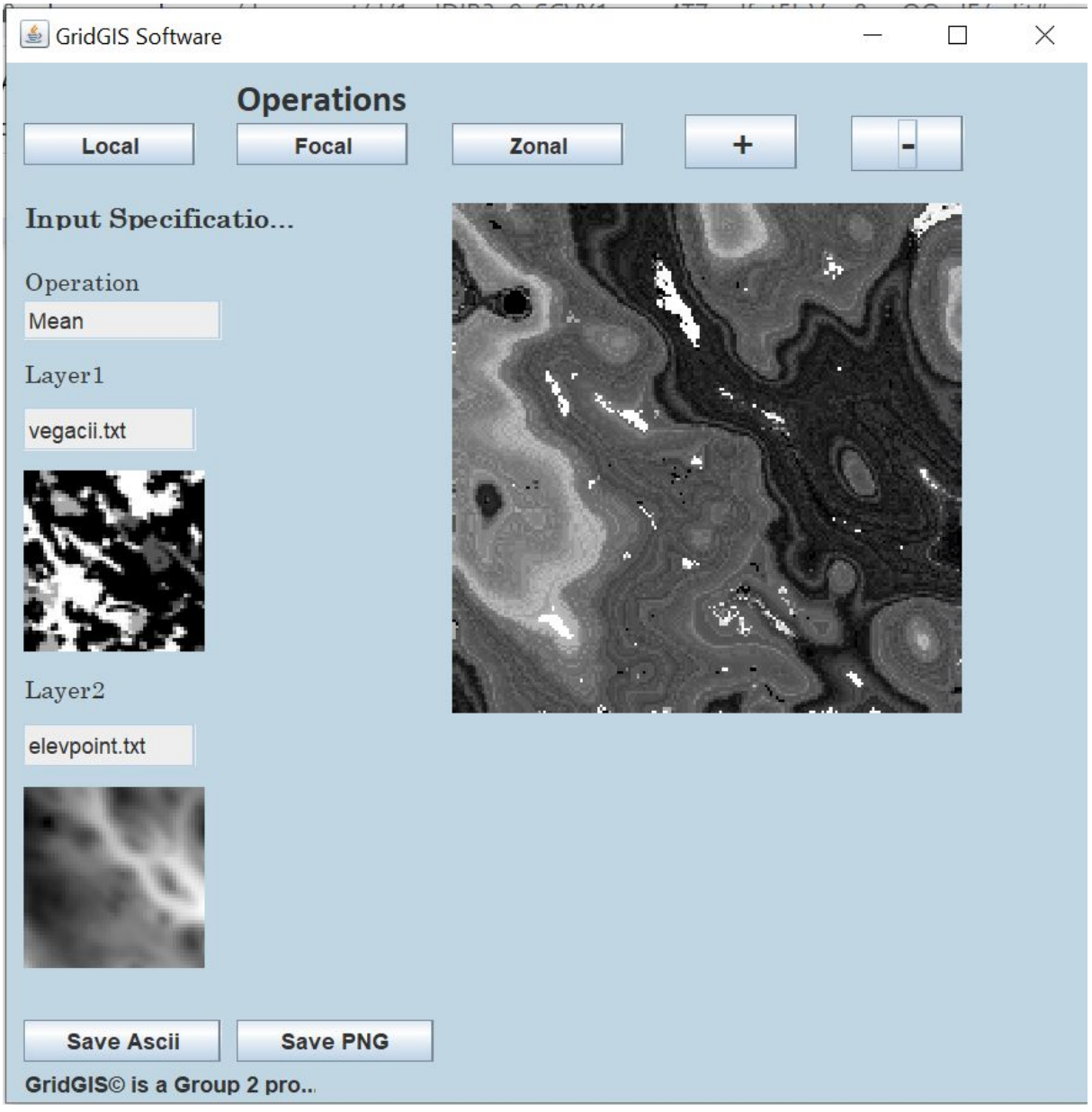


Figure 6.0. The user may decide to save the output of the operation.

6.1 Save as a Text File (.txt)

In order to save as a text file, the user should press the “Save ASCII” button. The user will then be able to select a desired output location, which for example may be in a folder named “result”.

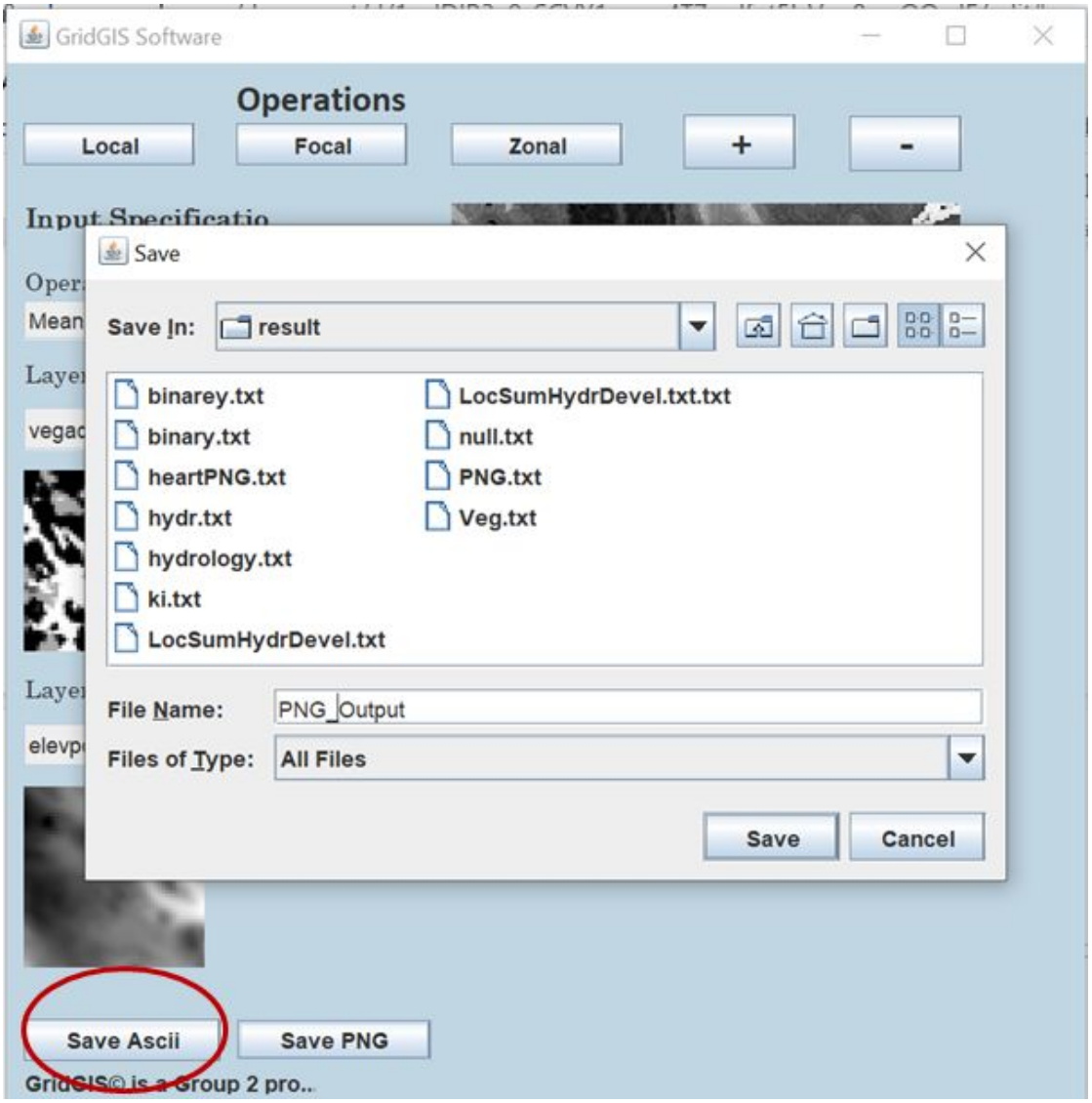


Figure 6.1. Bu clicking “Save Ascii” the user can save the output as a text file.

6.2 Save as a PNG file (.png)

If the user wants to save the output result as a PNG file, the user should press the button “Save PNG”. This will create a .png file with the selected name and a .txt file containing meta data.

The image created is a 24bit grayscale image. As such it can store a value span of 65536. Because normalization is used to convert between a grayscale image to numbers exact values cannot be obtained. As such a limitation is that decimal values are not supported and will be rounded to the closest whole value.

OBS! Storing the file in an image format is primarily intended to be used for demonstrative and as such does not deal with null values. Make sure the output file contains no null values before exporting as an image.

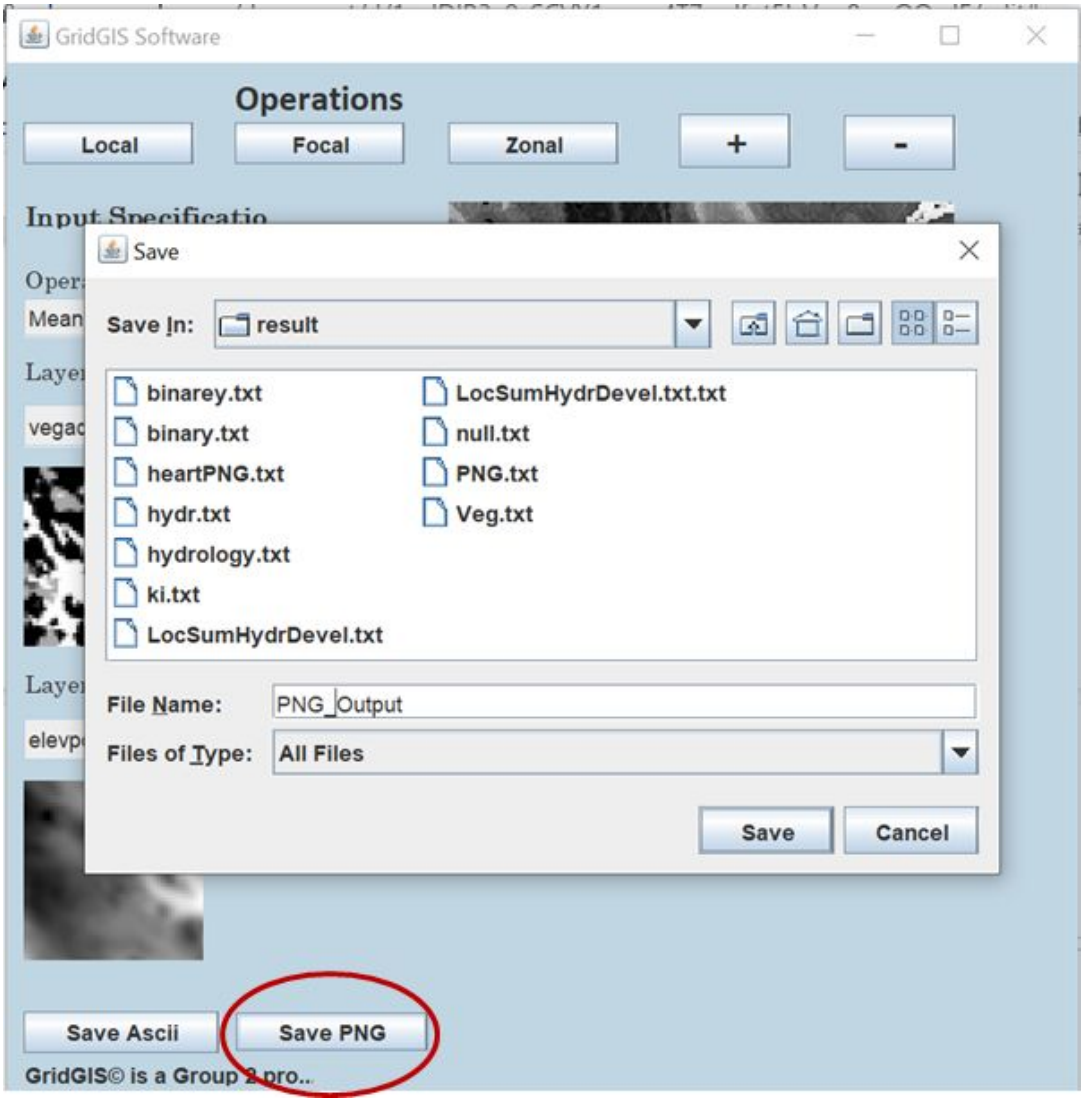


Figure 6.2. By clicking “Save PNG”, the user can save the output as a PNG file.

6.3 Naming Conventions for Saving

There are some limitations for naming the output result. The user should NOT name output files by
-having blank spaces in the name
-starting the name by a number
-naming the file “txt” (txt.txt) or “png” (png.png)
-having non-chracter or non-number signs in the name. Two exceptions of signs from this are “-” and “_”.

Not following these naming conventions may lead to unexpected errors that may be frustrating for the user.

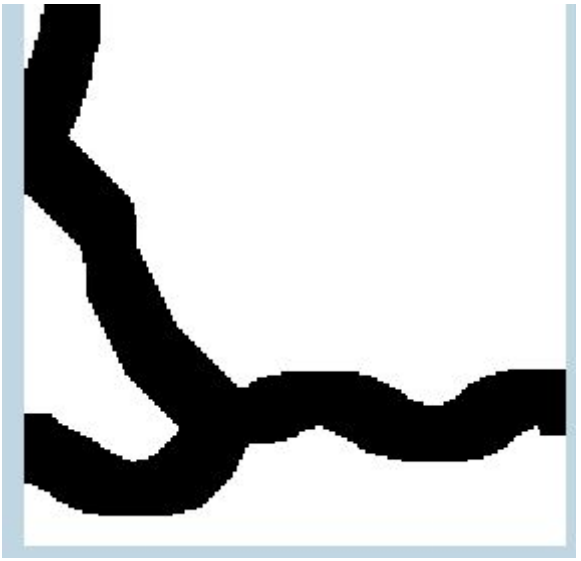
Chapter 7 - Areas of usage

7.1 Local Operations - Usage Examples

LocalSum	The local sum operation can be used for combining data of two maps. If the user is interested both in the road infrastructure and the locations of water bodies, a map of the infrastructure and the water bodies can be added together, so the content of both maps are shown in one map.
LocalSubstraction	If the user wants to look at a map of road infrastructure without buildings, the local subtraction operation can be used. If the user has a map visualizing both buildings and roads, the user can subtract houses from that map. This may require the user to use the local binary function for creating a map containing only numbers.
LocalDivision	The local division operation may be useful if the user is looking to analyse the content of a map with respect to content of another map. An example of this could be if the user has a grid population density map, and wants to analyse a property per capita.
LocalBinary	The local binary operation is good if the user is interested in looking for one or two specific values of one or two maps. If the user inputs two maps, the user must understand the meaning of the applied search value for both of the maps. This function can work for either looking for all buildings in a map. It can also be used as a step in a map analysation, for example by using the map containing only houses, and combining that map in another raster operation.
LocalMean	The local mean operation takes the mean value of the same position of each input map. This could be used for taking the mean value of temperature maps, of temperature measurements of two different dates..
LocalMax	The local min operation returns the minimum value of the two input maps. This operation can be used for finding the maximum value of for example precipitation of an area of different occasions.
LocalMin	The local max operation returns the maximum value of the two input maps. This operation can be used for finding the maximum value of for example the minimum snow thickness of two different occasions.
LocalVariety	Local variety will return either 1 or two, as it returns the count of values of the same position in two input files. This type of map may

	be valuable as a step in an map analysis. An example of this is looking at built environments of different times in history, to see how much areas that have been exploited compared to previously.

7.2 Focal Operations - Usage Examples

FocalSum	Focal sum returns the sum of the values in a neighborhood. This may be useful for calculating the sum of population within a radius from a hospital or similar.
FocalBinary	Focal binary lets the user search for a value within a map neighborhood. If the neighborhood contains the value, the center cell of the neighborhood will get the value searched for. As the operations is performed for all grid positions, the result will be a buffered area around the applied search value. This can be seen in the figure below. An operation like this could be valuable for looking at noise from roads.  *Figure below*. All roads of value 1 have been searched for with a radius of 5, resulting in the road being surrounded by a buffered area.
FocalMean	Focal mean returns the mean value of the neighborhood. This could be used as a filter for smoothing the input file.
FocalMax	Focal max will return the maximum value of the neighborhood, which may be good for finding and emphasizing areas of high elevation.
FocalMin	Focal min will return the minimum value of the neighborhood. This can be

	useful while analysing a temperature map.
FocalVariety	Focal variety will return the count of values within the neighborhood. This operation can be useful for looking at the diversity of functions in a built environment.

7.3 Zonal operations - Usage Examples

ZonalSum	The zonal sum operation will return the sum of all values within a zone. This operation can be useful if wanting to calculate for example the sum of population within an administrative zone.
ZonalBinary	The zonal binary operation can be used to search for an applied search value within a zone. If the zone input file layer contains districts, the user can use the zonal binary to find all zones containing elementary schools, or all zones containing traffic lights.
ZonalMean	The zonal mean will return the mean value of all values within a zone. This can be used for analysing, as the mean value of a property within a zone can work as a step map, used in further operations.
ZonalMax	The zonal max operation will return the maximum value within a zone for the whole zone. This operation can be useful, for example you might want to know what's the highest point in each zone.
ZonalMin	The zonal min operation will return the minimum value within a zone for the whole zone. If comparing precipitation of different zones a ZonalMin operation can be used to find the least amount of precipitation in different zones.
ZonalVariety	The zonal variety will return the count of values within a zone. This operation can be used to find the diversity of function within all specified zones within a built environment.