Local Authorities for Forest Fire Prevention

GUIDELINES FOR FOREST FIRE PREVENTION DEVELOPMENT OF ACTION PLANS

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1. INTRODUCTION

The Local Action Plan for Forest Fire Prevention is the main handbook and primary tool of every municipality for reducing the risk of wildfires. These action plans, risk analysis and maps are of decisive importance not only for prevention and operational planning purposes, but can also prove useful during the crisis and the rehabilitation processes as well.

This Guide aims on assisting the Municipal Civil Protection Offices to develop Action Plans and compile hazard maps for their area of responsibility. It provides detailed instructions and examples in a GIS environment and is divided in three Chapters:

Chapter 2: This Chapter displays the required data collection in a form of a list for the Action Plans development.

Chapter 3: This Chapter contains specific guidelines for retrieving the data described in Chapter 2. However, these guidelines refer only to the Greek administration system, therefore it is expected that in other countries different guidelines for data retrieval do apply.

Chapter 4: This Chapter provides step by step instructions and tutorials on using ArcGIS 10.0 to create necessary Action Plan maps.

2. REQUIRED DATA COLLECTION FOR THE DEVELOPMENT OF ACTION PLANS

Data collection is the most critical part for the Action Plan development. The quality as well as the credibility of the action plans largely relies on the input data. Therefore, it is important to use all up to date information. These data cover a wide area of Municipal characteristics and infrastructure that are necessary on Fire Prevention Planning.

Required data collection are listed below:

1) Official municipality boundaries.
2) Contour Lines of least 20m interval or Digital Elevation Model (DEM) with a minimum 30m spatial resolution.
3) Climatic data – Drainage Network – Drainage Basins.
4) Up to date forest maps.
5) Up to date Land Use map.
6) Geologic or Hydrolithologic map.
7) Forest Fuel map (type, density).
8) Road network data, classified according to their characteristics as primary or secondary (e.g. highways, national roads, rural roads, non paved/gravel/dirt roads) and width (wider or narrower than 7m).
9) Waterpoints divided in separate categories, such as: a) natural springs, lakes, b) fire hydrants, c) any other water abstraction point and d) water tanks (open or closed/covered).
10) Fires Service action plans, especially for observatory points and information on patrol routes and monitoring .
11) Settlements boundaries and possible illegal building areas.
12) Information on high and medium voltage electricity network. l
13) Landfills.
14) Railway network.
15) Camping and outdoor activities sites, factories and any other places needing special attention in the Action Plan either due to high population density or due to highly flammable material.
16) Catalogue of the Forestry service priority measures and needs (e.g. fuel reduction zones).
17) Fire Service location, manpower and availability of equipment.
18) Municipality and municipal Civil Protection Office manpower and equipment.

19) Forestry service manpower and equipment focusing on prevention actions.
20) Police and Coast Guard manpower and equipment, focusing on traffic police and evacuation plans.
21) Schools and their fire plans.
22) Central and regional hospitals manpower and equipment, focusing on their capability on burn and breathing treatments.
23) Gas stations and fire susceptible industries, along with fire plans.
24) Detailed recording of volunteers and their equipment, evaluation of their effectiveness and capability to participate in fire prevention and fire fighting actions.
25) External assistant gathering sites.
26) record of past Forest Fires (locality, date, burned area, cause of fire).
27) Fire protection zones.
28) Record of Protected sites and parks (National Parks, NATURA zones etc).
29) Localities of Firing ranges and Army training camps on explosives.
30) Record of military camps close to or inside the Municipality boundaries, along with their fire fighting engagement.
31) Record of helicopters landing sites, types of helicopters that can use them and refueling options.

3. GUIDELINES ON REQUIRED DATA COLLECTION

This Chapter contains specific guidelines for collecting the data described in Chapter 2 (Table 3.1). As these guidelines refer only to the Greek administration system and services, it is expected that different guidelines for data retrieval do apply in other countries.

A/A	REQUIRED DATA	SOURCES - GUIDELINES
1.	Official municipality boundaries.	*A) Ministry of Environment, Energy and Climate Change.*
2.	Contour Lines of least 20m interval or Digital Elevation Model (DEM) with a minumum 30m spatial resolution.	*A) Hellenic Military Geographical Service.* *B) Serres Municipality Computerization Department.*
3.	Climatic data – Drainage Network – Drainage Basins.	*A) Serres Municipality Cadastre and Urban Planning Departments.*
4.	Up to date forest maps.	*A) Periphery of Attica – Forestry Directorate (Ag. Ioannou & Eleftherias Str., Ag. Paraskevi)* *B) Serres Forestry Service (printed and electronic maps).* *C) Corine 2000 Land Use Map.*
5.	Up to date Land Use map.	*A) Ilioupoli Municipality GIS database.* *B) Municipality Urban Plan.* *C) Serres Municipality Cadastre and Urban Planning Departments.* *D) Corine 2000 Land Use Map.*
6.	Geologic or Hydrolithologic map.	*A) Institute of Geology and Mineral Exploration (I.G.M.E.) maps.*
7.	Forest Fuel map (type, density).	*A) National Agriculture Research Foundation maps.* *B) Serres Municipality Greenery Department (for Municipal forests) and Forestry Service (for public forests).*

A/A	REQUIRED DATA	SOURCES - GUIDELINES
8.	Road network data, classified according to their characteristics as primary or secondary (e.g. highways, national roads, rural roads, non paved/gravel/dirt roads) and width (wider or narrower than 7m).	*A) Digitization of Google Earth Images. Field measurements for roads width.* *B) Serres Municipality Labor Department and Serres Peripheral Unit Technical Services Department.*
9.	Waterpoints divided in separate categories, such as: a) natural springs, lakes, b) fire hydrants, c) any other water abstraction point and d) water tanks (open or closed/covered).	*A) Volunteer Firemen map was digitized.GPS data can also be used.* *B) Serres Fire Service.*
10.	Fires Service action plans, especially for observatory points and information on patrol routes and monitoring .	*A) Data available only by visiting the 7th Fire Station (9 Zefksipou Str,. Dafni).* *B) Serres Fire Service*
11.	Settlements boundaries and possible illegal building areas.	*A) Data result from street plans.* *B) Serres Municipality Cadastre and Urban Planning Departments.*
12.	Information on high and medium voltage electricity network.	*A) The Hellenic Electricity Distribution Network Operator provides for free only printed maps for medium voltage distribution lines. Payment is required for digital data.* *B) Hellenic Electricity Distribution Network Operator / Serres Department (for medium voltage distribution lines) and Independent Power Transmission Operator (IPTO or ADMIE) / Peripheral Unit.*

A/A	REQUIRED DATA	SOURCES - GUIDELINES
13.	Landfills.	*A) Municipal Cleaning Services.* *B) Serres Municipality, Department of Environment.*
14.	Railway network.	*A) Serres Municipality Cadastre and Urban Planning Departments.*
15.	Camping and outdoor activities sites, factories and any other places needing special attention in the Action Plan either due to high population density or due to highly flammable material.	*A) Municipality Technical Service.*
16.	Catalogue of the Forestry service priority measures and needs (e.g. fuel reduction zones).	*A) Forestry Service has no such data for Hymmetus Mountain. Data given by the Hymmetus Protection and Development Association (SPAY).* *B) Printed and digital data from Serres Forestry Service.*
17.	Fire Service location, manpower and availability of equipment.	*A) Data available by interviewing the staff of the 7th Fire Station (9 Zefksipou Str,. Dafni).* *B) Serres Forestry Service.*
18.	Municipality and municipal Civil Protection Office manpower and equipment.	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.* *B) Serres Municipality – Civil Protection Department.*
19.	Forestry service manpower and equipment focusing on prevention actions.	*A) Forestry Service has no such data for Hymmetus Mountain. Data given by the Hymmetus Protection and Development Association (SPAY).* *B) Serres Forestry Service.*
20.	Police and Coast Guard manpower and equipment, focusing on traffic police and evacuation plans.	*A) Hellenic Police.* *B) Serres Police Directorate.*

A/A	REQUIRED DATA	SOURCES - GUIDELINES
21.	Schools and their fire plans.	*A) Ilioupoli Municipality GIS database.* *B) Serres Municipality Education Department.*
22.	Central and regional hospitals manpower and equipment, focusing on their capability on burn and breathing treatments.	*A) Serres General Hospital.*
23.	Gas stations and fire susceptible industries, along with fire plans.	*A) Data available in the Internet.* *B) Serres Peripheral Unit – Directorate of Development.*
24.	Detailed recording of volunteers and their equipment, evaluation of their effectiveness and capability to participate in fire prevention and fire fighting actions.	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.* *B) Serres Municipality – Civil Protection Department.*
25.	External assistant gathering sites.	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.* *B) Serres Forestry Service.*
26.	record of past Forest Fires (locality, date, burned area, cause of fire).	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.* *B) Serres Forestry Service.*
27.	Fire protection zones.	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.* *B) Serres Forestry Service.*
28.	Record of Protected sites and parks (National Parks, NATURA zones etc).	*A) Published on Official Government Gazette. Also available at the following website: http://natura2000.eea.europa.eu.* *B) Serres Municipality, Department of Environment.*

A/A	REQUIRED DATA	SOURCES - GUIDELINES
29.	Localities of Firing ranges and Army training camps on explosives.	*A) Serres Municipality – Civil Protection Department.*
30.	Record of military camps close to or inside the Municipality boundaries, along with their fire fighting engagement.	*A) Serres Municipality – Civil Protection Department.*
31.	Record of helicopters landing sites, types of helicopters that can use them and refueling options.	*A) Ilioupoli Municipality Environment Directorate – Civil Protection Department.*

Table 3.1: Guidelines for collecting the data for the development of Action Plans

4. COMPILATION OF MAPS FOR THE ACTION PLAN

This manual is referred to the GIS Software "ArcGIS v10.0" and so are the images and commands listed hereby. This Chapter describes in detail all the necessary steps for compiling the maps that form the basic tool of every action plan.

4.1. Georeferencing images - Creating a new layer - Digitizing

Image georeferencing, creation and digitization of new layers are the principal procedures of map compilation in a GIS environment. These procedures are described in Chapters 4.1.1-4.1.3.

4.1.1. Georeferencing

Printed maps must be scanned and then georeferenced in order to be digitized. There are two options for this process:

1. using the four corner coordinates in printed maps.
2. using an existing layer, or an already georeferenced map.

The 1st option is the most difficult and time consuming. The use of the additional software "Coords_GR" is necessary in order to convert the printed map's coordinates to the Hellenic Geodetic Reference System 1987 (EGSA '87).

The most widely used georeferencing method is the 2nd one, as there are already enough georeferenced GIS data in the web for different countries (e.g. for Greece see the following website http://geodata.gov.gr/geodata/). A complete detailed guide on georeferencing maps using an existing layer can be found at: http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Georeferencing_a_raster_dataset.

4.1.2. Creating a new layer

In "Catalog" section, right click on the folder you want this layer (shapefile) to be created. Then click "New==>Shapefile" (Figure 4.1). The shapefile parameters can be edited in the appearing "Create New Shapefile" window (Figure 4.2)

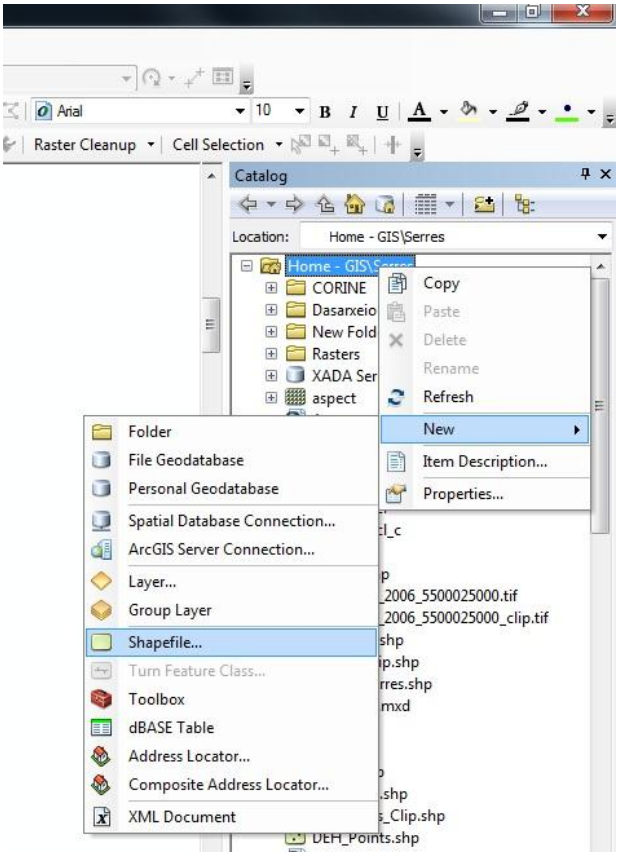


Figure 4.1

Type the name of the shapefile (e.g. Rivers) in the "Name" field and in the "Feature Type" field select the type of features you will create (points, lines or polygons). Select the spatial reference (e.g. Greek Grid for Greece), by clicking on "Edit..." and then Select==>Projected Coordinate Systems ==> Add ==> National Grids ==> Add ==> Europe ==> Add ==> GreekGrid.prj ==> Add ==> OK. Then, by clicking OK on "Create New Shapefile" window, the new shapefile is created and automatically appears in "Catalog" section.

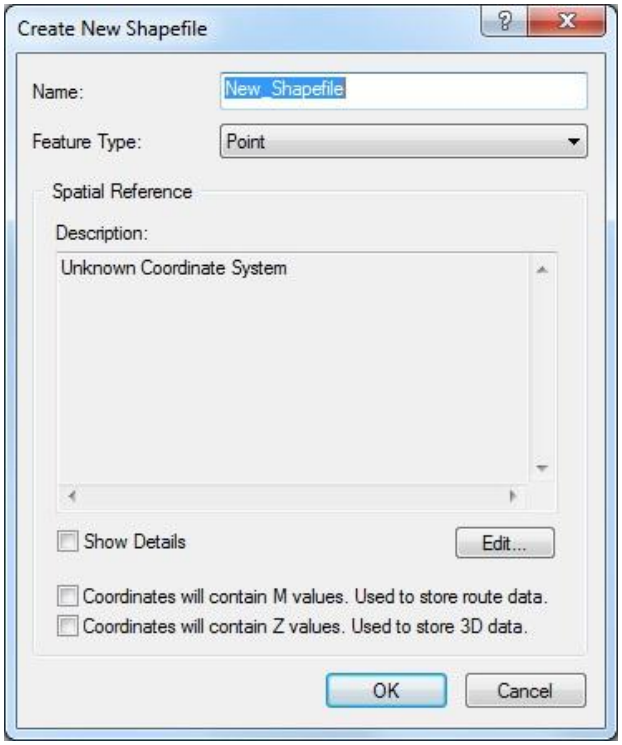


Figure 4.2

To add any layer on the map, click "Add data" in the standard toolbar (Figure 4.3).

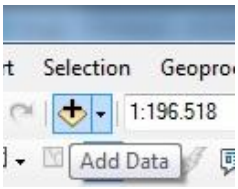


Figure 4.3

By adding the new layer, it also appears in the "Table of Contents" section. (Figure 4.4).

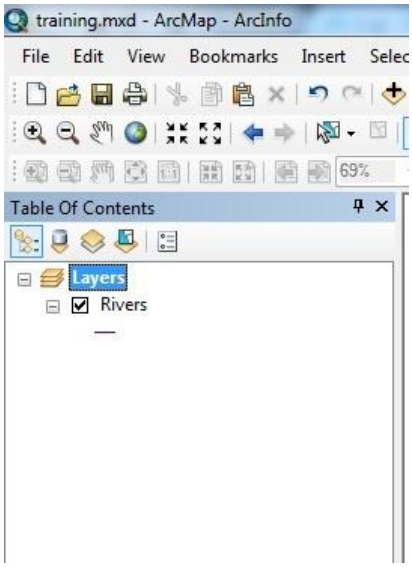


Figure 4.4

In the same section, right click on the newly added layer and select "Open Attribute Table". The corresponding database will then open in Table format. To create a new field at this Table click "Table Options==>Add Field" (Figure 4.5).

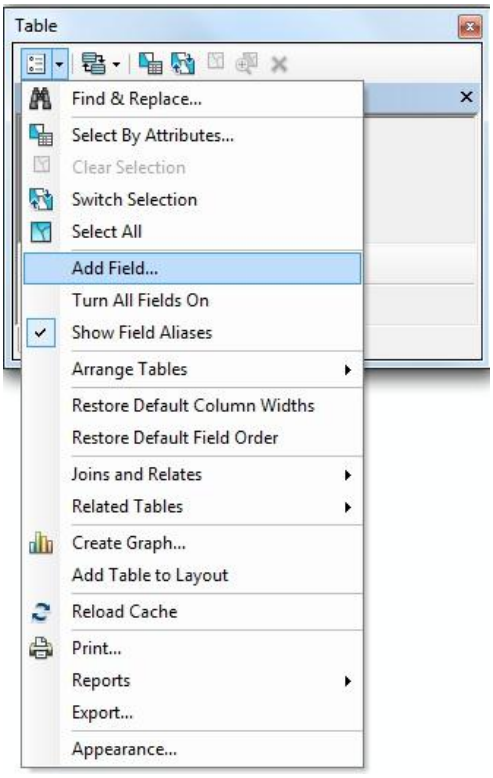


Figure 4.5

The "Add Field" window appears, where you can define the name and parameters of the new field (Figure 4.6).

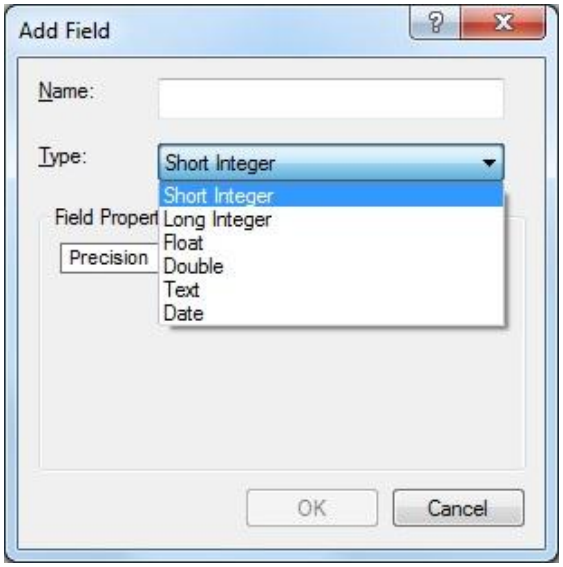


Figure 4.6

4.1.3. Digitizing

GIS digitization is the conversion of a printed map, that is scanned and added to GIS environment, to vector data (i.e. features).

This process is described in the following steps:

Step 1: Add the georeferenced scanned map (e.g. High voltage electricity network map) and the layer in which you will create the new features (e.g. Lines). (Figure 4.7).

Step 2: Click on "Editor==>Start Editing" to open the "Start Editing" window, where you can select the layer you wish to edit (Figure 4.8). Click "OK" to activate the "Create Features" section on the right of your screen (Figure 4.9) and start creating features by clicking on the map (Figure 4.10). With double clicking the features editing stops.

In order to insert any data in the corresponding database for the created features (e.g. powerline voltage), right click on the layer's name (e.g. Lines) in the "Table of Contents" and select "Open Attribute Table"(Figure 4.11). Each record in the "Attribute Table" represents a feature created on the map (Figure 4.12) and every cell of this table can then be edited. In order to calculate the size of the features (i.e. lines and polygons), a new field must be created (e.g. "Length" for lines). Then right click on the field and select "Calculate Geometry" (Figure 4.13).

To delete a feature, select it using the "Select Feature by Rectangle" tool and press "Delete" key.

Select "Editor ==> Save Edits" and "Editor ==> Stop Editing" to save the new edits and end the editing process.

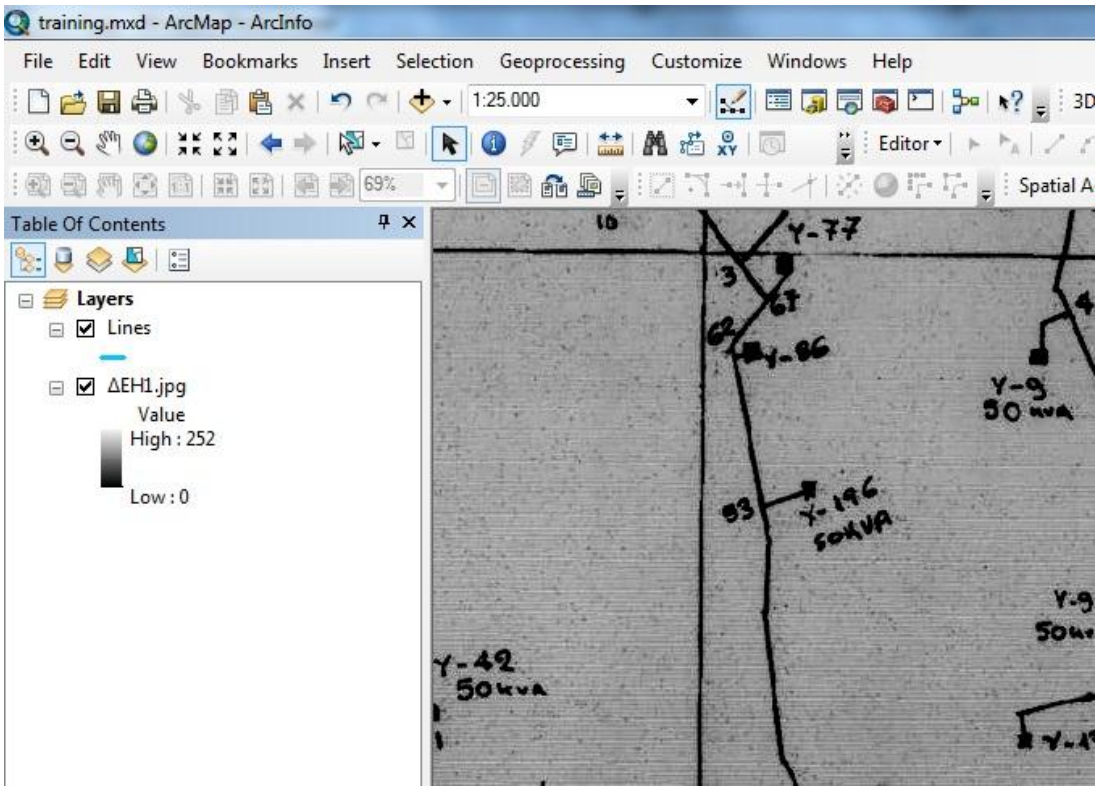


Figure 4.7

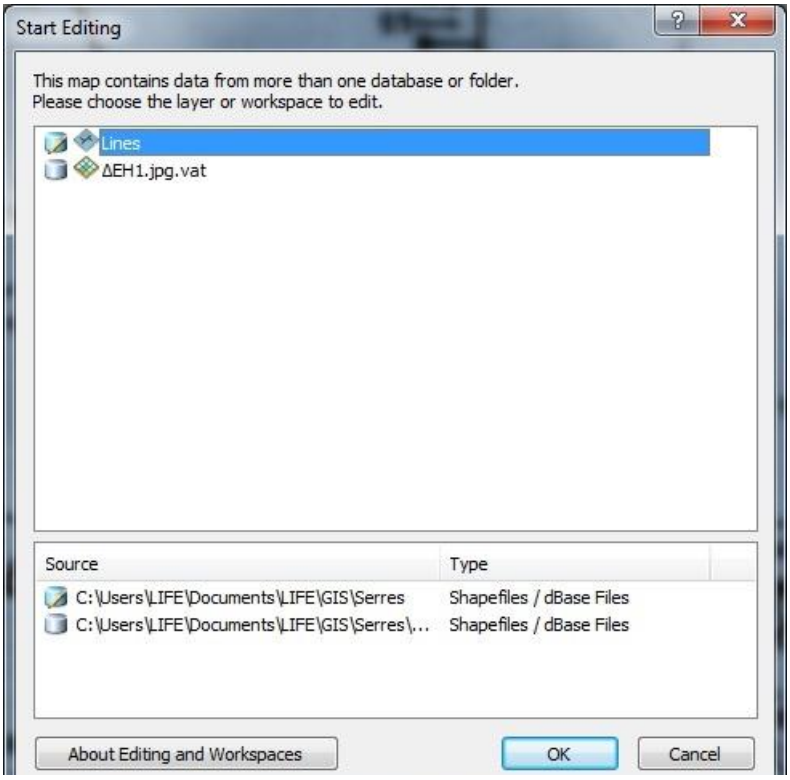


Figure 4.8

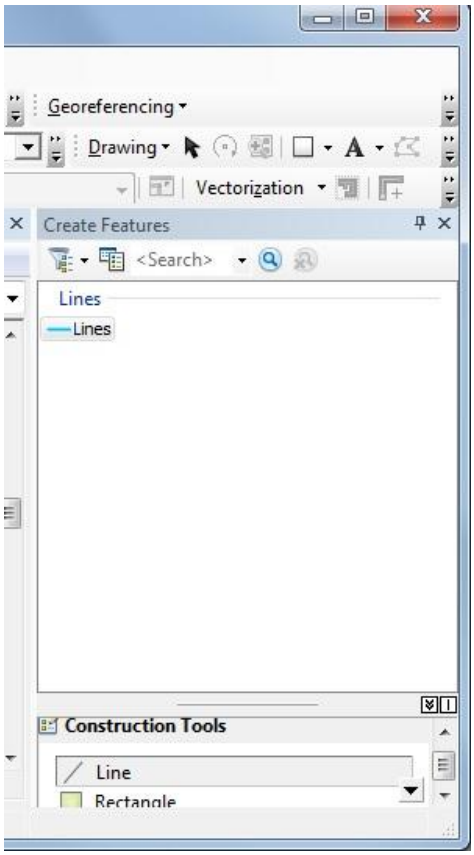


Figure 4.9

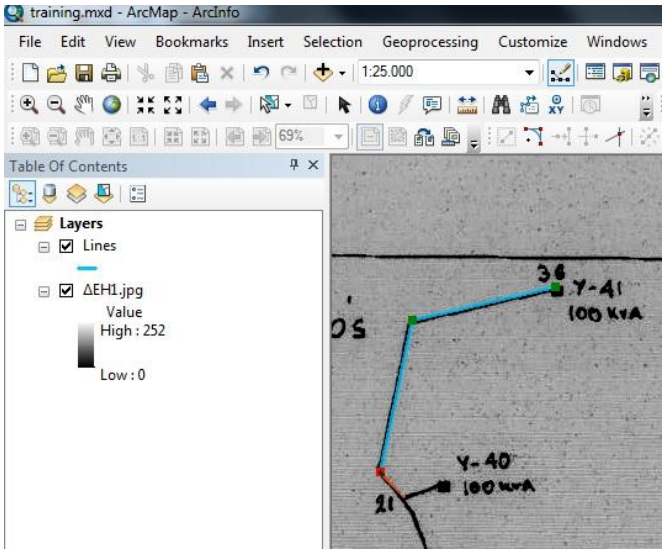


Figure 4.10

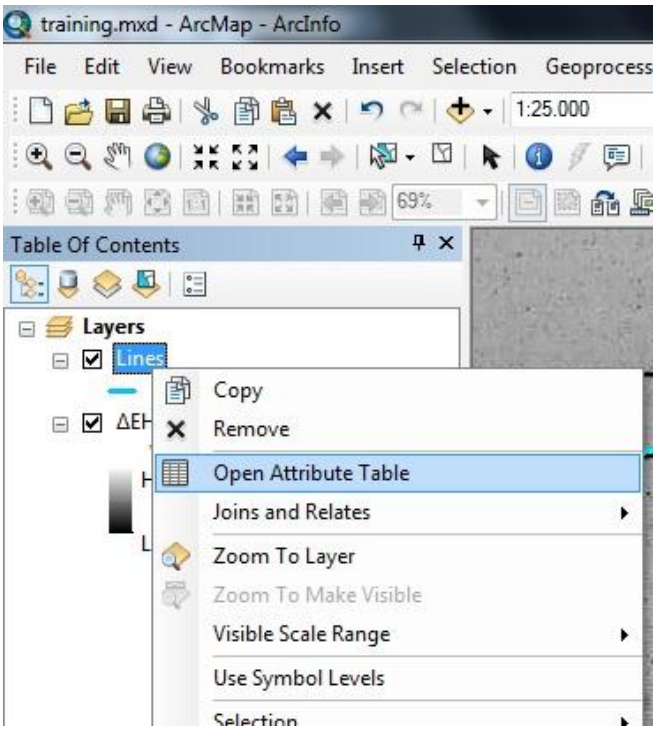


Figure 4.11

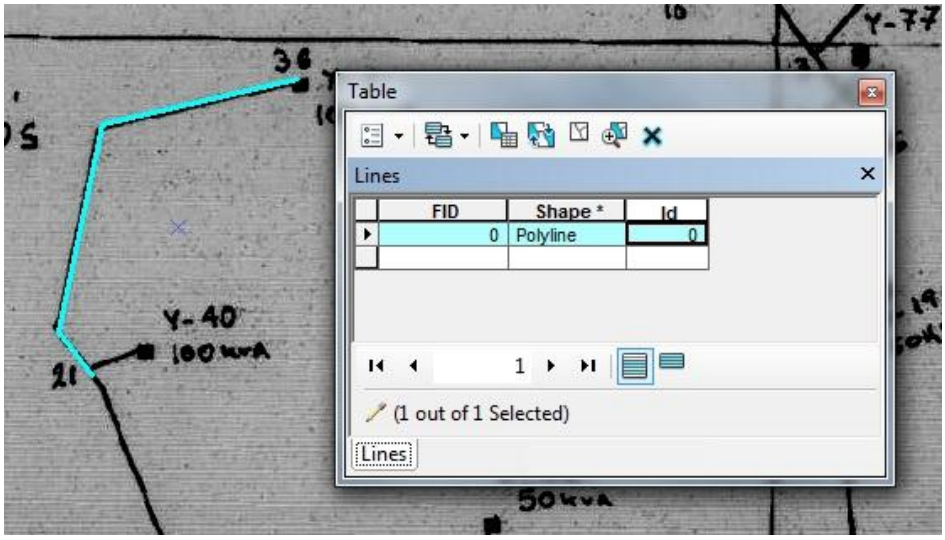


Figure 4.12

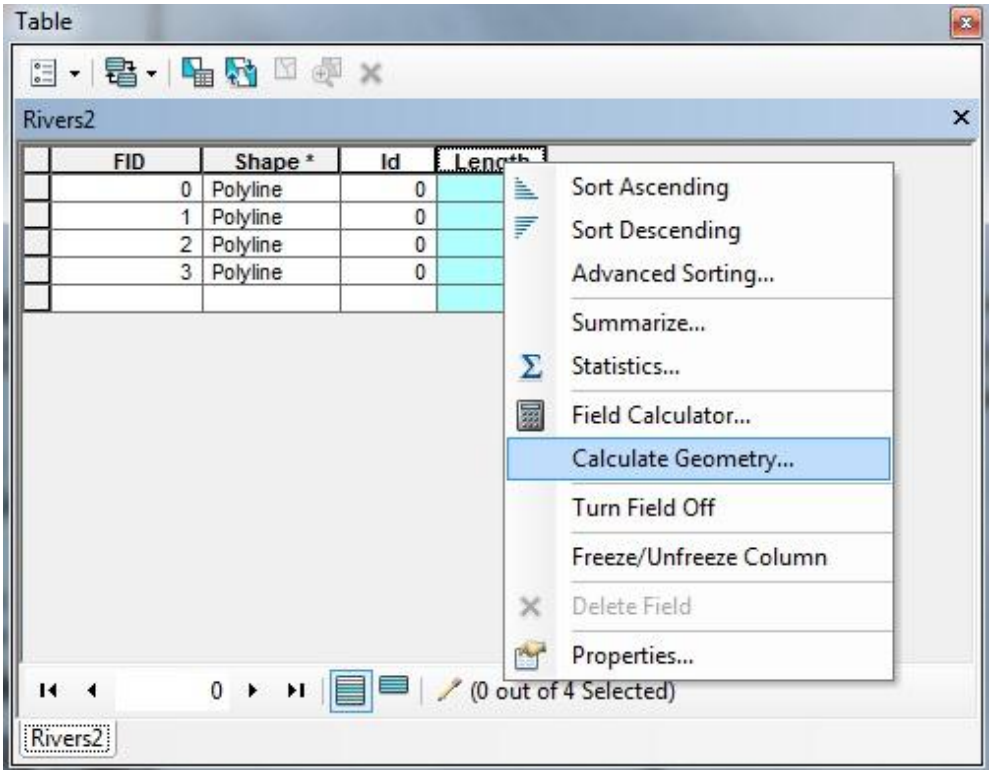


Figure 4.13

4.2. Municipality boundaries map – Neighboring municipalities

The 2011 census data are used. The municipality borders along with the neighboring ones will be displayed in the final layout.

Step 1: Add the Municipalities layer (in this example "oria_dhmwn_kallikraths.shp" layer) which, for Greece, can be found at: http://geodata.gov.gr/geodata/ (Figure 4.14)

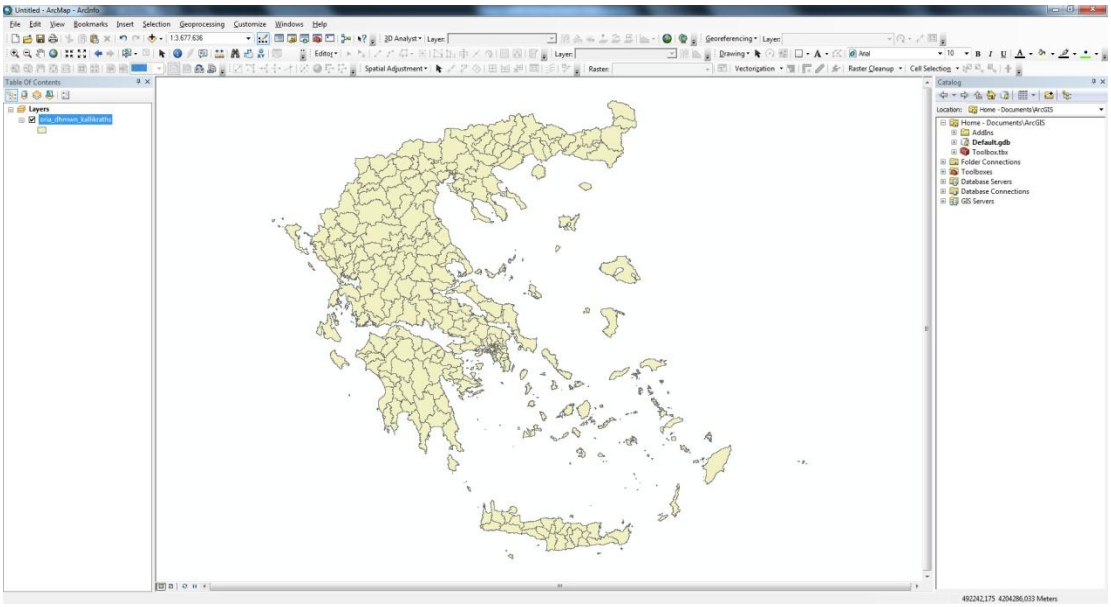


Figure 4.14

Next, use "zoom in" tool until the desired Municipality is displayed in an appropriate scale. You can add labels in the Municipalities polygon features by right clicking the "oria_dhmwn_kallikraths" shapefile at the "Table of Contents" and selecting "Label Features" (Figure 4.15).

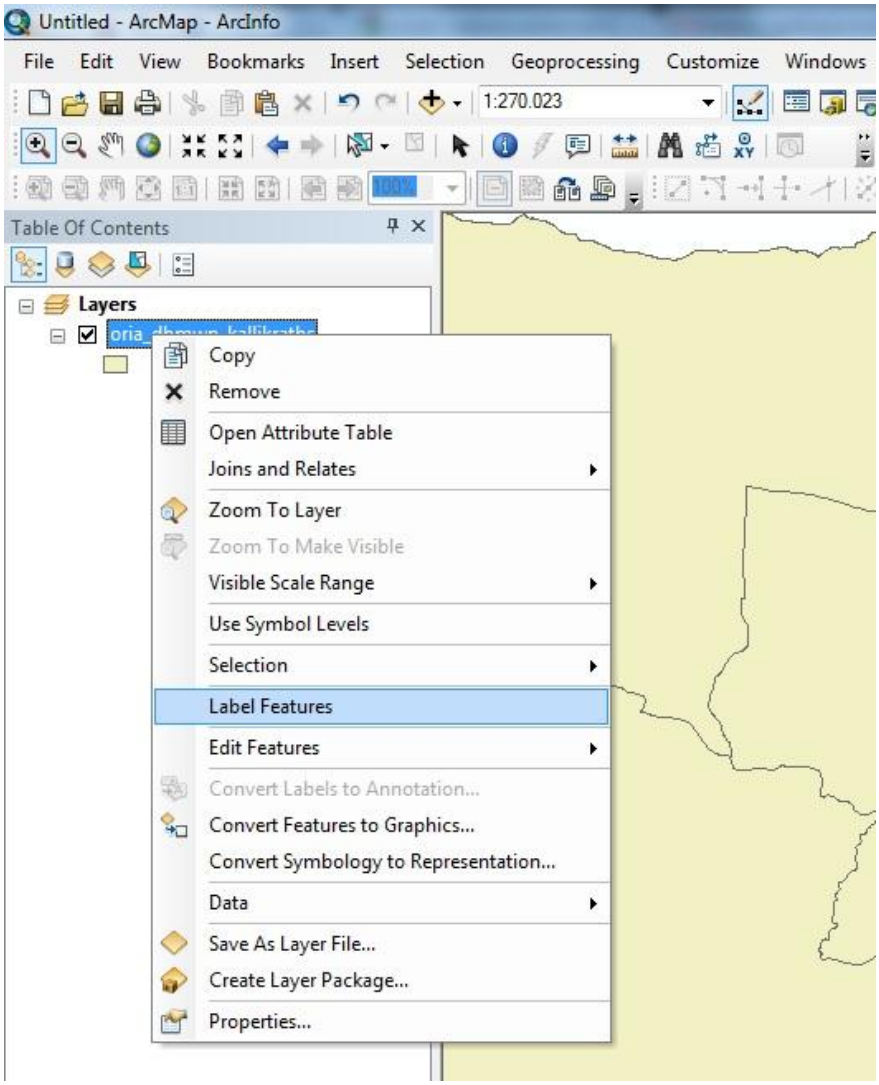


Figure 4.15

For more labels' editing and style options right click the "oria_dhmwn_kallikraths" layer in the Table of Contents and click on "Properties ==> Labels".

The municipalities polygon features styles can be edited by right clicking the "oria_dhmwn_kallikraths" shapefile at the Table of Contents and selecting "Properties ==> Symbology" (Figure 4.16).

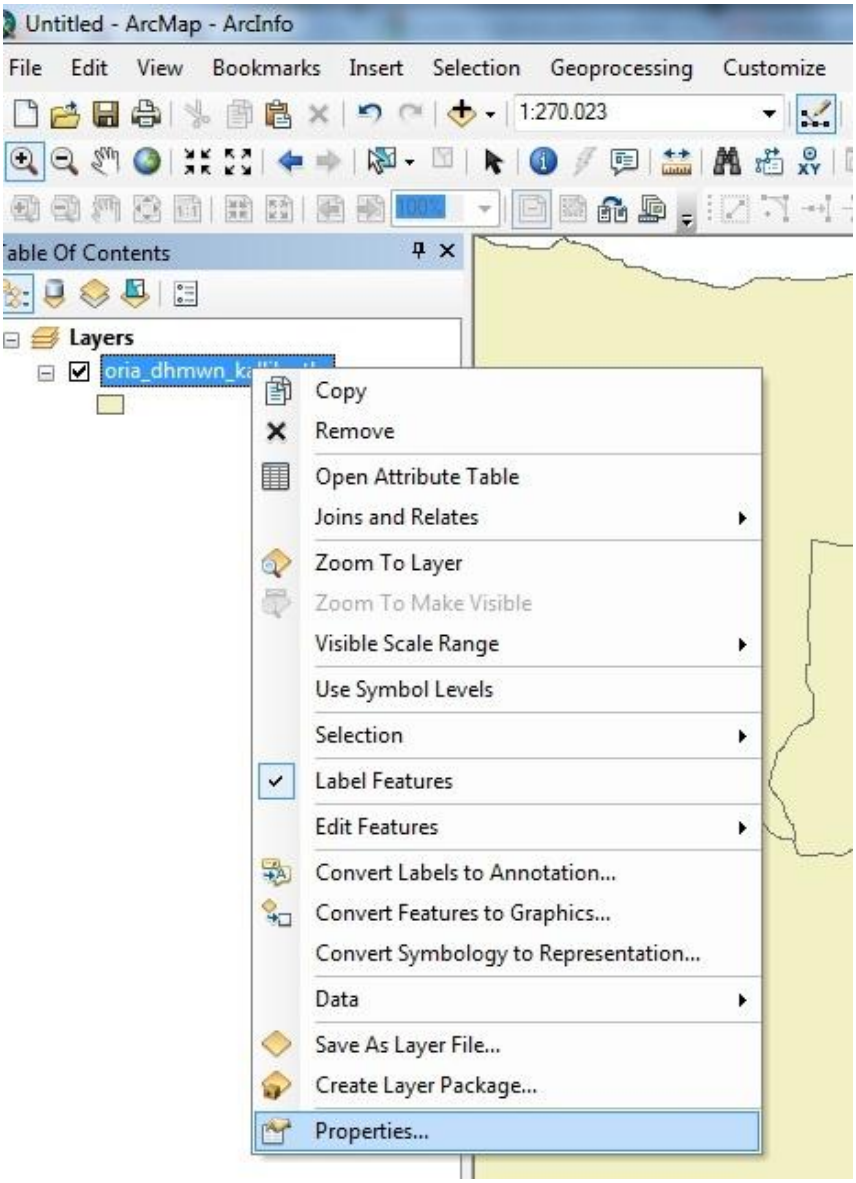


Figure 4.16

Step 2: Add the Digital Elevation Model (DEM) of the broader area, which must be clipped using the Municipality boundaries. If the DEM is already clipped, then proceed to Step 4.

Select the polygon feature referring to the Municipality using the "Select Feature by Rectangle" tool (Figure 4.17).

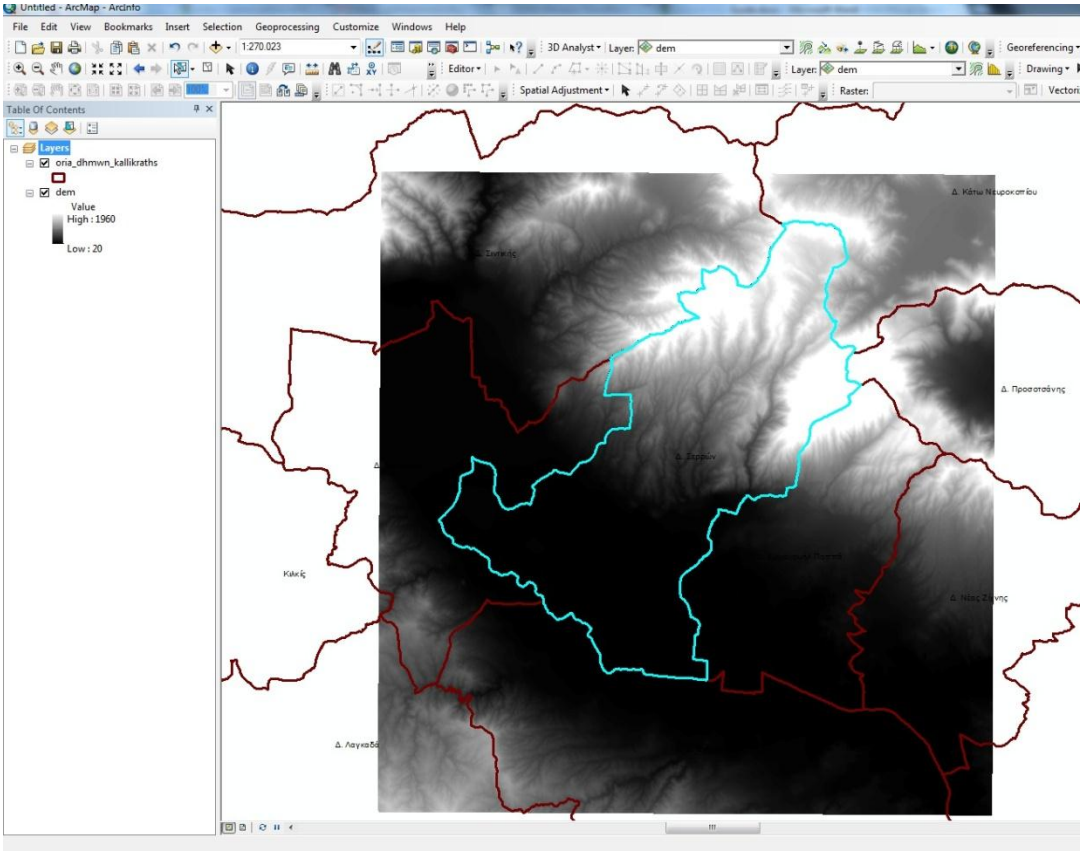


Figure 4.17

Click "ArcToolbox ==> Spatial Analyst Tools ==> Extract by Mask" (Figure 4.18) to open the dialogue box of the “Extract by Mask” tool (Figure 4.19). Select the DEM layer in the "Input Raster" drop down menu and "oria_dhmwn_kallikraths" layer in the "Input Raster or feature mask data" drop down menu. Type a name for the Output Raster (dem_guide on this guide) and browse for the destination folder on "Output Raster" field.

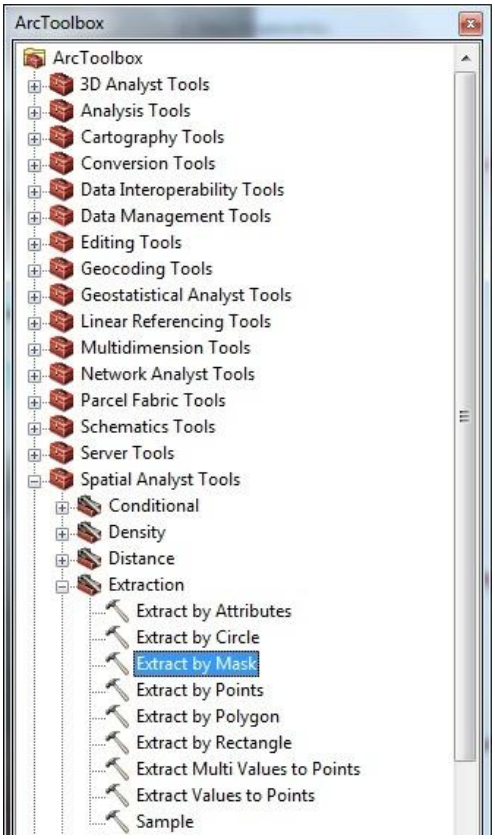


Figure 4.18

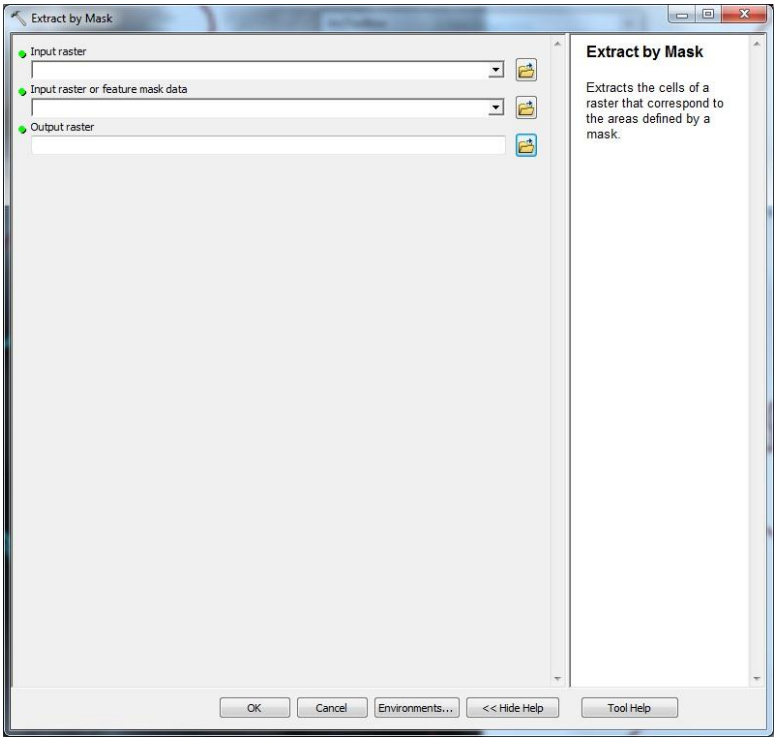


Figure 4.19

Step 3: Remove the initial DEM layer from the "Table of Contents", then right click on dem_guide and check "Properties ==> Symbology==>Stretched" to change the color scale of the dem_guide layer (Figure 4.20).

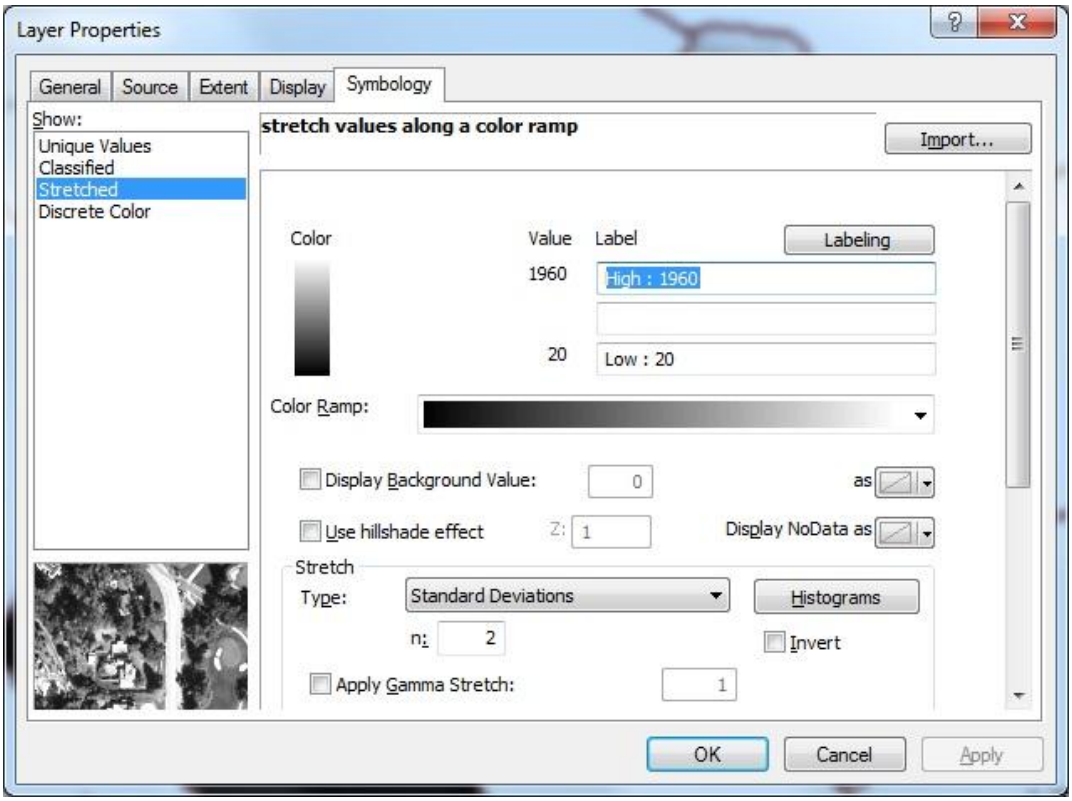


Figure 4.20

Then, the municipality DEM, along with the neigbouring municipalities will be displayed (Figure 4.21).

Step 4: Add the "oikismoi.shp" layer (settlements), which can be found at: http://geodata.gov.gr/geodata/. Label the settlements as described in Step 1, then click "Arc Toolbox==>Analysis Tools==>Extract==>Clip" (Figure 4.22) and follow the tool help on the right side of the tool window, in order to erase the settlements that are outside the municipality boundaries.

Step 5: Select "View ==> Layout view" to create a printable map layout with Legend, North Arrow and Scale (Figure 4.23). You can reshape the data frame using "Select Elements" tool, or relocate the map using "Pan" and "Zoom In" - "Zoom Out" tools. Change "Portrait" or "Lanscape" orientation by clicking "File ==> Page and Print Setup". Using the "Select Elements" tool, right click on the map and select "Properties" to open the Data Frame Properties window. Here you can access various map options, such as reference grid creation, frame border and color, etc. On the main menu click "Insert==> North Arrow" and "Insert==> Scale Bar" if you want to add a north arrow and a scale to your map. Map Legend

Wizzard can be accessed by clicking "Insert ==> Legend" on the main menu bar. (Figure 4.24).

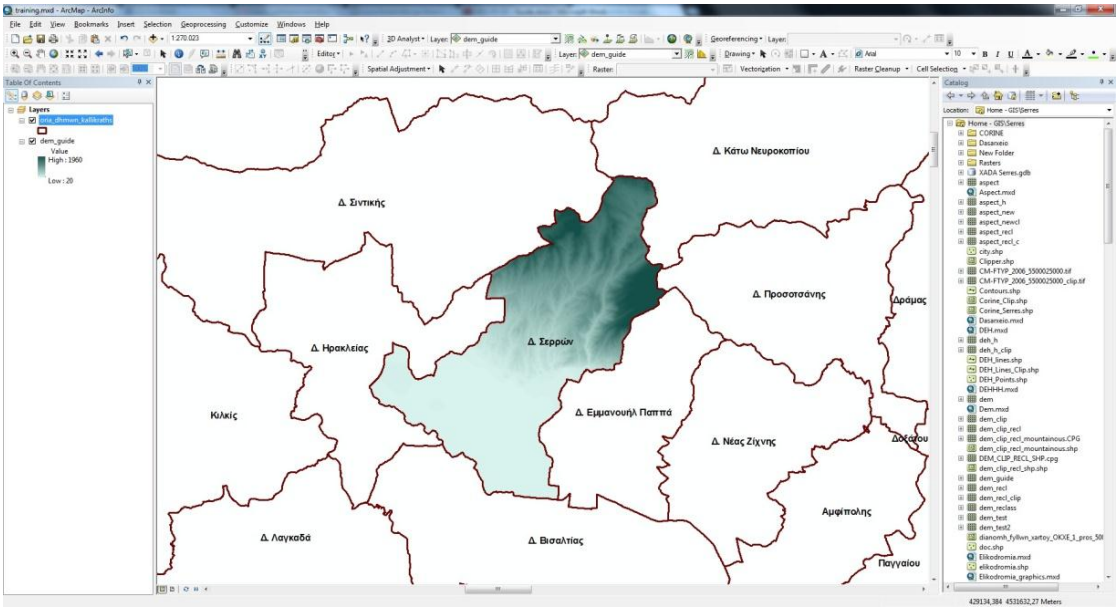


Figure 4.21

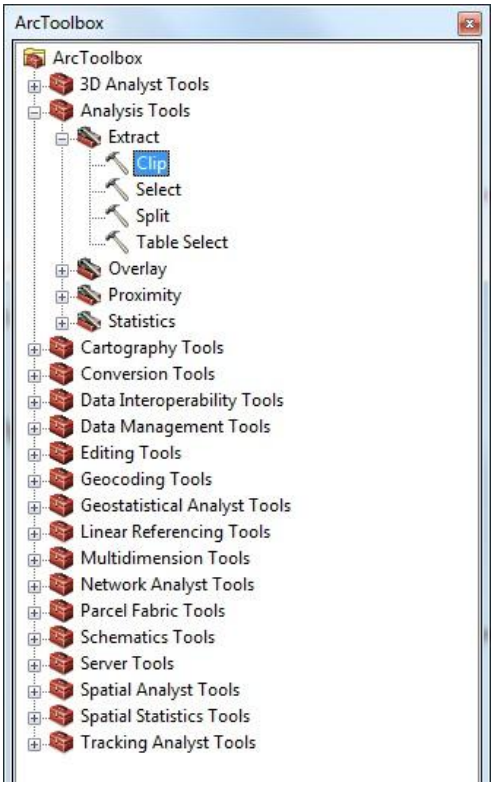


Figure 4.22

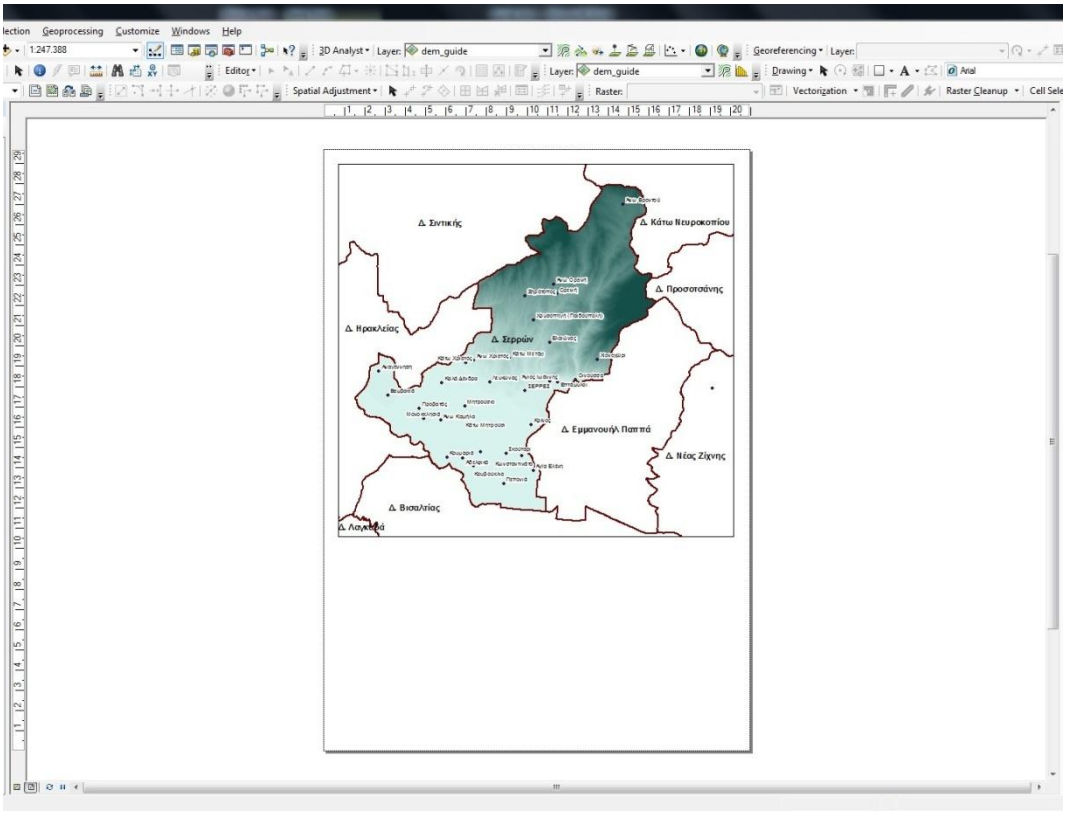

Δ. Σιντικής
Δ. Κάτω Νευροκοπίου
Δ. Προσοτσάνης
Δ. Ηρακλείας
Δ. Σερρών
Δ. Εμμανουήλ Παππά
Δ. Νέας Ζίχνης
Δ. Βισαλτίας
Δ. Λαγκαδά

Figure 4.23

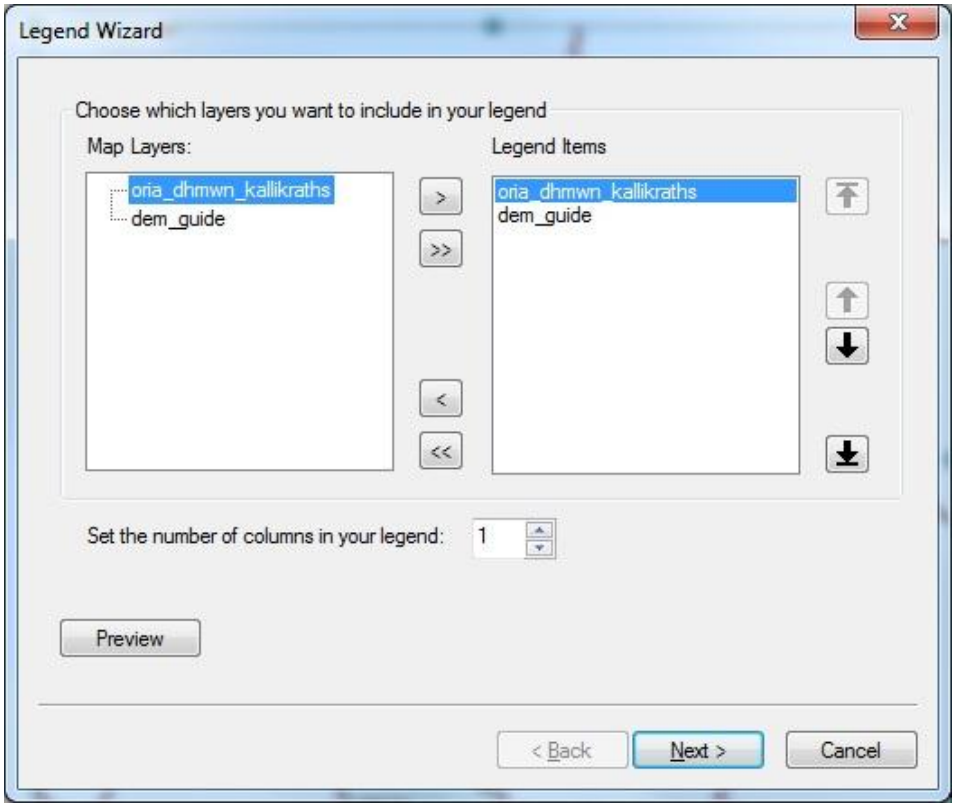


Figure 4.24

On the main menu bar select "File==>Export Map" (Figure 4.25) to export the map in image format. You can also define the format, resolution, name and destination folder of the image file.

North Arrow, Scale Bar and Legend should appear in every map you create (e.g. Figure 4.26).

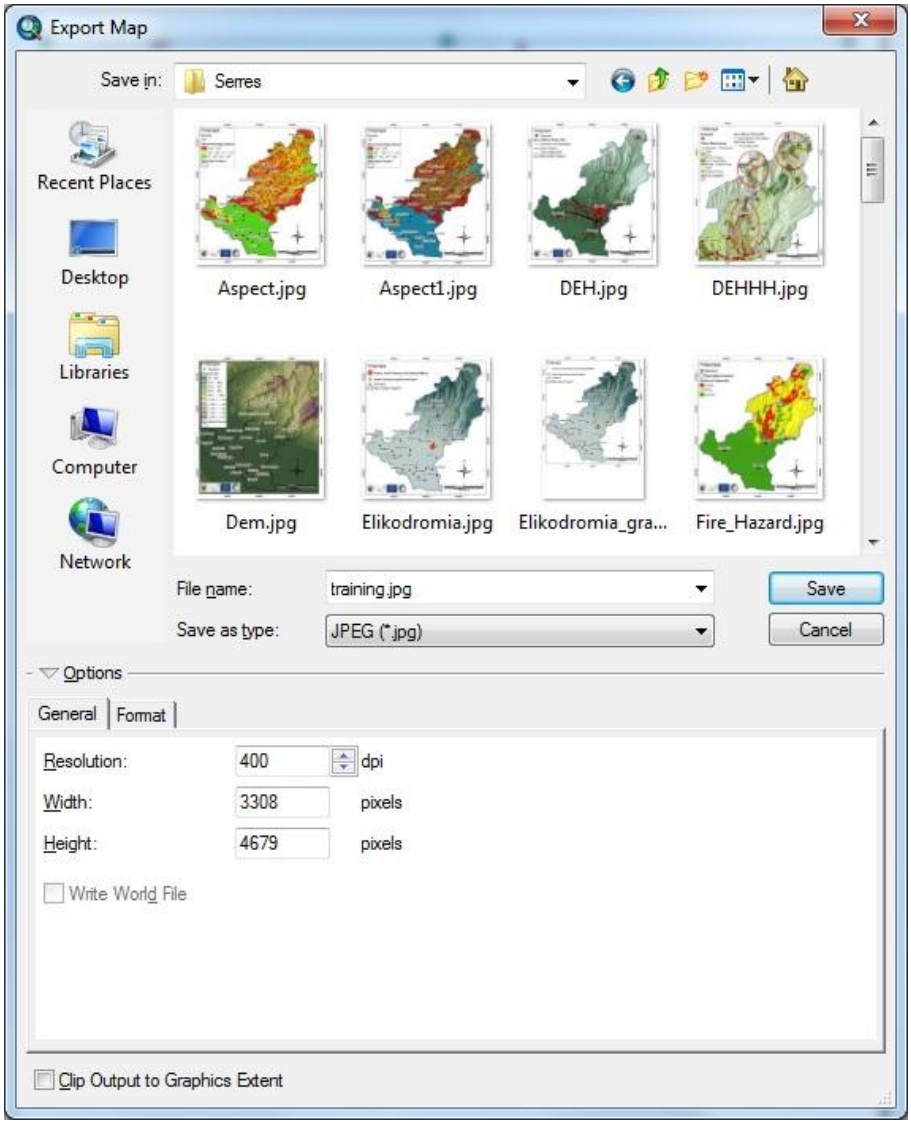

Export Map
Save in:
Serres
Recent Places
Desktop
Libraries
Computer
Network
Aspect.jpg
Aspect1.jpg
DEH.jpg
DEHHH.jpg
Dem.jpg
Elikodromia.jpg
Elikodromia_gra...
Fire_Hazard.jpg
File name:
training.jpg
Save as type:
JPEG (*.jpg)
Save
Cancel
Options
General
Format
Resolution:
400
dpi
Width:
3308
pixels
Height:
4679
pixels
Write World File
Clip Output to Graphics Extent

Figure 4.25

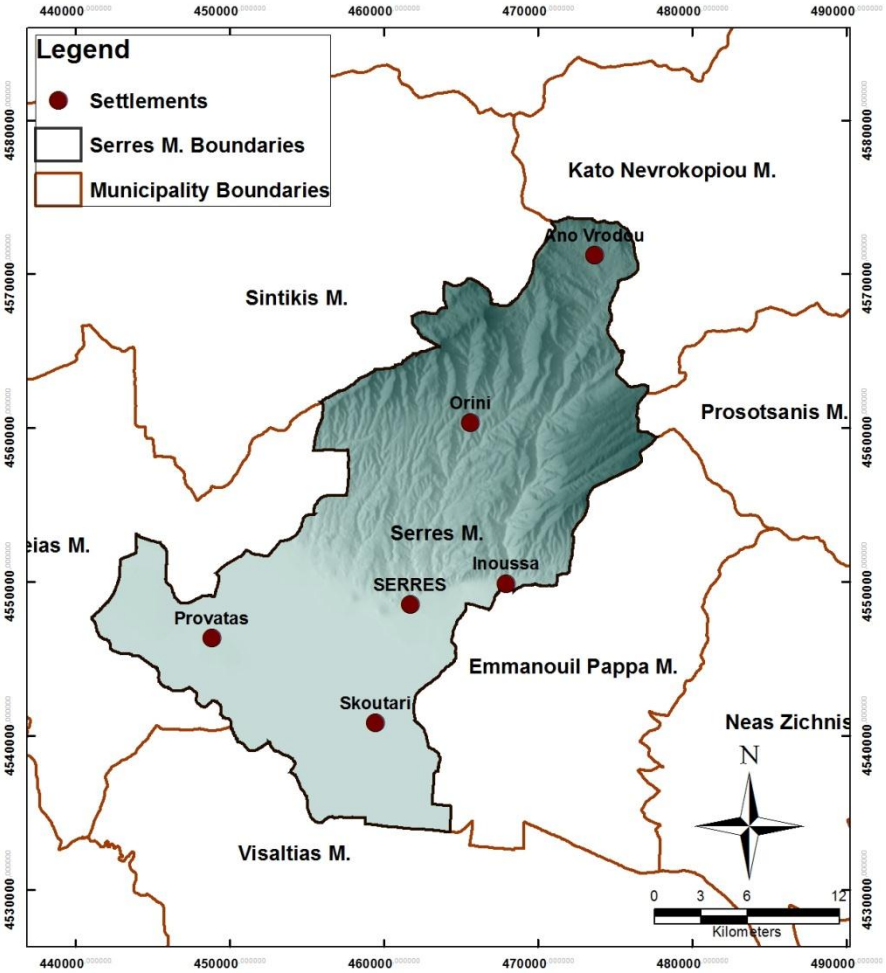

Legend
Settlements
Serres M. Boundaries
Municipality Boundaries
Kato Nevrokopiou M.
Ano Vrodou
Sintikis M.
Orini
Prosotsanis M.
Serres M.
Inoussa
SERRES
Provatas
Emmanouil Pappa M.
Skoutari
Neas Zichnis
Visaltias M.
N
0 3 6 12
Kilometers
440000
450000
460000
470000
480000
490000
4580000
4570000
4560000
4550000
4540000
4530000

Figure 4.26

4.3. Digital Elevation Model (DEM) Topographical map

After following the steps of the previous chapter (Chapter 4.2) on Step 3, at the "Layer Properties" window (Figure 4.20) select "Symbology==>Classified". Click on "Classify" button and then select "Defined Interval" on the "Classification" drop down menu (Figure 4.28). Type "100" at the "Interval Size" box and then click "OK" to proceed to "Layer Properties" window and define the desired color scale in "Color Ramp" (Figure 4.29). Your final map should look like the map displayed in Figure 4.30 (DEM for surrounding areas is not clipped in this example).

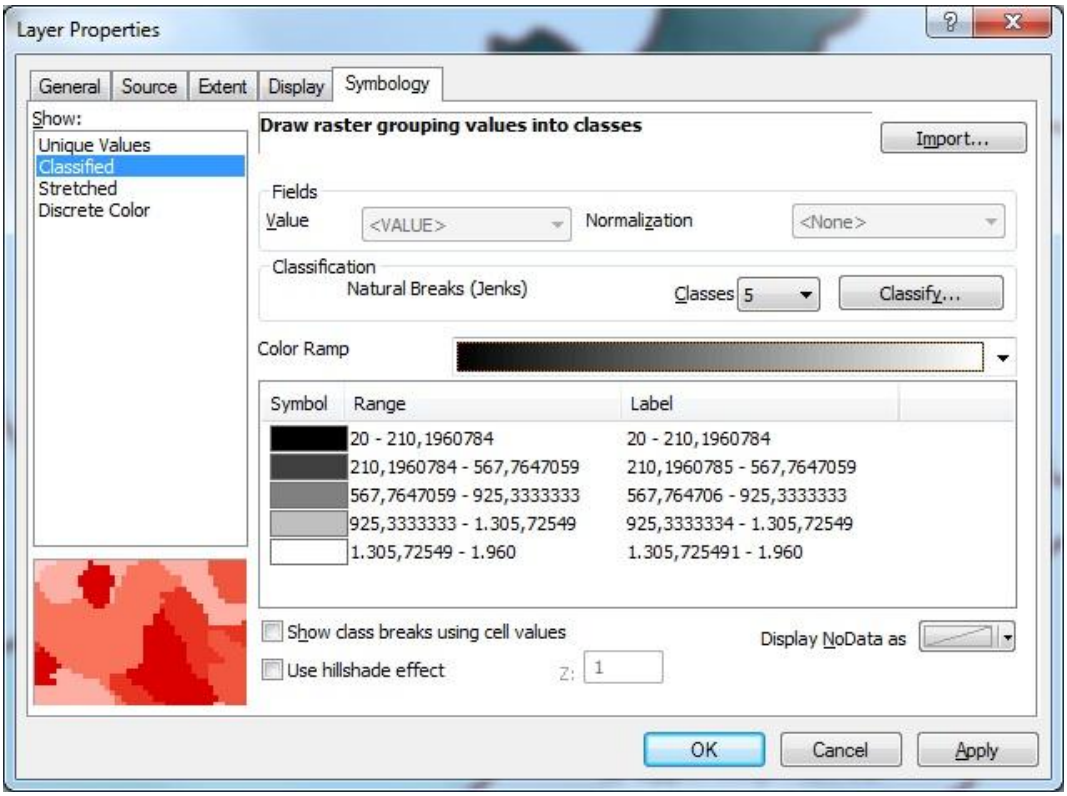


Figure 4.27

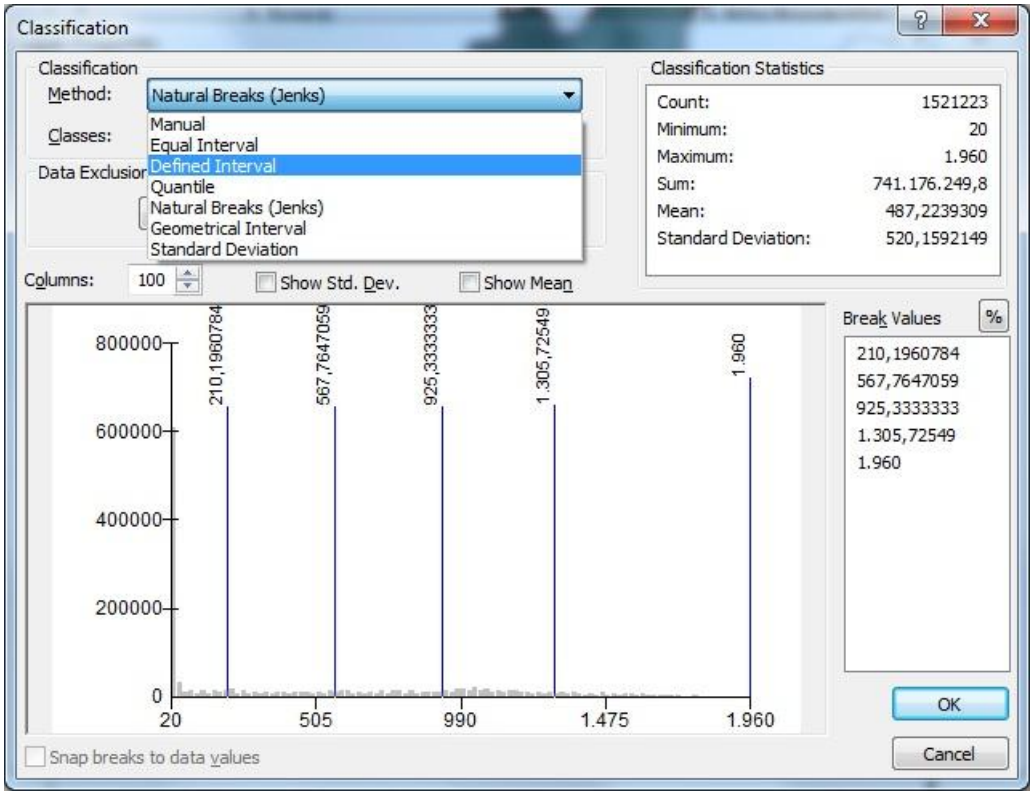


Figure 4.28

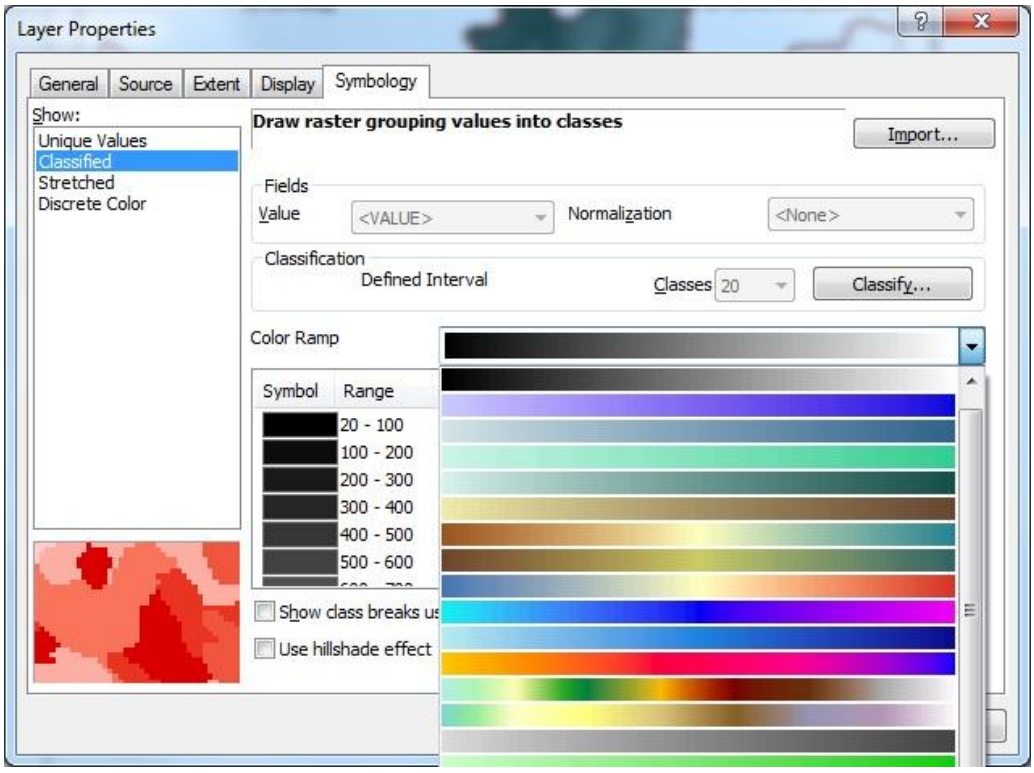


Figure 4.29

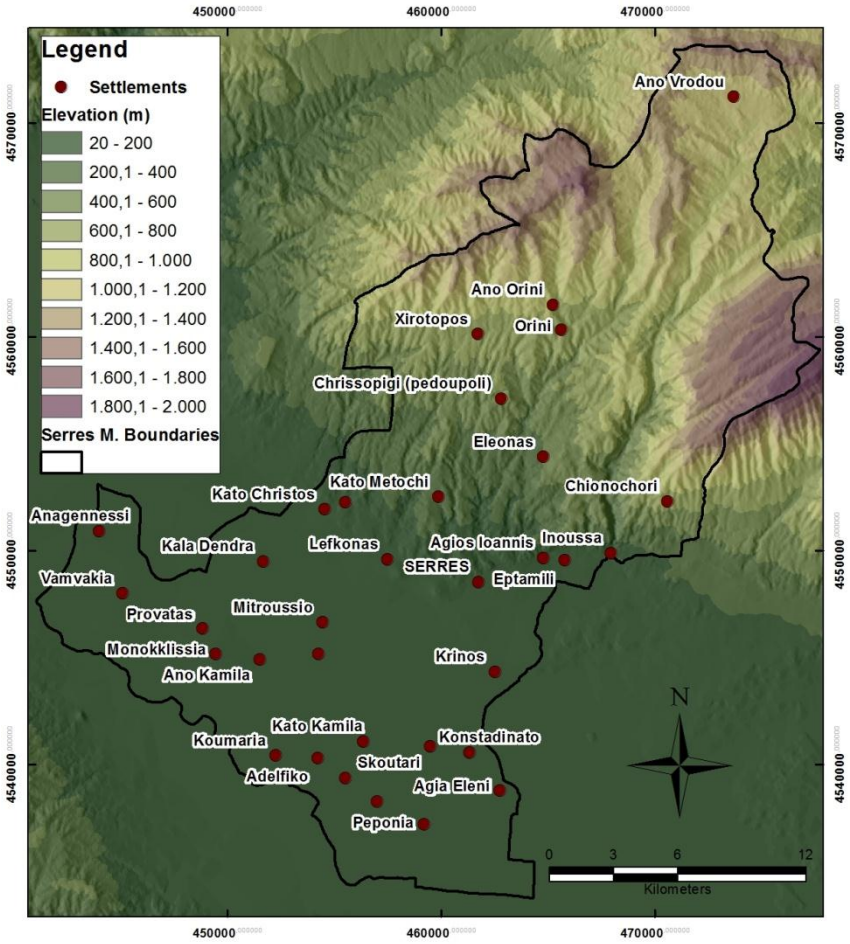


Figure 4.30: Serres Municipality DEM

4.4. Drainage network map

The drainage network shapefile for the whole municipality area is required for this map. Topographical maps of 1:5.000 up to 1:50.000 scale can be used, if no such shapefile already exists (see also Chapter 4.1 for georeferencing and digitization processes). Add the DEM and the Settlements layers in order to create the final layout (Figure 4.31).

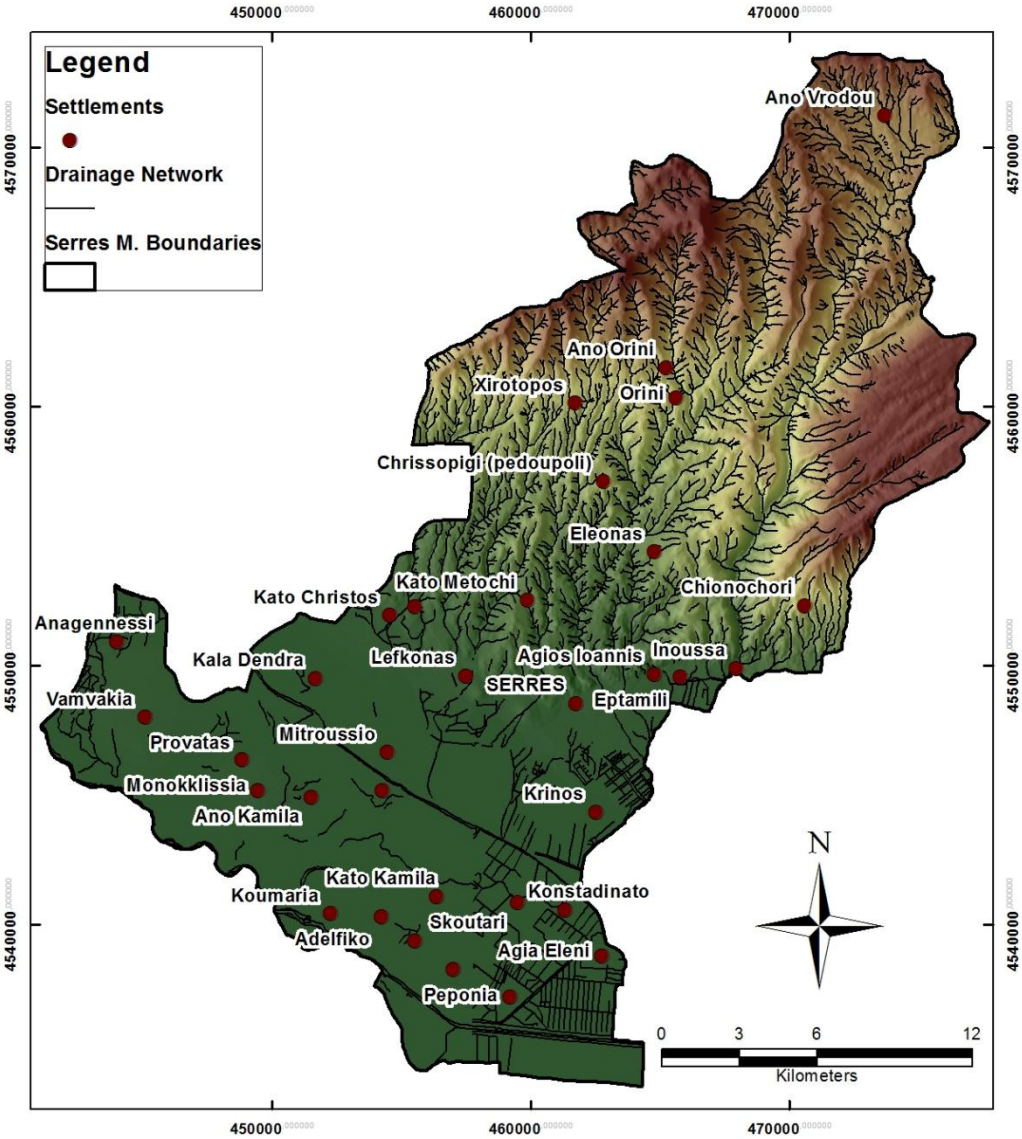


Figure 4.31: Serres Municipality drainage network.

4.5. Slope map

Add the DEM layer (e.g. dem_guide) on your map window and select Arc Toolbox ==> Spatial Analyst Tools ==> Surface ==> Slope (Figure 4.32). In the Slope tool window (Figure 4.33) select the dem_guide layer for the "Input Raster", the output raster name (e.g. Slope_guide) and destination folder for the "Output Raster" and the "Percent Rise" for the "Output measurement" in order to calculate the percent slope. Click "OK" to create the new raster layer and automatically add it to the map (Figure 4.34). Right click on the new slope raster at the "Table of Contents" and select "Properties==>Symbology" to define the slope values classification (see also instructions on altitude classification process from Chapter 4.3). Slope values should be classified as following: a) Slope values from 0% to 13% (low risk) , b) Slope values from 13,1% up to 40% (medium risk) and c) Slope values from 40,1% up to the highest values (high risk) (e.g. Figure 4.35).

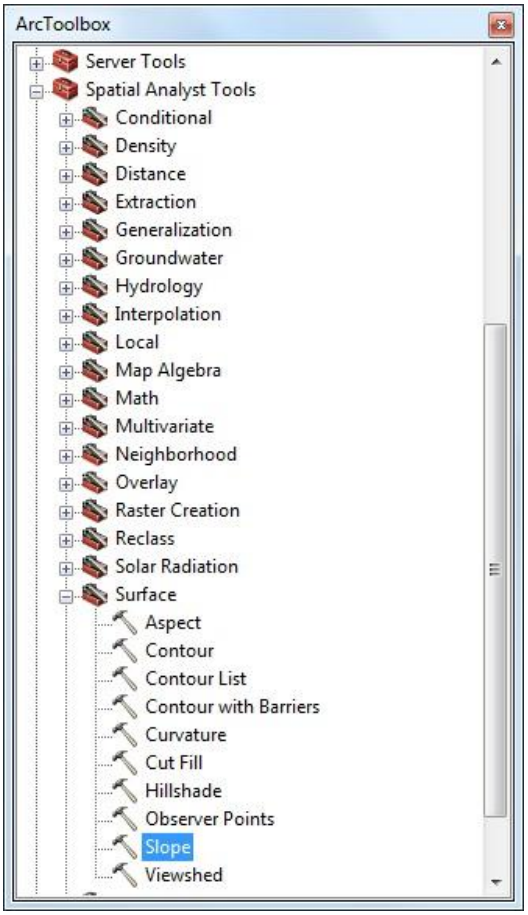


Figure 4.32

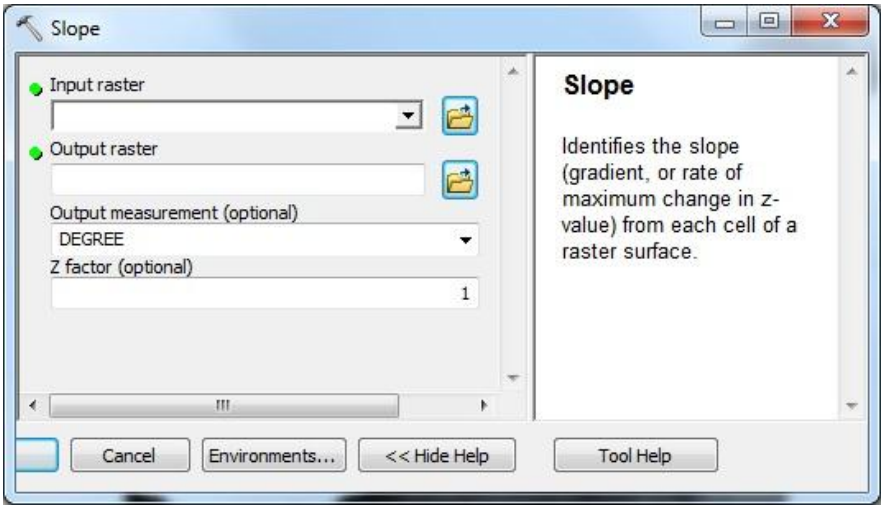


Figure 4.33

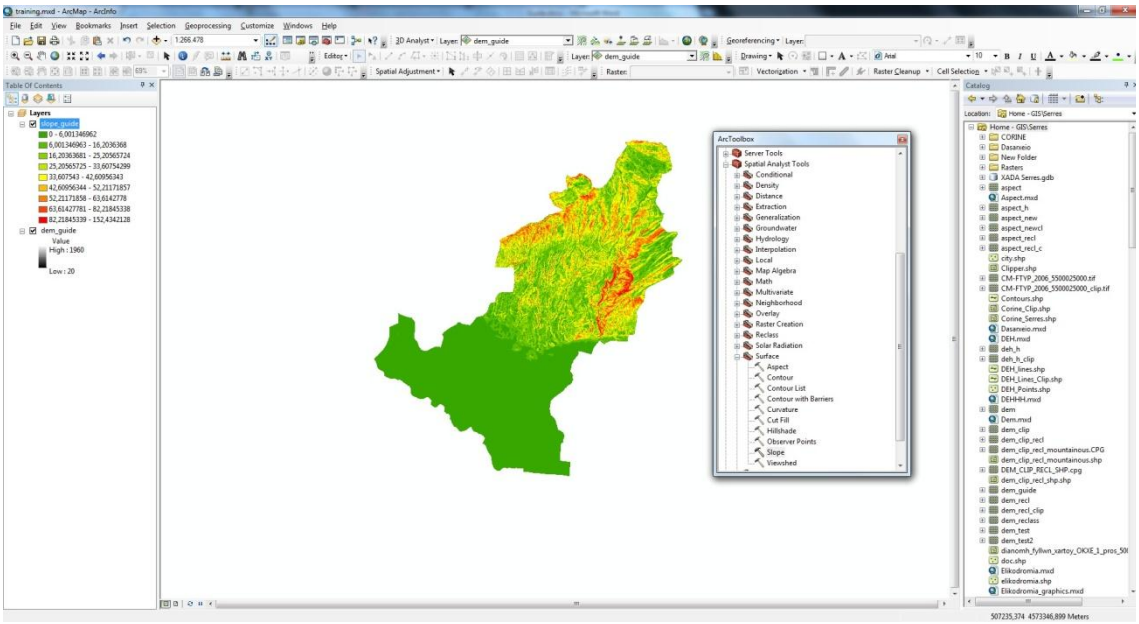


Figure 4.34

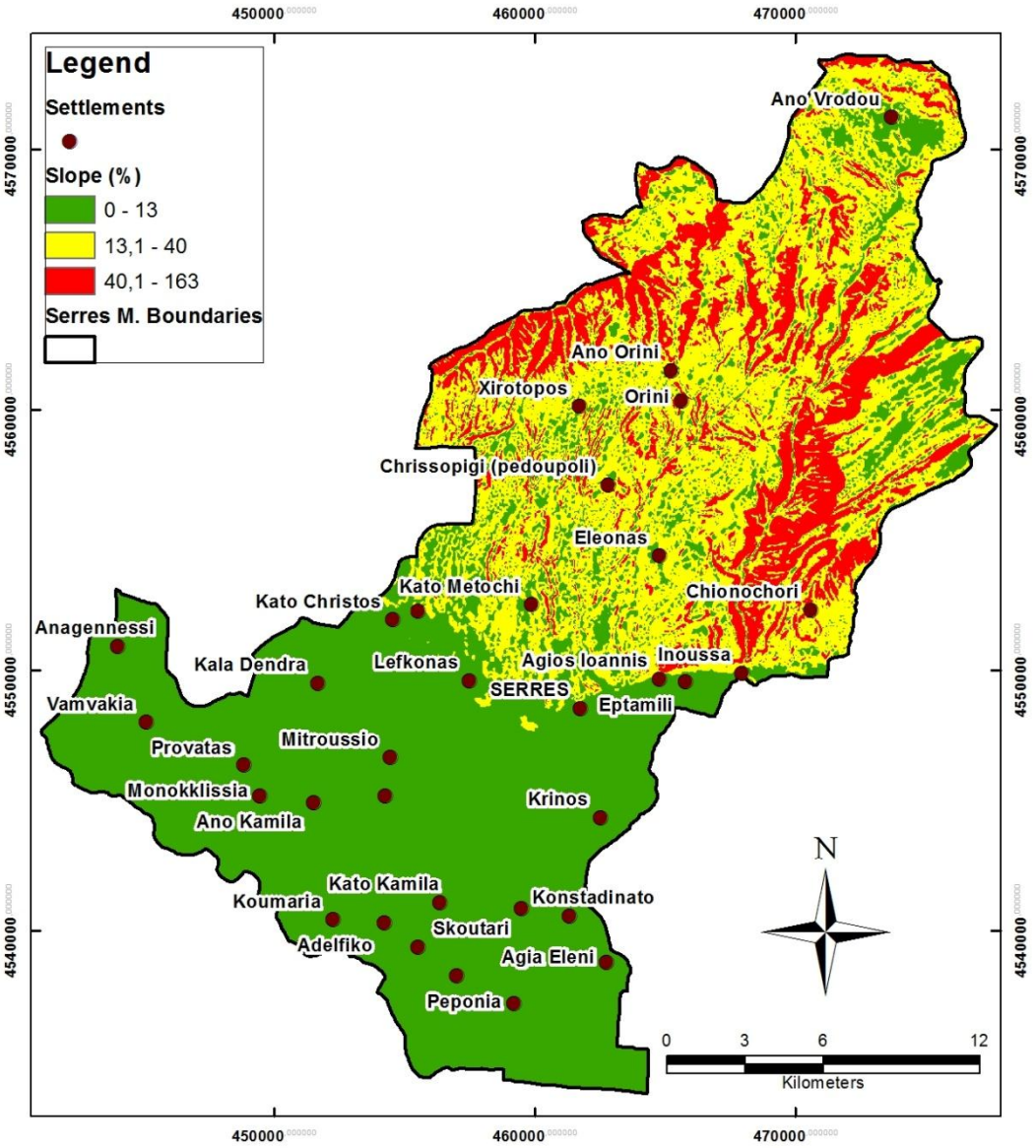


Figure 4.35: Serres municipality slope map

4.6.Aspect map

Add the DEM layer in your map window (e.g. dem_guide) and select ArcToolbox ==> Spatial Analyst Tools ==> Surface ==> Aspect (Figure 4.36). In the Aspect tool window (Figure 4.37) select the dem_guide layer for the "Input Raster", the output raster name (e.g. Aspect_guide) and destination folder for the "Output Raster" and click "OK" to create the new raster layer and automatically add it to the map (Figure 4.38). Right click on the new aspect raster at the "Table of Contents" and select "Properties==>Symbology" to define the aspect values classification (see also instructions on altitude classification process on Chapter 4.3). Aspect values should be classified as following: a) Aspect values from 0^o to 45^o and from 316^o to 360^o (low risk) , b) Aspect values from 46^o to 134^o and 271^o to 315^o (medium risk) and c) Aspect values from 135^o to 270^o (high risk) (e.g.Figure 4.39).

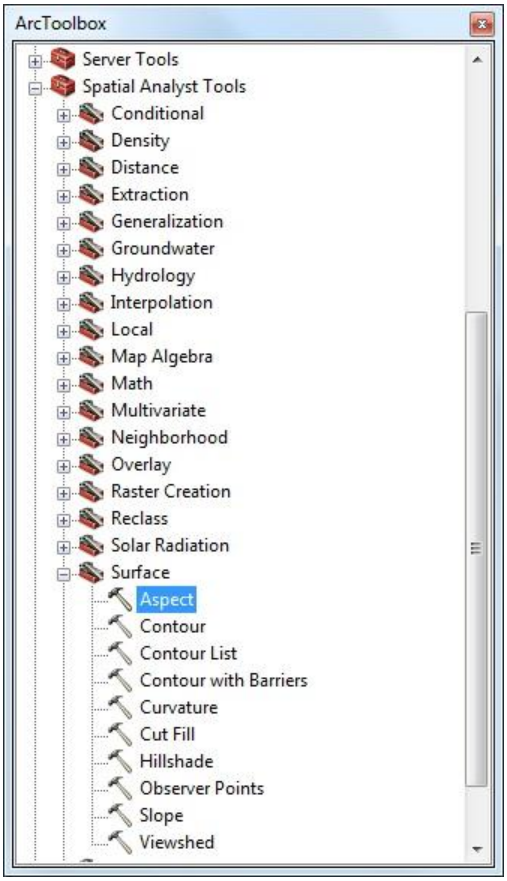


Figure 4.36

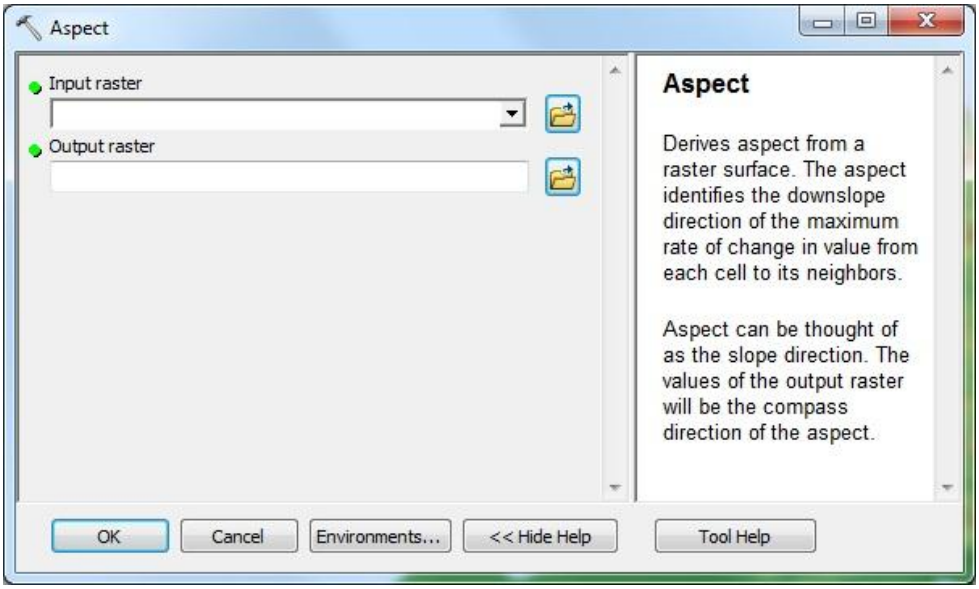


Figure 4.37

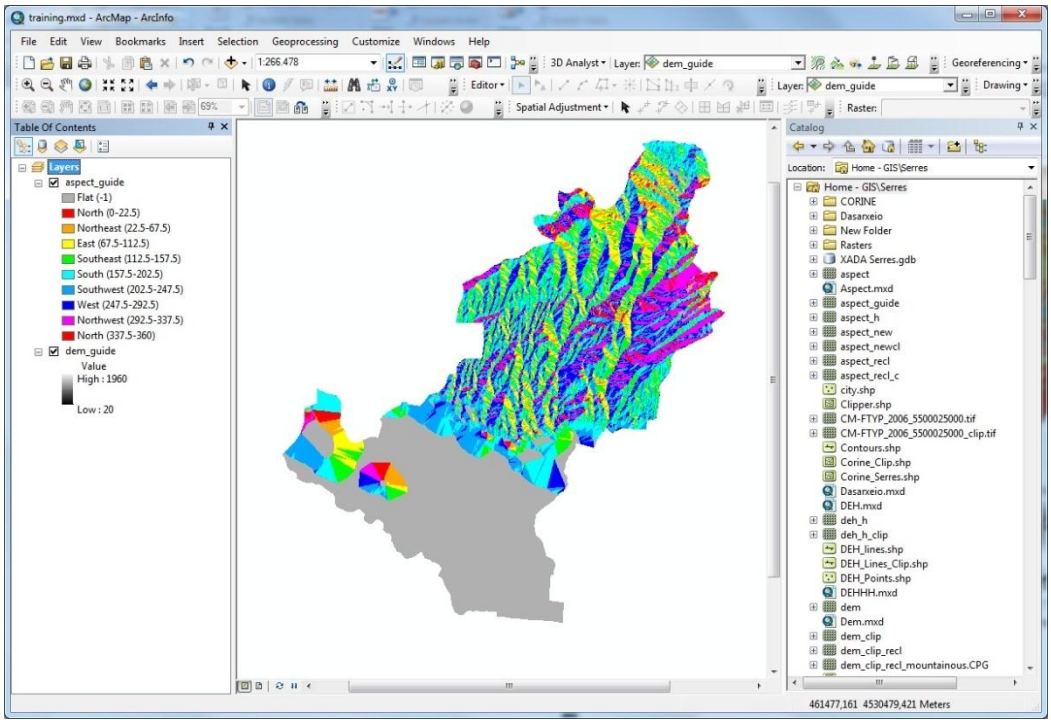


Figure 4.38

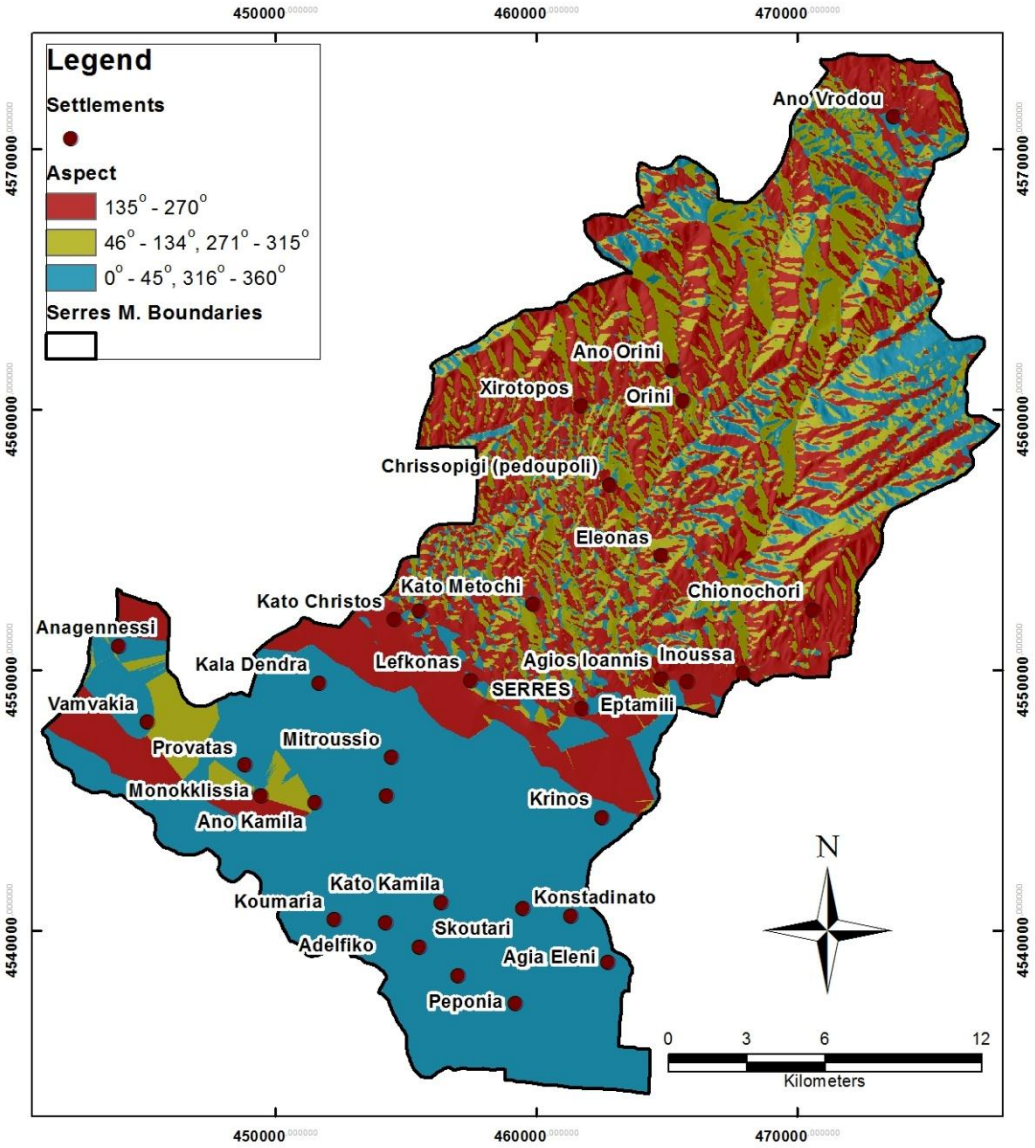


Figure 4.39: Serres municipality aspect map

4.7.Land Use map

Add the "Corine 2000" shapefile which you can download at: http://geodata.gov.gr/geodata/ (Figure 4.40). Use "Clip" tool (see also Chapter 4.2) to keep and display only the data inside the municipality polygon. The "COR" field at Corine's "Attribute Table" contains 3-digit numbers, each one corresponding to a different Land Use (Figure 4.41). Create a new text field (e.g. "Description", see also Chapter 4.1.2) and fill it with the Land Use description for each 3-digit number. Use the "PARARTIMA_A.doc" file to connect numbers with corresponding descriptions (Figure 4.42).

Right click on Corine layer at the "Table Contents" and select "Properties ==> Symbology ==> Categories ==> Unique Values". Select "Value Field ==> Description ==> Add All Values" to add all the different Land Uses of the municipality. Choose desired colors and patterns by clicking on each style on the "Symbol" column (Figure 4.43).

The final layout should look like the map on Figure 4.44.

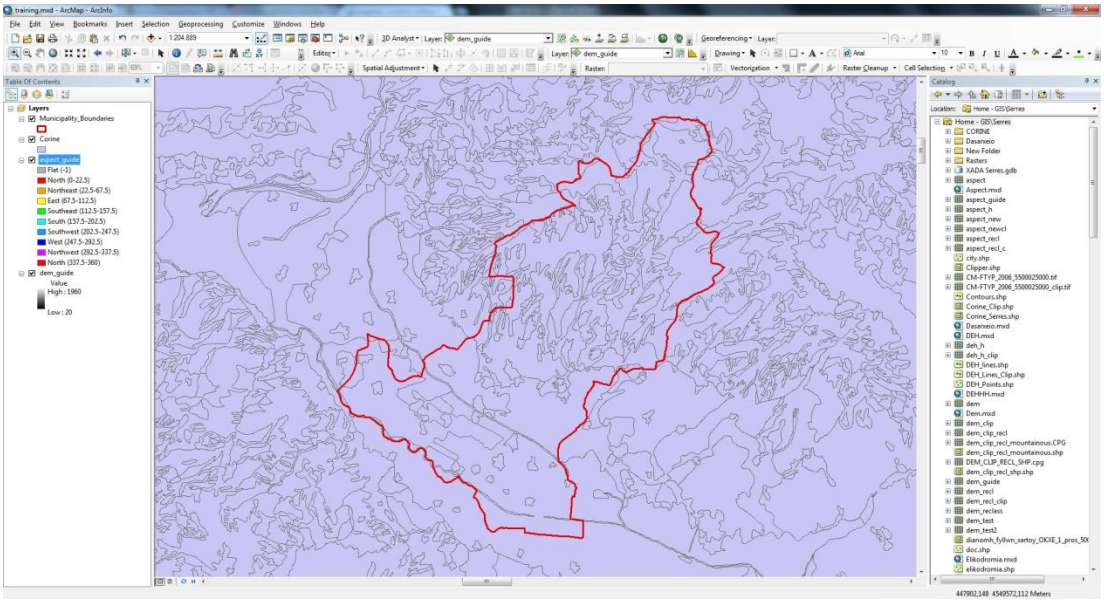
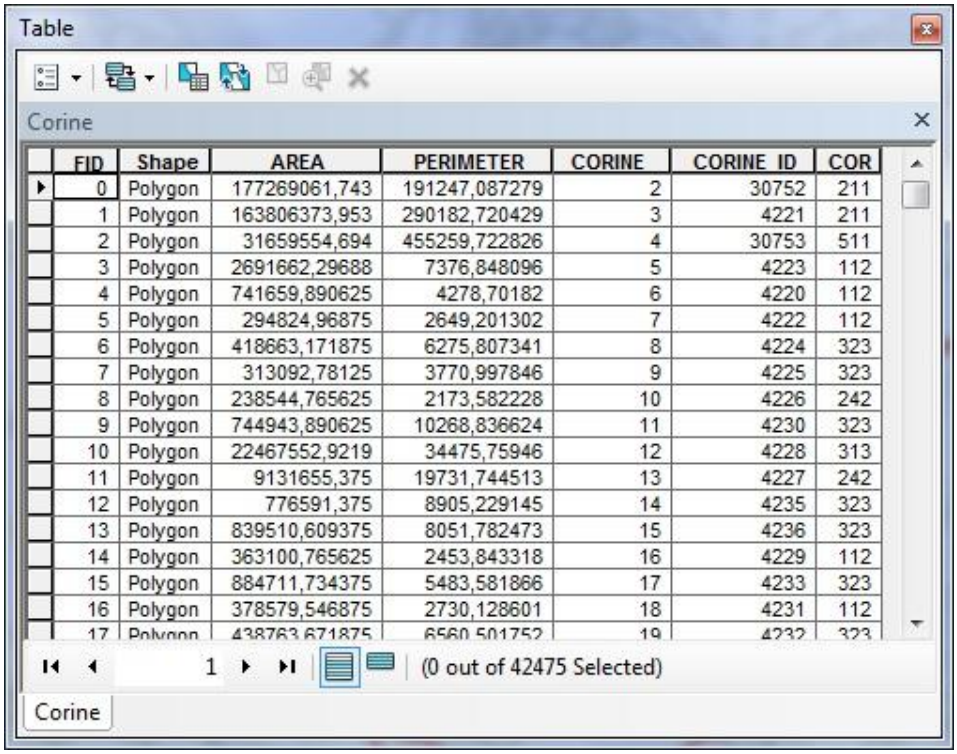


Figure 4.40



FID	Shape	AREA	PERIMETER	CORINE	CORINE_ID	COR
0	Polygon	177269061,743	191247,087279	2	30752	211
1	Polygon	163806373,953	290182,720429	3	4221	211
2	Polygon	31659554,694	455259,722826	4	30753	511
3	Polygon	2691662,29688	7376,848096	5	4223	112
4	Polygon	741659,890625	4278,70182	6	4220	112
5	Polygon	294824,96875	2649,201302	7	4222	112
6	Polygon	418663,171875	6275,807341	8	4224	323
7	Polygon	313092,78125	3770,997846	9	4225	323
8	Polygon	238544,765625	2173,582228	10	4226	242
9	Polygon	744943,890625	10268,836624	11	4230	323
10	Polygon	22467552,9219	34475,75946	12	4228	313
11	Polygon	9131655,375	19731,744513	13	4227	242
12	Polygon	776591,375	8905,229145	14	4235	323
13	Polygon	839510,609375	8051,782473	15	4236	323
14	Polygon	363100,765625	2453,843318	16	4229	112
15	Polygon	884711,734375	5483,581866	17	4233	323
16	Polygon	378579,546875	2730,128601	18	4231	112
17	Polygon	438763,671875	6560,501752	19	4232	323

Figure 4.41

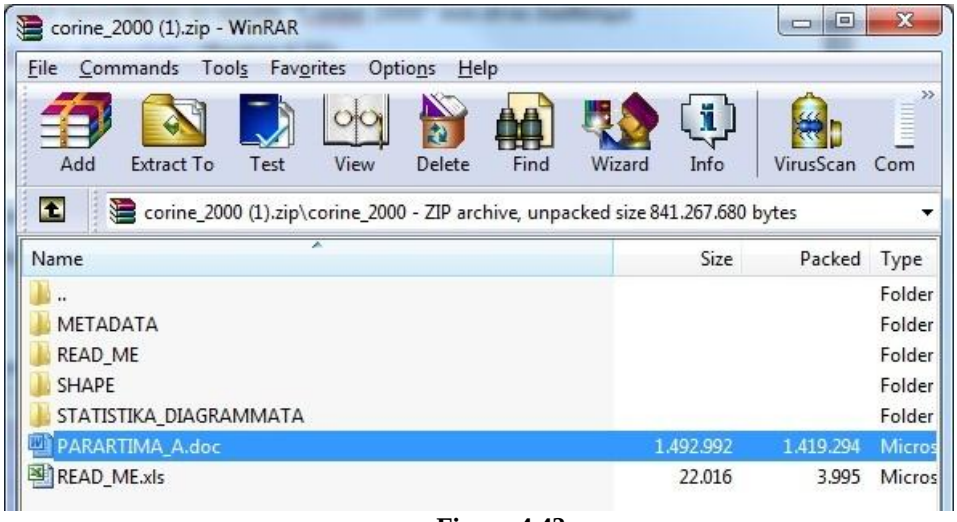


Figure 4.42

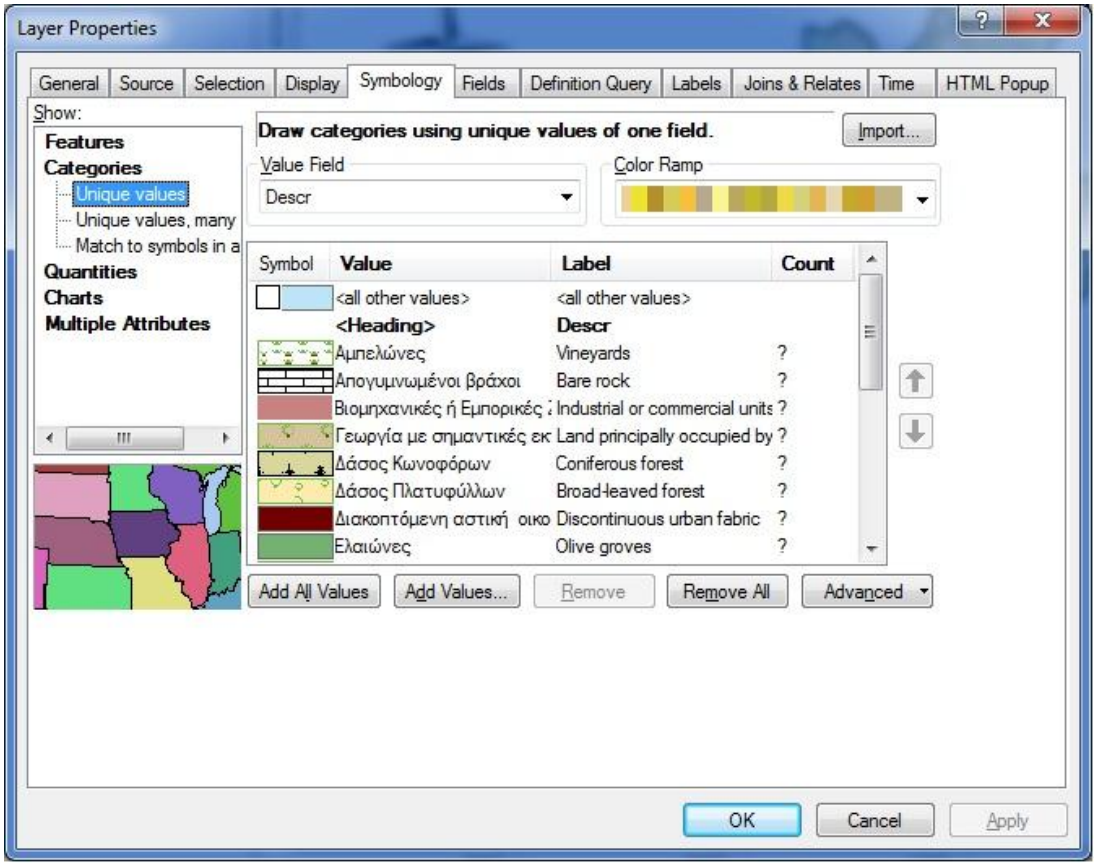

Layer Properties
General
Source
Selection
Display
Symbology
Fields
Definition Query
Labels
Joins & Relates
Time
HTML Popup
Show:
Features
Categories
Unique values
Unique values, many
Match to symbols in a
Quantities
Charts
Multiple Attributes
Draw categories using unique values of one field.
Import...
Value Field
Descr
Color Ramp
Symbol
Value
Label
Count
<all other values>
<all other values>
<Heading>
Descr
Αμπελώνες
Vineyards
Απογυμνωμένοι βράχοι
Bare rock
Βιομηχανικές ή Εμπορικές
Industrial or commercial units
Γεωργία με σημαντικές εκ
Land principally occupied by
Δάσος Κωνοφόρων
Coniferous forest
Δάσος Πλατυφύλλων
Broad-leaved forest
Διακοπτόμενη αστική οικο
Discontinuous urban fabric
Ελαιώνες
Olive groves
Add All Values
Add Values...
Remove
Remove All
Advanced
OK
Cancel
Apply

Figure 4.43

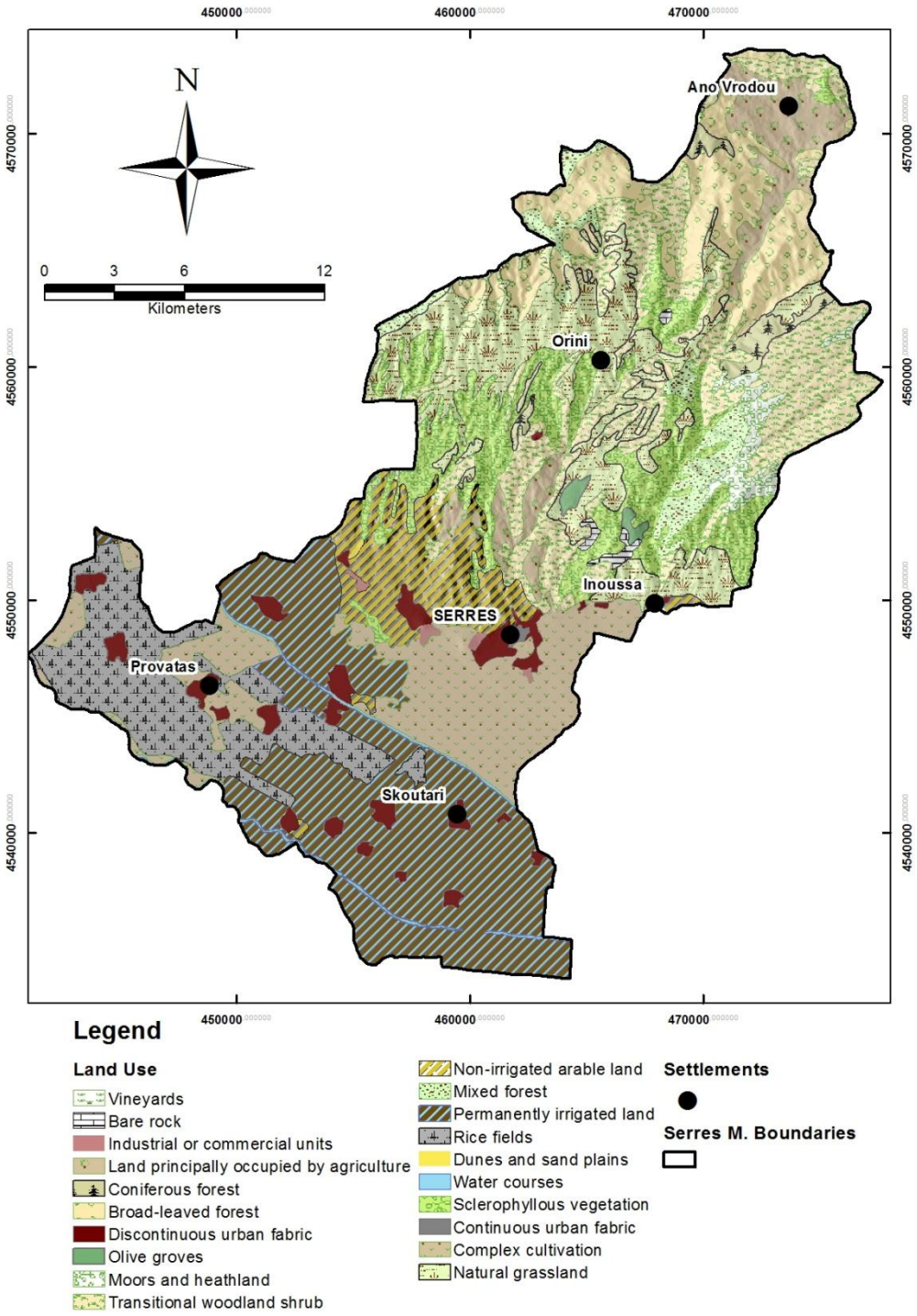


Figure 4.44: Serres municipality land use map

4.8. Vegetation map

Forestry services or the National Agriculture Research Foundation (N.AG.RE.F.) can provide vegetation maps. Printed maps must be digitized (see Chapters 4.1.1 - 4.1.3) if no shapefiles are available.

Follow guidelines from Chapter 4.7 to create the final map, which should be similar to the map of Figure 4.46. Use "Drawing" toolbar (Figure 4.45) to highlight areas of high fire risk potential.

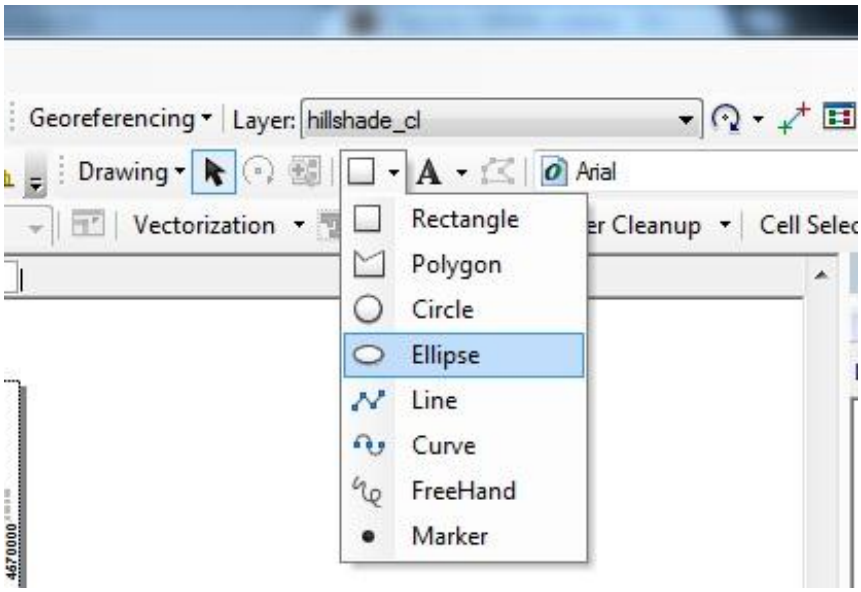


Figure 4.45

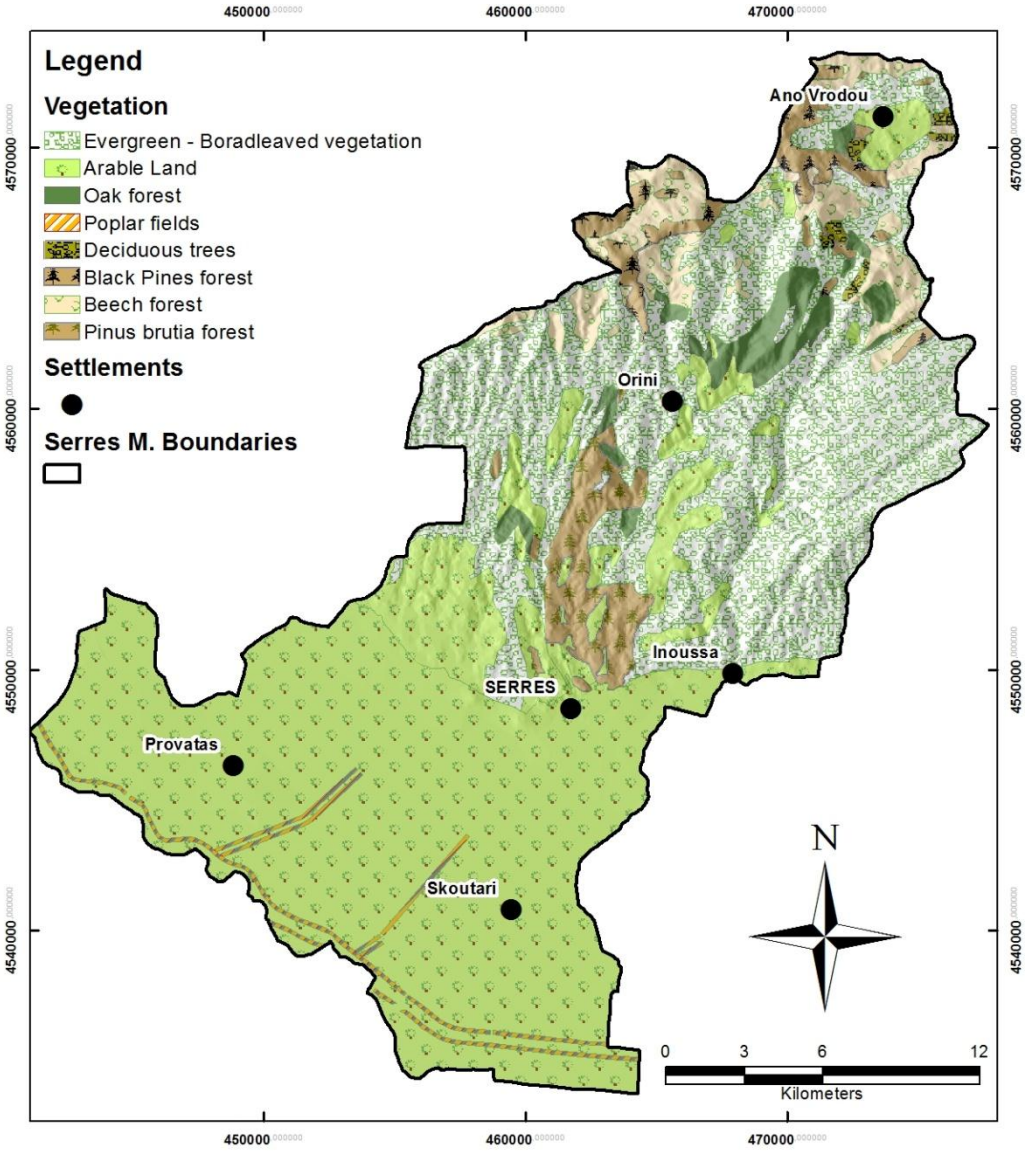


Figure 4.46: Serres municipality vegetation map

4.9. Protected Natural Sites, Parks and Conservation areas map

Add the municipality boundaries layer along with "Natura.shp" layer which you can download at: http://geodata.gov.gr/geodata/ (Figure 4.47). Use "Clip" tool (see Chapter 4.2) to extract the Natura.shp features outside the municipality boundaries. Follow guidelines from Chapters 4.1.1 - 4.1.3 and 4.7 to create the final Natura sites map, which should be similar to the Figure 4.48 map. Follow the same guidelines to add any other protected areas dataset to your map.

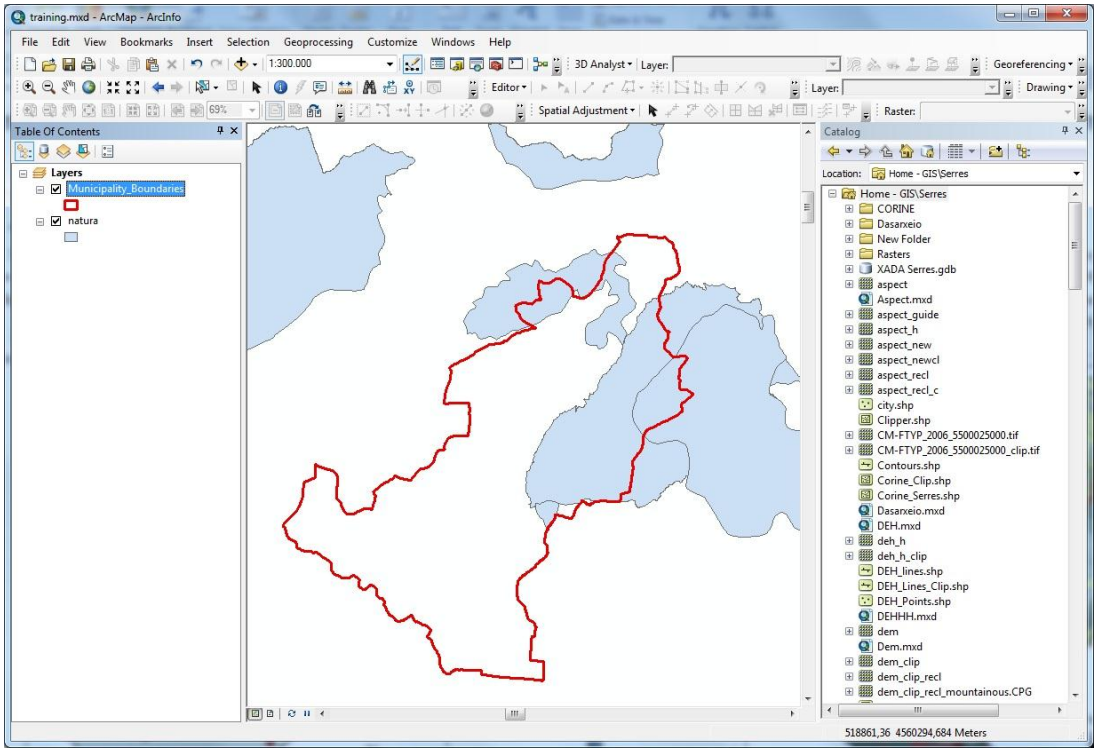


Figure 4.47

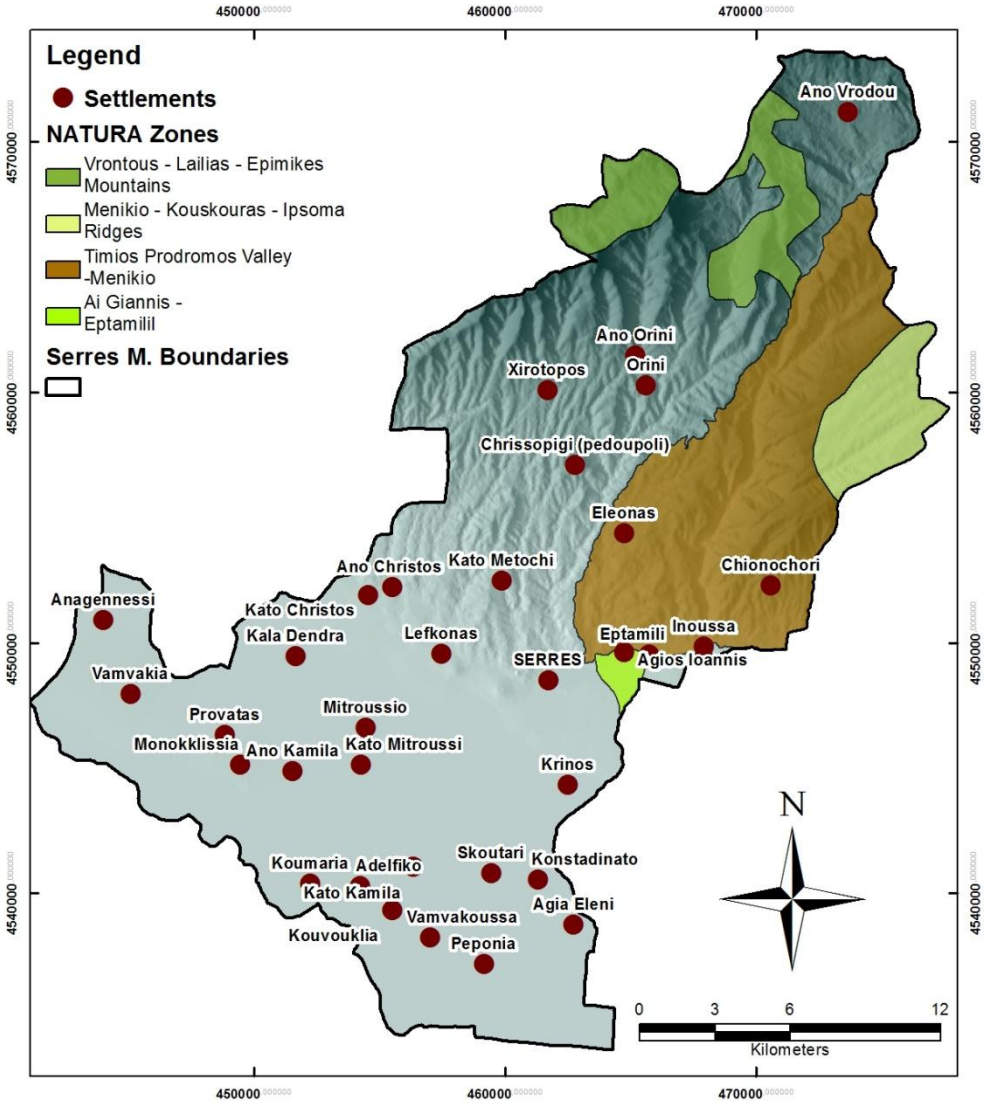


Figure 4.48: Serres municipality Natura sites map

4.10. Road network map

Roads datasets are usually available at the municipalities urban planning services. Another option for Greek data are the 1:50.000 Hellenic Military Geographical Service maps, but they must be digitized (see Chapters 4.1.1 - 4.1.3). Create a new "Description" field in the roads shapefile attribute table and update it with the corresponding road category (paved/Ashpalt, Gravel/dirt road, etc). Roads should have discrete symbols for each category (see how to edit Symbology in Chapter 4.7).

Add the Municipality DEM and Settlements layers and create the final layout, which should be similar to the map of Figure 4.49. See Chapter 4.8 for instructions on highlighting areas with high fire risk potential.

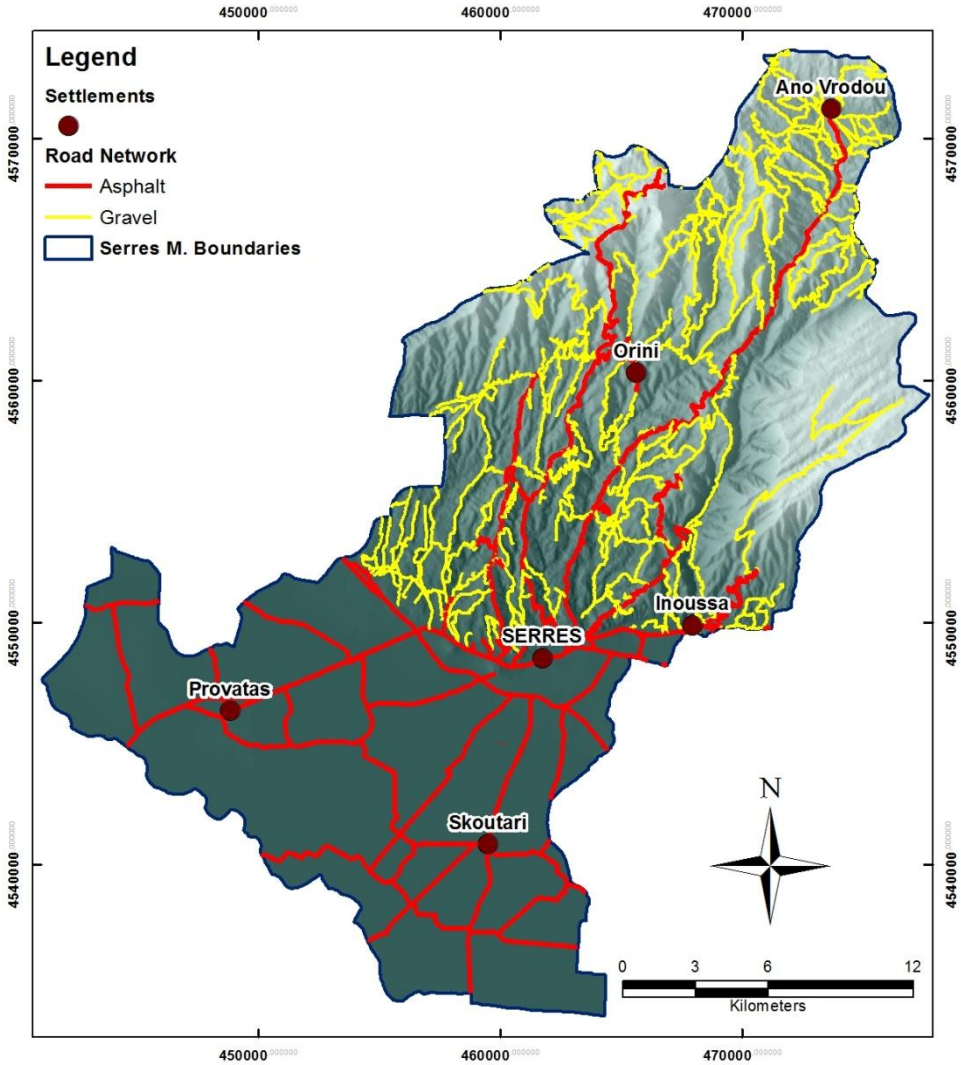


Figure 4.49: Serres municipality roads map

4.11. High and Medium voltage electricity network

If no electricity network is available in shapefiles, you can digitize the Electric Provider's scanned maps (see Chapters 4.1.1- 4.1.3). See Chapters 4.7 and 4.10 for instructions on different distribution lines and substations symbology.

Final layout should be similar to the one at Figure 4.50.

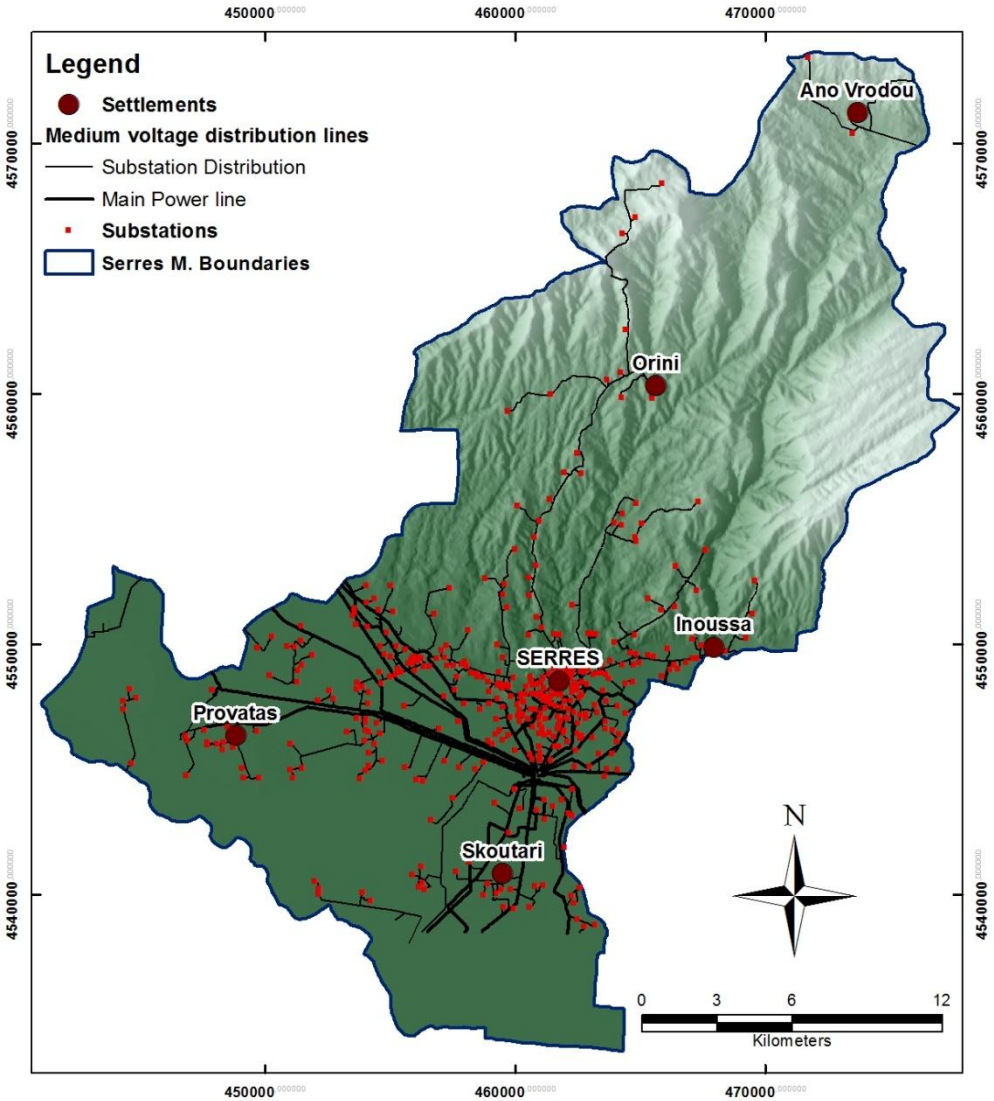


Figure 4.50: Serres municipality medium voltage distribution lines and substations

You can also add the Vegetation layer and highlight the areas of high risk (see also Chapter 4.8), where power distribution lines cross vulnerable vegetation.

4.12. Waterpoints map

Waterpoints datasets are usually available either in shapefiles or in spreadsheets (e.g. Excel files) with two separate columns for their longitude and latitude coordinates.

In the first case, just add the shapefile on your map window and edit their symbology (see also Chapters 4.1.2 and 4.7). If your data are in a spreadsheet click "File ==> Add Data ==> Add XY Data..." on the main menu bar (Figure 4.51). Browse for your Excel file and define the X and Y columns on the "Add XY Data" window (Figure 4.52). Click "OK" to add the waterpoints features to your map and edit their symbology (see also Chapters 4.7 and 4.10).

Final layout should be similar to Figure 4.53.

Areas with poor or no waterpoints distribution can be highlighted following the instructions at Chapter 4.8.

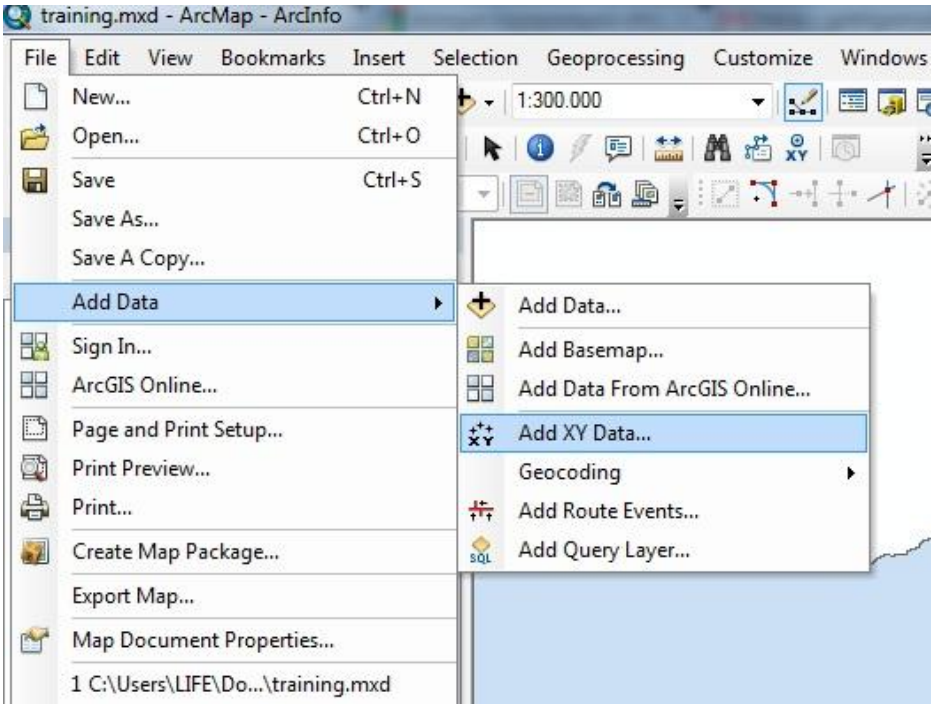


Figure 4.51

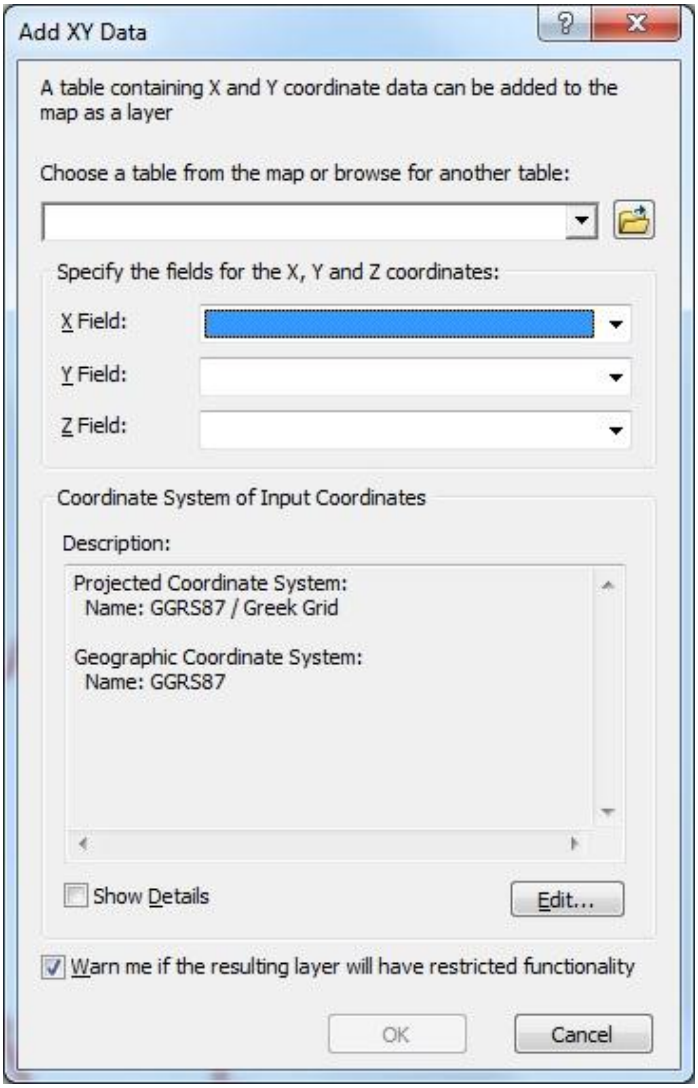

Add XY Data
A table containing X and Y coordinate data can be added to the map as a layer
Choose a table from the map or browse for another table:
Specify the fields for the X, Y and Z coordinates:
X Field:
Y Field:
Z Field:
Coordinate System of Input Coordinates
Description:
Projected Coordinate System:
Name: GGRS87 / Greek Grid
Geographic Coordinate System:
Name: GGRS87
Show Details
Edit...
Warn me if the resulting layer will have restricted functionality
OK
Cancel

Figure 4.52

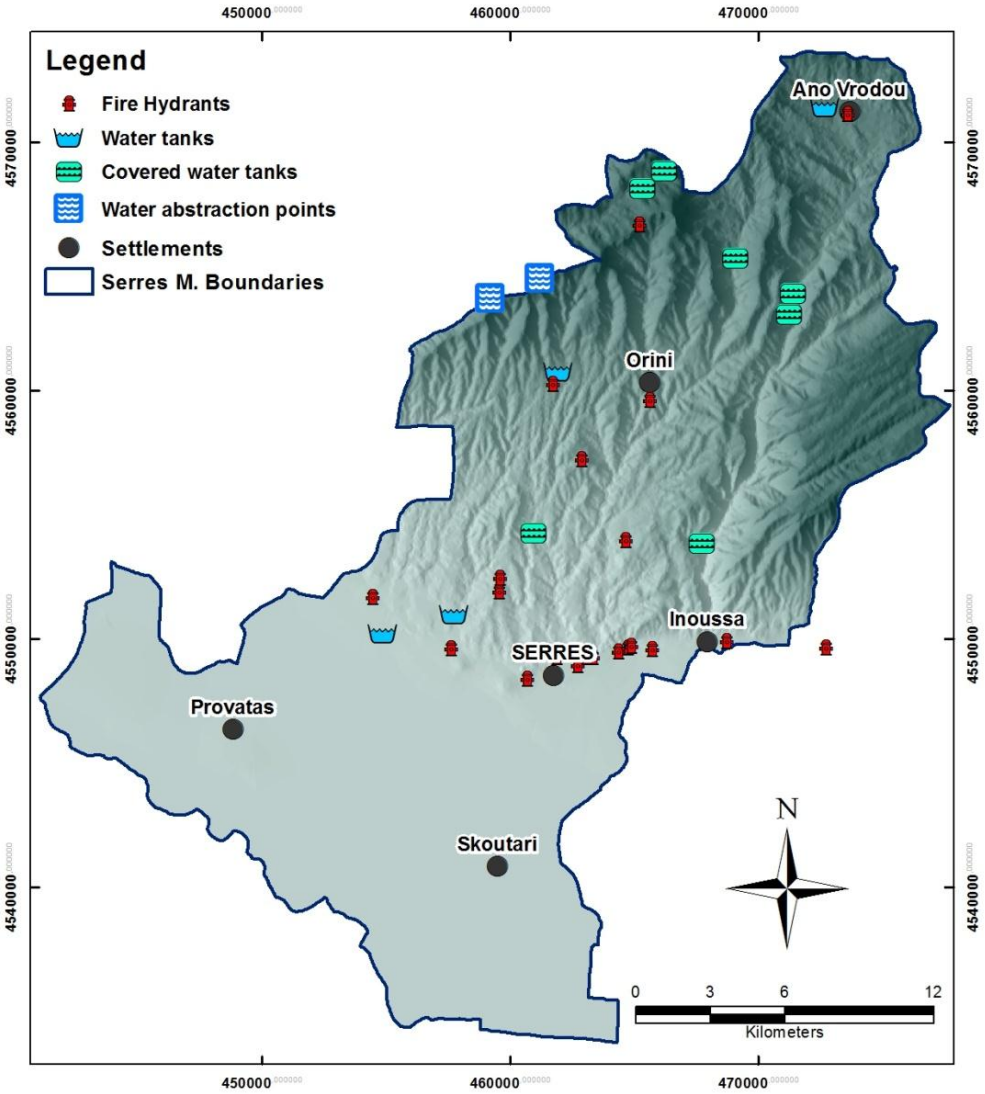


Figure 4.53: Distribution of waterpoints in the municipality of Serres

4.13. Landfills map

Similarly to the previous Chapter, Landfill datasets are usually available either in shapefiles or in spreadsheets (e.g. Excel files) with two separate columns for their longitude and latitude coordinates.

In the case of shapefile availability, just add the shapefile on your map window and edit their symbology (see also Chapters 4.1.2 and 4.7). If your data are in a spreadsheet follow the instructions presented in Chapter 4.12.

Final layout should be similar to Figure 4.54.

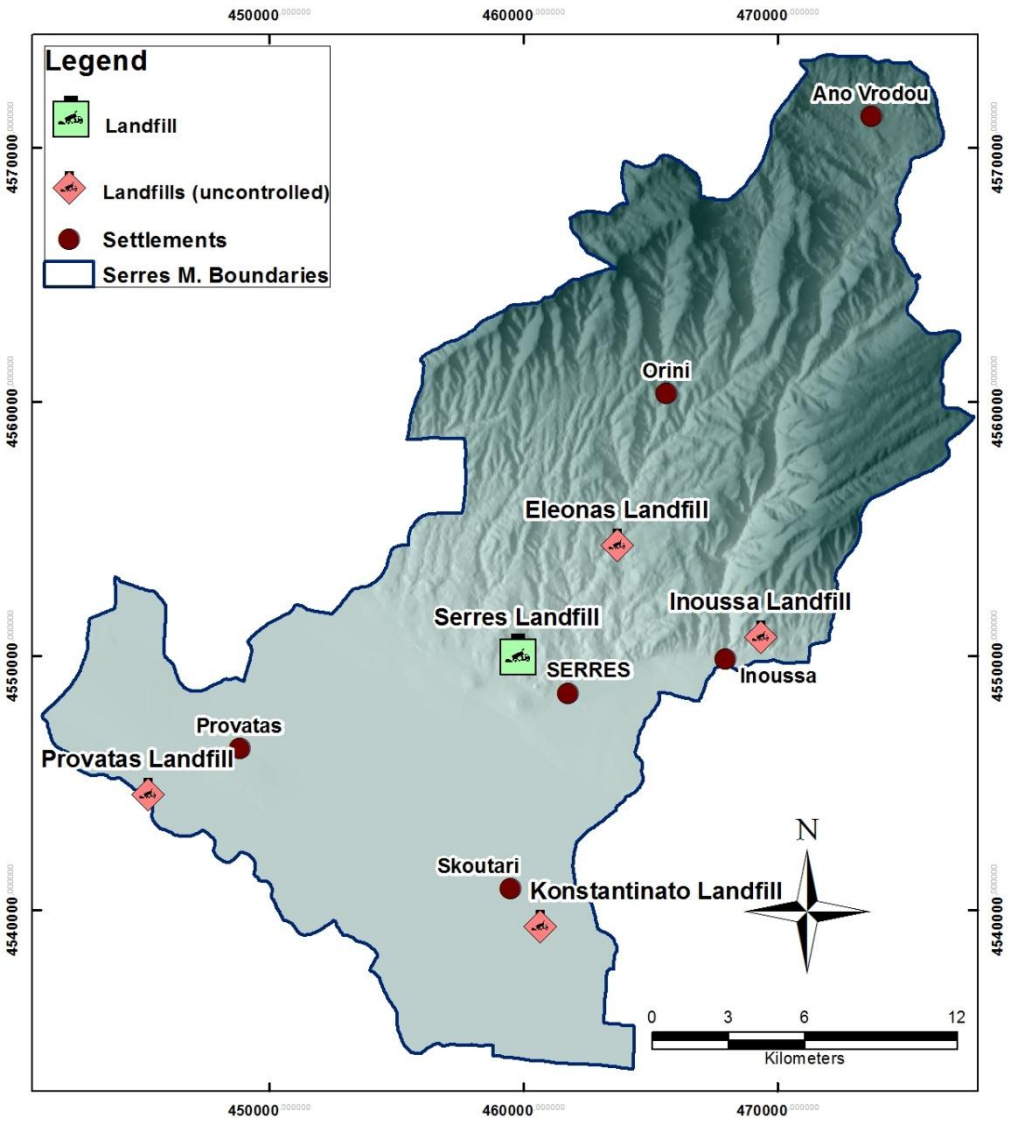


Figure 4.54: Serres municipality landfills map

4.14. Map of past forest fires

Usually no datasets are available regarding old wildfires. Newer maps are available and extracted from Google Earth and other satellite images and display the boundaries of the burnt areas in digital form. In case any information is provided, maps can be created using the instructions on previous Chapters.

4.15. Helicopter Landing Points and Areas of external assistance map.

Usually no datasets for Helicopter Landing Points are available. In case of external assistance sites, you can either use a spreadsheet with longitude and latitude coordinates (see Chapter 4.12 for instructions) or a shapefile. In many cases, when a small number of such points exists, it is easier to digitize them directly on your map (see Chapter 4.1.3).

Final layout should be similar to Figure 4.55.

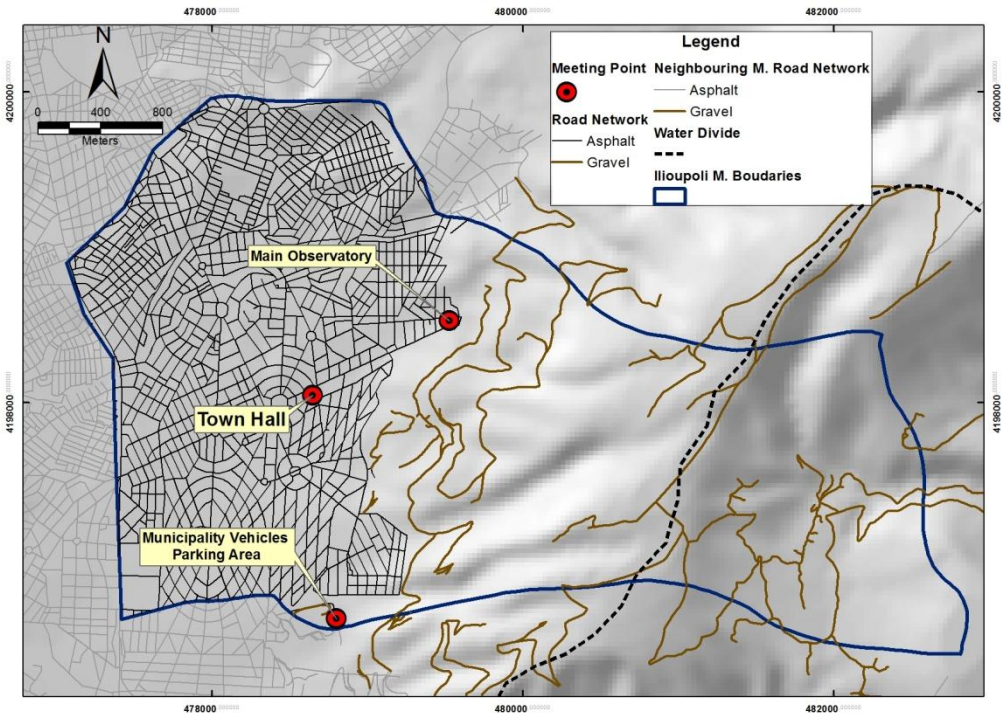


Figure 4.55: Map showing the sites where the external assistance will be gathered in the municipality of Ilioupoli.

4.16. Observatory Points – Visibility map

Observatory points and the DEM of the surrounding areas are the optimum datasets for a Visibility map. Create the Observatory points dataset using the instructions on Chapter 4.12. In case no such data are available you can use the datasets within the Municipality area.

Add the DEM and the Observatory points layers on your map (Figure 4.56) and select Arc Toolbox ==> 3D Analyst Tools ==> Raster Surface ==> Viewshed (Figure 4.57). In the Viewshed tool window (Figure 4.58) select the DEM (e.g. dem_guide) layer for the "Input Raster" field and the observatory points layer for the "Input point of polyline observer features". Browse for the destination folder and choose a name for the new raster on the "Output Raster" field.

Final layout should be similar to Figure 4.59.

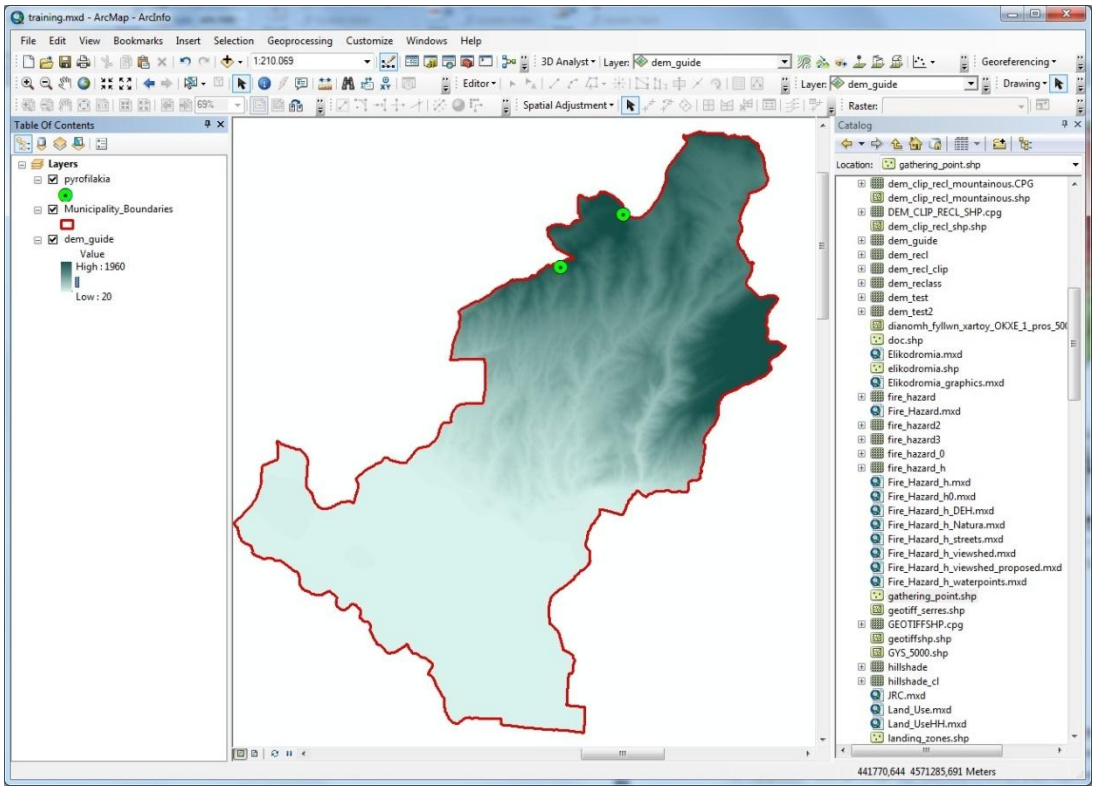


Figure 4.56

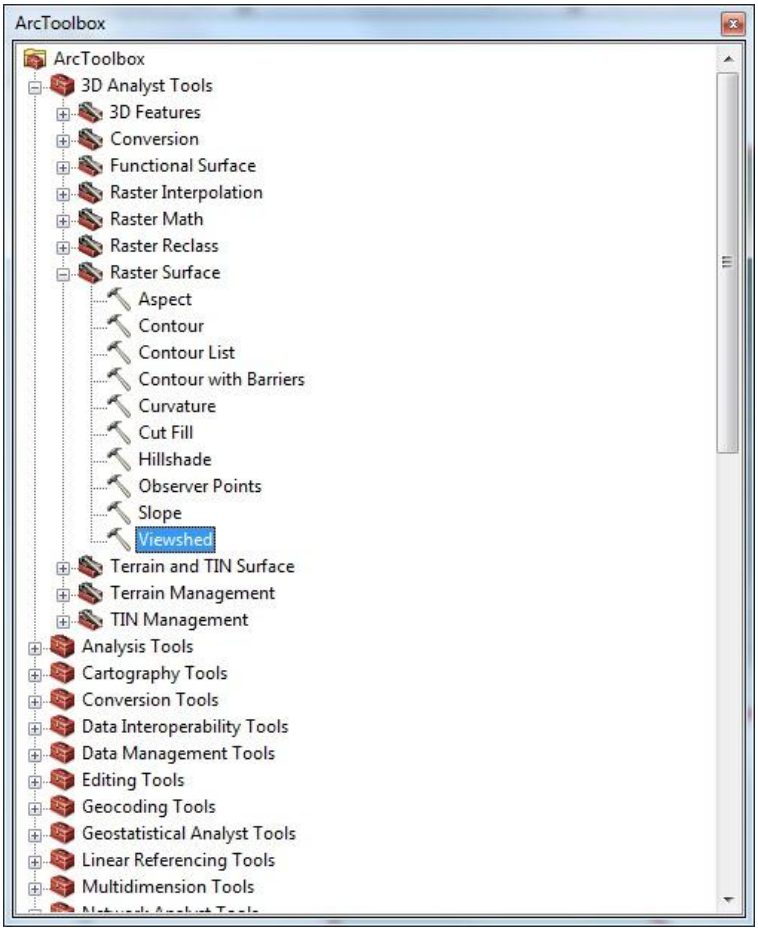


Figure 4.57

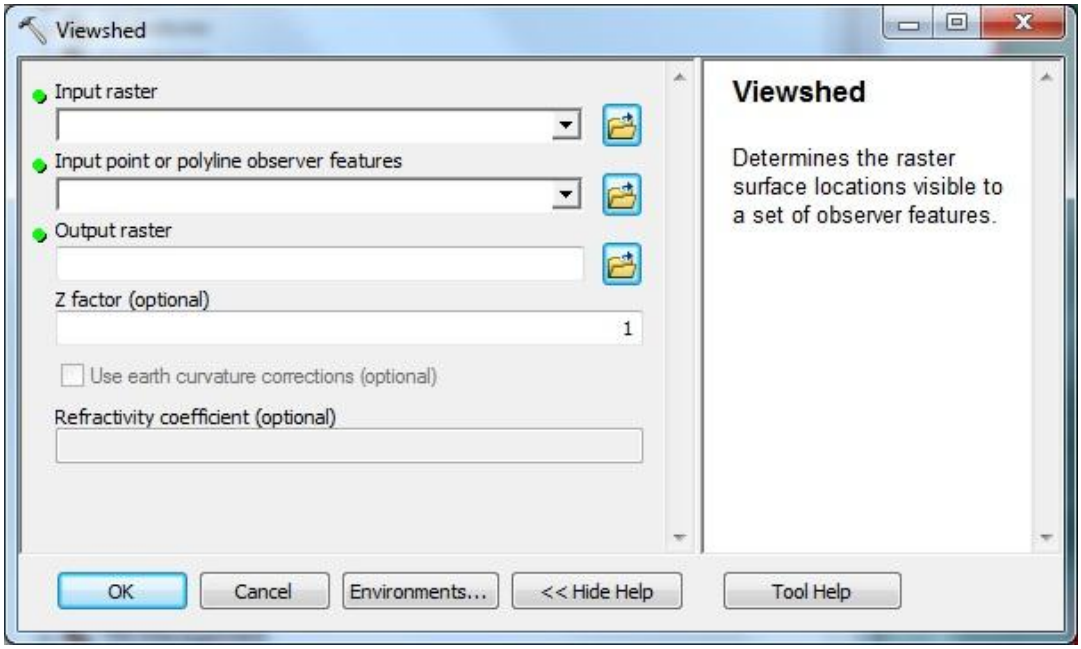


Figure 4.58

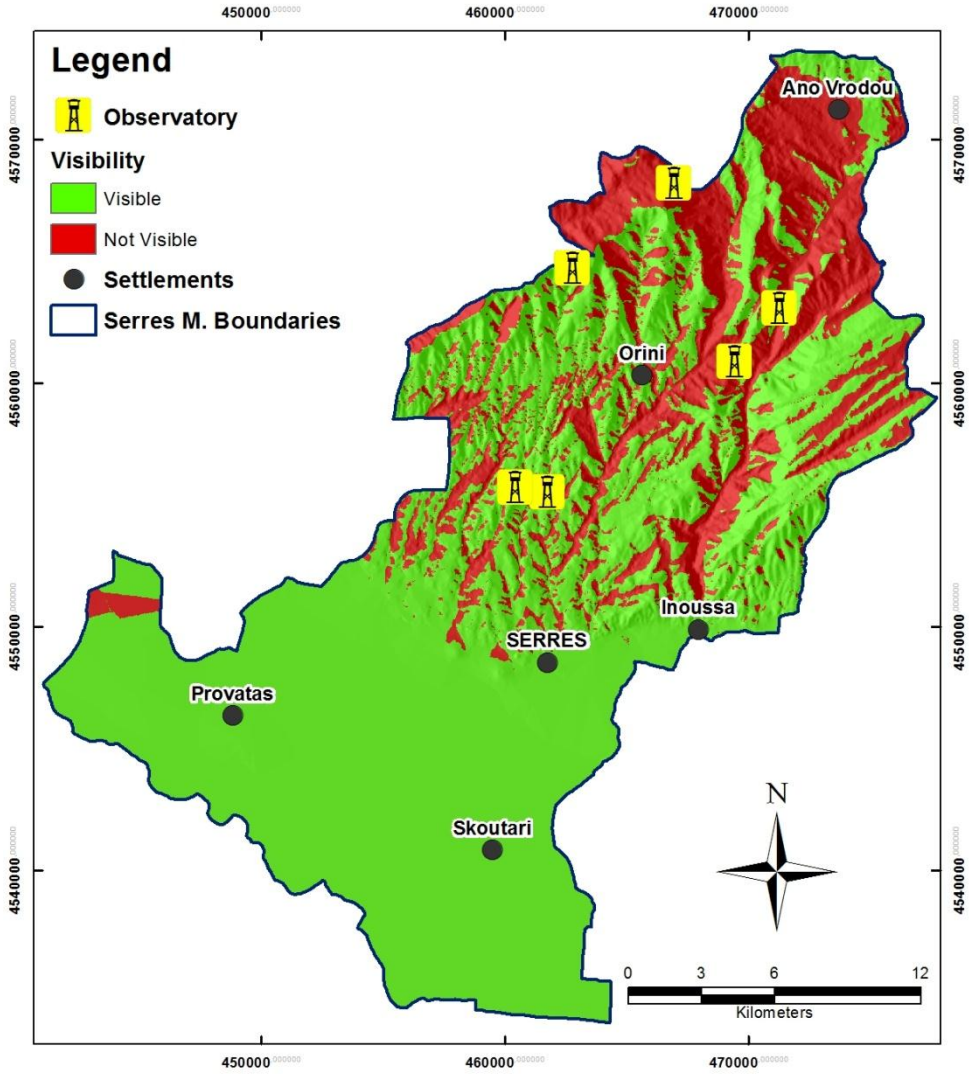


Figure 4.59: Serres municipality view points and visibility map

4.17. Qualitative multiparameter fire hazard maps

You can create qualitative multiparameter fire hazard maps by simply overlapping different layers (e.g. Vegetation, Roads, Visibility, Waterpoints etc) in a GIS software. Examples for such types of maps are available in the next figures (Figure 4.60 - Figure 4.62). See Chapter 4.8 for instructions on highlighting areas with high fire risk potential.

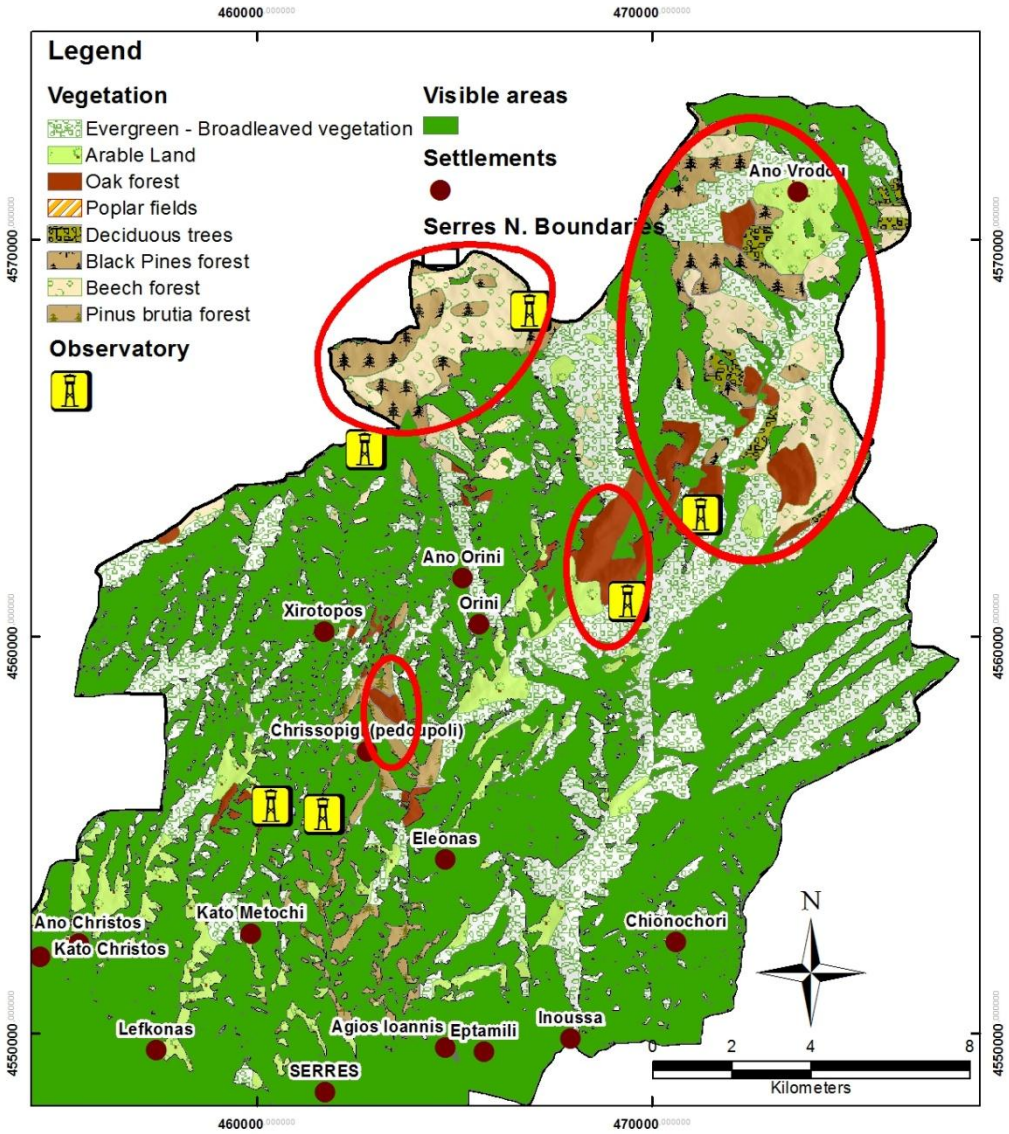


Figure 4.60: Qualitative multiparameter fire hazard map combining vegetation and visibility layers

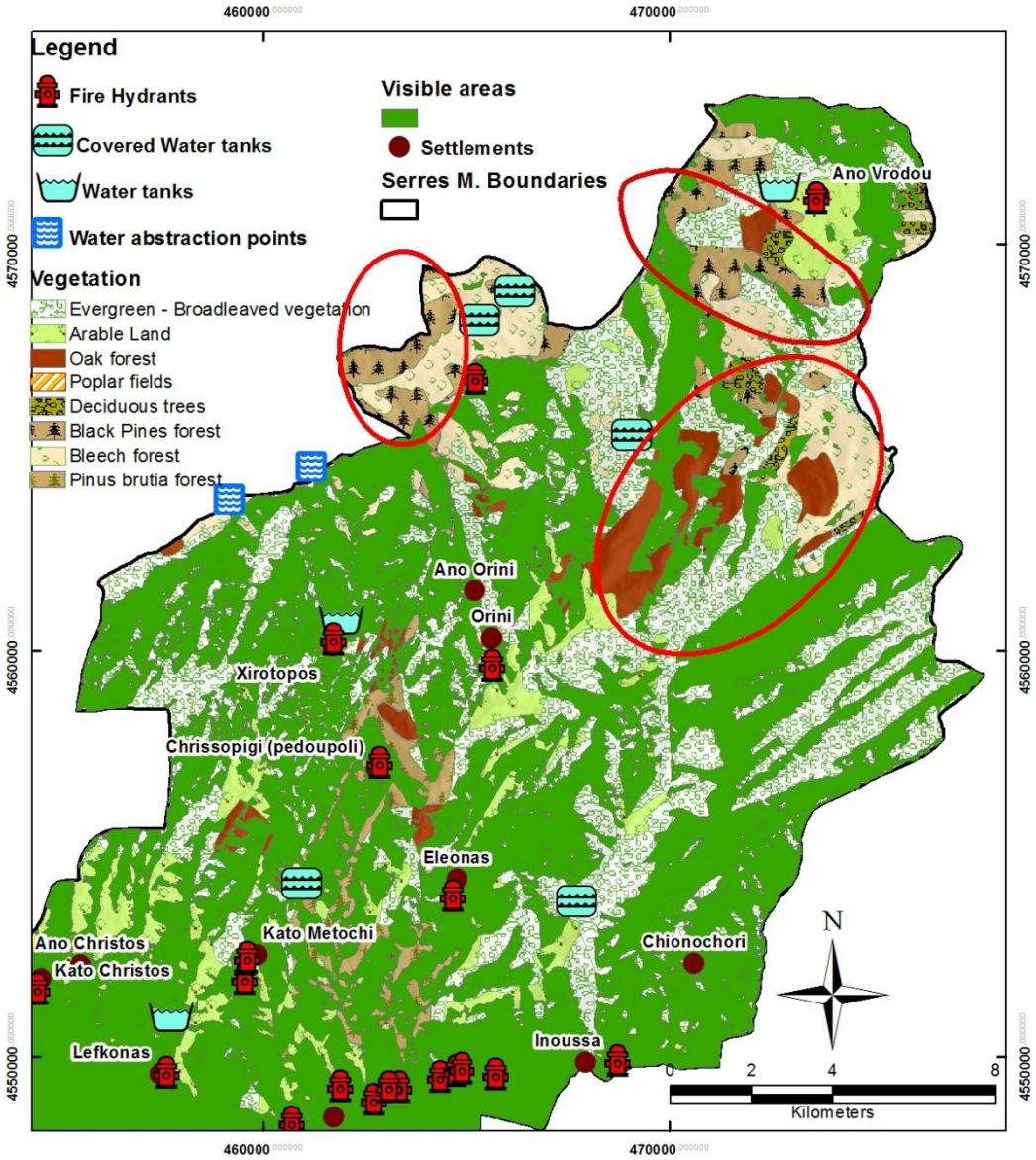


Figure 4.61: Qualitative multiparameter fire hazard map using vegetation, visibility and waterpoints layers

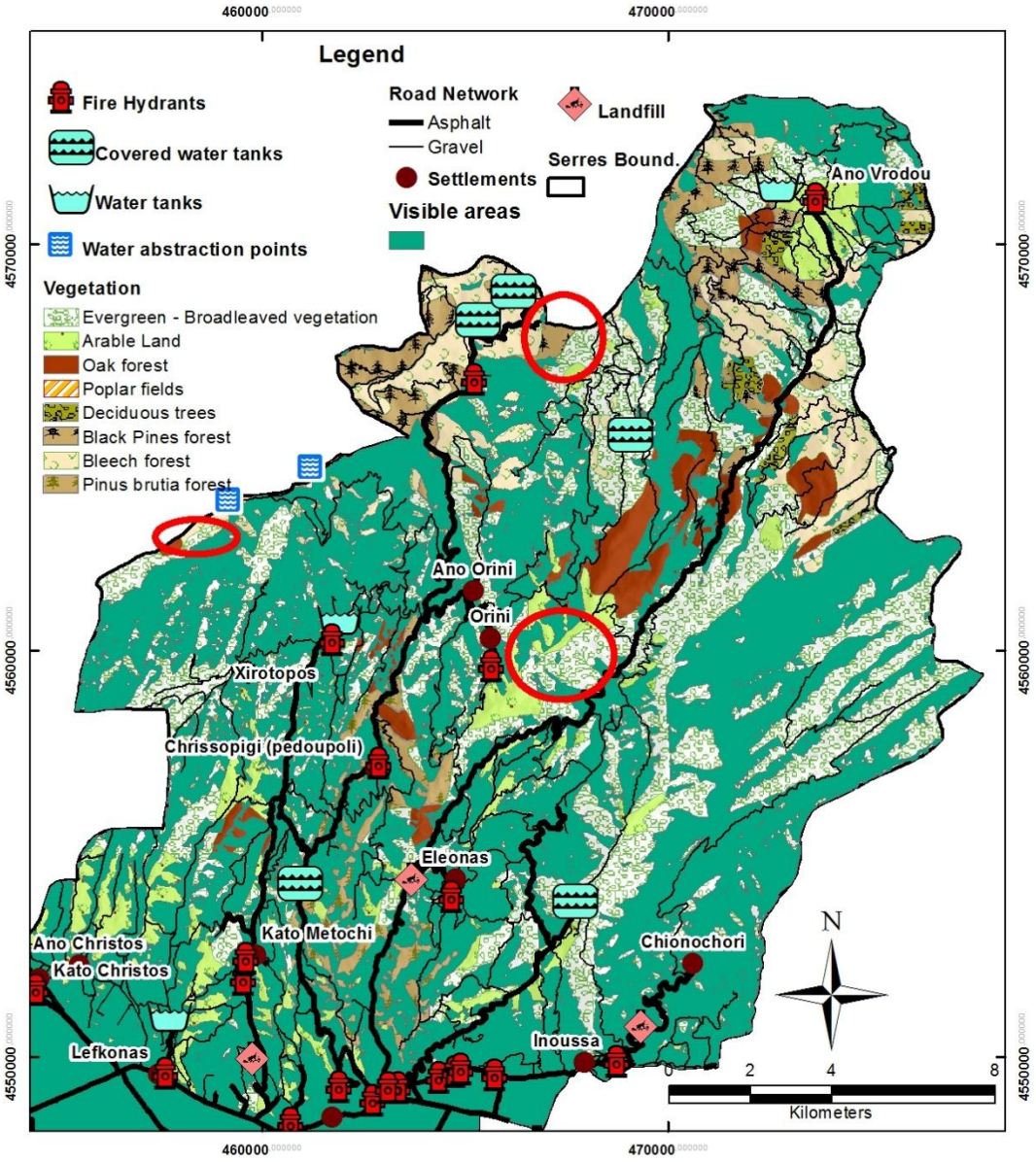


Figure 4.62: Qualitative multiparameter fire hazard map using vegetation, visibility, waterpoints, roads and landfills layers

4.18. Quantitative combinational fire hazard maps

The Universtity of Athens Laboratory of Natural Hazards' Prevention and Management has developed a model for 5 scaled quantitative combinational fire hazard maps, under the "Local Authorities for Forest Fire Prevention" Life EU Project. This model is a modified version of the Golden Gate National Recreation Area Fire Management Plant Fire Hazard Model (FEIS, 2005).

Input variables of this model are both natural, weighting of 65% and human, weighting 35%. Natural variables include vegetation (45%), slope (15%) and aspect (5%), while human

variables include settlements and landfills (13%), roads (12%) and high and medium electricity network (10%).

Hazard ratings vary from 1 (lowest) to 5 (highest) for each variable (Table 4.1).

VARIABLE	HAZARD RATING		WEIGHT
Vegetation	Coniferous Forest	5	45%
	Broad-leaved Forest	4	
	Dense bushes	3	
	Sparse bushes	2	
	Agricultural areas	1	
Slope (%)	40,1% -	5	15%
	13,1% - 40%	3	
	0% - 13%	1	
Aspect (degrees)	135° - 270°	5	5%
	46° - 135° and 271° - 315°	3	
	0° - 45° and 316° - 360°	1	
Settlements - Landfills	Settlements (400m buffer zone)	4	13%
	Landfills (100m buffer zone)	5	
Roads (50m buffer zone)	Asphalt / Paved road	5	12%
	Gravel/ non paved/ dirt road	4	
Power distribution lines (30m buffer zone for medium and 50m for high voltage respectively)	5		10%

Table 4.1: Input variables, weights and hazard ratings for the Quantitative multiparameter Fire Hazard model

The qualitative multiparameter map can be developed in 6 Steps:

Step 1: Add a new "Class" field in the Vegetation layer's "Attribute table" (follow instructions on Chapter 4.1.2) and update it for every feature following the Hazard Rating

column on Table 4.1. Click Arc Toolbox ==> Conversion Tools ==> To Raster ==> Polygon to Raster (Figure 4.63). In the Polygon to Raster tool window (Figure 4.64) select the Vegetation layer as "Input Feature" and the new "Class" field as "Value Field". Browse for the destination folder and choose a name for the new raster at the "Output Raster" field. It is not necessary to fill the optional fields. Click "OK" to create a new Raster layer with pixel values ranging from 1 up to 5, depending on the vegetation flammability and vulnerability to fire (Figure 4.65).

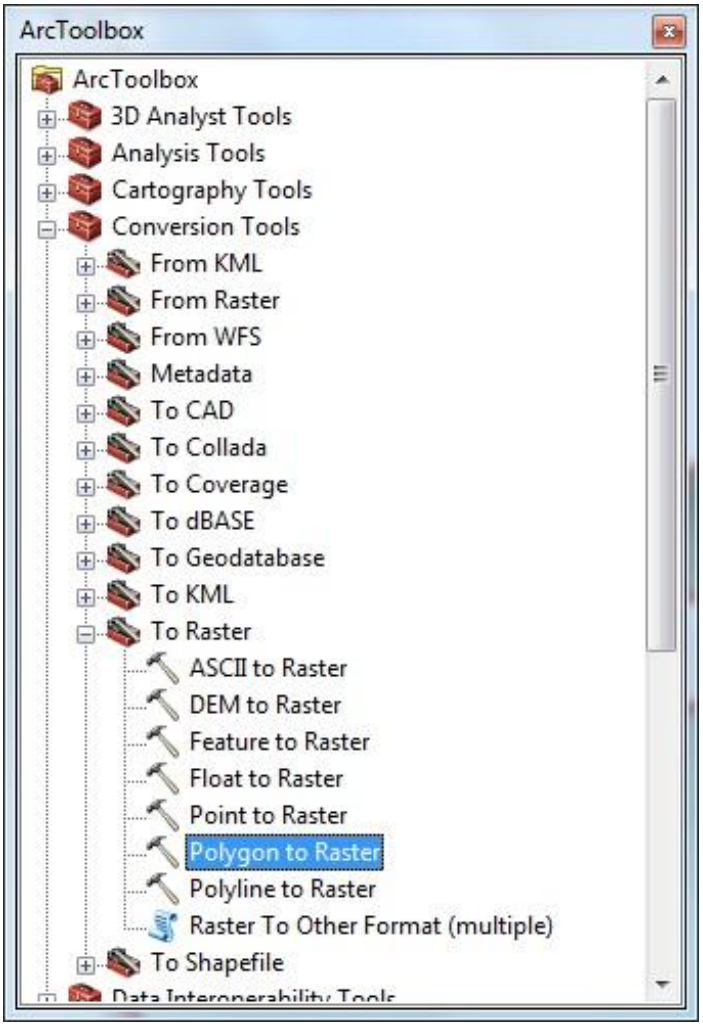


Figure 4.63

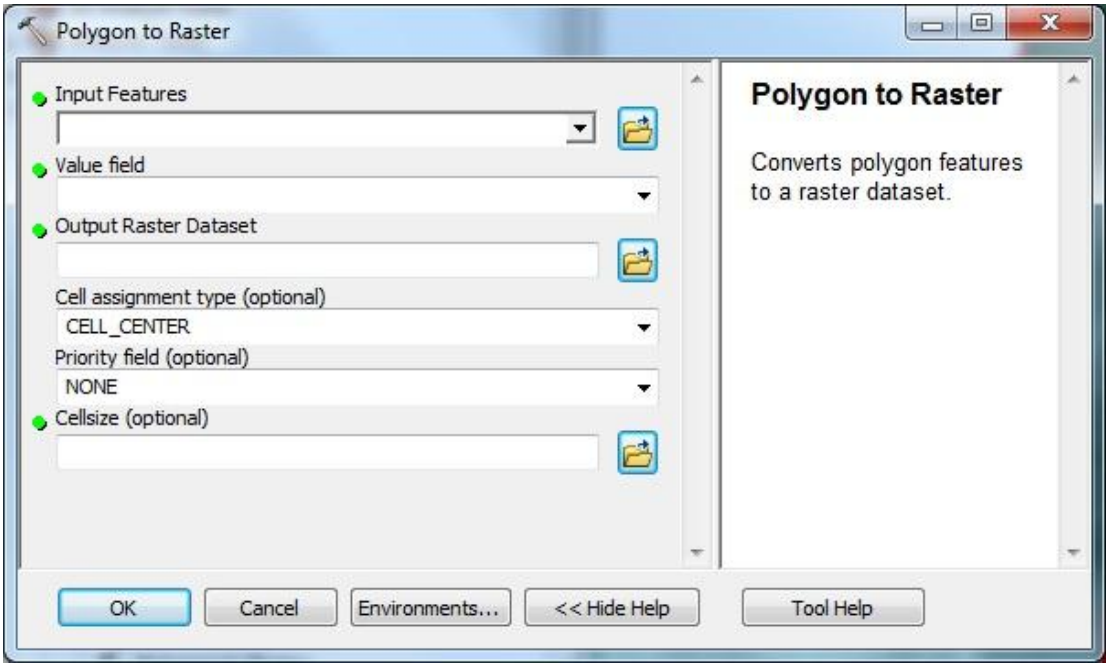


Figure 4.64

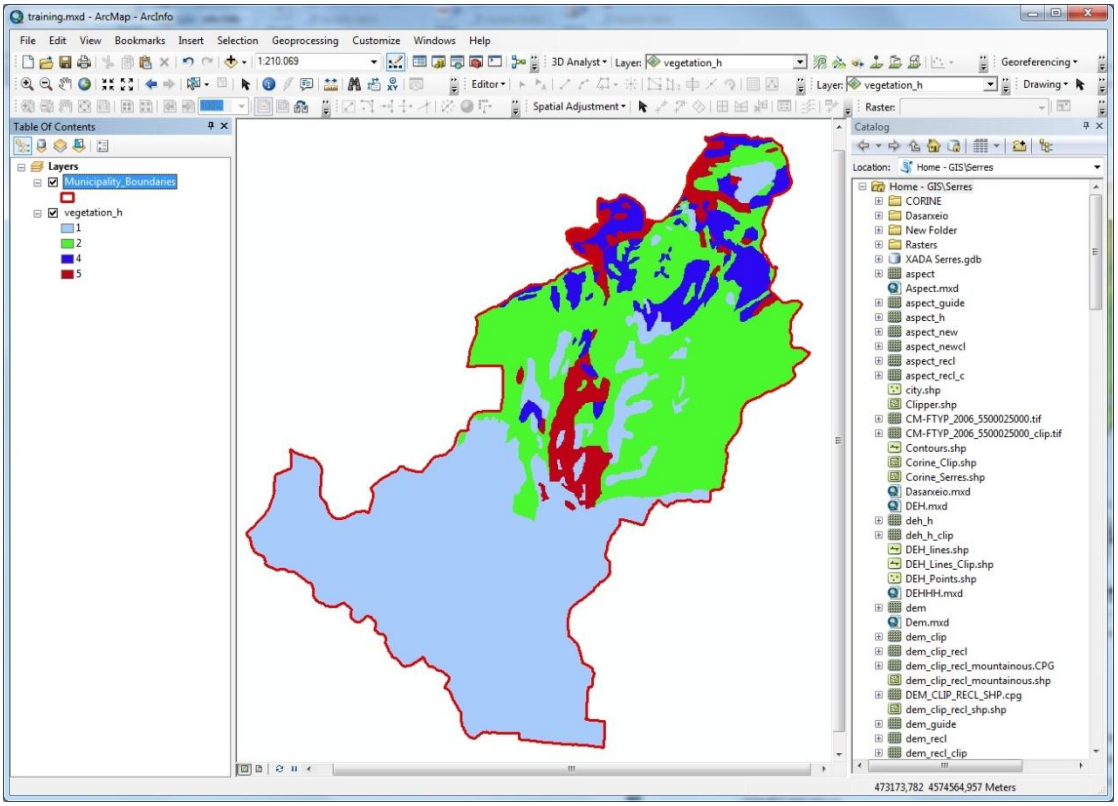


Figure 4.65

Step 2: Reclassify the slope and aspect raster pixels so as to comply with the hazard ratings of Table 4.1. For the aspect map, select Arc Toolbox ==> Spatial Analyst Tools ==> Reclass ==> Reclassify (Figure 4.66). In the Reclassify tool window (Figure 4.67) select the aspect raster as "Input raster" and Value field as "Reclass Field". Browse for the destination folder and choose a name for the new raster (e.g. "aspect_rec") at the "Output Raster" field. Select and delete all Values in the "Reclassification" field by clicking the "Delete Entries" button. Click the "Add Entry" to add new hazard ratings for every aspect width, following the Hazard Ratings column of Table 4.1, as shown in Figure 4.68. Click "OK" to create the new reclassified raster file with pixel values 1, 3 and 5, depending on the aspect (Figure 4.69). Follow the same instructions for the reclassified slope map, using the hazard rating values of Table 4.1.

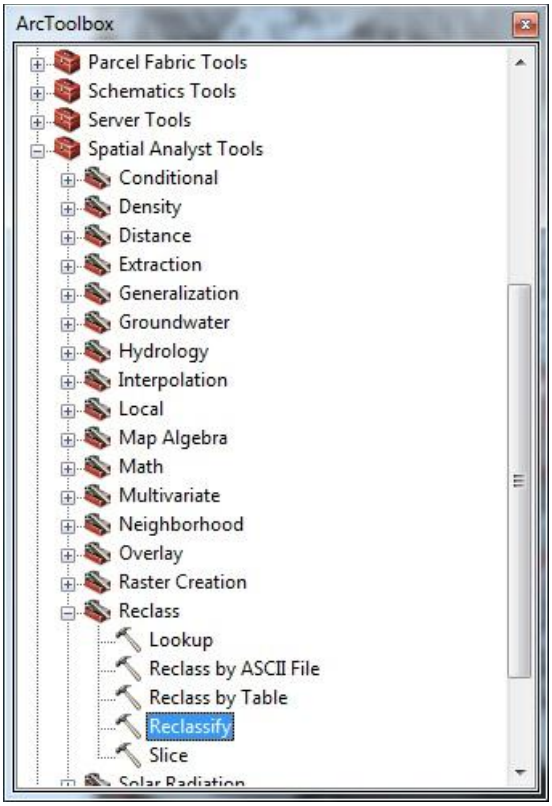


Figure 4.66

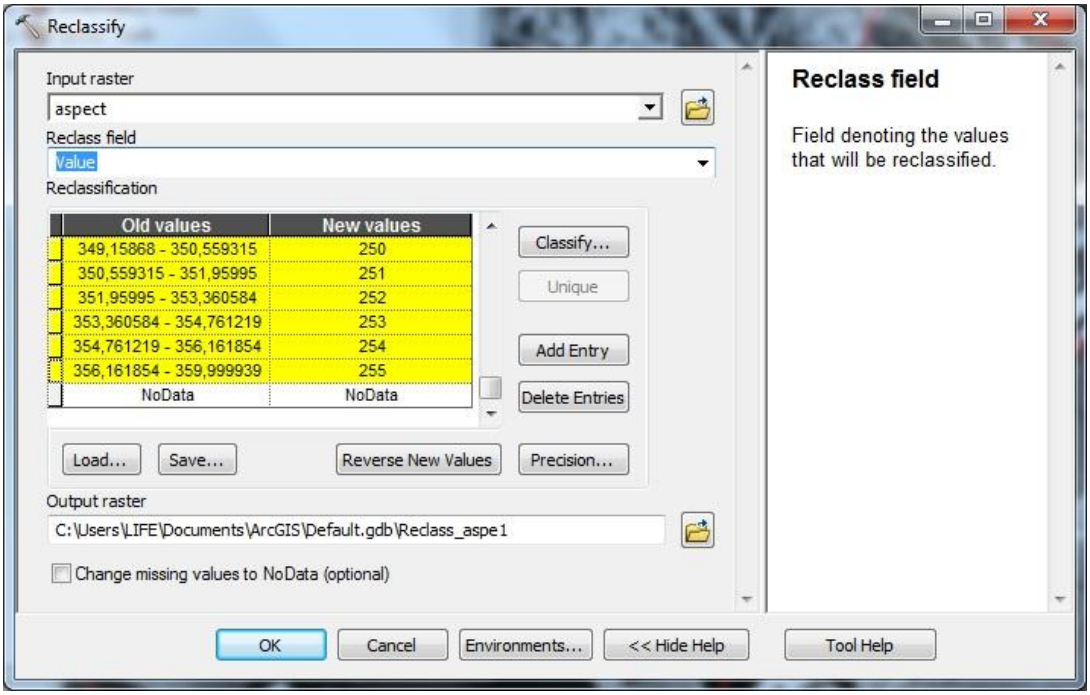


Figure 4.67

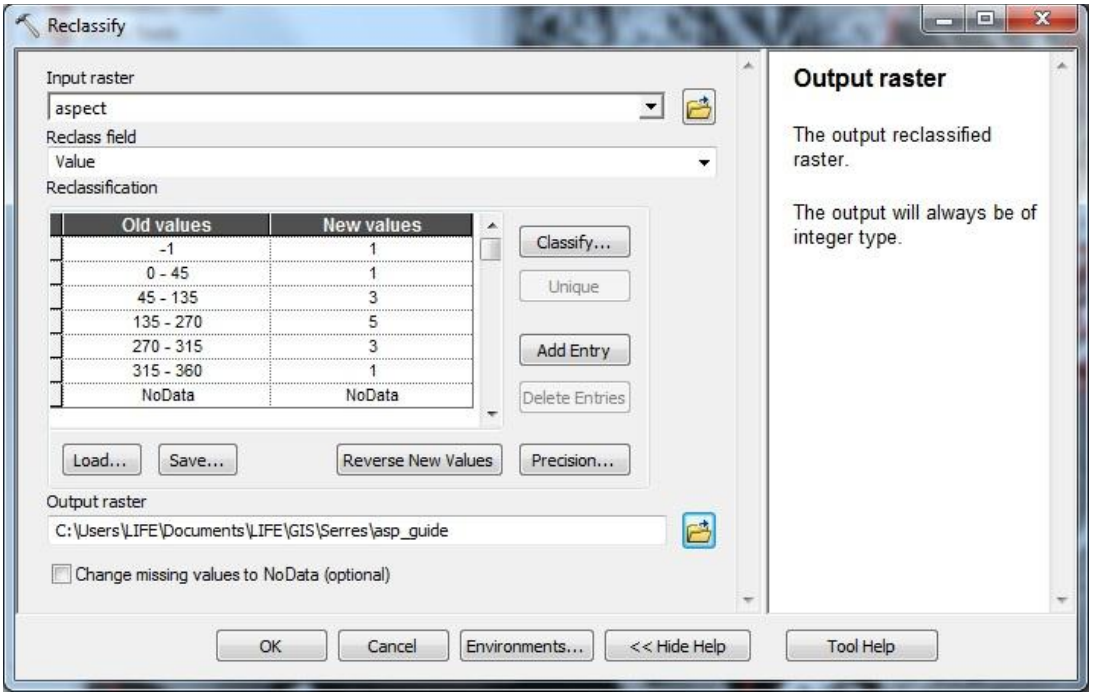


Figure 4.68

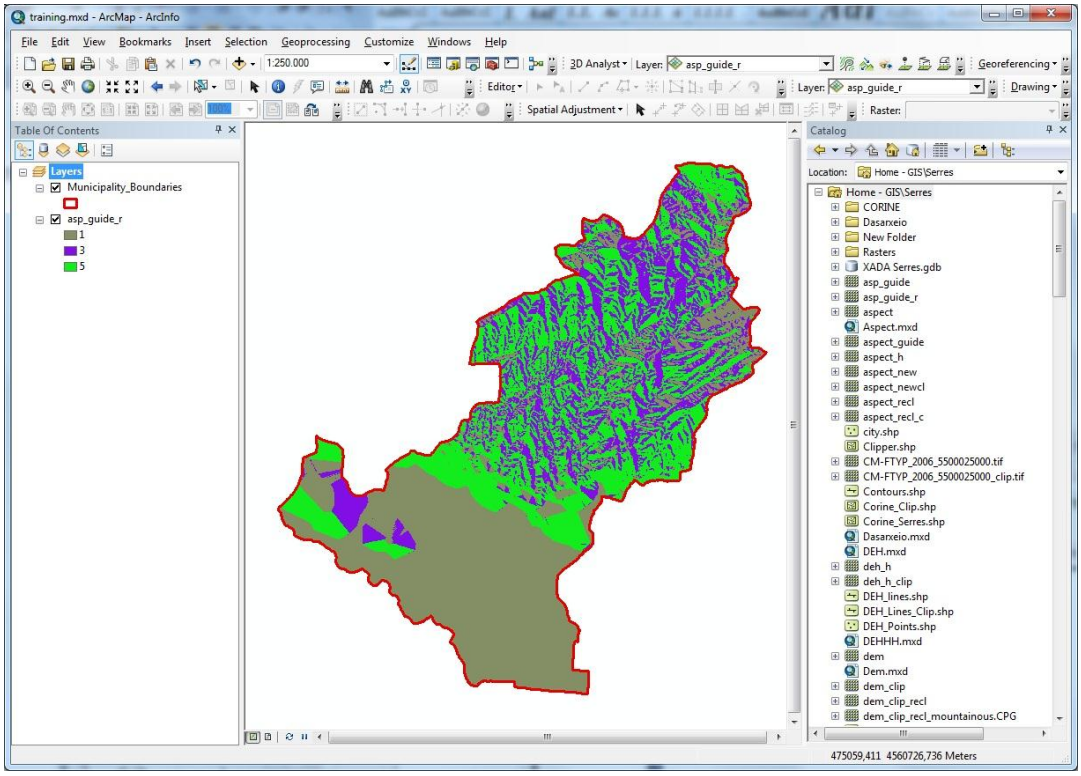


Figure 4.69

Step 3: Add the Settlements layer in your map window. Select Arc Toolbox ==> Spatial Analyst Tools ==> Distance ==> Euclidean Distance (Figure 4.70). In the Euclidean Distance tool window (Figure 4.71) select the Settlements layer as "Input raster of feature source data". Browse for the destination folder and choose a name for the new raster (e.g. "settl_rec") at the "Output distance raster" field. It is not necessary to fill the optional fields. Click "OK" to create a new raster file with pixel values representing distance from Settlements (Figure 4.72). Use "Reclassify" tool (see also Step 2 on current Chapter) to create a new raster with pixel values 0 (for pixels more than 400m away from Settlements) or 4 (for pixels less than 400m away from Settlements), as shown in Table 4.1.

Follow the same instructions for the landfills map, using the "Euclidean Distance" and "Reclassify" tools, along with the Table 4.1 hazard rating values, and add both Settlements and Landfills reclassified rasters in your map window.

Then, select Arc Toolbox ==> Spatial Analyst Tools ==> Map Algebra ==> Raster Calculator (Figure 4.73) in order to sum both new reclassified rasters for Settlements and Landfills and create the final "Settlements-Landfills" variable (see Table 4.1). In the Raster Calculator tool window (Figure 4.74) double click on the Settlements raster on "Layers and Variables" section, click on "+" button and double click on the Landfills raster on "Layers and

Variables" section. Browse for the destination folder and choose a name for the new raster at the "Output distance raster" field. Click "OK" to create a new raster with pixel values 0, 4 or 5, depending on the pixels distance from Settlements or Landfills (Figure 4.76). In case some pixels have a value of 9 (settlements next to landfills) use "Reclassify" tool (see also Step 2 on current Chapter) to give these pixels the value of 5.

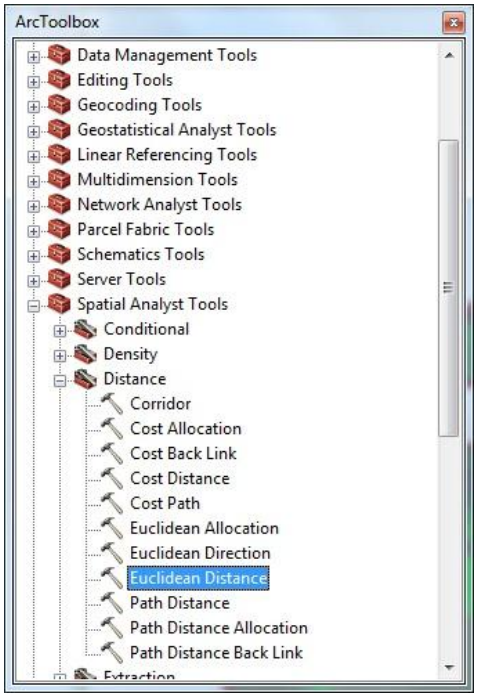


Figure 4.70

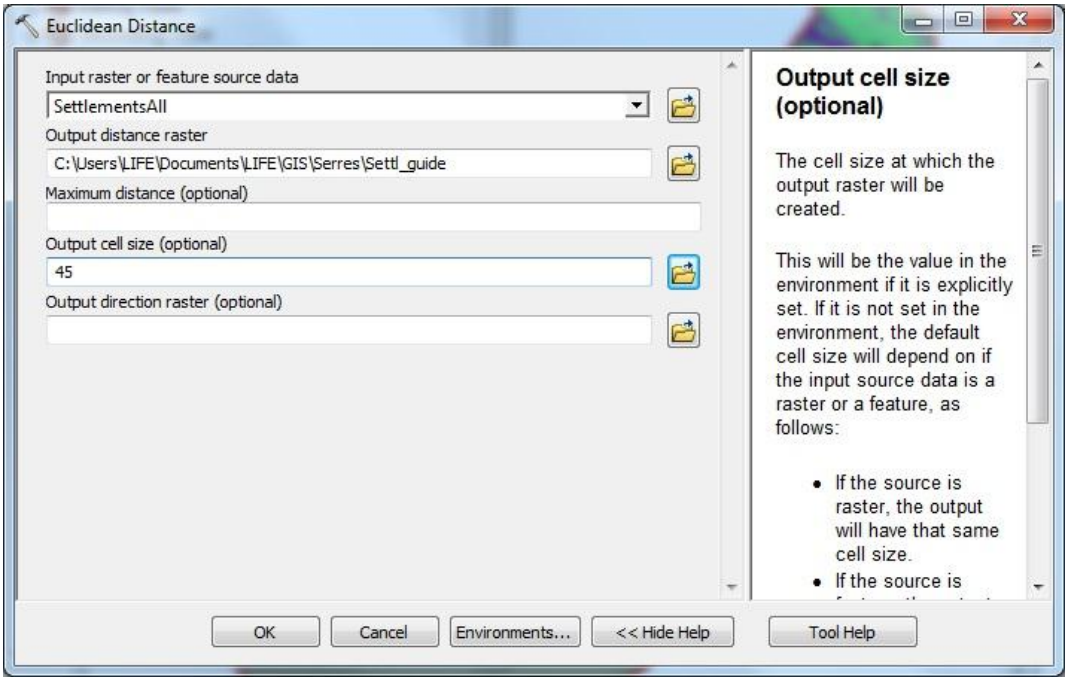


Figure 4.71

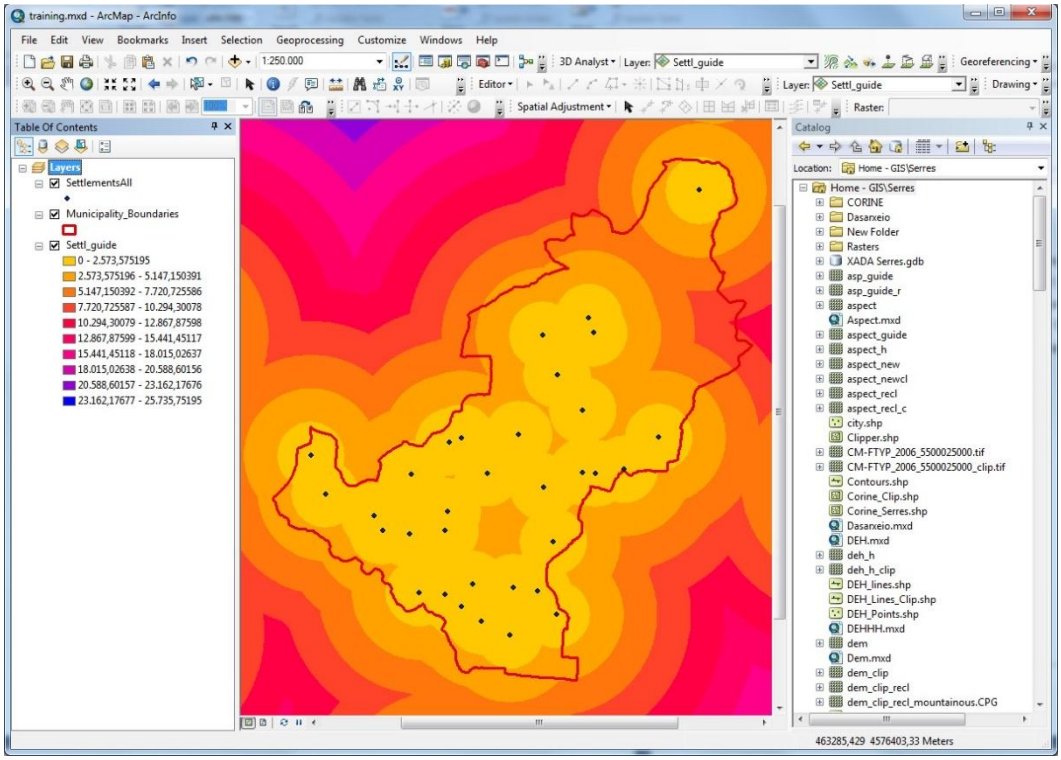


Figure 4.72

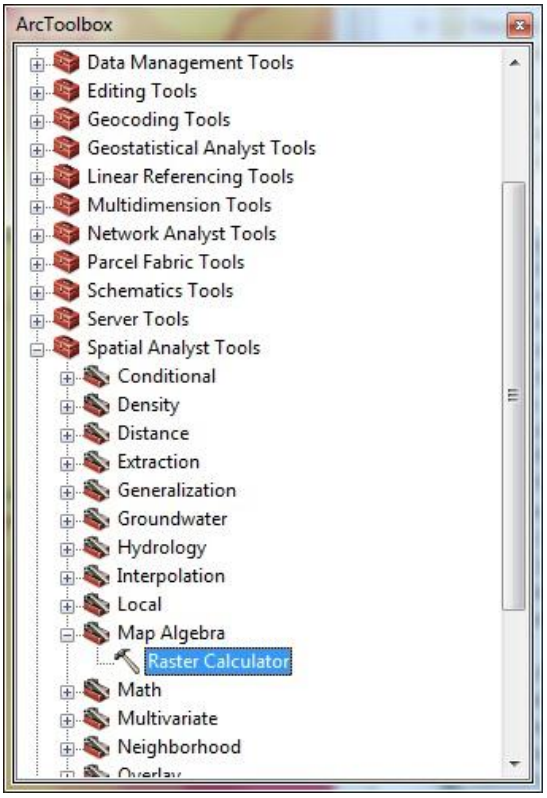


Figure 4.73

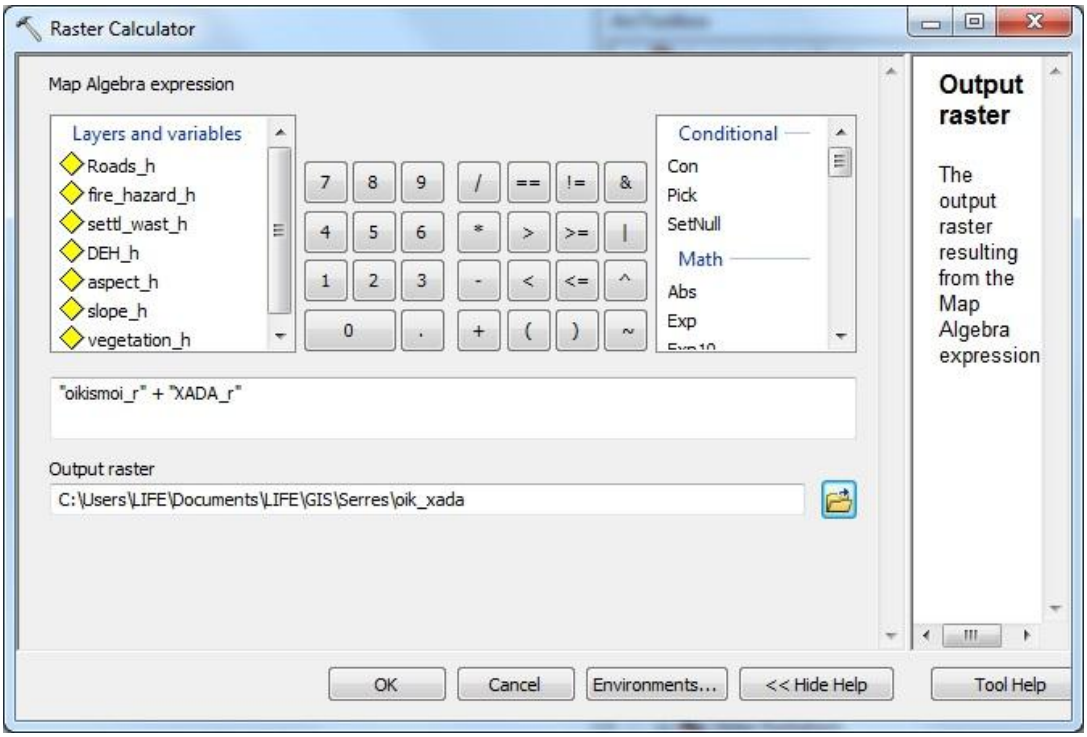


Figure 4.74

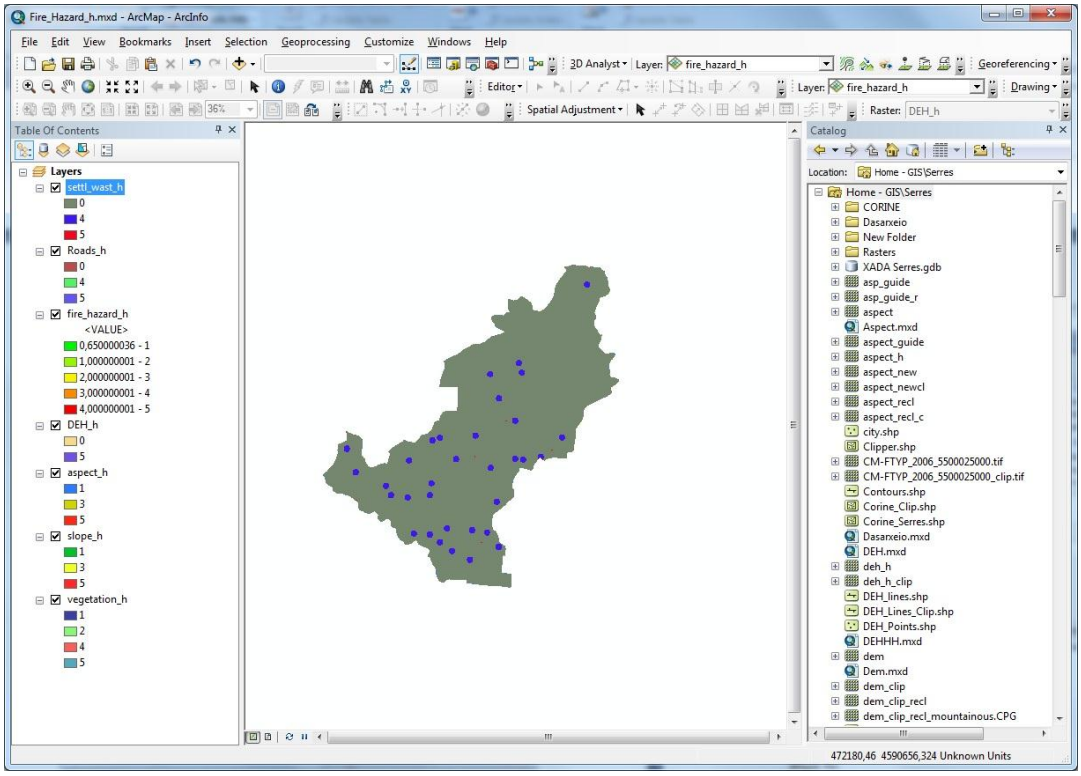


Figure 4.75

Step 4: Add the Roads layer in your map window. Create two separate layers, one for paved roads/asphalt and one for non-paved/dirt/gravel roads: in Arc Catalogue copy and paste the road layer in the same working folder, then delete the gravel roads from one roads layer and the asphalt roads from the other. Afterwards, follow the instructions given in this Chapter's Step 3 and Table 4.1 to create the roads reclassified raster (Figure 4.76).

Step 5: Create the reclassified power distribution lines raster following the instructions of Step 3 and Table 4.1.

Step 6: Add all the reclassified rasters you have already created in the previous steps in your map window. Use this operation: 0.45*"vegetation raster" + 0.15*"slope raster" + 0.05*"aspect raster" + 0.12*"roads raster" + 0.1*"power lines raster" + 0.13*"settlements and landfills raster" as a guide to sum the reclassified rasters with "Raster Calculator" tool (see also Step 3 on this Chapter) and the "Weight" column in Table 4.1 (Figure 4.78).

At the Table of Contents right click on the Output Raster ==> Properties ==> Symbology, and change the raster symbology using different colors for the following classes: 0-1, 1-2, 2-3, 3-4 and 4-5 (see also Chapter 4.2).

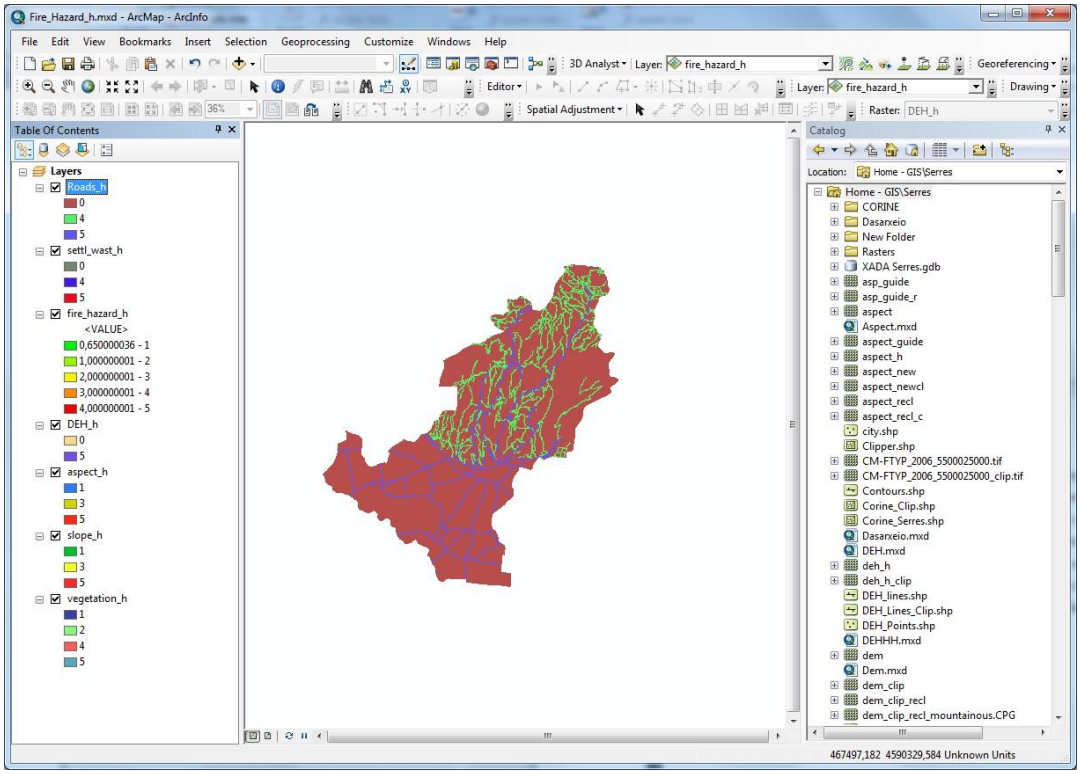


Figure 4.76

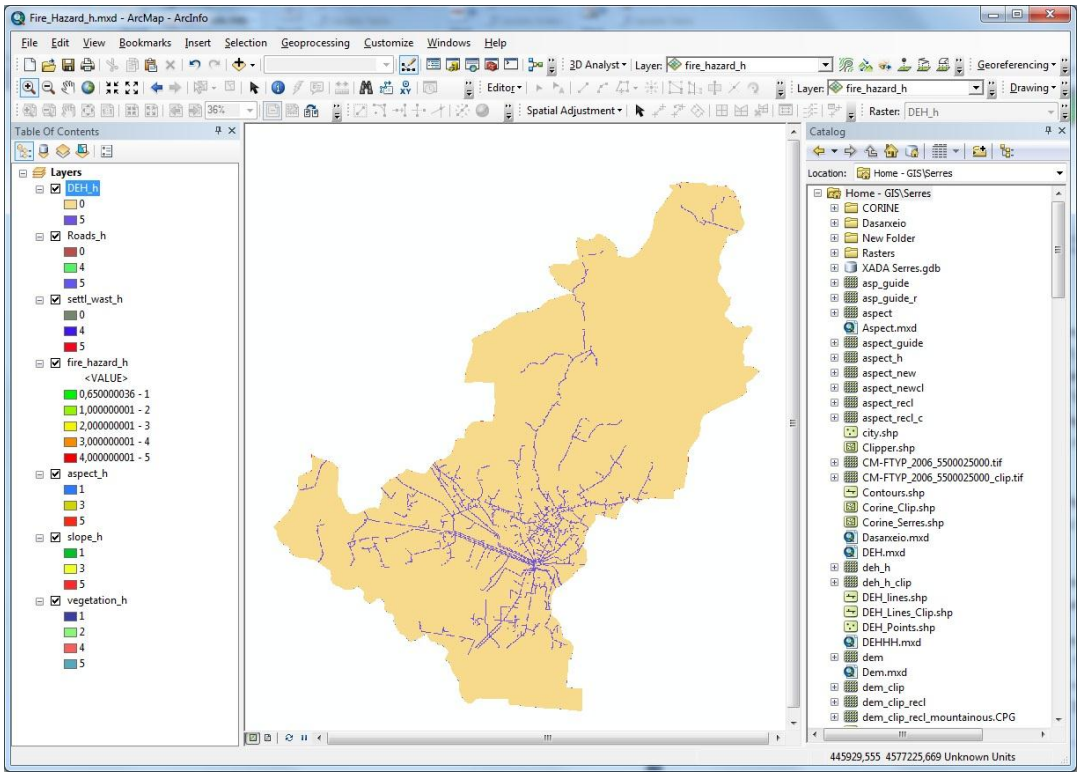


Figure 4.77

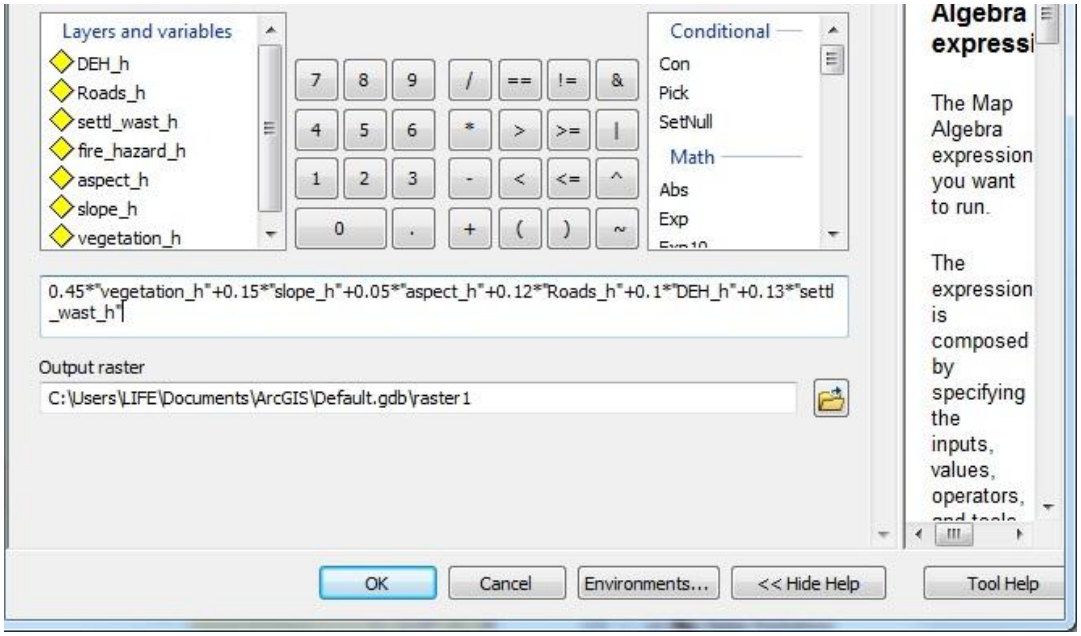


Figure 4.78

The final fire hazard map should be similar to the one shown in Figure 4.79. You can overlay different layers in order to highlight and pinpoint areas of high risk (e.g. high risk areas with little or no access, Figure 4.80). See Chapter 4.8 for instructions on highlighting areas in your layout.

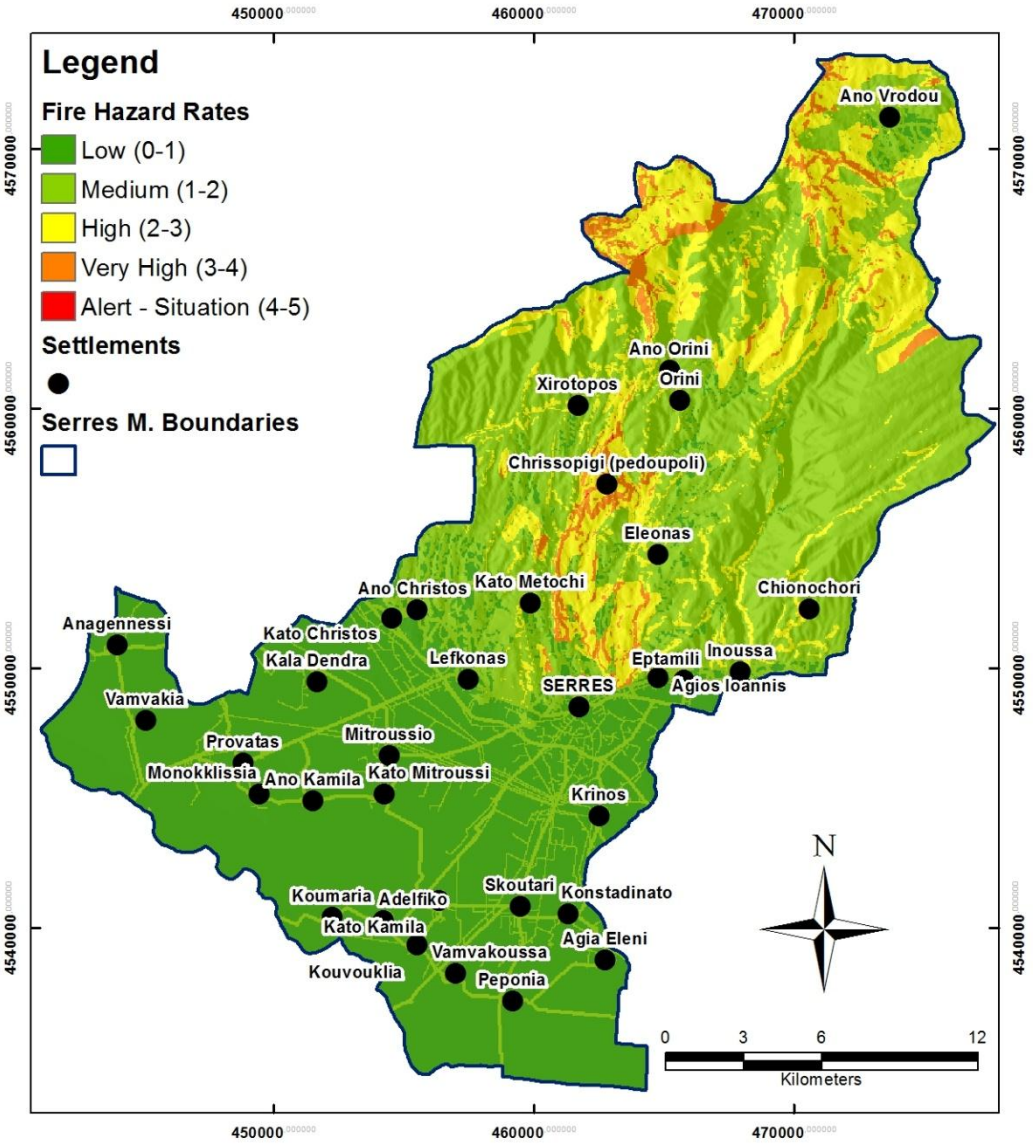


Figure 4.79: Serres Municipality Qualitative Multiparameter Fire Hazard Map

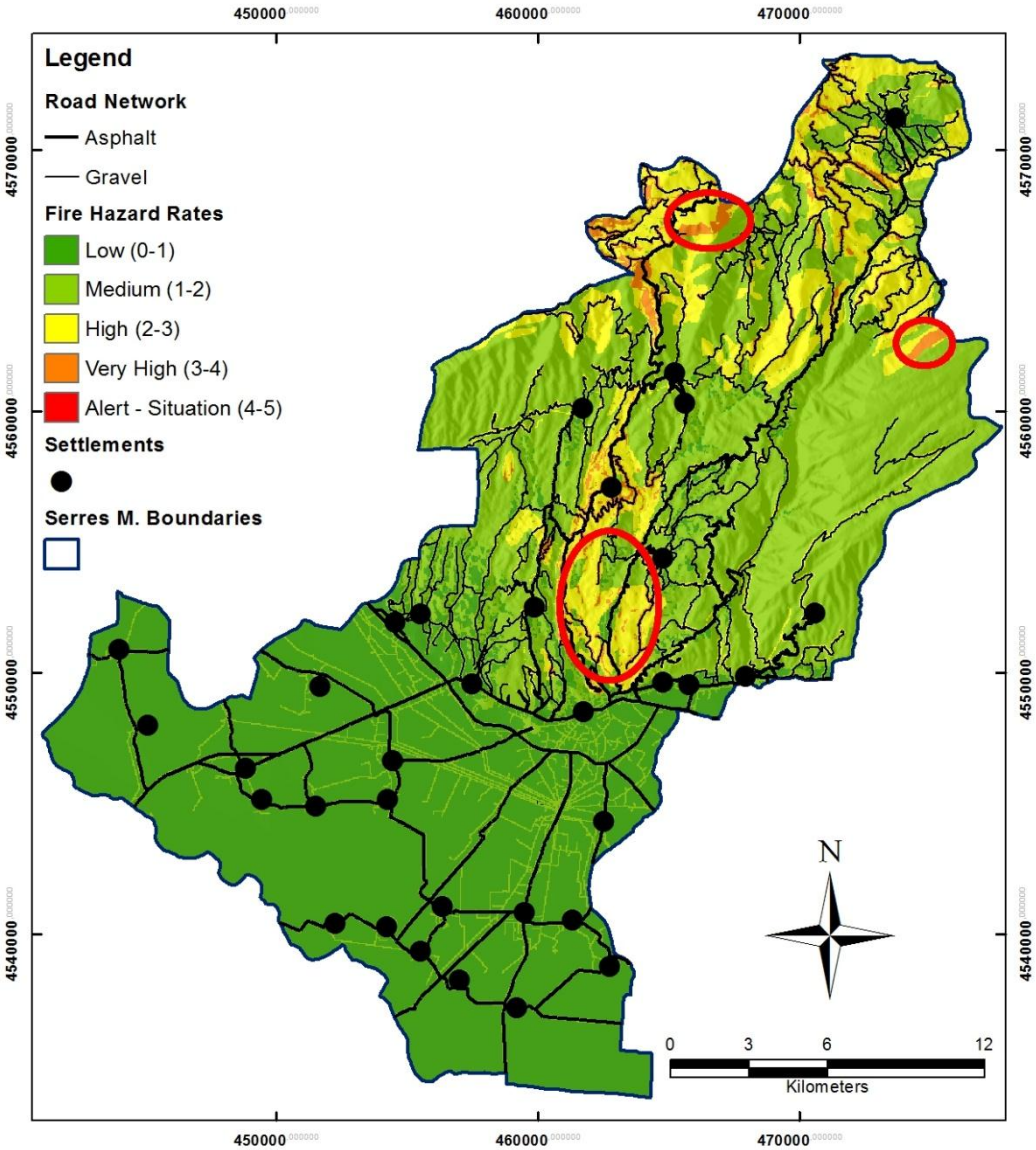


Figure 4.80: Road network map overlaying the municipality of Serres quantitative multiparameter fire hazard map

5. REFERENCES

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National Park Service, 2005. Golden Gate National Recreation Area Fire Management Plan [WWW] Golden Gate National Recreation Area. Available at: http://parkplanning.nps.gov/document.cfm?parkID=303&projectId=13822&documentID=13599 [Accessed at: 16/04/2012].

Stavrakakis, G. & Gompakis, K., 2011. Dynamic Forest Fire Risk Assesment Tool Manual (DFF Risk Manual) [WWW] Technical University of Crete. Available at: http://www.forestcities.gr/downloads/Manual%20DFF%20Risk.pdf [Accessed at: 08/04/2012].