GIS Manager Training Module

Revision History

Version	Date	Revision Description
0.1	25/5/2014	Initial draft
0.2	25/10/2014	Final draft version
0.3	28/12/2014	Final version for approval

Contents

1. Introduction

This document is part of training modules for the Nile Basin Decision Support System (DSS). These modules are developed for use in classroom training that is given to Nile Basin countries and as a self-learning training material that will be made available as part of the DSS helpdesk and knowledgebase.

1.1. Purpose

The purpose of this document is to provide a tutorial to the DSS GIS Manager. The tutorial starts with the basics and progressively increases in complexity.

1.2. Module pre-requisites

The following prerequisites are needed before taking this tutorial:
Software prerequisites: The Mike by DHI version 2014 and the DSS version 2.0 have to be installed.
User prerequisites: User is expected to be familiar with the DSS user interface basics.

1.3. Expectations

Upon successful completion of the lessons, exercises and review questions in this document, you will be familiar with most of the GIS Manager functionalities.

1.4. Conventions

The following conventions are followed in this document:

 means a tip for the user

 means important information

1.5. Module data

The files needed to run this tutorial are located in the **..\ GISExp\Data** folder.

1.6. Links to additional resources

In addition to the information presented in this module, below are links to additional resources that you can access to obtain further information on the following:

- GIS Manager:
  - The DSS help file
- Map suite (the software used to develop the GIS Manager in the DSS)
  - http://thinkgeo.com/map-suite-developer-gis/
- XML Schema:
  - Definition of standard types http://www.w3.org/2001/XMLSchema
  - Editing and validating schema (www.xmlfox.com/)

1.7. Problem Reporting Instructions

This document will be updated regularly. Therefore, it is highly recommended to report any spotted problem to helpdesk@nilebasin.org so it can be corrected in future versions. When reporting the problem, you are kindly requested to provide the following:

- Document title
- Document version
- Page number where the problem was spotted
- A description of the problem

2. Lessons

In this section the following lessons (with exercises) are included:

- General: This lesson briefly introduces you to the GIS, its uses, data formats and data projections. This is then followed by an explanation of how the GIS data is handled within the DSS. It concludes with a list of tools that exist in the DSS to handle GIS data.
- GIS Manager basics: This lesson introduces you to the components of the GIS Manager and basic tasks such as activating the manager and organizing data within the manager.
- Vector and Raster data basics: This lesson shows you how vector and raster data can be created or imported, moved or removed, visualized, edited and exported in the GIS Manager.
- Handling changes and metadata: This lesson introduces you to the change log and metadata sections of vector and raster data. It also shows how they can be used.
- Vector data selection (queries): This lesson describes how GIS functions within the DSS can be used to select vector data by attribute or spatial location.
- Vector and raster data processing: This lesson describes how GIS tools within the DSS can be used to dissolve vector data or create Thiessen polygons. It also shows you how resampling raster data and producing zonal statistics are achieved within the DSS.
- Advanced raster data processing: This lesson describes how the following GIS tools can be used on raster data:
    - Raster calculator
    - Interpolation
    - Catchment delineation
    - temporal analysis
- GIS data conversion: this lesson introduces you to the conversion between raster and vector formats.

  After completing the lessons and exercises in this section you will be able to use the GIS Manager to manage vector and raster GIS data within the DSS.

2.1. General

Introduction

This lesson describes some GIS definitions and concepts. If you are familiar with those definitions and concepts you can skip this and move to the next lesson.

Topics covered in this lesson:

- What is a GIS? And what are its uses?
- What are the GIS data formats and data projections?
- List of the GIS Manager tools and their functions

Lesson objectives:

After completing this lesson, you will be able familiar with the following:

- GIS concepts, uses, and data types and projections
- The GIS Manager tools

What is GIS?

A Geographic Information System (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. GIS applications are tools that allow users to create interactive queries, analyze spatial information, edit data in maps, and present the results of all these operations.

What are the uses of GIS?

GIS has many applications in various fields today. Some of which include traditional geographically related fields like urban planning and cartography, but also environmental impact assessment reports and natural resource (e.g. water, land) management.

In addition, GIS is now finding its place in business and related fields. Business GIS as it has come to be known is usually the most effective in advertising and marketing, sales, and the logistics of where to locate a business.

Whichever way it is used though, GIS has had a profound influence on geography and will continue to be used in the future as it allows people to efficiently answer questions and solve problems by looking at easily understood and shared data in the form of tables, charts, and most importantly, maps.

What are the main GIS data formats?

There are two main data formats for storing GIS data. These are the vector and the raster formats. The ***vector format*** has three basic objects in its data model: points, lines, and polygons. These are defined by the coordinates of the point or the coordinates of the vertices of the line or polygon. The vector data model is often the data model of choice for GIS because it can contain information about topology which underlies a large number of GIS operations. The ***raster format*** is used in a GIS application when we want to display information that is continuous across an area and cannot easily be divided into vector features such ground levels. A raster dataset is composed of rows (running across) and columns (running down) of pixels (also known as cells). Each pixel represents a geographical region, and the value in that pixel represents some characteristic of that region. A Temporal Raster is used to represent a time series of rasters (e.g. satellite rainfall maps at different times) which share the same extents and projection.

What are projections?

Projections are mathematical transformations that take spherical coordinates (latitude and longitude) and transform them to an XY (planar) coordinate system. This enables you to create a map that accurately shows distances, areas, or directions. With this information, you can accurately work with GIS data to calculate areas and distances and measure directions.

How GIS data is handled with the DSS

The DSS GIS Manager is built using a GIS component that was developed by the 'ThinkGeo' software company. It is called 'Map Suite'[1]. The manager's functionality allows the user to manipulate GIS data the way it is manipulated in other GIS tools.

[1] See http://thinkgeo.com/map-suite-developer-gis/ for more details.

The user has also a number of built-in tools to manipulate, process or analyze the data (See GIS manager tools for details) and/or tools created by the user under the scripting manager (See Scripts Manager training module for details).

GIS Manager Tools

A number of tools are incorporated into the DSS to process, manipulate and analyze GIS data. Those tools are object sensitive (i.e. when an object is selected such as a map, only those tools which are applicable to this object appears in the Tools Explorer. The table below shows a list of tools available for GIS data. In the following tables, a list of all GIS tools is presented with a description of what they can be used for.

Category: Import Tools	
Tool	**Function**
Import from ASCII file	Imports point features from an ASCII file.
Import from KML file	Imports features from a KLM file.
Import from shape file	Imports features from a shape file
ASCII Temporal Import Tool	Imports rasters in ASCII grid format from a folder as a temporal raster
Import from ASCII grid file	Imports rasters stored in an ASCII formatted grid file
Import from DSF2 file	Imports features from DSF2 file (Grid format for Mike by DHI products)
Import from Image file	Imports rasters stored in an image file. (An image can be in JPEG, TIFF, BMP, PNG, or EXIF format).
Import from IMG file	Imports raster from IMG files (Erdas Imagine file format)
Import from NETCDF file	Imports features from a NETCDF file
Import from TIFF file	Imports raster from a TIFF file

Category: Output Tools	
Tool	**Function**
Export to KML file	Exports a feature class to a KML file.
Export to shape file	Exports a feature class to a shape file.

Category: Output Tools	
Tool	**Function**
To attribute table	Adds the attribute table to a table data view.
To database	Stores an in memory feature or raster class to the database.
To display (feature class)	Adds a feature class to a “New map” or to the “Active map”
Export to ASCII grid file	Exports a feature class to an ASCII grid file.
Export to DFS2 file	Exports a feature class to a DSF2 file.
To display (Raster)	Adds a raster class to a “New map” or to the “Active map”

Category: Geo Processing	
Tool	**Function**
Dissolve Feature Class	Combines multiple polygons with identical attribute values (user selected attribute) into a single feature.
Measure	Adds the attributes “area” and “perimeter” to a polygon feature class or attribute “length” to a line feature class.
Thiessen Polygons	Calculates Thiessen Polygons for point features

Category: Raster Interpolation	
Tool	**Function**
Flood Map Interpolation	Calculates flood maps based on gauge levels or time series of gauge levels.
Inverse Distance Weighted Interpolation	Interpolates point data producing a raster with values given by the specified attribute of the input point feature class using an Inverse Distance Weighted algorithm.
Kriging Interpolation	Interpolates point data producing a raster with values given by the specified attribute of the input point feature class using a kriging algorithm
Nearest Neighbour Interpolation	Interpolates point data producing a raster with values given by the specified attribute of the input feature

Category: Raster Interpolation	
Tool	**Function**
	class using a nearest neighbour algorithm
Radial Basis Interpolation	Interpolates point data producing a raster with values given by the specified attribute of the input point feature class using the radial basis algorithm

Category: Raster Processing	
Tool	**Function**
Vector to raster	Converts a feature class to a raster using attribute values for each of the features in the feature class to fill in the raster.
Zonal statistics	Calculates statistics for the areas defined by an input feature based on raster values.
Flow direction	Calculates the flow direction of a raster representing elevation values (DEM) based on the slope of steepest decent from any given cell
Project	Projects a raster to another coordinate system
Raster appearance	Defines the style type of a raster (prior to display – it is persistent in such a case)
Raster calculator	Performs raster math on input rasters using syntax commonly found in spreadsheet function programs
Raster to vector	Creates a feature class with features for each value range specified. If value ranges are not specified, it creates features for each unique value in the raster
Reclassification	Reclassifies a raster replacing single values or ranges of values with the values to reclassify with
Resample	Resamples a raster to a different cell size
Slope	Calculates the slope for a raster in degrees
Slope length	Calculates the slope length for each cell in a raster representing elevation values by following the slope down from each cell (similar to river tracing) and calculating the change in height and the length until the

Category: Raster Processing	
Tool	**Function**
	slope breaks by the SlopeBreak value that the provides

Category: Soil erosion	
Tool	**Function**
Crop Management (C)	Calculates crop management factor (C) for the RUSLE soil erosion equation (Refer to the DSS help file for more information on the RUSLE equations).
Erosion Control (P)	Calculates erosion control factor (P) for the RUSLE soil erosion equation.
Soil Erodibility (K)	Calculates soil erodibility (K) for the RUSLE soil erosion equation.
Mean annual soil loss (A)	Calculates the mean annual soil loss (A) based on the RUSLE soil erosion equation.
Rainfall erosivity (R)	Calculates rainfall erosivity (R) for the RUSLE soil erosion equation.
Slope Length (LS)	Calculates slope length (LS) for the RUSLE soil erosion equation

Category: Temporal Tools	
Tool	**Function**
Temporal Disaggregation	Disaggregates a scalar attribute value according to patterns defined as a fractional time series
Temporal Zonal statistics	Calculates statistics for areas defined by the input feature class getting the values from temporal raster. All statistics are added to a time series named after the selected attribute.

Review Questions

1. What is GIS?
2. Give two examples of the GIS uses.

3. What are the tool categories of the GIS Manager?
4. List the interpolation methods within the DSS.

Answers

1. A geographic information system (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. GIS applications are tools that allow users to create interactive queries, analyze spatial information, edit data in maps, and present the results of all these operations
2. Urban planning and cartography, but also environmental impact assessments and natural resource (e.g. water, land) management
3. Import, output, geo processing, raster processing, raster interpolation, soil erosion, and temporal tools categories.
4. Inverse Distance Weighted, Kriging, Nearest Neighbour and Radial Basis Interpolation methods.

2.2. GIS Manager basics

Introduction

This lesson introduces to you a number of basic tasks that can be undertaken using the GIS Manager.

Topics covered in this lesson:

- GIS Manager components
- Activating the GIS Manager
- Organizing data within the GIS Manager

Lesson objectives:
By the end of this lesson, it is anticipated that you will be able to:

- Be familiar with the GIS Manager components
- Activate the GIS Manager
- Organize data within the GIS Manager

Lesson pre-requisites

You have to be familiar with the DSS user interface basics to take this lesson.

GIS Manager components

Figure 1[2] shows the components of the DSS GIS Manager, namely:

1. The GIS explorer: where GIS data is organized in user defined groups and subgroups. The explorer has two main groups called 'Database' and 'Raster Database'. These two groups are created by default when a new DSS database is created. Under the 'Database' group vector data is stored while raster data is stored under the 'Raster Database' group.
2. The GIS Window area: where the GIS data is viewed.
3. The Table view area: where the attributes data of vector layer is displayed
4. Tools Explorer: where the tools that are relevant to GIS are accessed.

[2] This figure was manipulated to show a map and a table. It does not show the default view.

5. The Properties Window: where the selected GIS data or tool properties are displayed, property values are set and selected tools are executed.

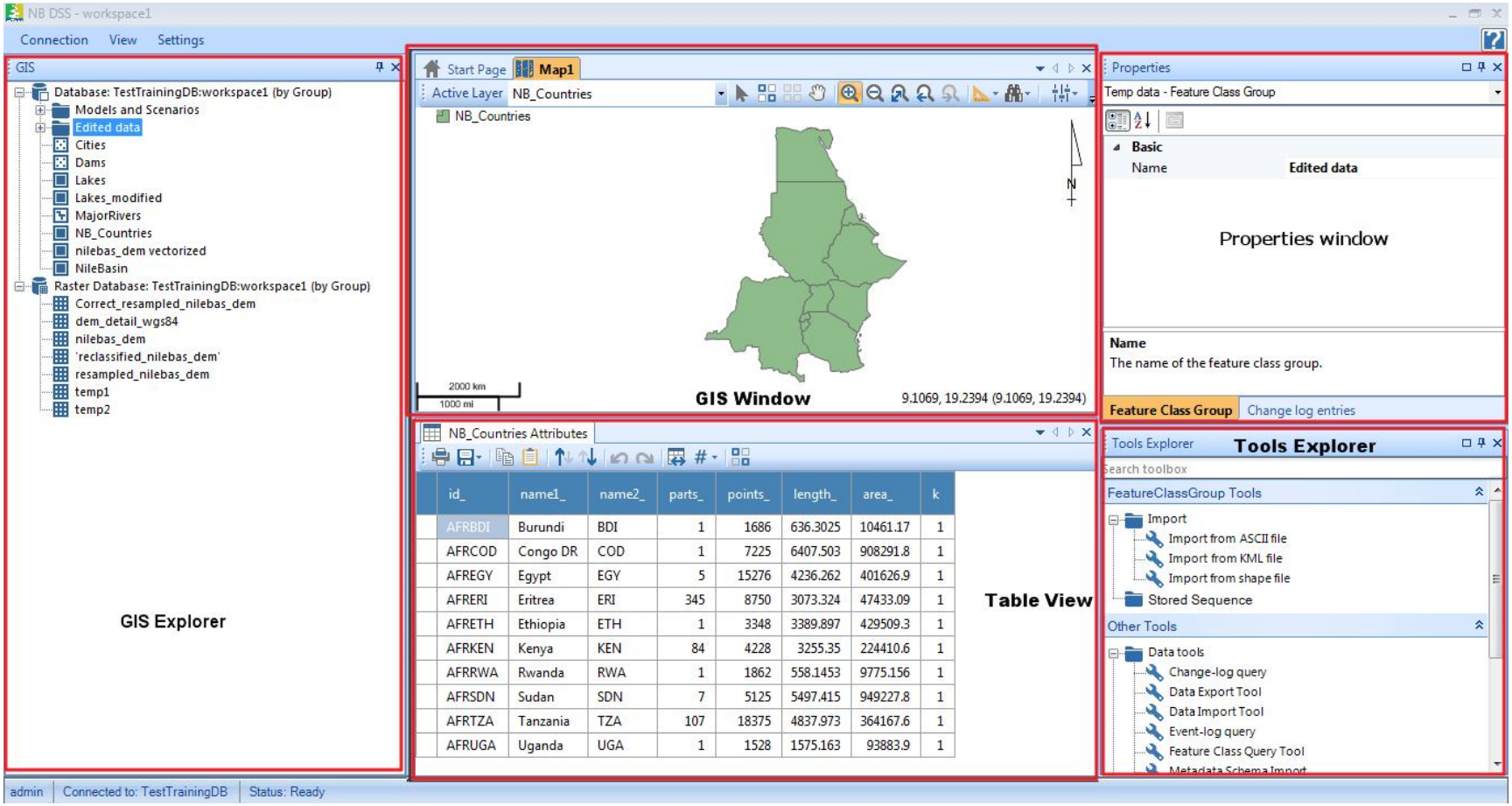


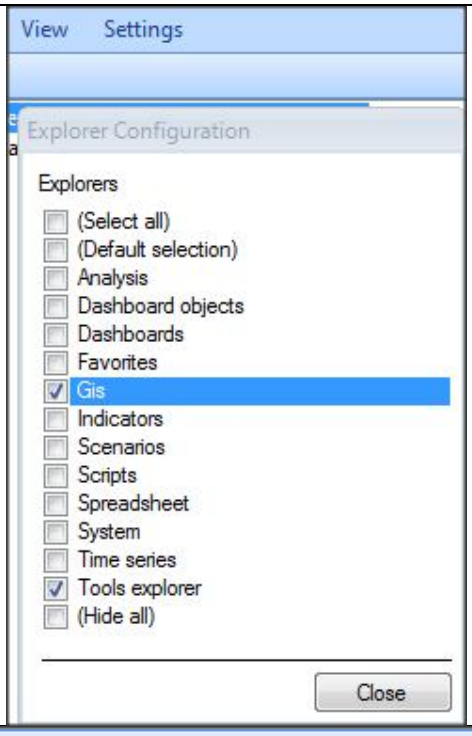
Figure 1: GIS Manager components

Exercises

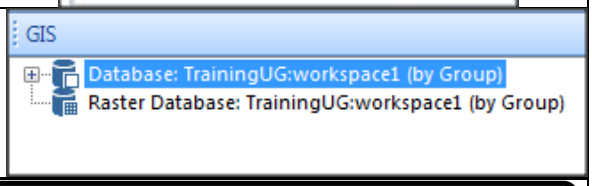
Activating the GIS Manager

1- In the DSS, click on View Menu, click "Explorers…" and the Explorer Configuration box appears.

2- Tick the box next to GIS explorer and also ensure that the Tools Explorer box is ticked to be able to use the GIS tools.



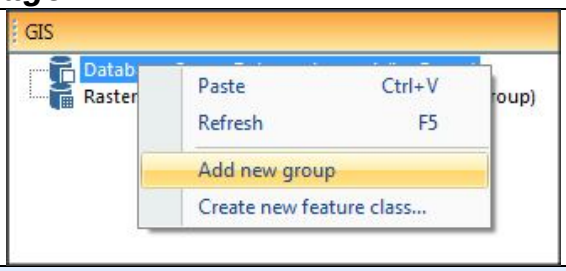
3- GIS explorer should appear within the DSS window.



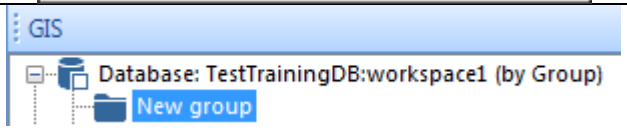
If the DSS database contains models and scenarios, a group called 'Models and Scenarios' is created for them in the 'GIS' explorer under the "Database" root node.

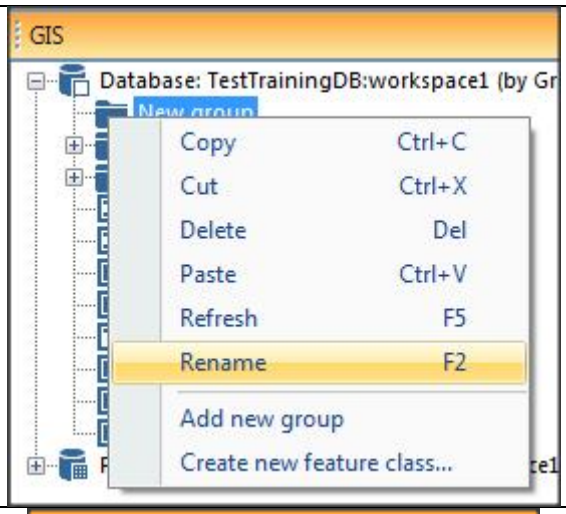
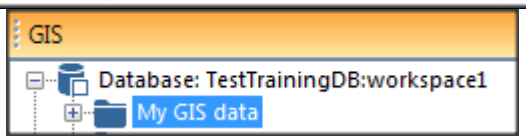
Organize data within the GIS Manager

1- Within the GIS explorer, right click either the 'Database' or 'Raster Database' group.



2- Click on the Add new group option. A new group is added as shown next.



3- Select the new group and either right click - and select Rename or press the keyboard function Key 'F2' to rename it.	
4- Enter a suitable name (e.g. My GIS data). You can add more user defined groups to easily access your GIS data.	

The group context menu allows you to also move (i.e. cut and then paste), copy and delete user defined groups. Familiarize yourself with those operations.

Review Questions

1. What are the components of the GIS Manager?
2. Layers are viewed in map and a table windows by default when opened in the DSS.
   - True
   - False

Answers

1. the components of the DSS GIS Manager, namely:
   - The GIS explorer.
   - The GIS Window area
   - The Table view area
   - Tools Explorer
   - The Properties Window
2. False (Data view has to be manipulated to show the map and table windows. It is not a default behavior).

2.3. Vector and raster data basics

Introduction

This section introduces you to vector and raster data basic operations.

Topics covered in this lesson:

- Creating or Importing vector and raster data
- Moving or removing (deleting) data
- Visualizing data as a map or in a table for vector data.
- Editing vector data[3].
- Exporting data for use in other applications.

Lesson objectives:

By the end of this lesson, it is anticipated that you will be able to:

- Create or Import vector and raster data into the DSS
- Move or remove (delete) data
- Visualize data as map or in a table for vector data.
- Edit vector data.
- Export data for use in other applications.

Lesson pre-requisites

You have to be familiar with GIS basics (See GIS concepts and GIS Manager basics sections for details) to take this lesson.

Importing and exporting GIS data

It is a common task in GIS programs to import and export data. The GIS Manager is no exception as it offers the same functionality. Data can be imported into the DSS from a number of common formats such as ASCII, KML and shape formats for vector data and from ASCII grid, Dfs2, image, NETCDF and Tiff formats for raster data. Data can also be exported to KML and shape formats for vector data, and to ASCII grid and Dfs2 formats for raster data. This is all done seamlessly within the

[3] Raster data cannot be edit directly within the DSS

DSS user interface. The processes of importing and exporting data are all explained in details in the exercise sections below.

GIS data visualization

Data can be visualized in the DSS for different purposes such as creating maps, checking imported data and data processing. There are a few ways to do so in the DSS. Vector data can be viewed in a map or as a table whilst raster data can only be viewed in a map.

Viewing data in a map

As explained in the GIS manager components section, the GIS Manager has 5 components. The GIS window is one of these components where data editing and visualization are carried out. The window has its own components as shown in Figure 2.

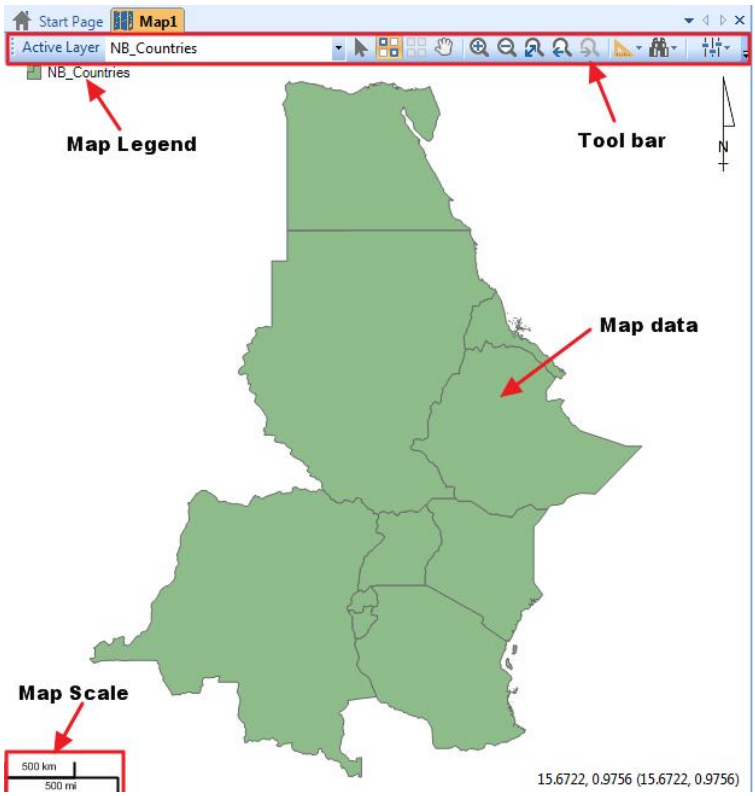


Figure 2: GIS window components

The main components are the map area, the scale, the legend and the toolbar. The map area is where the data is displayed. The map scale is calculated by the program and based upon the data that is added to the map. This scale also changes when you zoom in or out. The map legend shows the different layers that are added to the map.

The toolbar has buttons that help you undertake frequent tasks (e.g. zoom in or out and select features). The GIS window toolbar allows you to do the following tasks:

View and Select the active layer


Select object (e.g. in the legend)


Select vector data items (e.g. Polygons)


Clear vector data selection (Active when a feature or more are selected)


Pan the map


Zoom in and out


Zoom to full extent


Show previous extent


Show next (zoom) extent (Active when a next zoom extent is available).


Measure length and/or area of a free hand line or a polygon. It can also calculate the length and/or area of a map feature.


Undertake spatial or attribute queries (See Vector data queries section for details). Note that queries are only active when a vector data is active.

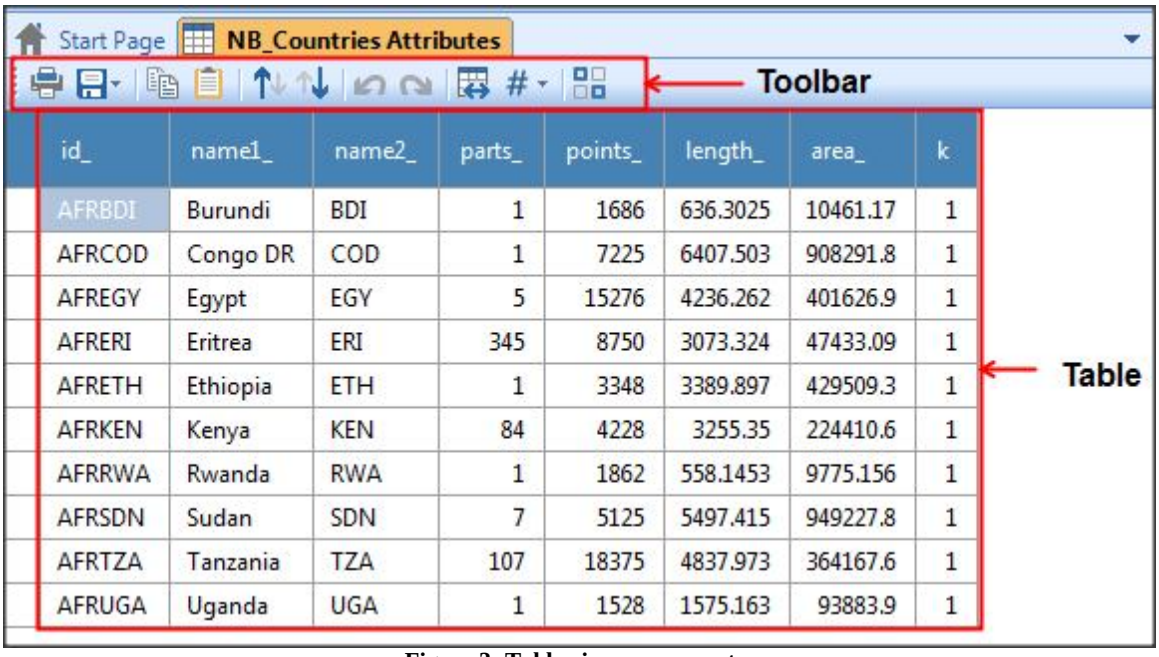

Calculate zonal statistics by a polygon or a feature for a raster (See the zonal statistics section for more details). Note that this button is only active when a raster layer is active.


Show grid cell value (for raster data). Note that this button is only active when a raster layer is active.


Edit the active layer (See editing vector data section for details) or delineate catchments using raster data (See the Catchment Delineation section for details).

Viewing data in a table

As explained in the GIS Manager components section, the GIS Manager has 4 components. The table view is one of these components where attribute data editing can be carried out. The table view has its own components as shown in Figure 3.



id_	name1_	name2_	parts_	points_	length_	area_	k
AFRBDI	Burundi	BDI	1	1686	636.3025	10461.17	1
AFRCOD	Congo DR	COD	1	7225	6407.503	908291.8	1
AFREGY	Egypt	EGY	5	15276	4236.262	401626.9	1
AFRERI	Eritrea	ERI	345	8750	3073.324	47433.09	1
AFRETH	Ethiopia	ETH	1	3348	3389.897	429509.3	1
AFRKEN	Kenya	KEN	84	4228	3255.35	224410.6	1
AFRRWA	Rwanda	RWA	1	1862	558.1453	9775.156	1
AFRSDN	Sudan	SDN	7	5125	5497.415	949227.8	1
AFRTZA	Tanzania	TZA	107	18375	4837.973	364167.6	1
AFRUGA	Uganda	UGA	1	1528	1575.163	93883.9	1

Figure 3: Table view components

The main components are the table area and the toolbar. The table area is where the attribute data is displayed and can be edited.

The toolbar has buttons that help you undertake frequent tasks. The table toolbar allows you to do the following tasks:

 Print the table.

 Save or save-as the current table to the database

 Copy the selected data to the clipboard

 Paste clipboard contents

 Sort table data in ascending order

Sort table data in descending order

Undo the latest operation

Redo the latest operation

Fit the column width to view width

Set the number format

Filter selected features

Editing vector data

In the DSS, you can edit vector data directly in the Map data view (on-screen editing). When editing vector data, an additional floating toolbar can be accessed to facilitate the editing operations. The toolbar can be accessed using the button as shown below in Figure 4.

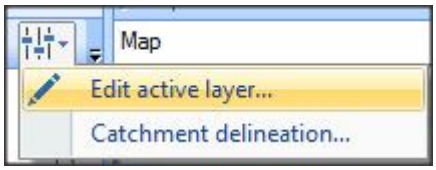


Figure 4: Accessing the edit layer toolbar

Figure 5 shows the function of each button on the edit layer toolbar

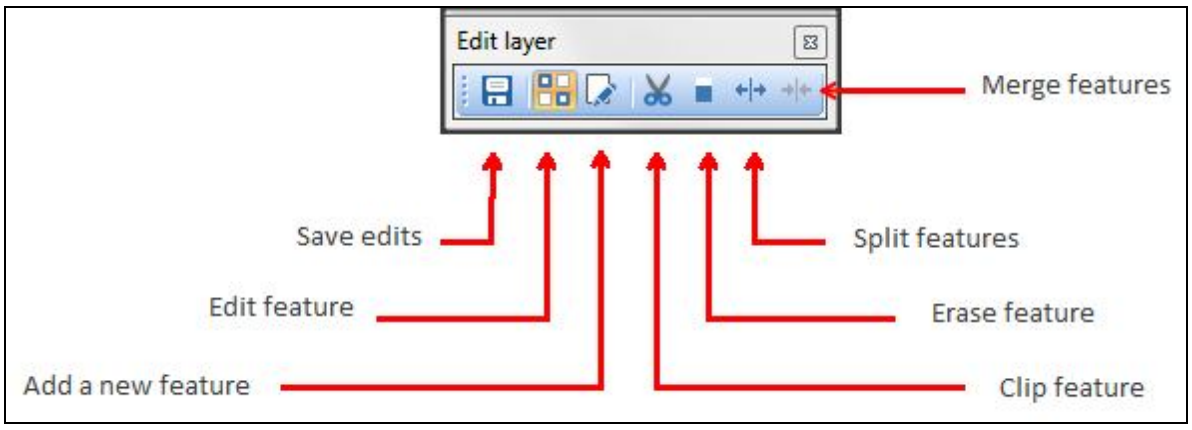
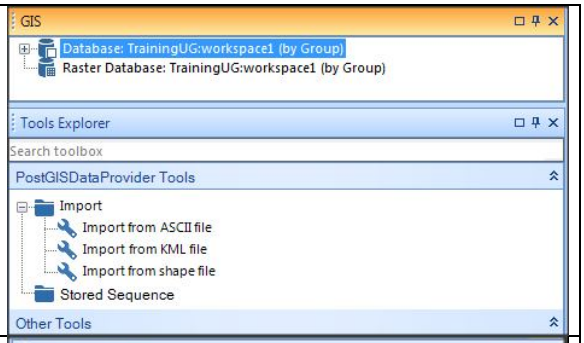


Figure 5: Function of the edit layer buttons

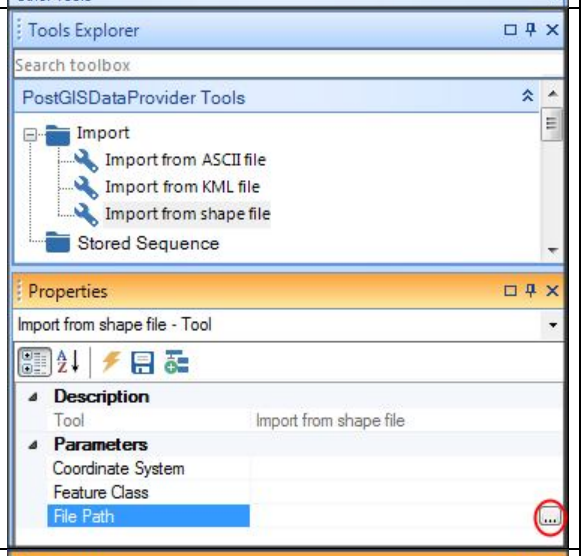
Vector data Exercises

Importing vector data into the DSS

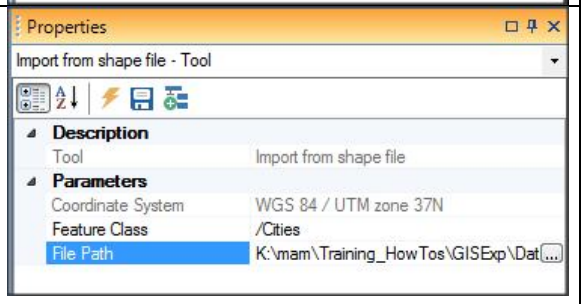
1- Within the GIS explorer, select either the 'Database' or a Group that is under the 'Database'. Look for the 'Import' category within the Tools Explorer and Select 'Import from shape file'.



2- Once the 'Import from shape file' tool is selected, its properties appear in the Properties explorer. First provide the path to your file by clicking the ... button. GIS data is stored at **..\ GISExp\Data**. Select the **'Cities.shp'** file and click OK.

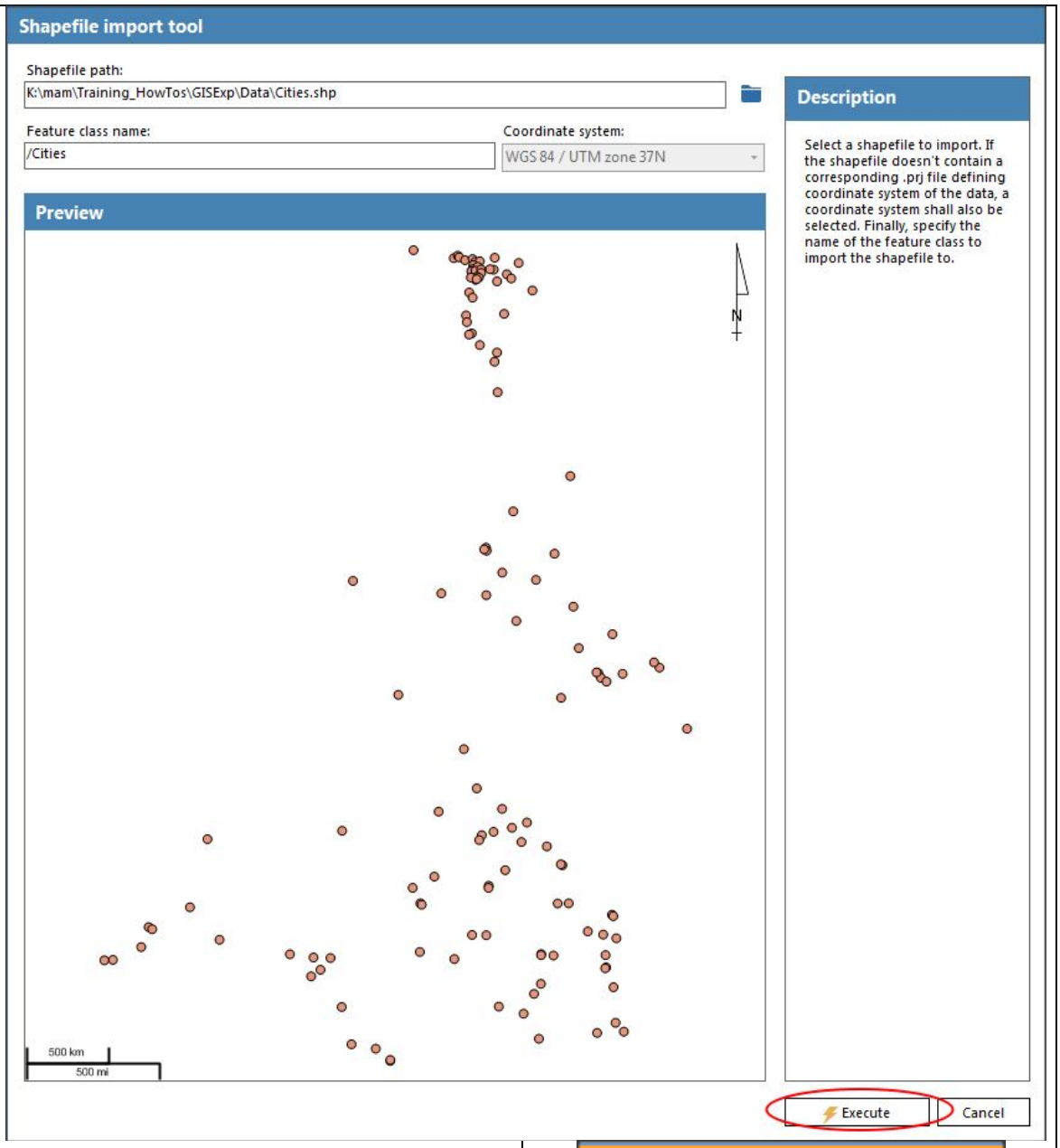


3- Once the file is selected, its properties are populated in the Properties explorer. Note that the coordinate system was read from the shape file (if projection data is supplied as part of the shape file, otherwise, it has to be selected from the list). Click  to run the tool.

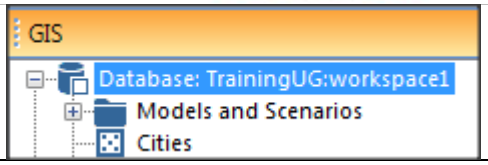


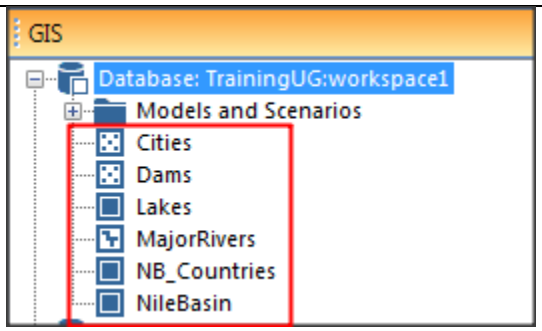
4- The window shown below appears showing a preview of the shape file. This window allows the user to check whether the data was read correctly by the tool or not, before actually importing it into the DSS. To finalize the import process, press the 

button.

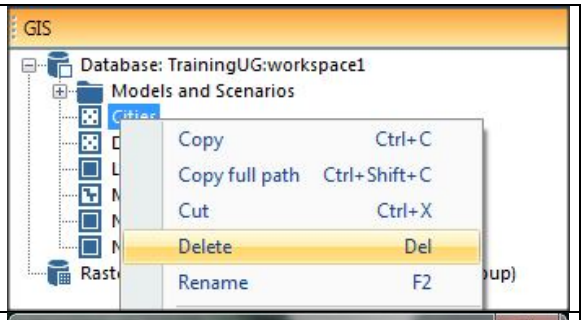
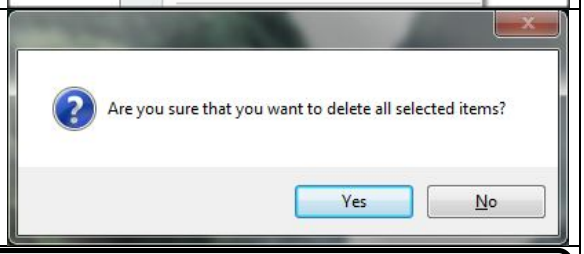


Data has now been added to the database.



5- Repeat the above steps to import the following files from the **..\ GISExp\Data** folder: - Dams.shp - MajorRivers.shp - NB_Countries.shp - Lakes.shp - NileBasin.shp Once this is done the 'Database' group should look like the window shown on the right.	

Removing (deleting) vector data

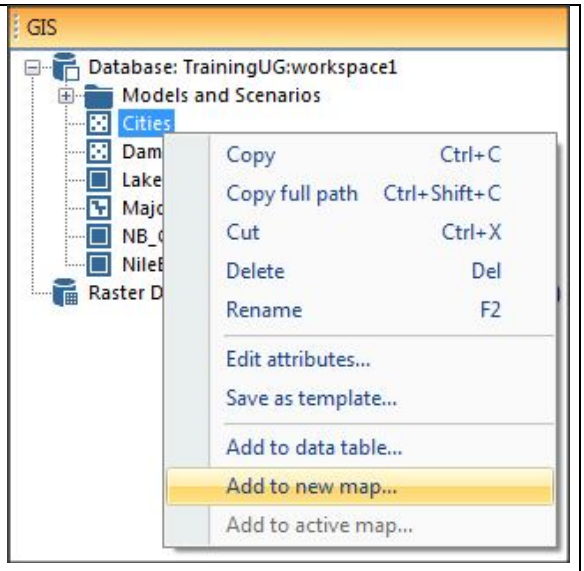
1- To remove (delete) a vector data item, right click the item and then click 'Delete'. You can alternatively select the item and press the 'Del' button on the keyboard.	
2- Confirm the deletion by clicking 'Yes' then the item will be deleted	

The delete operation is undoable. Once the item is deleted, it cannot be recovered. It will need to be re-imported.
Multiple items can be deleted together.

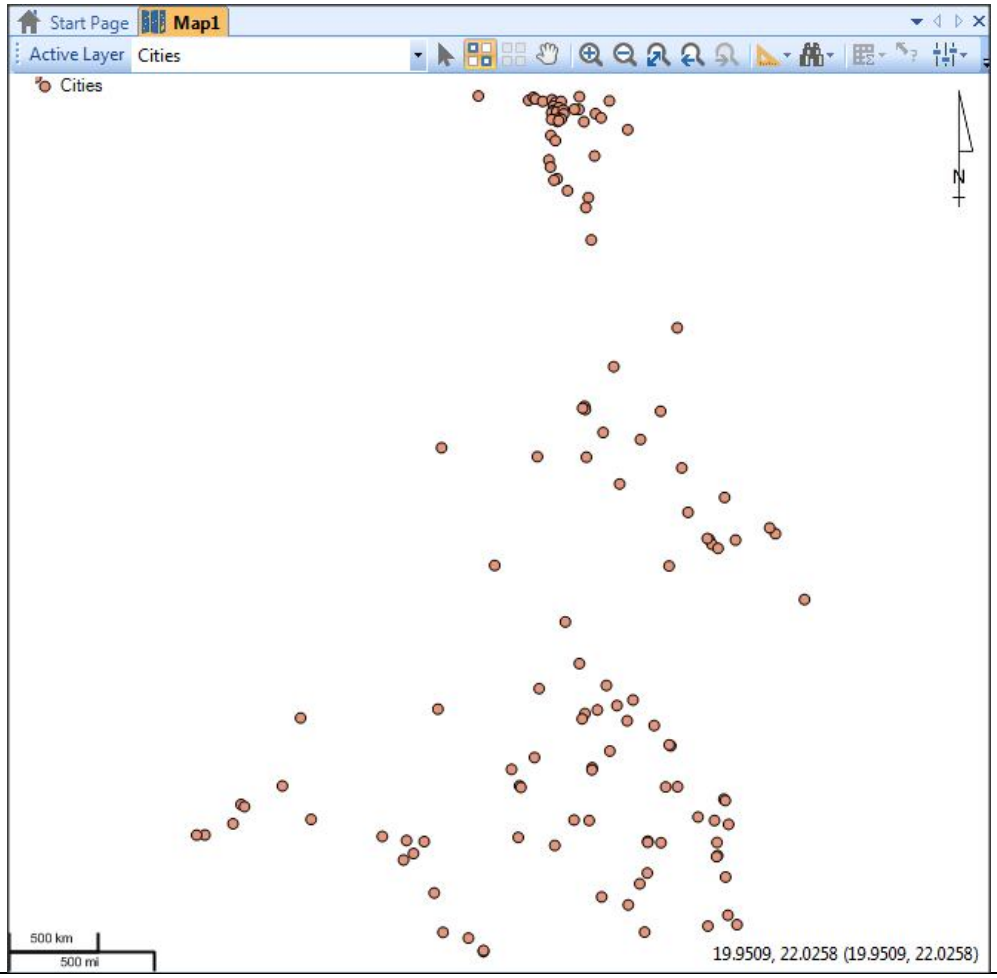
Viewing vector data

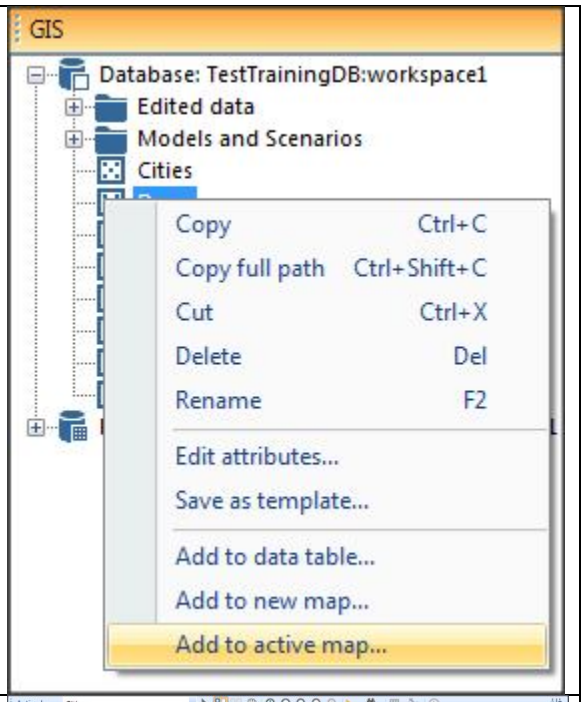
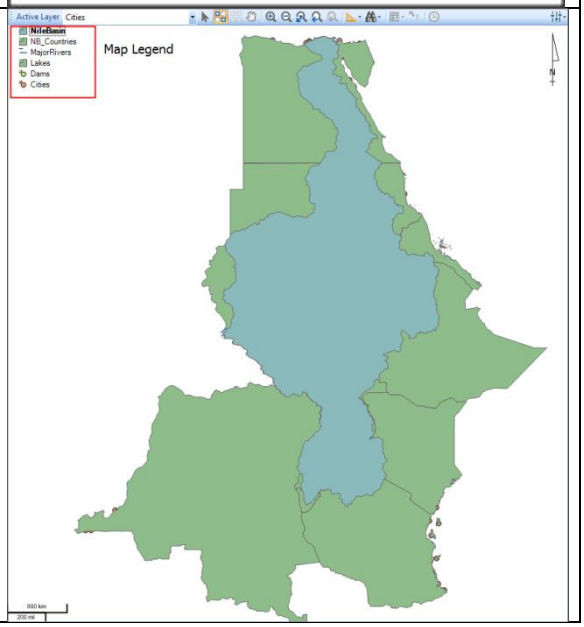
View data in a map

1- Right click the **'Cities'** vector data item and then click the Add to new map... option. The layer is now added to the map view.

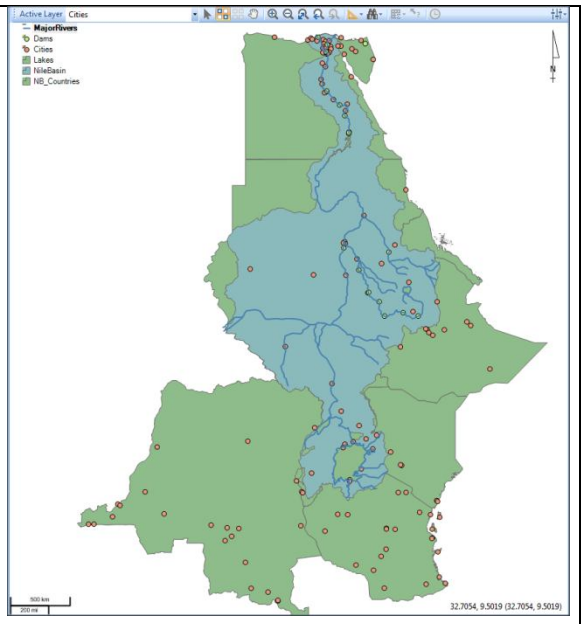


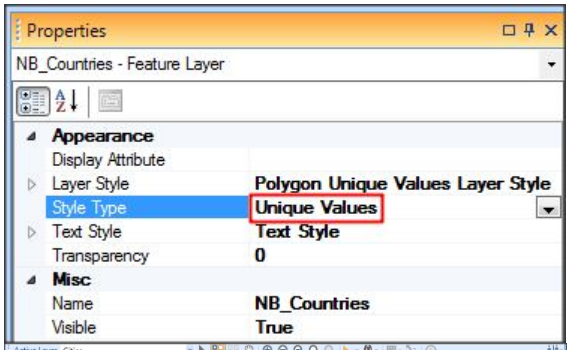
The data is now added to a map.



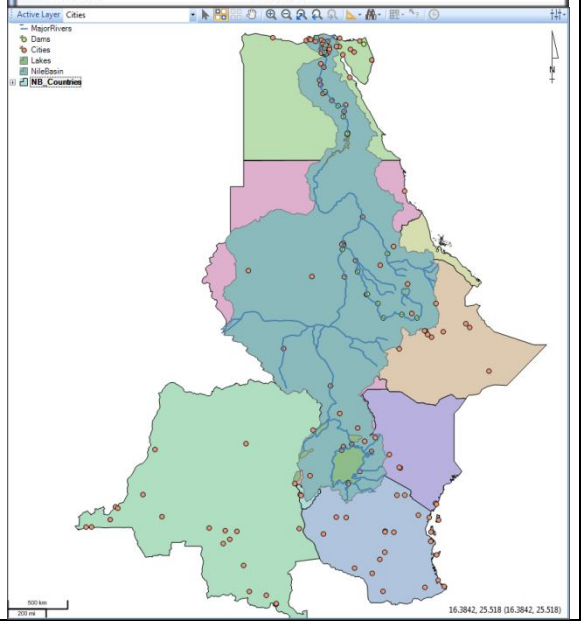
2- Repeat the above steps with the rest of the vector data items but using the Add to active map... option to add them one by one in the same order to active map rather than a new map.	
3- The map now looks like the window shown on the right. It is clear that some of the items have covered other items, which cannot be seen anymore. To improve this, right click on the items in the map legend and move them up and down until all layers are shown.	

4- The map now looks better. Map View can be improved further by giving each Nile Basin country a different color. To do this, Select NB_Countries item in the legend and in the Properties explorer set the 'Style Type' to 'Unique Values'.



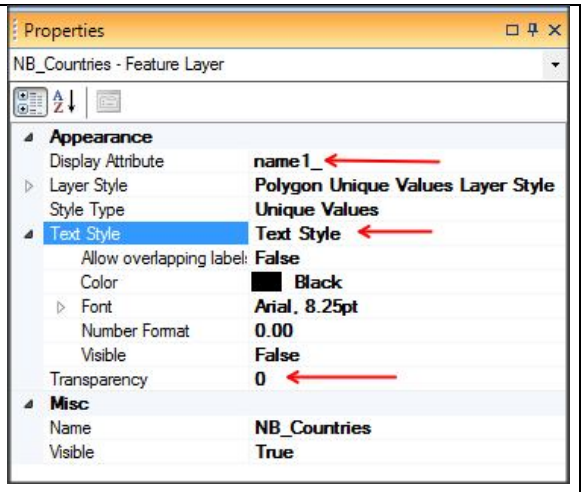


The map now looks even better now.



5- Other properties can also be set to improve the view such as:

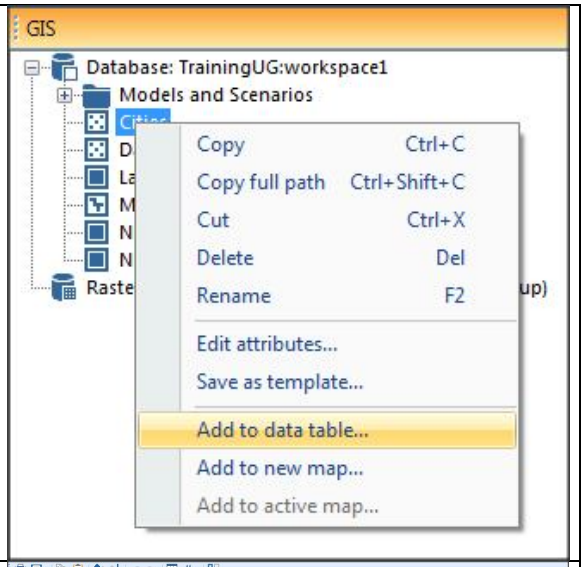
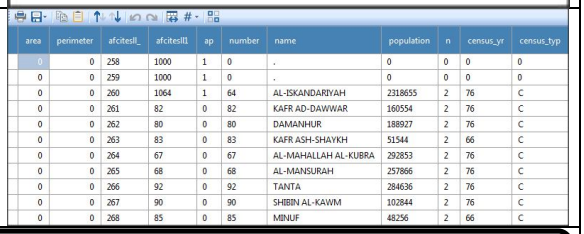
- Display attribute: to show an attribute for each feature in the vector data item as label
- Text style: to set the style of the displayed attribute such as font size, visibility and color.
- Transparency: to make a vector data item transparent. This is given in percentage. 0 means not transparent and 100% means fully transparent.



6- Use the toolbar buttons  to pan, zoom in and out to see the map details. Check how the scale changes as you undertake those operations.

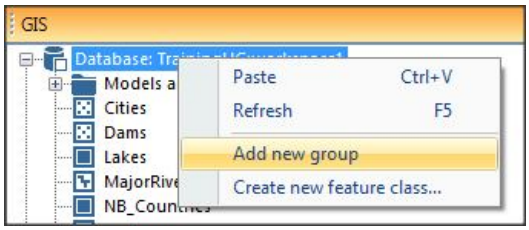
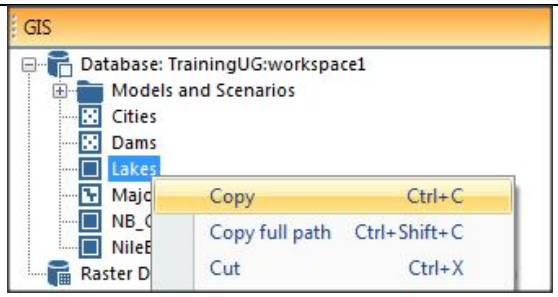
The map legend (right click) menu allows the user to remove (from the view), hide and zoom to the extent of a data layer. User can also reset the data layer view settings to defaults (i.e. reset symbology) or save them as default.

View vector data in a table

1- Right click the vector data item then click the Add to data table... option.	
2- The data is now added to a table.	

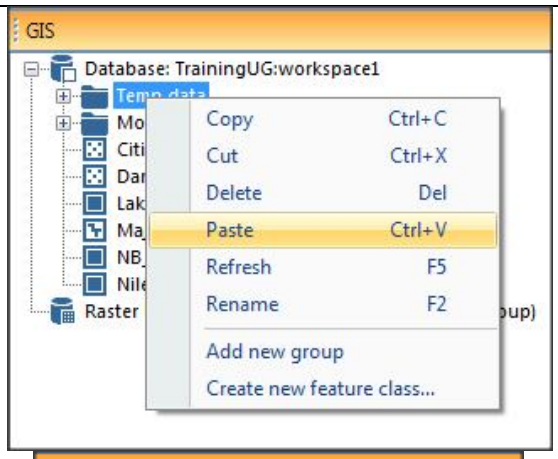
Unlike maps, only one vector data item can be added to a table at a time. Adding another layer to a table will open another table.

Editing vector data

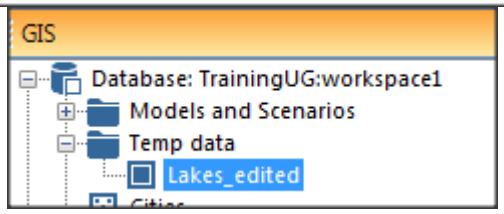
1- In the GIS explorer, create a new group directly under the database node to store exercise data. Call the new group 'Temp data'.	
2- It is always a good practice to make a copy of your data before starting the edit session, to avoid changing original data. To make a copy of the **'Lakes'**	

vector data, right click the layer name and select copy.

Now right click the 'Temp data' group and select paste.

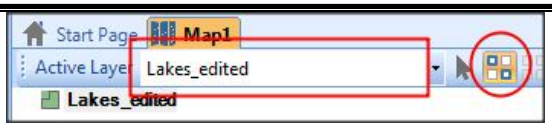


Rename the copied item to **'Lakes_edited'** by right clicking and selecting rename.



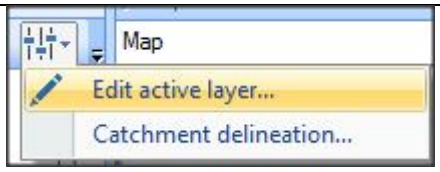
Copying and pasting a GIS layer from one group to another can be achieved by dragging and dropping while pressing the Ctrl Key. Without pressing Ctrl, the layer is moved rather than copied.

3- Add the **'Lakes_edited '** vector data to a new map. Ensure that the 'Active layer' is **'Lakes_edited'**.



4- Go to the dropdown icon at the right end of the map toolbar and select 

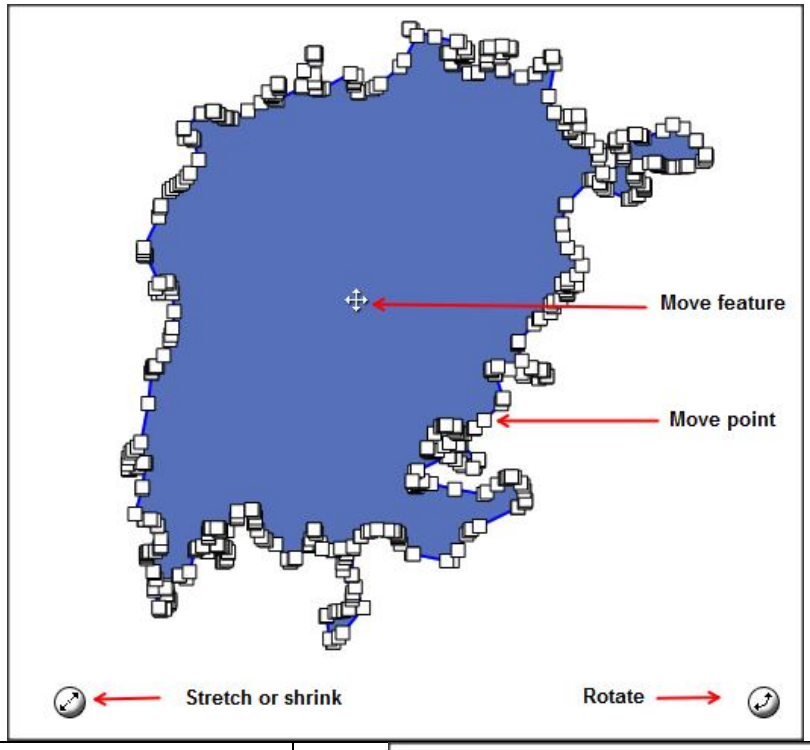
. The edit layer toolbar appears (See editing vector data section for details).



5- Select the icon from the 'Edit layer' toolbar and then select a lake on the map (e.g. Lake Victoria).

Once the lake is selected, its vertices become visible and two icons appear at the bottom.

You can move the lake points by clicking and dragging them. You can move, rotate, stretch or shrink the lake using the handling icons as shown below.

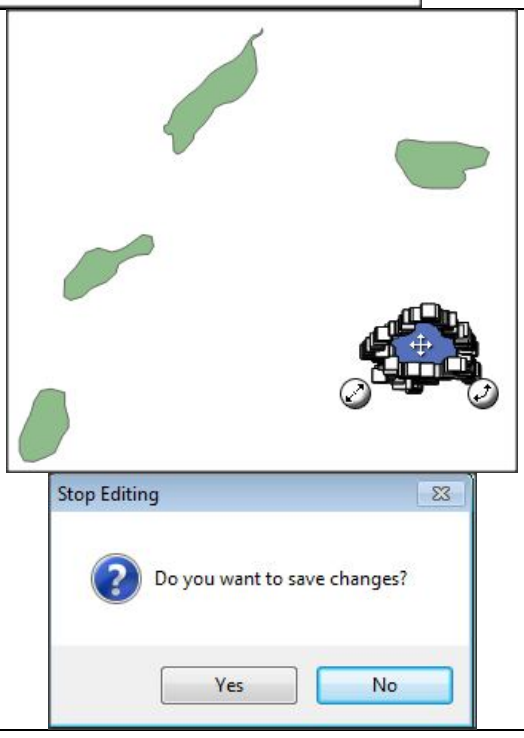


6- Try all editing functions.

In this case, lake Victoria was moved, rotated and shrunk.

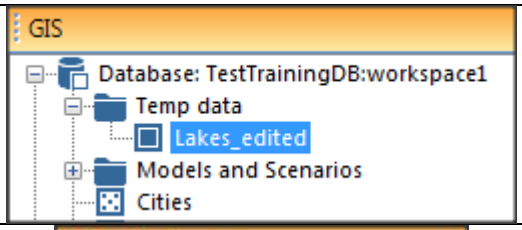
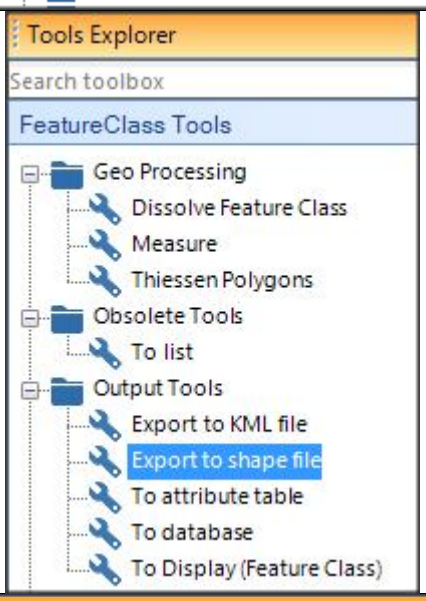
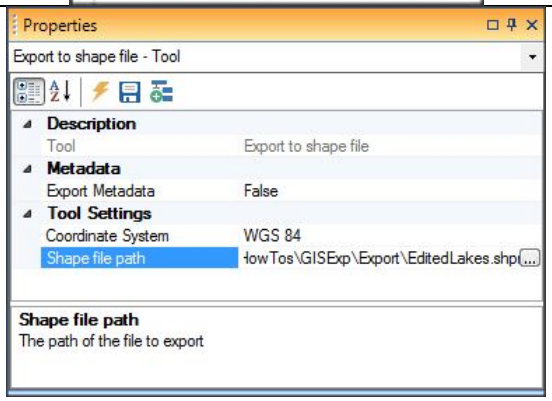
When editing is complete, click the button on the toolbar to save your edits.

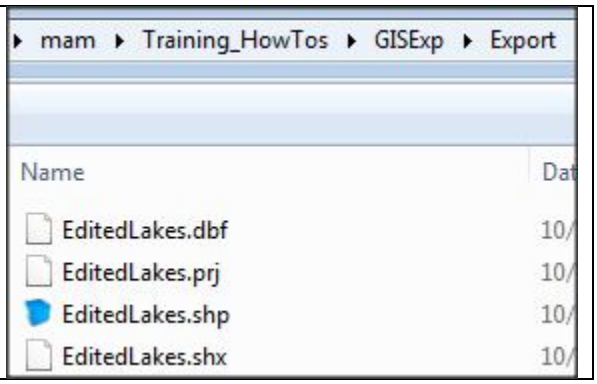
If you do not want to save the edits them close the 'Edit layer' toolbar using the button at the top right corner then click 'No' to



dismiss the 'Stop Editing' message.	

Exporting vector data

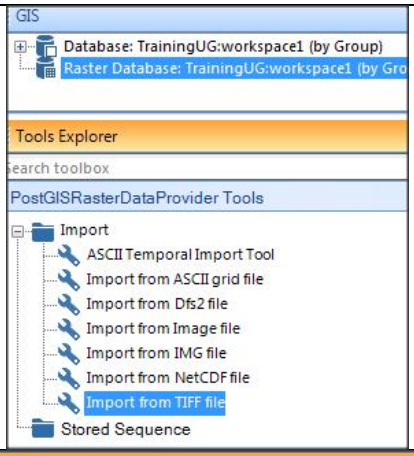
1- In the GIS explorer, select the **'Lakes_edited'** vector data that you have saved in the previous exercise.	
2- In the tools windows, select the 'Export to shape file' tool under the 'Output Tools'	
3- Once the tool is selected, its properties appear in the properties window as shown next. The tool allows you to: - Export the Metadata (if it exists) - Set the coordinate system (if you want to change it from what is saved) - Specify the file path of the shape file. Leave the default values for exporting the metadata and the coordinate system and specify the file path of the shape file	

4- Click the  to run the tool. Check that the data has been exported by examining the export folder.	

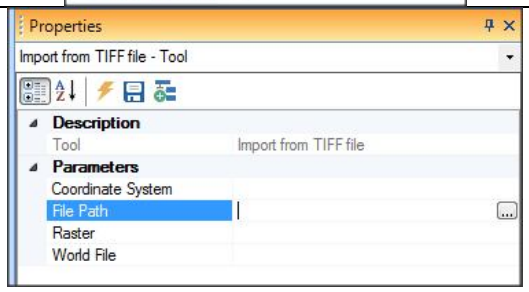
Raster data Exercises

Importing raster data into the DSS

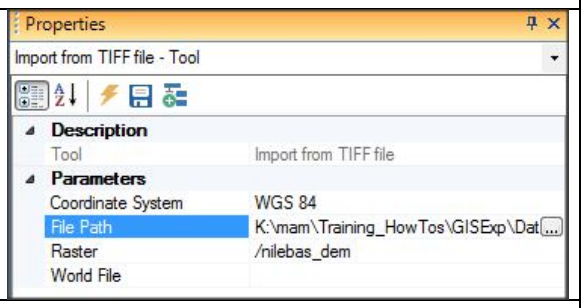
1- Within the GIS explorer, select either the 'Raster Database' or a Group that is under the 'Raster Database'. Look for the 'Import' category within the Tools Explorer and select 'Import from Tiff file'.



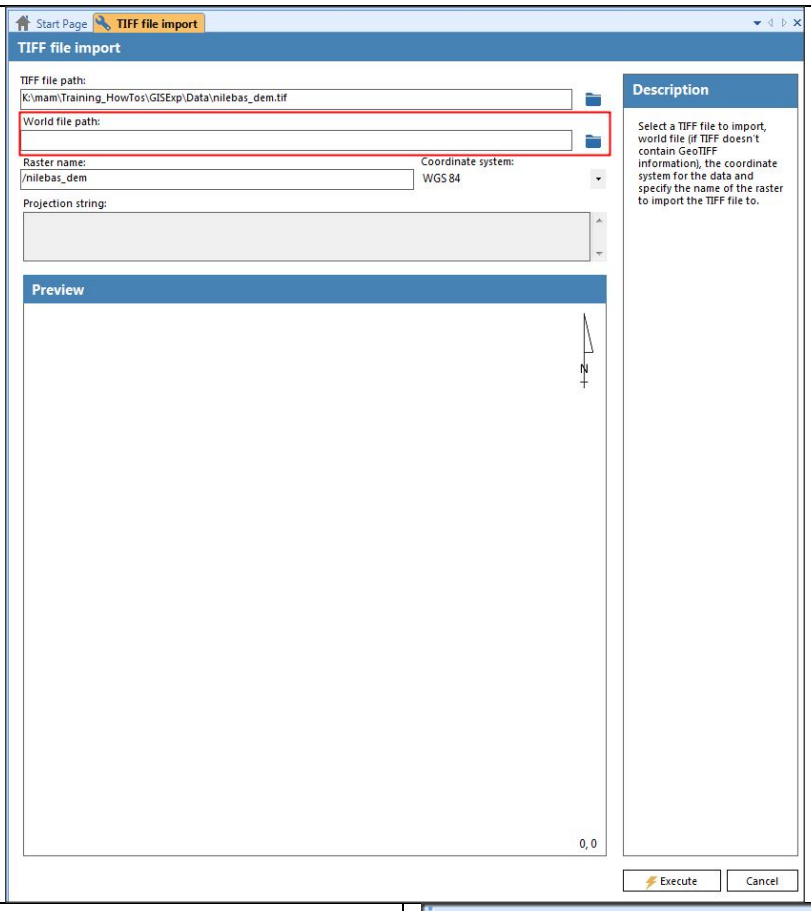
2- Once the 'Import from Tiff file' tool is selected, its properties appear in the Properties explorer. First provide the path to your file by clicking the ... button. GIS data is stored at **..\ GISExp\Data**. Select the **'nilebas_dem.tif'** file and click OK. This file is the DEM of the Nile Basin.



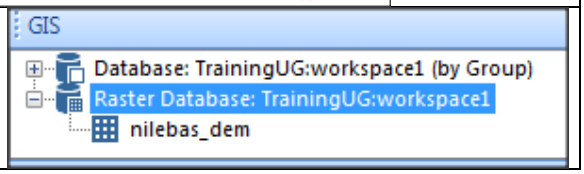
3- Once the file is selected, its properties are populated in the Properties explorer. Note that the coordinate system was read from the raster file. Click to run the tool.



4- The window shown below appears showing a preview of the raster file. This window allows the user to check whether the data was read correctly by the tool or not before actually importing it into the DSS. It also allows the user to select a world file (i.e. file that has the geo reference information of the image) so it can be plotted in the right geographical location. Select the file by pressing the . File is located at **..\GISExp\Data** and its name is **'nilebas_dem.tfw'**. To finalize the import process, press the Execute button.

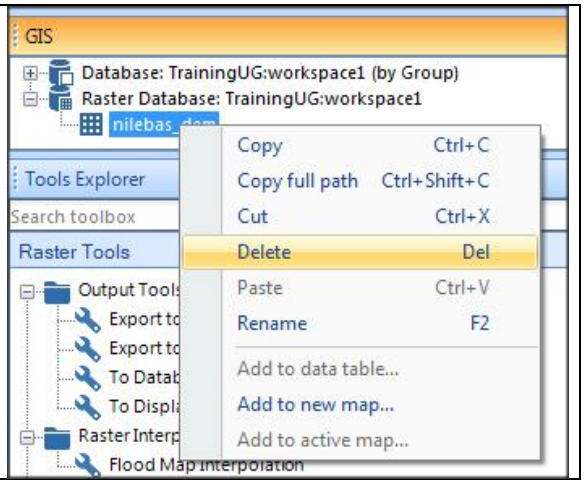


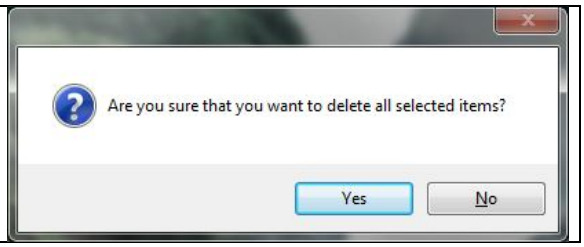
5- The Tiff file has now been added to the database.



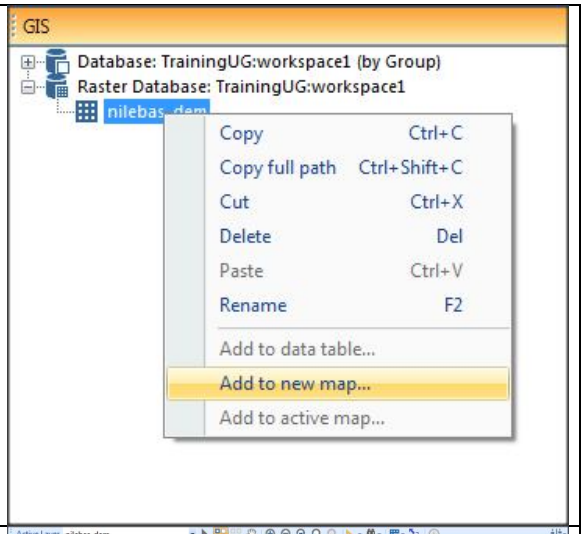
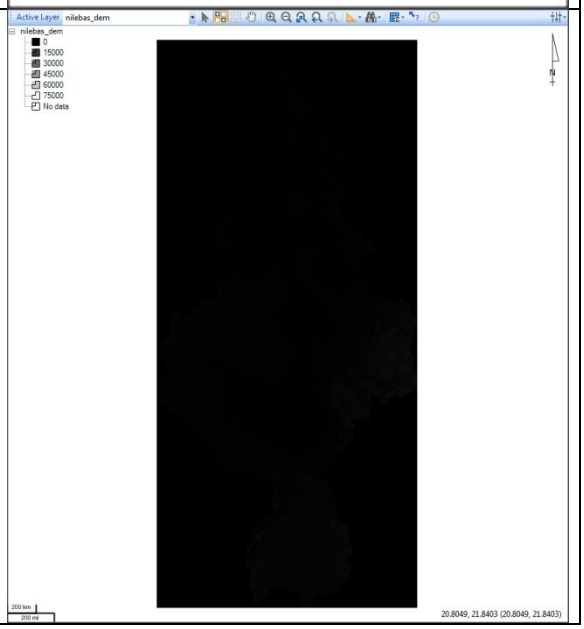
Removing (deleting) raster data

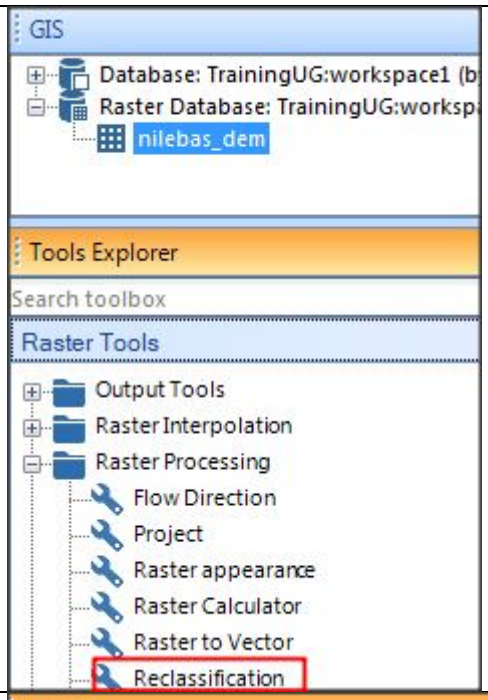
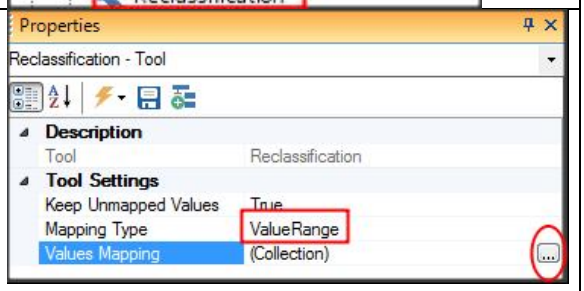
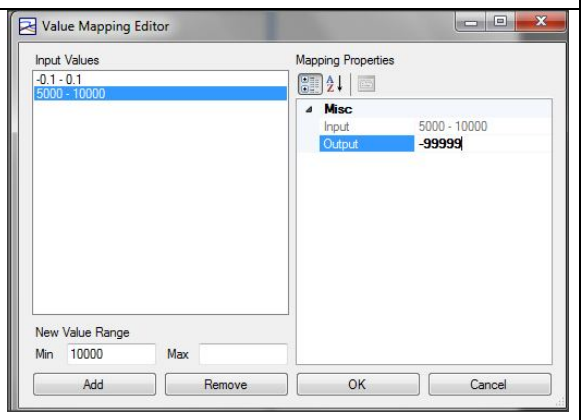
1- To remove (delete) a raster data item from the database, right click the item and then click 'Delete'. You can alternatively select the item and press the 'Del' button on the keyboard.



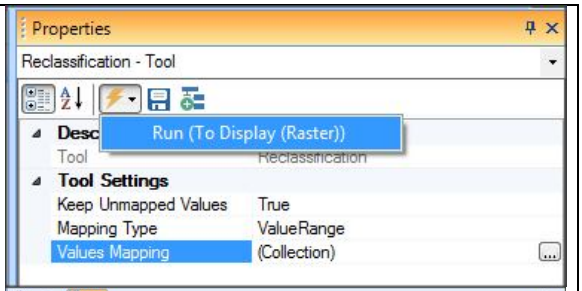
2- Confirm the message by clicking 'Yes' then the item will be deleted	

Viewing raster data

1- Right click the **'nilebas_dem '** raster data item and then click the Add to new map... option.	
2- The data is now added to a map. As can be seen, the data on the map is shown as black rectangle. This is due to two issues: - Black area all around the DEM – due to the fact that value 0 is used to represent no data - Upper value of the raster is set to 55537 due to some 'intentional' error when creating the file.	

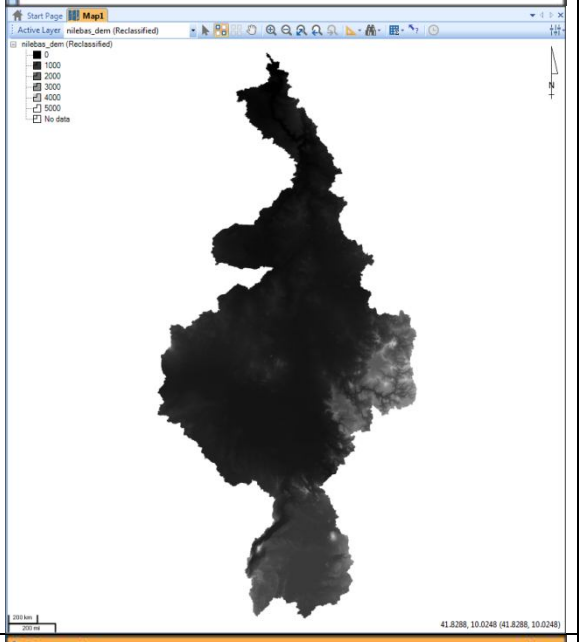
3- To solve these problems, the 'Reclassification' tool will be used. Select the **'nilebas_dem'** raster item. Look for the 'Raster processing' category within the Tools Explorer and Select the 'Reclassification' tool.	
4- Once the tool is selected, its properties are populated in the Properties explorer. First change the Mapping type to 'ValueRange'. This to reclassify a range of values instead of a single value. Click the ... button to change the value mapping of the raster data.	
5- In the Values Mapping, create to mappings for the ranges: - MinValue = -0.1; MaxValue = 0.1; Output value = -99999. This is to change the zero value to -99999. - MinValue = 5000; MaxValue = 100000; Output = -99999. this is to change the 55537 to -99999 ***Note***: As the TIFF file contains no information about the value to use for missing data, -99999 is used.	

6- Click  to run the tool.

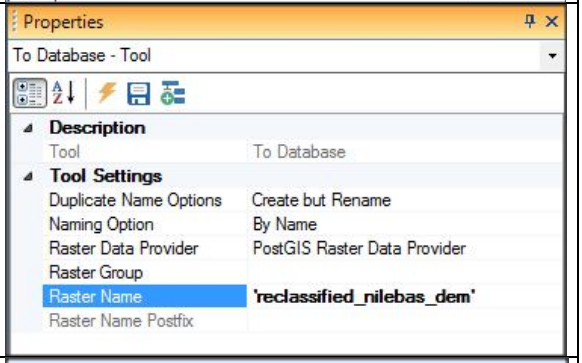


The map now looks like the window shown next. It is clear that the reclassification has improved the map visualization.

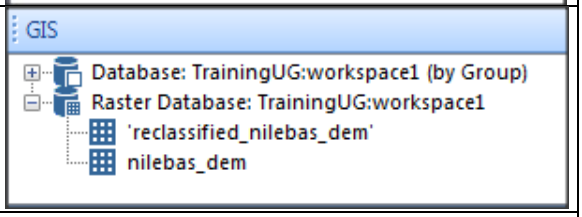
You can use the  icon to check raster cell values. Click the icon and then click a cell on the grid and check the Properties explorer.



7- Select the newly generated raster in the legend, select the “To database” tool in the Tools Explorer and save the reclassified raster as **'reclassified_nilebas_dem'**. Click  to run the tool.



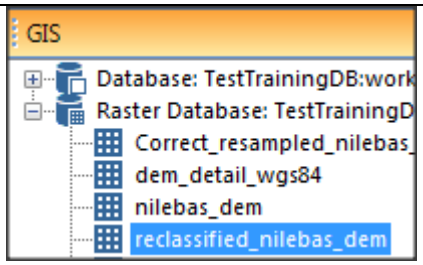
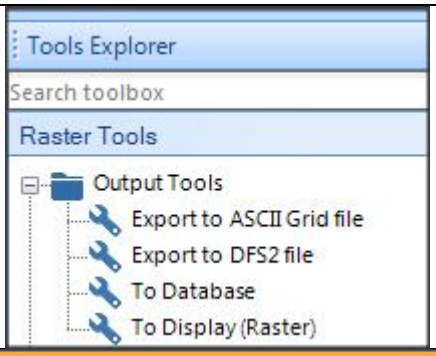
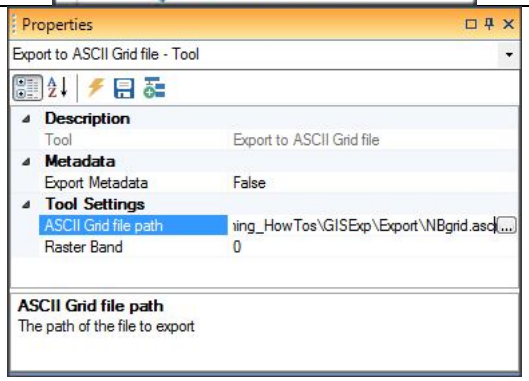
8- The new raster **'reclassified_nilebas_dem'** has been added to the GIS explorer.

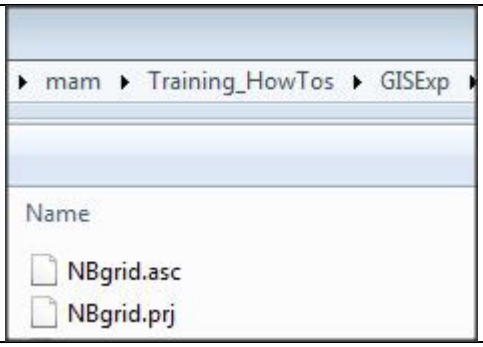


9- Use the toolbar buttons  to pan, zoom in and out to see the map details. Check how the scale changes as you undertake those operations.

The map legend (right click) menu allows the user to remove (from the view), hide and zoom to the extent of a data item. User can also reset the data item view settings to defaults (i.e. reset symbology) or save them a default.

Exporting raster data

1- In the GIS explorer, Select the **'reclassified_nilebas_dem'** rater data that you have created in the previous exercise.	
2- In the tools windows, select the 'Export to ASCII grid file' tool under the 'Output Tools'	
3- Once the tool is selected, its properties appear in the properties window as shown next. The tools allows you to: - Export the Metadata (if it exists) - Set the raster band to be exported (in case more than one band exist in the rater data) - Specify the file path of the ASCII gird file. Leave the default values for exporting the metadata and the coordinate system and specify the file path of the ASCII grid file	

4- Click the  to run the tool. Check that the data has been exported by examining the export folder.	

Review Questions

1- List three import formats for vector and raster data.

2- List two export formats for vector and raster data.

3- Raster data can be edited in the DSS.

- True
- False

4- Describe the components of the GIS window.

5- Scale is calculated automatically in GIS window.

- True
- False

6- You can delete features using the GIS window toolbar.

- True
- False

Answers

1- Import formats for vector data are shape, KML and ASCII files. Import formats for raster data are ASCII grid, image and DSF2 files.
2- Export formats for vector data are shape and KML files. Export formats for raster data are ASCII grid and DSF2 files.
3- False (Only vector data).
4- GIS view components are:
    - Map area.
    - Map legend
    - Map scale
    - Toolbar
5- True.
6- False (The Edit layer toolbar).

2.4. Handling changes and metadata

Introduction

This lesson introduces you to the handling of GIS data changes and metadata within the DSS.

Topics covered in this lesson:

- Examining the change log entries for GIS data
- Importing and editing GIS metadata

Lesson objective:

After completing this lesson, you will be able to:

- Understand the change log entries for GIS data
- Handle GIS metadata

Lesson pre-requisites

You have to be familiar with GIS basics (See the GIS data basics section for details) to take this lesson.

GIS change log and metadata

One of the main challenges to data users is to keep a log of the changes made to a data set and also save and keep its metadata updated. The DSS solves this problem though ‘Change log’ and ‘Metadata’. When GIS data is added to the GIS Manager, the DSS monitors all operations that are carried out on it noting the time and date of each operation, and who carried it out. For example, when a vector layer is added, an entry is automatically added to the ‘Change log’ to show the time and date of adding this data and also a description of the operation as shown in the figure below.

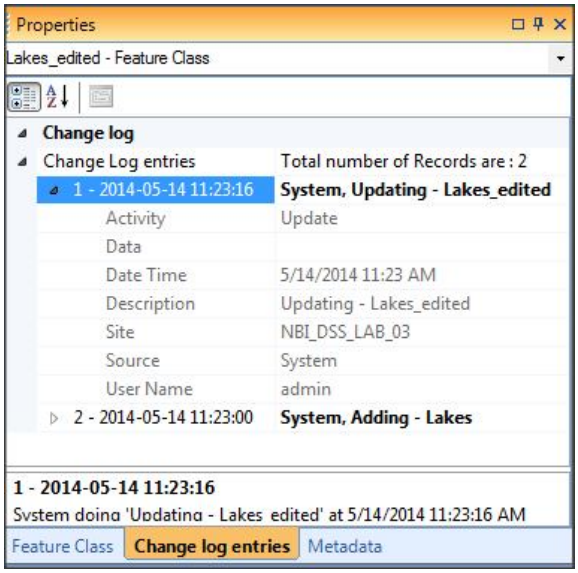


Figure 6: Change log example

The DSS allows the users to import a metadata xml schema for GIS data. Once the schema is within the DSS database, it is saved and linked to all GIS data where the metadata can be entered and updated by the users (manually) as needed.

To define the metadata properties an agreement on a common set of metadata properties has to be made. At a technical level the metadata properties must be expressed as an XML schema. An example of a simple schema is given below.

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema attributeFormDefault="unqualified" elementFormDefault="qualified"
xmlns:xs="http://www.w3.org/2001/XMLSchema">
<xs:element name="metadata" > <!--Root node -->
<xs:complexType>
<xs:sequence>
<xs:element name="identification" minOccurs="0" > <!--Category -->
<xs:complexType>
<xs:sequence>
<xs:element name="originator" type="xs:string" minOccurs="0" />
<xs:element name="publicationdate" type="xs:dateTime" minOccurs="0" />
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```

The above simple schema defines one property, `identification`, which is optional (i.e. minoccurs=0) and consists of two (also optional) values, `originator` and `publicationdate`.

The first is a string, while the latter is a date-time. Note in addition to 'string' and 'datetime' data types, 'decimal' types are also used. Data types of properties in such a schema should be kept to standard types as defined by http://www.w3.org/2001/XMLSchema

You are encouraged to read more about the xml schema in the 'Data Quality Assurance Guideline: Data Processing, Quality Assurance and Metadata' report that was published as part of the 'Data Compilation and Pilot Application of the Nile Basin Decision Support System (NB-DSS)' study (Work Package 2: Stage 2).

Free software is available and can help create and/or edit XML schemas. One such software is XMLFox which can be downloaded from http://www.xmlfox.com/. It shows the schema as a tree (Figure 7) and allows easy editing. It creates the XML tags automatically.

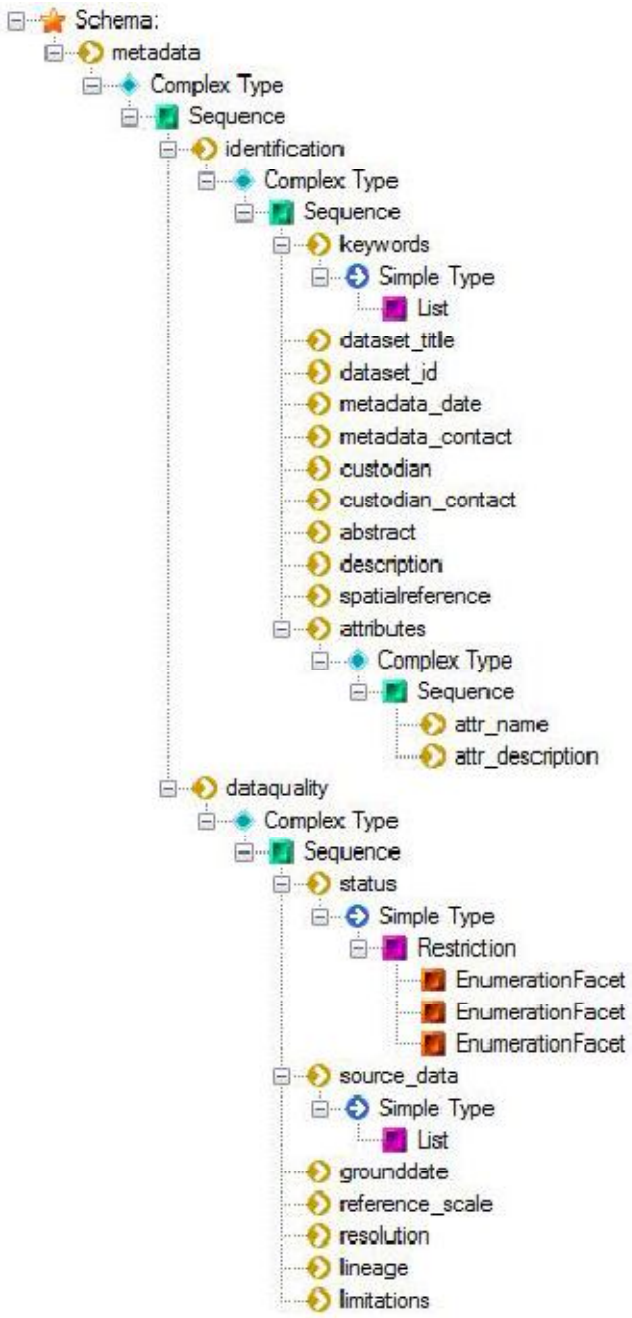
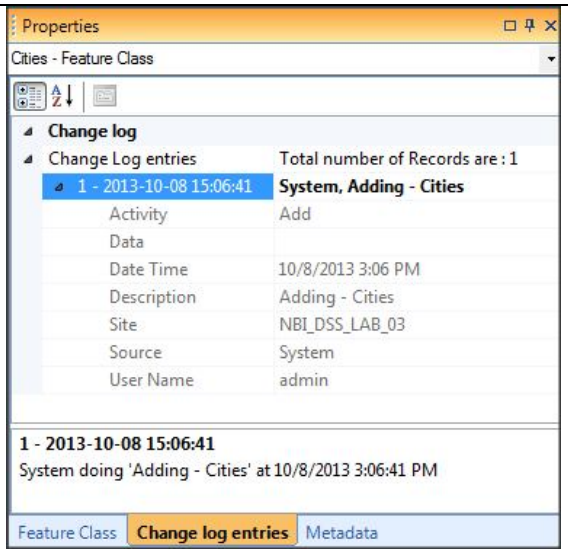
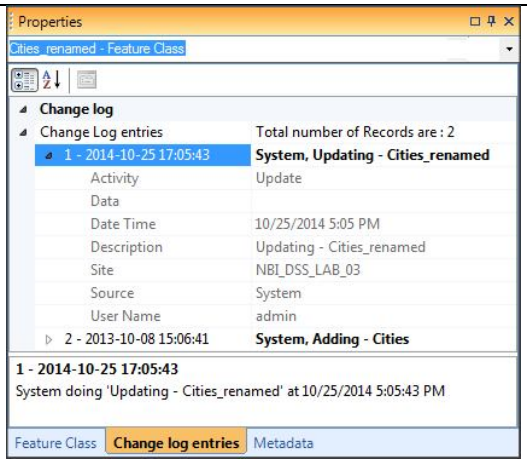


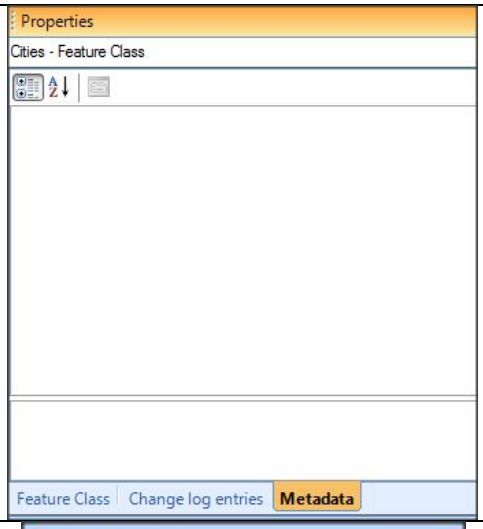
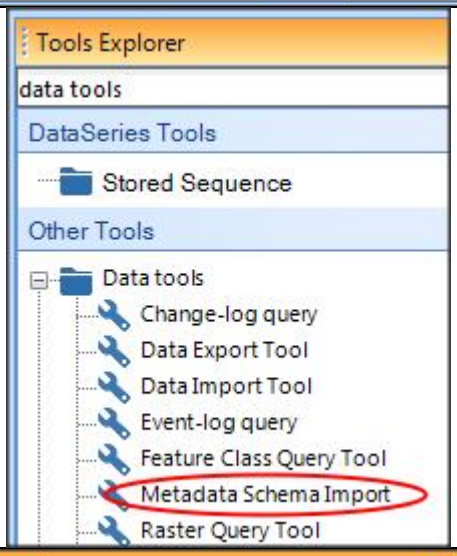
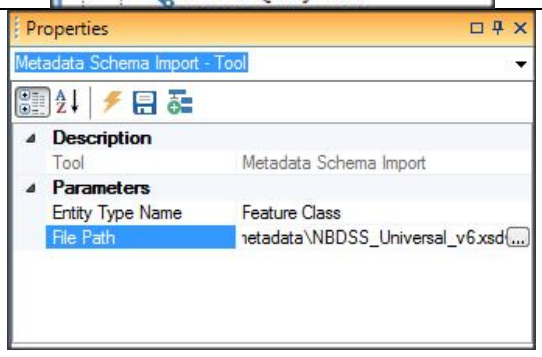
Figure 7 NB DSS Universal Metadata Schema in XMLFox

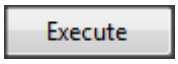
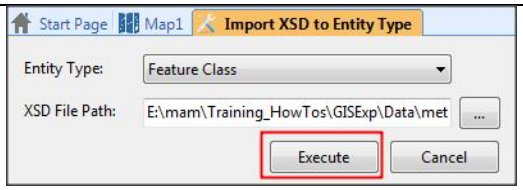
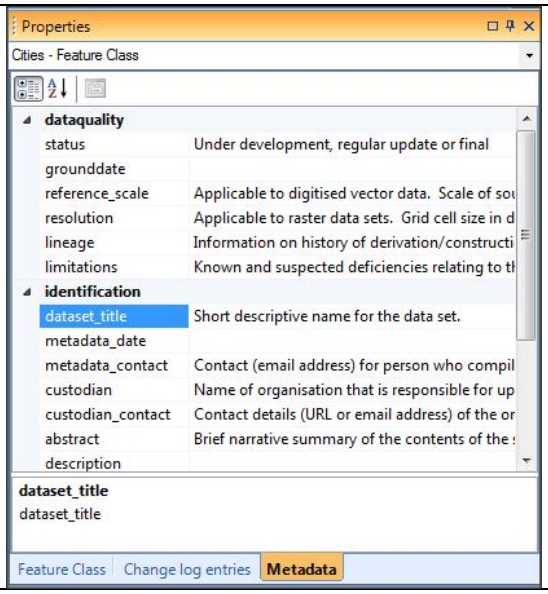
Exercises

Handling GIS data change Log

1- Repeat the steps carried out to import a vector data file into the GIS Manager (See importing vector data into the DSS section for details). Check the 'Change log entries' tab after the import. You will notice that there is one entry in the change log. The entry shows that the data was added to the database. Double click the entry to expand. You can see more details such as the activity type, date and time and user who carried out the activity.	
2- Rename the vector data that you have imported above and check the again the 'Change log entries' tab. What did you notice? Write down your observations. (Hint: compare what you see against the next figure). 3- Try editing the attribute table or the vector data and observe the change log entries It is worth noting that entries in the log are ordered from the most recent to the oldest.	

Handling Metadata

1- Switch to the third tab on the properties called ‘Metadata’ For the selected GIS layer (Select one if none is selected), no metadata exists. There no fields in the first place	
2- If metadata fields do not exist, a schema needs be imported using the ‘Metadata Schema Import’ tool under the ‘Data tools’ category. To use the tool, select ‘Metadata Schema Import’ from the ‘Data tools’ category.	
3- Once the tool is selected, its properties appear in the Properties window. Two parameters need to be entered for this tool. The first is the DSS entity type (i.e. 'Feature Class' in this case but can be 'Raster' for raster data) and the second is the ‘File Path’ to the metadata schema file. Select the **'NBDSS_Universal_v6.xsd**' file that is located in the '**..\GISExp\Data\metadata**' folder.	

4- Click the  button. The next dialog box appears. Confirm that both entity type and XSD file path are correct and then click the  button.	
5- The metadata fields are imported into the 'Metadata' tab. Select a GIS layer and go to the metadata tab to familiarize yourself with the content, the template contains descriptions of the various fields. You can start entering metadata for any layer.	

Review Questions

1. Explain how GIS data metadata is imported and maintained within the DSS.
2. The DSS keeps track of all the operations made on GIS vector and raster data.
   - True
   - False

Answers

1. The DSS allows the users to import GIS data metadata through an xml schema using the ‘Metadata Schema Import’ tool. Once this schema is within the DSS, it is saved and linked to GIS data belonging to the specified ‘Entity Type’. Metadata can also be updated directly by the users if needed.
2. True.

2.5. Vector data selection (queries)

Introduction

This lesson introduces you to applying queries on vector data (i.e. selection of vector data) within the GIS Manager.

Topics covered in this lesson:

- Selection of vector data based on location (spatial query).
- Selection of vector data based on properties (attribute query).

Lesson objectives:
At the end of this lesson, you will be able to

- Query vector data based on properties or location

Lesson pre-requisites

You have to be familiar with the vector data basics to take this lesson.

Spatial and attribute queries

In the DSS, users can query vector data. The following query methods exist:

1. Spatial query: select features based upon their spatial properties (i.e. latitude, longitude).
2. Attribute query: select features based upon their attribute values.

The spatial query allows users to select one or more features in a vector data item and then run queries on another different vector data item(s) to answer questions such as 'find rivers located within Uganda' or 'dams located in Sudan'.

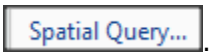
The attribute query allows users to select one or more features in a vector data item based upon the value of their attributes to answer questions such as 'find cities with population higher than 200,000 capita or rivers longer than 1 km given that this information are stored in the attribute table of the layer.

Exercises

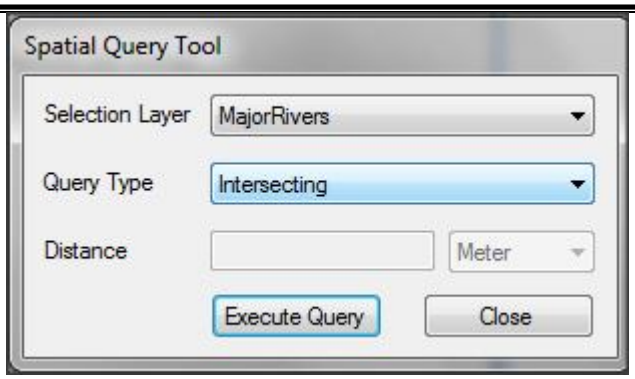
Vector data spatial query

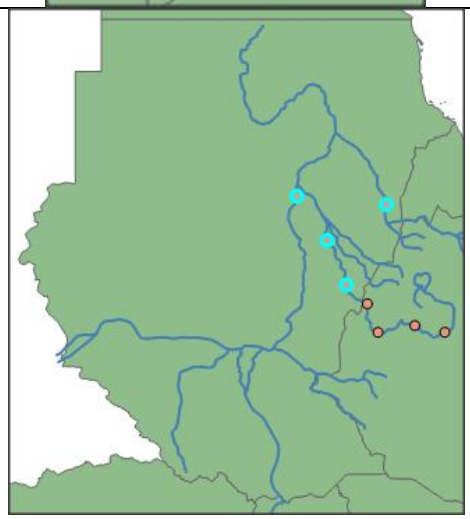
1- Add the **'MajorRivers'** and **'NB_Countries'** vector data to a new map. Make the **'NB_Countries'** the active layer and select Uganda using the  icon.

Holding SHIFT key allows multiple selection of features.

2- In the map toolbar click the  icon and then 

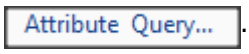
. Fill the 'Spatial Query Tool' box options as shown. The options mean 'find all features in the MajorRivers layer that intersect Uganda (as the selected feature)'. Click 'Execute Query'.



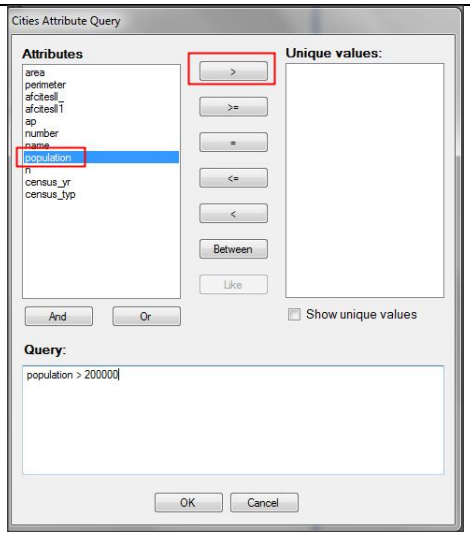
The tool selected those rivers that intersect Uganda.	
3- Add the Dams vector data and repeat the above but selecting 'Sudan' on the active layer, 'Dams' as the Selection Layer and 'Within' as the Query Type in the “Spatial Query” tool dialog to Find all dams located within Sudan. The Query selects dams in Sudan as shown.	

Vector data attribute query

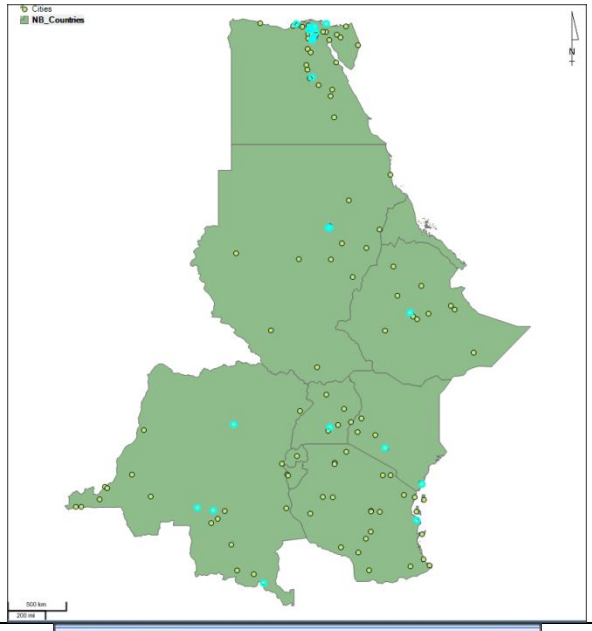
1- Add the **'Cities'** and **'NB_Countries'** vector data to a new map. Make sure the **'Cities'** data is the active layer.

2- In the map toolbar click the  icon and then 

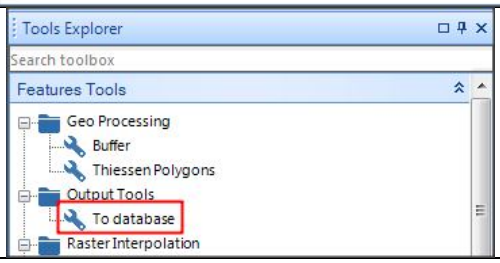
. Fill the 'Attribute Query' box options as shown. This can be done by double clicking the 'population' attribute in the 'Attributes' list then the '>' sign and then write '200000'. This query means 'find cities that have population more than 200,000 capita'. Click 'OK'.

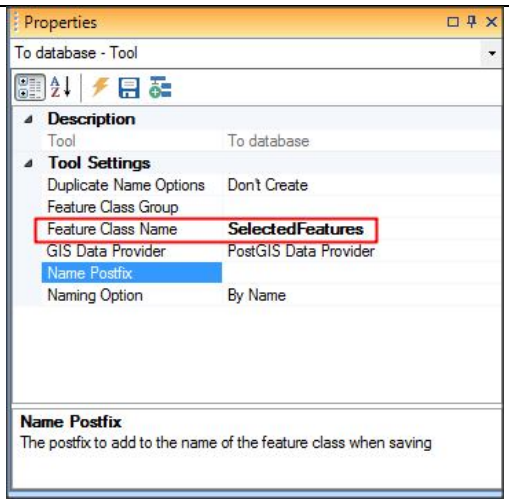
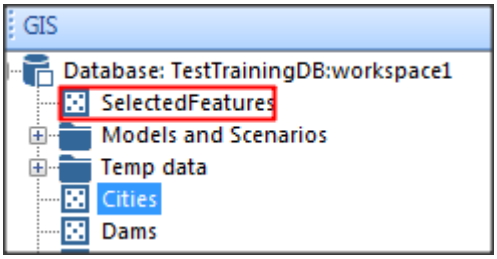


Cities are selected as shown.



3- Select the 'To database' tool under the 'output tools' category to save the selected features to a new feature class



4- Once the tool is selected its properties appear in the Properties window. Enter a suitable name (e.g. SelectedFeatures) in the 'Feature Class Name' box. Click the  to run the tool. A new layer is now added to the explorer. Open it in a new map to check that the selected features were only saved.	 

Review Questions

1. What are the two query methods of vector data in the DSS?
2. Spatial query can be run on raster data
   - True
   - False
3. Which of the following queries is valid when querying country names that have a letter ‘n’ attributes? Is the ‘like’ operator case sensitive?
   - name1_ like ‘n’
   - name1_ like ‘*n*’
   - name1_ like ‘%n%’
   - name1_ like ‘#n#’
4. Can the ‘Between’ operator be used to query ‘Text’ attributes? Is the ‘Between’ operator case sensitive?
   - True
   - False

Answers

1. In the DSS, users can query vector data. The following query methods exist:
   - Spatial query: select features based upon their spatial properties.
   - Attribute query: select features based upon their attribute values.
2. False (Only vector data)
3. name1_ like ‘%n%’ . The ‘Like’ operator is case sensitive and is used to query an attribute for values that meet a given criteria
4. True. The ‘Between’ operator is used to query text, number and date-time attributes. The following query returns country names that start with letter c up to those that start with letter q. those that start with letter r are not included. The ‘Between’ operator is NOT case sensitive.
   - name1_ Between 'c' And 'r'

2.6. Vector and raster data processing

Introduction

This lesson introduces you to a number of vector and raster data processing tools within the DSS.

Topics covered in this lesson:

- Using the measure tool
- Dissolving and creating Thiessen polygons for vector data
- Resampling and calculating zonal statistics for raster data

Lesson objective:

After completing this lesson, you will be able to apply the following tools on vector and raster data:

- Dissolve
- Creating Thiessen polygons
- Resample
- Zonal statistics

Lesson pre-requisites

You have to be familiar with GIS basics (See the vector and raster data basics section for details) to take this lesson.

Vector data processing tools

A number of vector data processing tools are available in the DSS. They all share the following pattern:

- They require one or more feature classes as input to run.
- Tools can produce a new vector data or a table that is placed in memory (i.e. not saved).
- In-memory vector data can be stored in the database using the 'To database' tool.
- Layer data need not be displayed to apply the tools.

The following three tools will be used in this section:

1. The 'Measure' tool to add the length attribute to a line vector data file.
2. The 'Dissolve' tool to combine multiple polygons with identical attribute values (user selected attribute) into a single feature as shown in Figure 8.

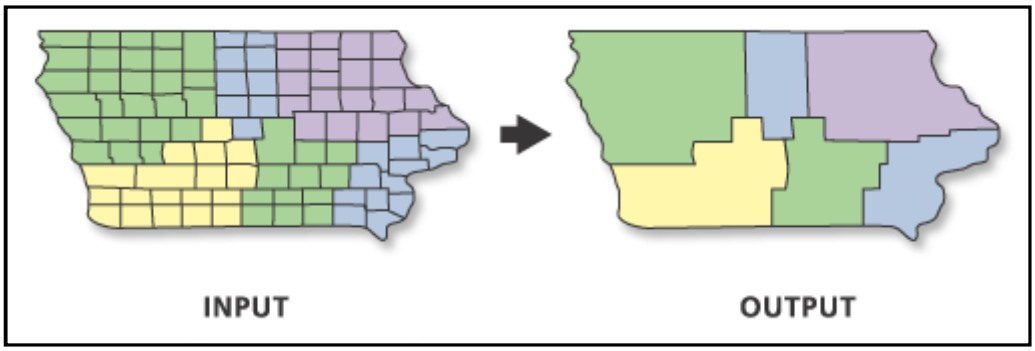


Figure 8: Dissolve example

3. The 'Thiessen polygons' tool that generates polygons from a set of sample points. Each Thiessen polygon defines an area of influence around its sample point, so that any location inside the polygon is closer to that point than any of the other sample points. This is commonly required in raingauge data processing. An example is shown in Figure 9.

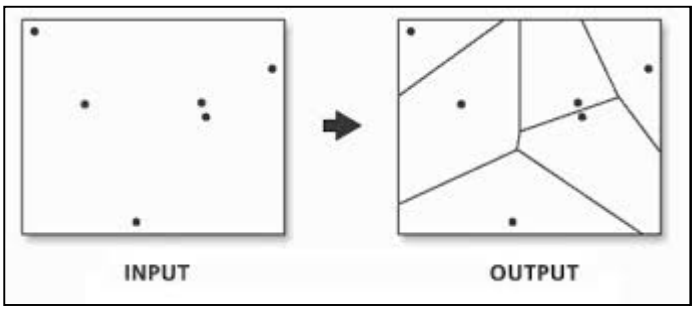


Figure 9: Thiessen polygons example

Raster data processing tools

Two tools have been already used in the import raster data section to reclassify and save raster data to the DSS database. A number of more advanced raster data processing tools are also available in the DSS. In the section below, the following tools will be used:

1. The 'Resampling' tool which is used to change the grid size of a raster data into a user specified grid size. It is possible to resample into larger grid sizes as shown in Figure 10 where the grid has been resampled based on the middle grid cell value.

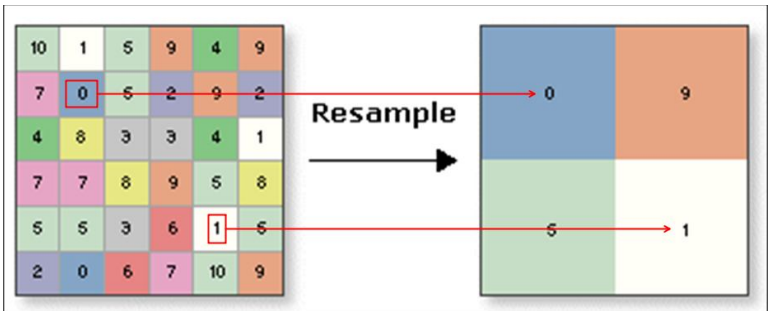


Figure 10: Resampling example

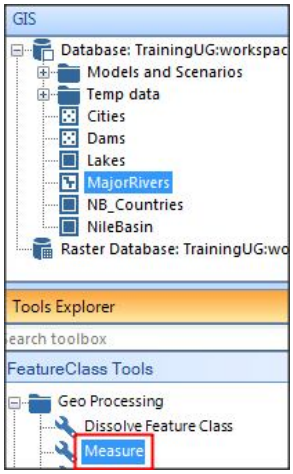
- The 'Zonal statistics' toolbar functionality[4] which is used to calculate basic statistics using the grid cell values (described in the main GIS data formats section) in a raster within a specific area (e.g. if the grid cell values represent elevation, the zonal statistics will represent statistics of elevation for all cells falling within a polygon). There are two options to do this:
  - Statistics for cells within a polygon manually drawn
  - Statistics for cells within an existing feature of polygon type

[4] This operation is done using toolbar buttons rather than using a tool within the Tools Explorer.

Vector Data Exercises

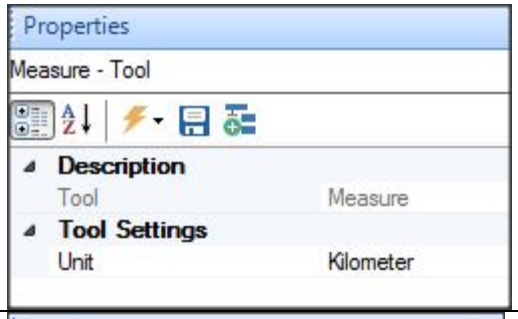
Using the measure tool

1- Select the **'MajorRivers'** vector data in the GIS explorer. Check the attributes of this layer by opening the layer in a table (See viewing vector data in a table section). How many attributes it has? (Hint: 2) Does it contain a length attribute? (Hint: No).

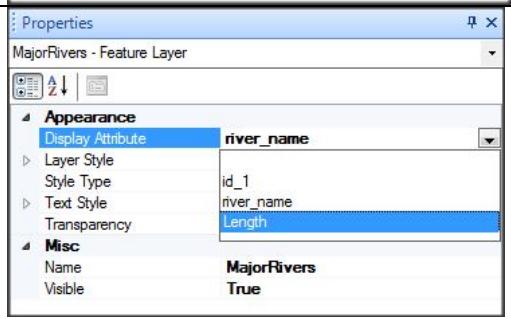


In the Tools Explorer, select the 'Measure' tool under 'Geo Processing' tools.

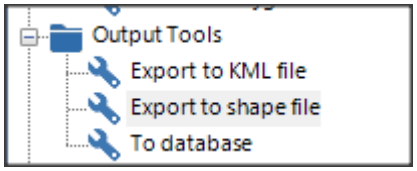
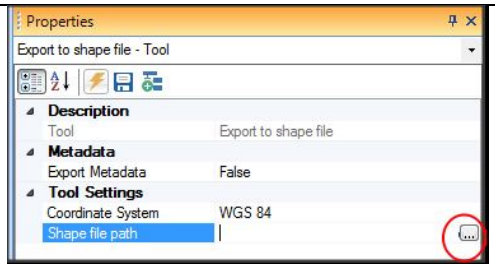
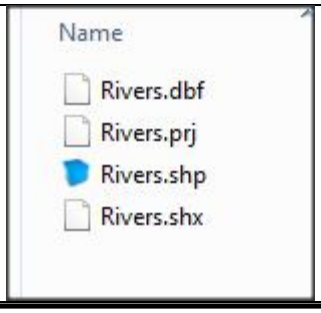
Once the 'Measure' tool is selected its properties appear in the Properties explorer as shown. The DSS identifies the vector data (i.e. line) and provides the suitable units for this (e.g. Kilometer).



2- Click on the  icon and select Run (To Display (Feature Class)). A new map is created. Select the created layer from the legend. If you then look at the attributes list in the Properties explorer, a new attribute length is now added.



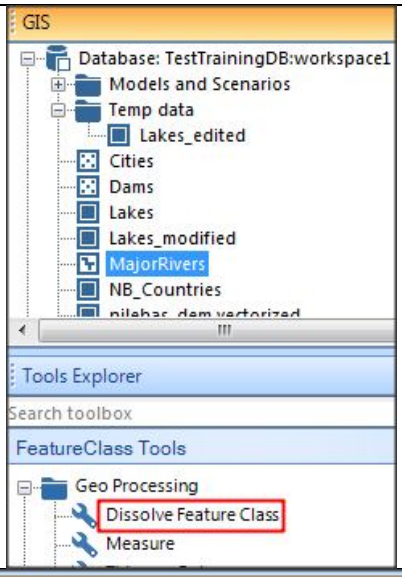
4- Repeat the steps 1-3 but select Run (To attribute table). A table is created and the length is added to each river.

5- Close the table window and get back to the map that was created in step 3. Select the new **'MajorRivers'** vector layer in the legend. In the Tools Explorer, find the 'Export to shape file' tool under the 'Output Tools'.	 
6- Once the 'Export to shape file' tool is selected its properties appear in the Properties explorer as shown. Provide a file path by clicking the ... button and then click on the icon.	
7- Check the export folder. You should find the shape file there.	

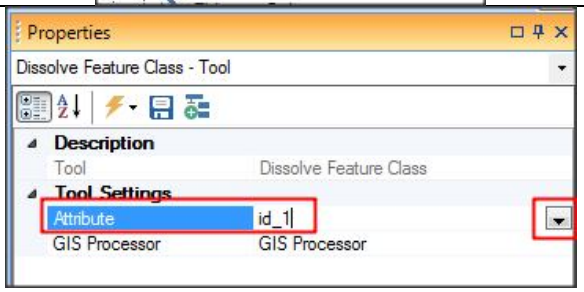
Layer data can also be saved to the Database using the 'To Database' tool under the 'Output tools' category.

Dissolving features

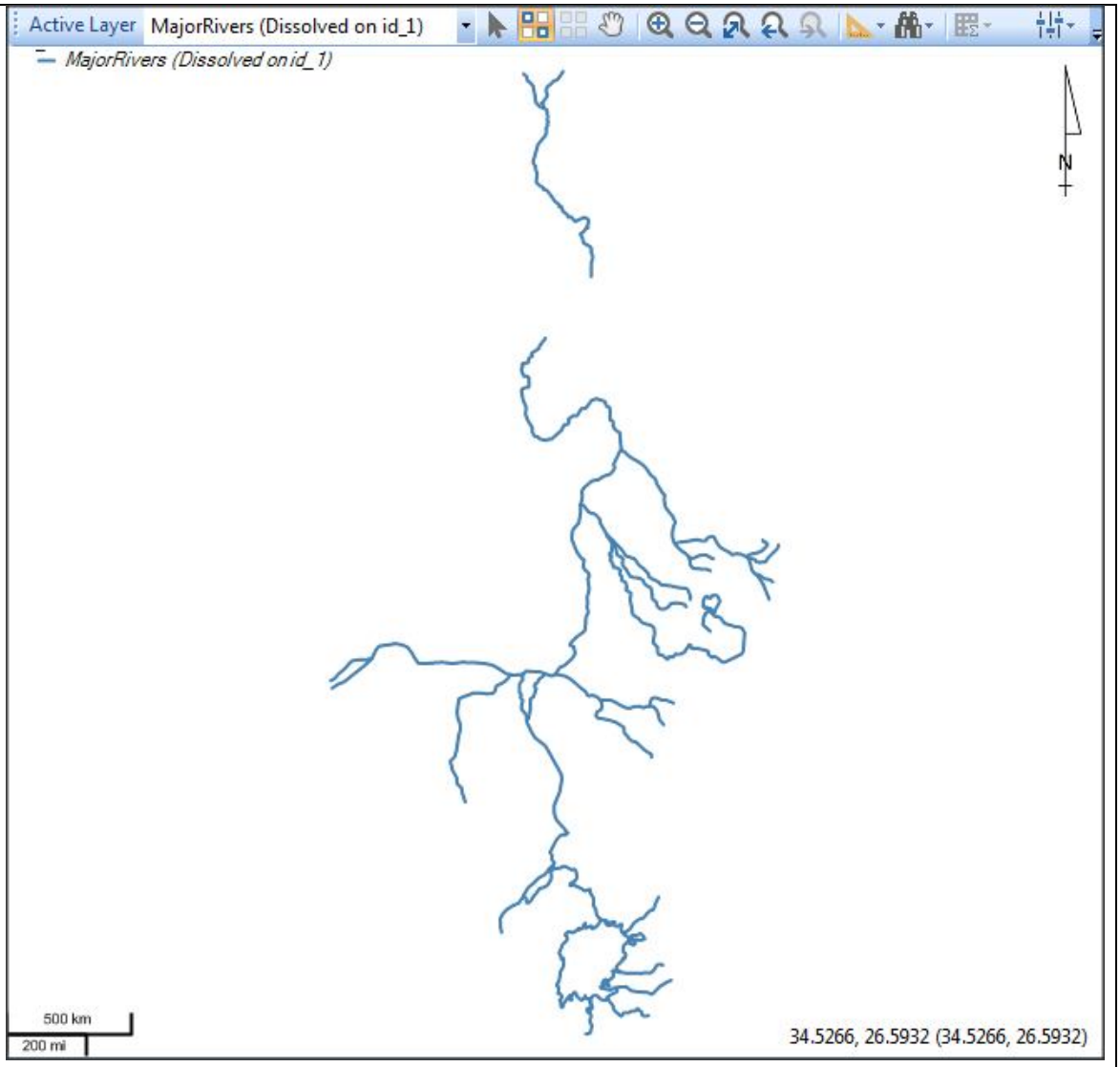
1- In this exercise, you will merge all the river features into one feature (i.e. dissolving). To do this, select the **'MajorRivers'** vector data in the GIS explorer. In the Tools Explorer, select the 'Dissolve Feature Class' tool under 'Geo Processing' tools.



2- Once the 'Dissolve Feature Class' tool is selected its properties appear in the Properties explorer as shown. The DSS fills up the attribute box list with the feature class attributes. Click the  button and select the 'id_1' attribute if not selected.



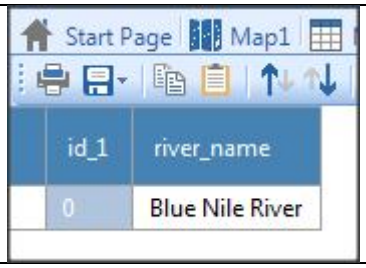
3- Click on the  icon and select  . A new map is created.



Try to select one feature now. What do you notice? write down your observation(s).

4- Repeat the steps 1-3 but select Run (To attribute table).

A table is created and it has only one feature.

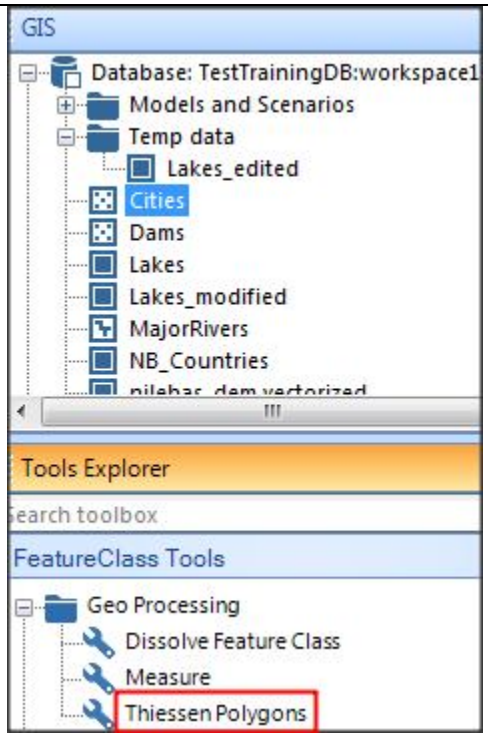


Creating Thiessen polygons

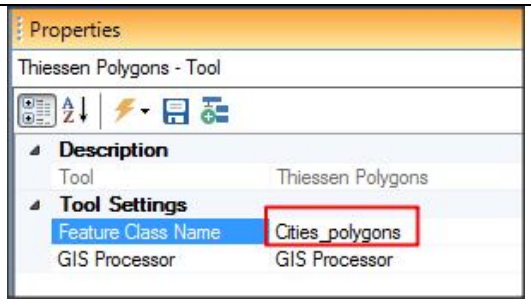
1- In this exercise, you will assume that each city in the **'Cities'** layer has a meteorological station and each station has an area of influence, which can be delineated using the 'Thiessen Polygons' tool.

Select the **'Cities'** vector data in the GIS explorer. In the Tools Explorer, select the 'Thiessen Polygons' tool under 'Geo Processing' tools.

The layer has to be point feature class; an error message is displayed if a line or polygon feature class is selected.

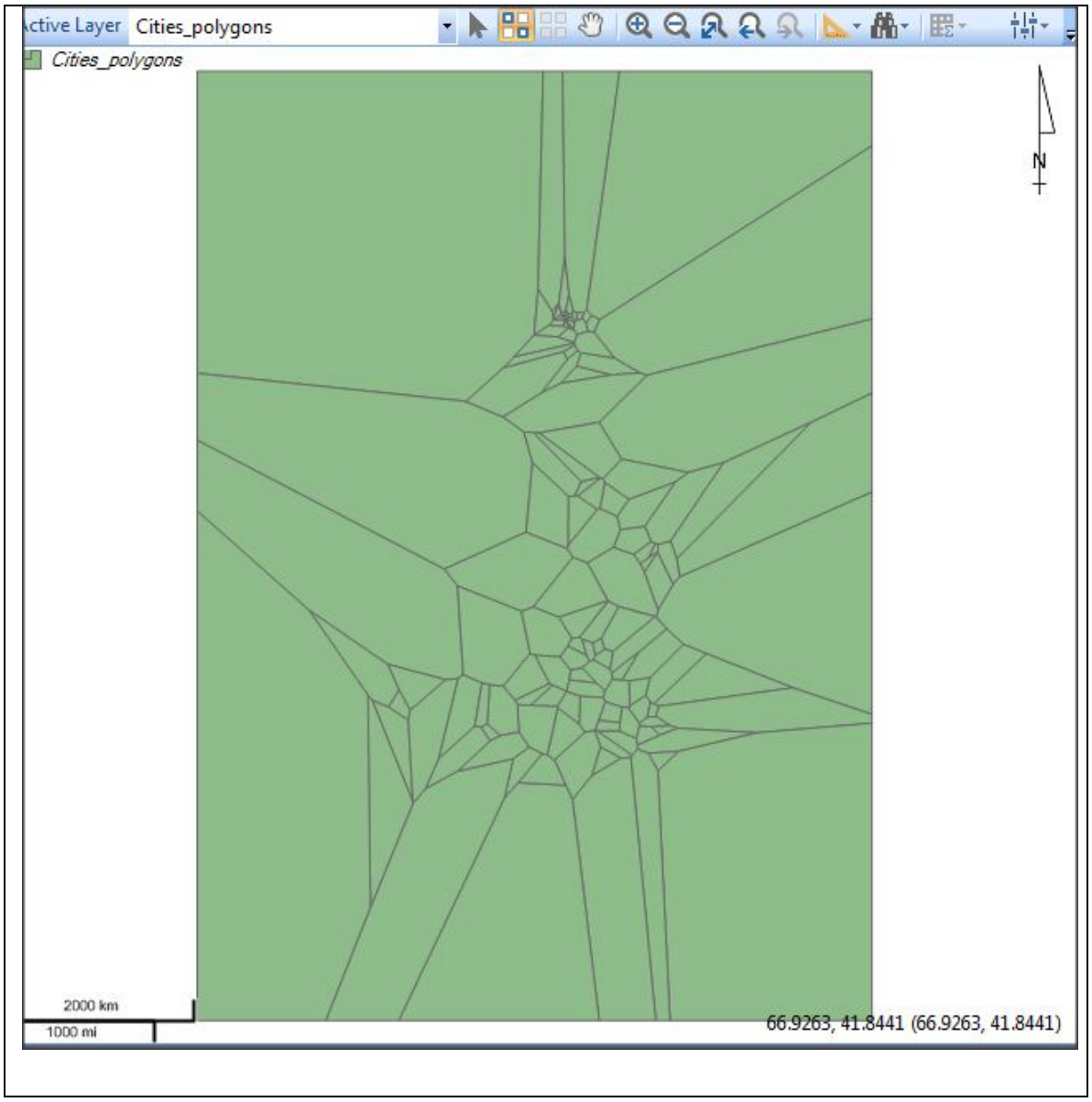


2- Once the 'Thiessen Polygons' tool is selected its properties appear in the 'Properties' explorer as shown. You need to enter a suitable name for the created polygons (i.e. Cities_polygons)



3- Click on the  icon and select Run (To Display (Feature Class)). A new map is created as shown below (or the feature is added to the active map if one is active).

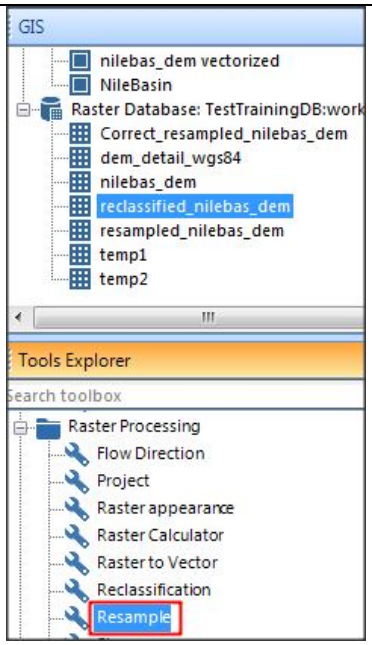
Each polygon shows the area of influence of each station.


ctive Layer
Cities_polygons
Cities_polygons
N
2000 km
1000 mi
66.9263, 41.8441 (66.9263, 41.8441)

Raster Data Exercises

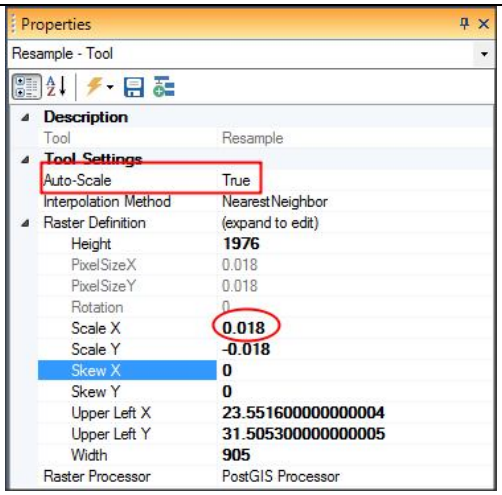
Resampling rasters

1- In this exercise, The resample tool is used to sample the **'reclassified_nilebas_dem'** to have a resolution of 0.018 degrees. To do this, select the **'reclassified_nilebas_dem'** raster data item. Select the 'Resample' tool under the 'Raster Processing' category within the 'Tools' Explorer.

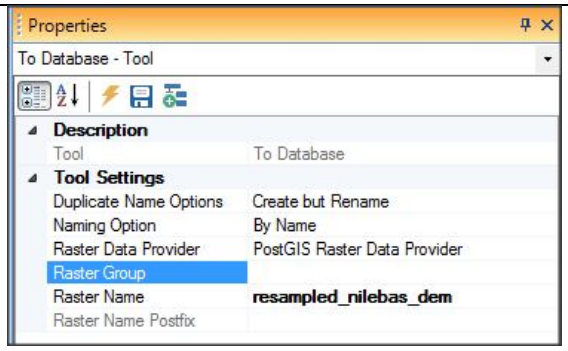
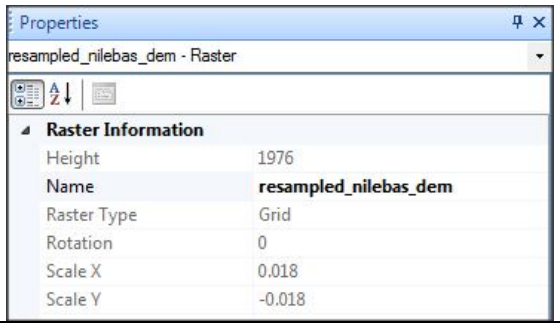


2- Once the tool is selected, its properties are populated in the Properties explorer.

Change the 'Scale X' property to 0.018 and the rest of the properties will be calculated automatically as the 'Auto-Scale' property is set to 'True'. Click  to run the tool.

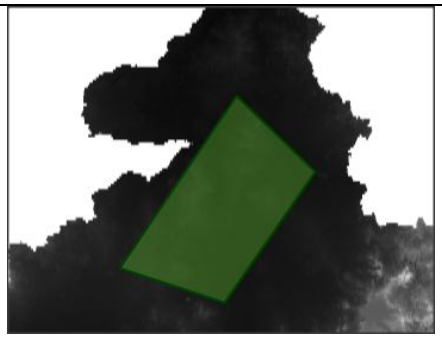


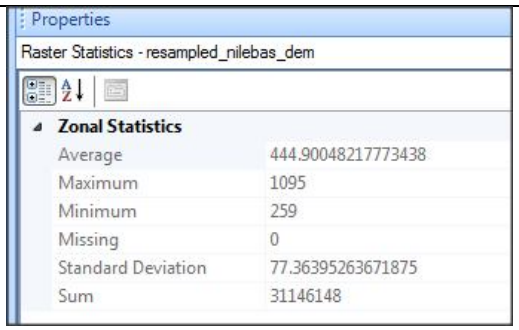
When Auto-Scale is set to true, changing a property in the Raster Definitions will automatically adjust the scale, width and height so that the scales are the same and the resampled raster has the same size as the original raster.

3- Select the newly generated raster in the legend, select the “To database” tool in the Tools Explorer and save the reclassified raster as **'resampled_nilebas_dem'**. Click  to run the tool. Now select the **'resampled_nilebas_dem'** and check its properties. Its resolution is 0.018 by 0.018 degrees as shown in the table.	 

Zonal Statistics

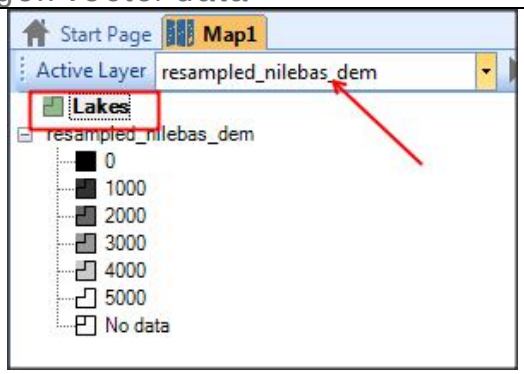
Statistics for cells within a polygon manually drawn

1- Right click the **'resampled_nilebas_dem'** and add it to a new map. Select the raster in the legend and click the  icon and then 'Zonal Statistics by Polygon'.	
2- Start drawing the polygon defining the area (see window shown next for an example) to get statistics for cells overlaid by the polygon and finish by double clicking. The statistics are displayed in the Properties explorer. In this example, the average level of the zone is 444.9 m and the maximum and minimum levels are 1095m and 259m respectively.	



Statistics for cells within existing polygon vector data

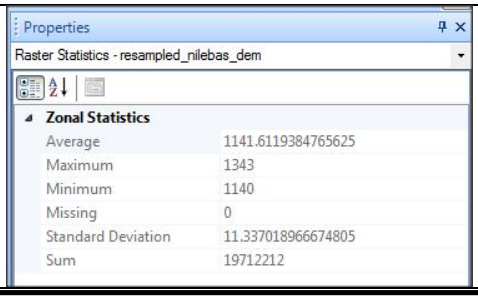
1- Add the **'resampled_nilebas_dem'** raster and the Lakes vector data to a new map.



2- Select the vector data in the legend and select raster data as the active layer.

3-Click the  icon and then 'Zonal Statistics by Feature'.

4- Select a polygon on the map to calculate statistics for (e.g. Lake Victoria)



Multiple selections are possible by pressing the Shift key while selecting polygons on the map.

Review Questions

1. What fields are added to a feature class when the measure tool is used?
2. Zonal statistics can be applied using line feature data

- True
- False

Answers

1. For line features a length field is added. For polygon features, length and area fields are added.
2. False (with polygon data)

2.7. Advanced raster data processing

Introduction

This lesson introduces you to using a number of advanced tools on raster data within the DSS.

Topics covered in this lesson:

- Raster calculator
- Interpolation
- Catchment Delineation
- Temporal analysis

Lesson objective:

After completing this lesson, you will be able to use the following tools:

- Raster calculator to process raster data
- Interpolation to create raster data from, for example, point data.
- Catchment Delineation to delineate catchments based on a Digital Elevation Model (DEM) and digitize river networks.
- Temporal analysis

Lesson pre-requisites

You have to be familiar with GIS basics (See the vector and raster data basics section for details) to take this lesson.

Raster calculator

The Raster calculator tool can be used to make calculations using a single raster or multiple rasters. This is useful, for example, when a user wants to adjust all the cells in single raster by a certain value or calculating the water depth by subtracting the ground levels from water levels if both provided as rasters.

Interpolation

Interpolation is used to interpolate point data into a raster according to attribute values of the points. Four methods are currently available in the DSS[5]: Nearest

[5] For each of the interpolation tools refer to the DSS help file to obtain more information on the interpolation methods and their parameters.

Neighbour, Inverse Distance Weighted, Kriging and Radial Basis Function. Each of these methods has its strengths and weaknesses depending on the spatial distribution of the point data and on the interpolation purpose. The four methods will be presented below in the exercise section.

Catchment Delineation

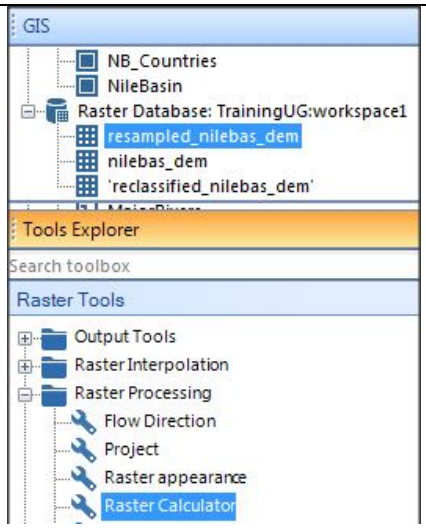
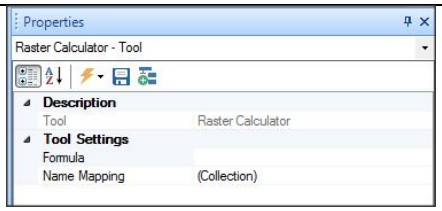
Using the Catchment Delineation functionality, you can delineate catchments and digitize river networks using a raster representing elevation values (called a digital elevation map, or DEM).

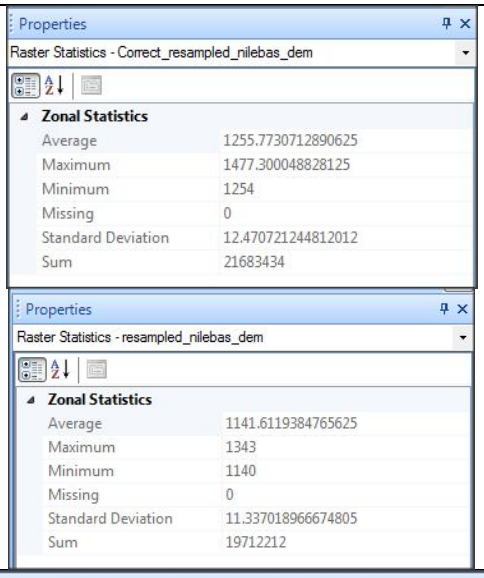
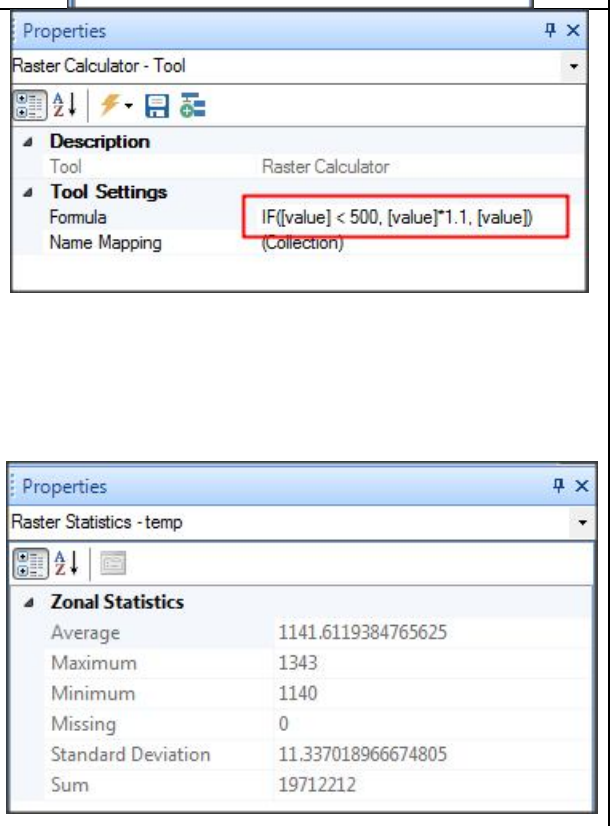
Temporal analysis

Exercises

Raster calculator

Calculation using a single raster

1- In this exercise, we will assume that a systematic error was found in the ground levels. This error reduced the levels by approximately 10%. So to get the right ground levels, we need to multiply all the levels by 1.1. To do this, select the **'resampled_nilebas_dem'**. Select the 'Raster Calculator' tool from the 'Raster processing' category within the Tools Explorer and	
2- Once the tool is selected, its properties are populated in the Properties explorer. In the formula box, Type "[value] * 1.1" (without the double quotes). The expression [value] here means each cell value in the grid is used since a single raster is used in this exercise. Click  to run the tool. A new raster is added to a new map or the active map if one is active.	
3- Save the raster layer to the database and call it **'Correct_resampled_nilebas_dem'**. To check the values, add the **'Lakes'**	

vector data to the active map and recalculate the statistics for lake Victoria. As shown the values of the average, maximum and minimum increased by 10% when compared to those calculated before (see bottom figure.)	
4- Raster calculator can also be used to work with certain values, allowing conditional statements. For example, increase the ground level by 10 % if level is below 500 but keep values above or equal to 500 as is. To do this repeat the above exercise but in the formula type IF([value] < 500, [value]*1.1, [value]). To check the values, add the **'Lakes'** vector data to the active map and recalculate the statistics for lake Victoria. As shown the values of the average, maximum and minimum has not changed as they are above 500 m.	

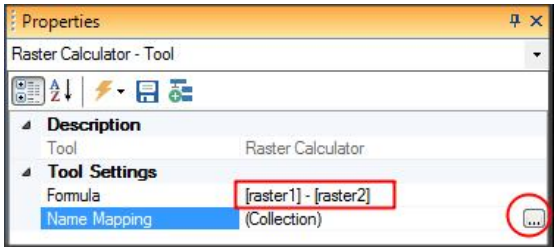
Calculation using multiple rasters

Working with two rasters in the raster calculator is similar to working with one raster, however, we need to map each raster to an identifier so the calculator can distinguish between the two rasters.

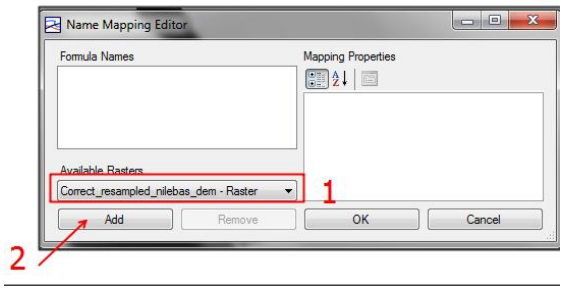
1- Select both **'resampled_nilebas_dem'** and **'Correct_resampled_nilebas_dem'**	

rasters. Select the “Raster Calculator” tool in the Tools Explorer.

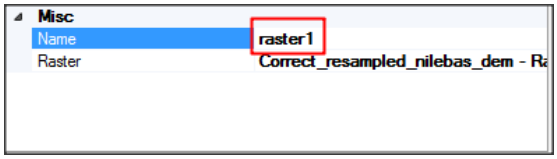
2- In the formula box Type “[raster1] - [raster2]” (without the double quotes). Where [raster1] is the identifier of one raster and [raster2] the identifier of the second raster. We now need to map [raster1] and [raster2] to the input rasters.



3- Click the ... in the 'Name Mapping' property in the 'Property' explorer. A list of the selected rasters is displayed in the mapping dialog. First select the **'Correct_resampled_nilebas_dem'** from the Available Rasters' list then click the Add button.

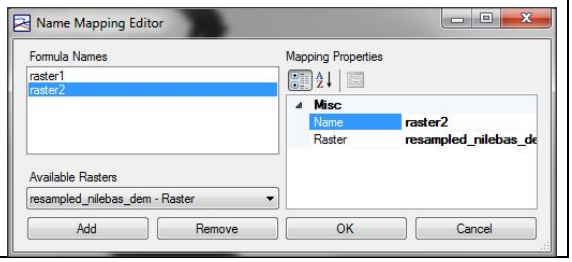


Now, go to the 'Mapping Properties' box and change the name to raster1.



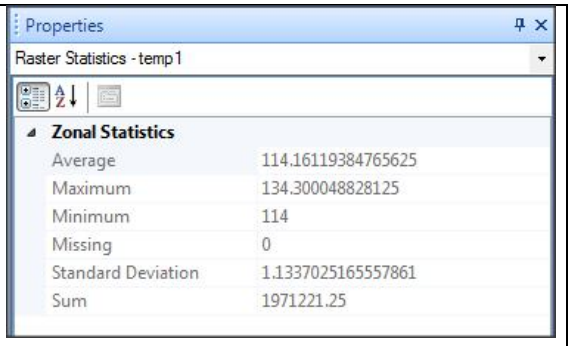
Repeat the same steps with the **'resampled_nilebas_dem'** raster but call it raster2.

Name mapping should look like the window shown next. Click OK to close the editor.



4- Click to run the tool.

A new raster has been added to the map. Save to the database. To check the values, add the **'Lakes'** vector data to the active map and recalculate the statistics for lake Victoria based upon the new raster. As shown the average, maximum and minimum values are 10 % of the **'resampled_nilebas_dem'** values which is correct.



The description for the formula property (See below) is a good source of information of how the formulas shall be written. Note that the '=' sign is optional and can be omitted when writing the formulas.

Formula description

The formula to apply for the calculation. Use syntax normally found in spreadsheets, but instead of cell references, enter raster names as mapped in the Mapping property within square brackets, e.g. [myraster]. Examples of this are:

'= [raster1] + [raster2]' which calculates the sum of raster1 and raster2. raster1 and raster2 need to be mapped in the Mapping property. Only one output raster is returned.

'= AVERAGE([raster1], [raster2], [raster3], [raster4])' which calculates the average value of 4 rasters. raster1, raster2, raster3, and raster4 need to be mapped in the Mapping property. Only one output raster is returned.

The tool can also produce one output for each input in case '[value]' mapping is used, meaning the current input raster being used in the loop over input rasters. Examples are:

'= SQRT([value])' Which calculates the square root for each input raster, and returns a corresponding output raster, value shall not be mapped in the Mapping property.

'= IF([value] < 1000, 0, [value])' Which replaces in each raster, all values below 1000 with 0 and keeps the values bigger than or equal to 1000 and returns a corresponding

output raster, value shall not be mapped in the Mapping property.

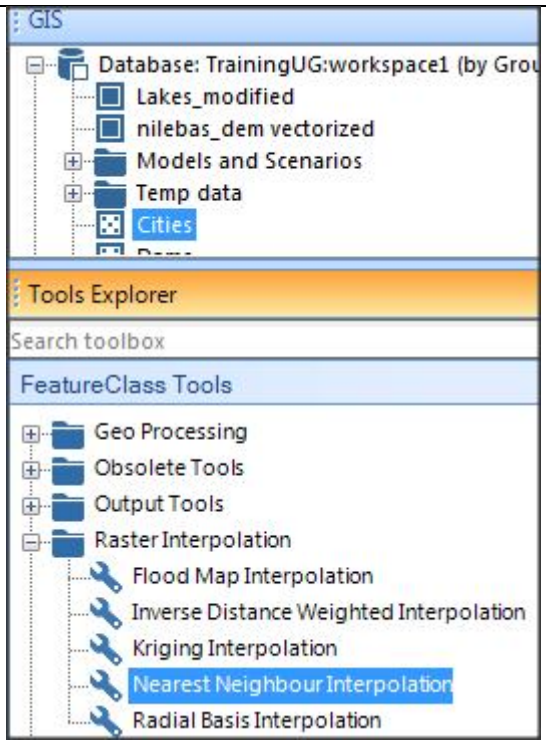
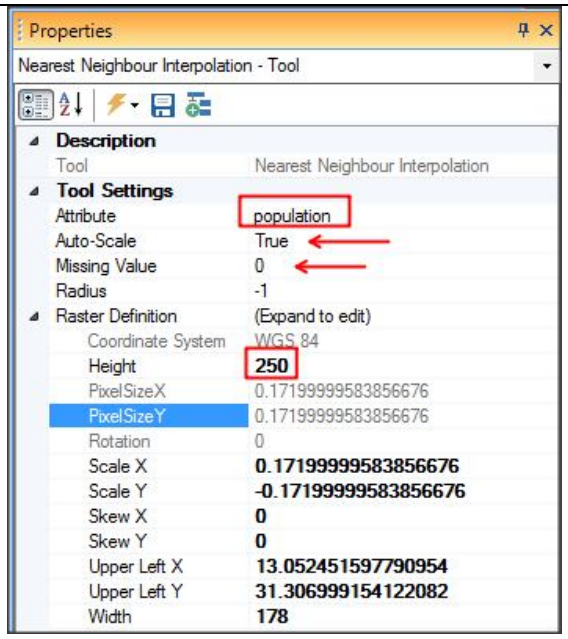
Missing or 'No Data' values can be represented in the formula with any of the following key words (which must be in brackets): [null], [nothing], [nodata], [novalue], [missing], [missingdata], [missingvalue]. An example is shown below:

'= IF([value] < 1000, [missing], [value])' Which replaces in each raster, all values below 1000 with 'No Data' and keeps the values bigger than or equal to 1000 and returns a corresponding output raster, value shall not be mapped in the Mapping property.

Interpolation

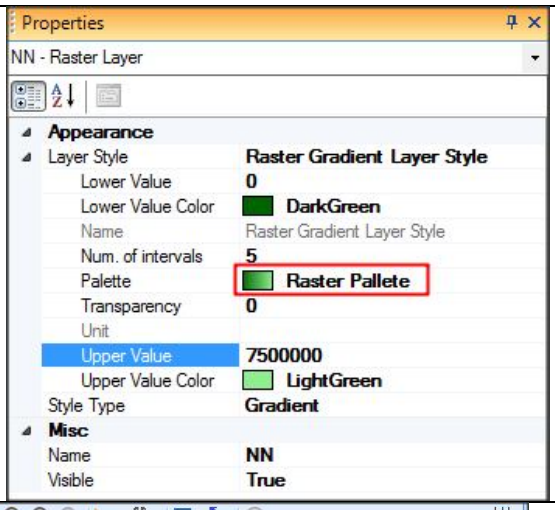
1- In this exercise, you will the 'population' attribute of the **'Cities'** layer to interpolate the data across the cities. Right click the **'Cities'** vector data in the GIS explorer and add it to a data table. Check the 'population' attribute values. Notice that values vary from 23 thousands to a bit more than 5 millions.

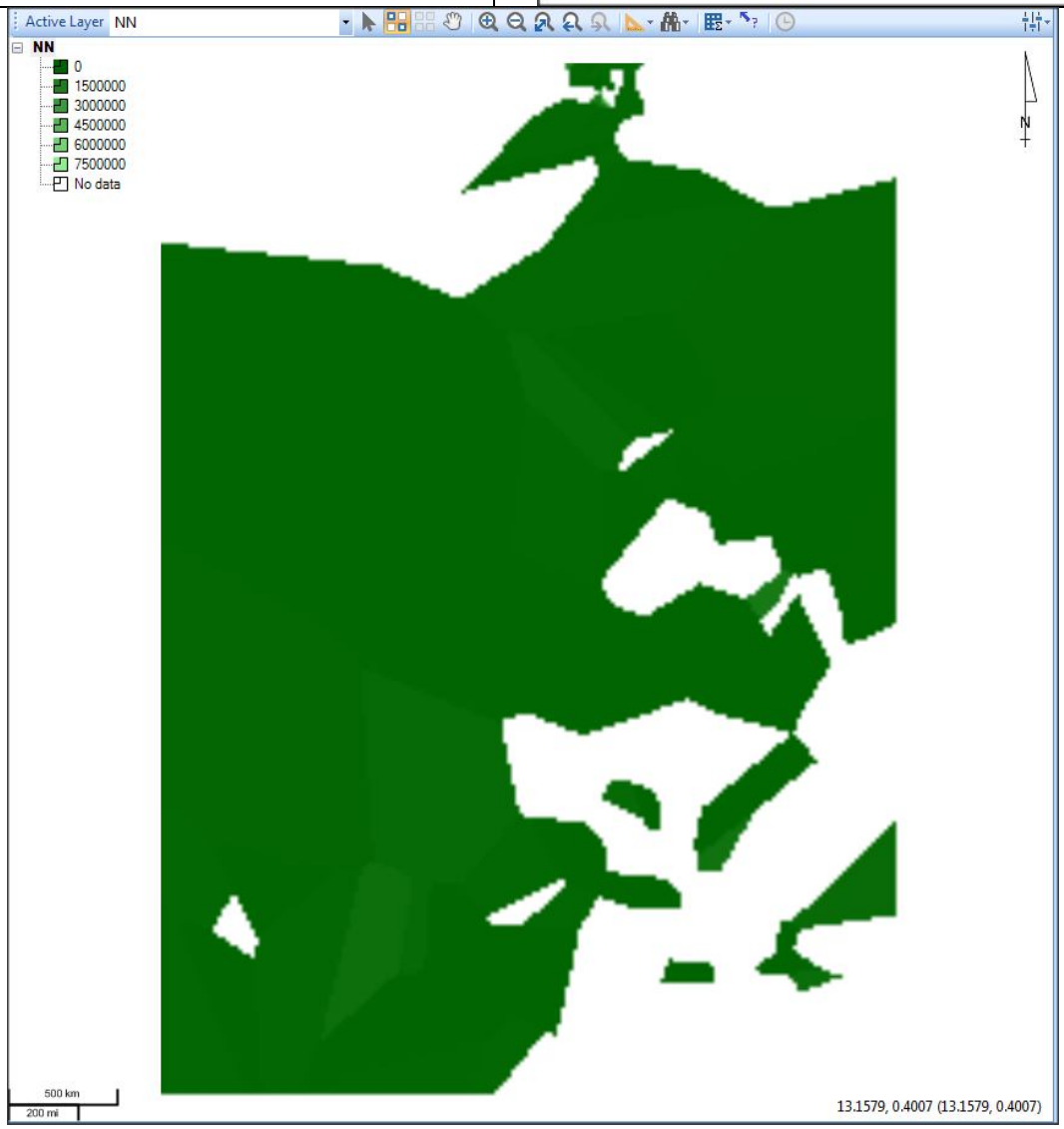
name	population	n
DODOMA	23559	2
MWANZA	34861	2
MIT GHAMR	43665	2
NAKURU	45000	2
MINUF	48256	2
QALYUB	49303	2
KAFR ASH-SHAYKH	51544	2

2- Select the **'Cities'** vector data in the GIS explorer. 3- Select the 'Nearest Neighbour Interpolation' tool under 'Raster Interpolation' category within the Tools Explorer.	
4- Once the tool is selected, its properties are populated in the Properties explorer. Set the Attribute to population. Leave 'Auto-Scale' as 'True'. Change the missing value to '0' and the 'Raster Definition' to have a Height of 250 (this is not actually a height, it is the number of rows and the width is the number of columns of the raster). Click  to run the tool.	

5- A new raster is created and added to the map. Select the raster in the legend and change the 'Palette' in properties to green.

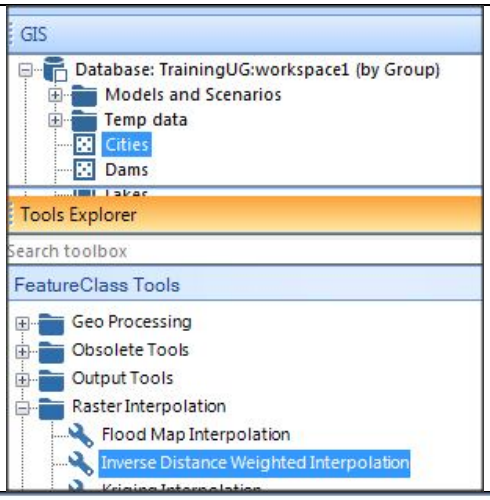
The Map looks like what is shown below.

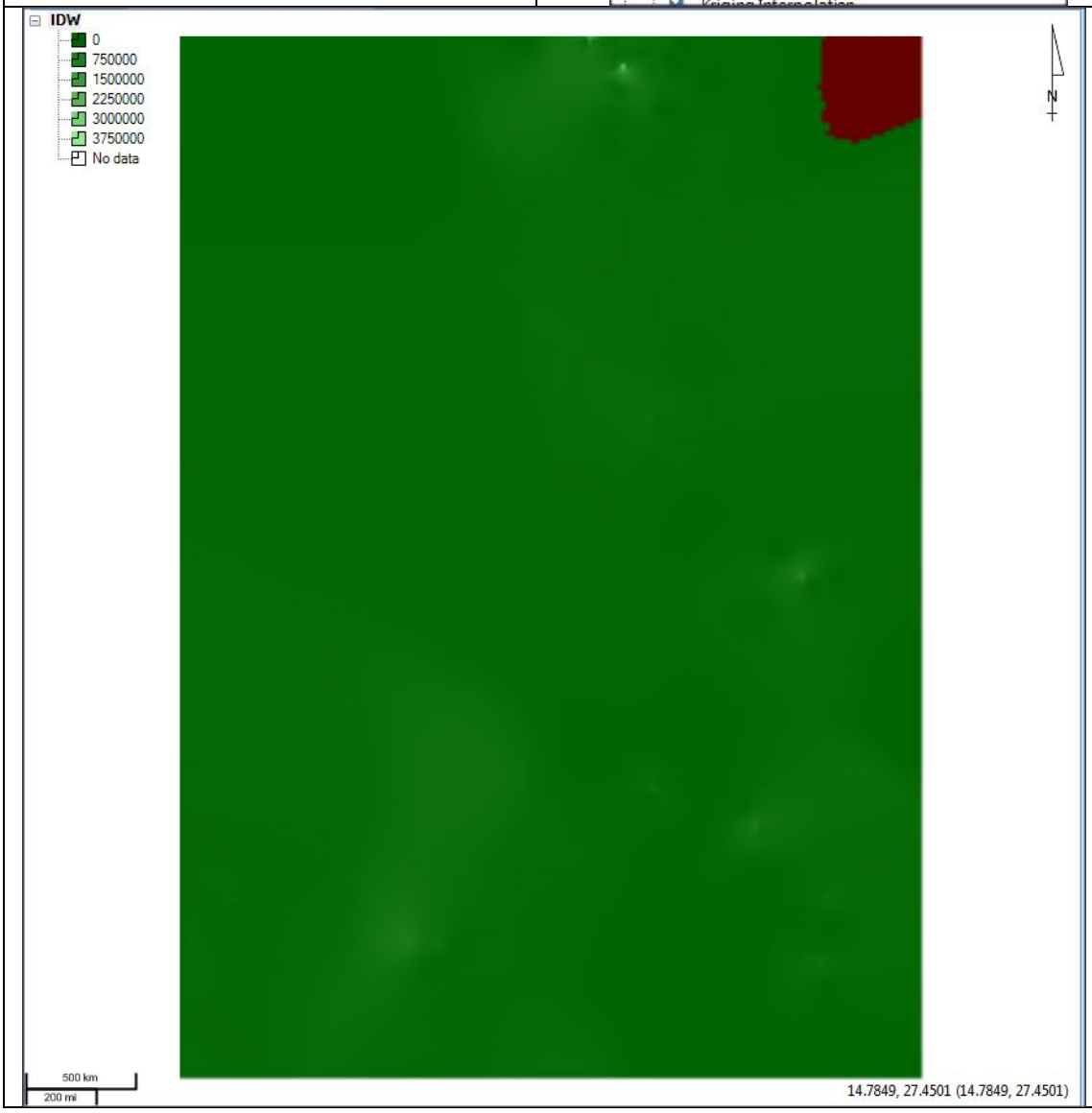




6- Repeat the steps 1-5 for the 'Inverse Distance Weighted Interpolation' tool.

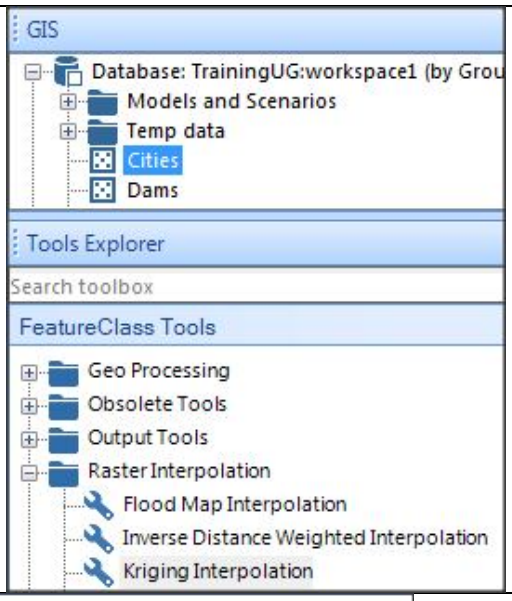
The Map looks like what is shown below

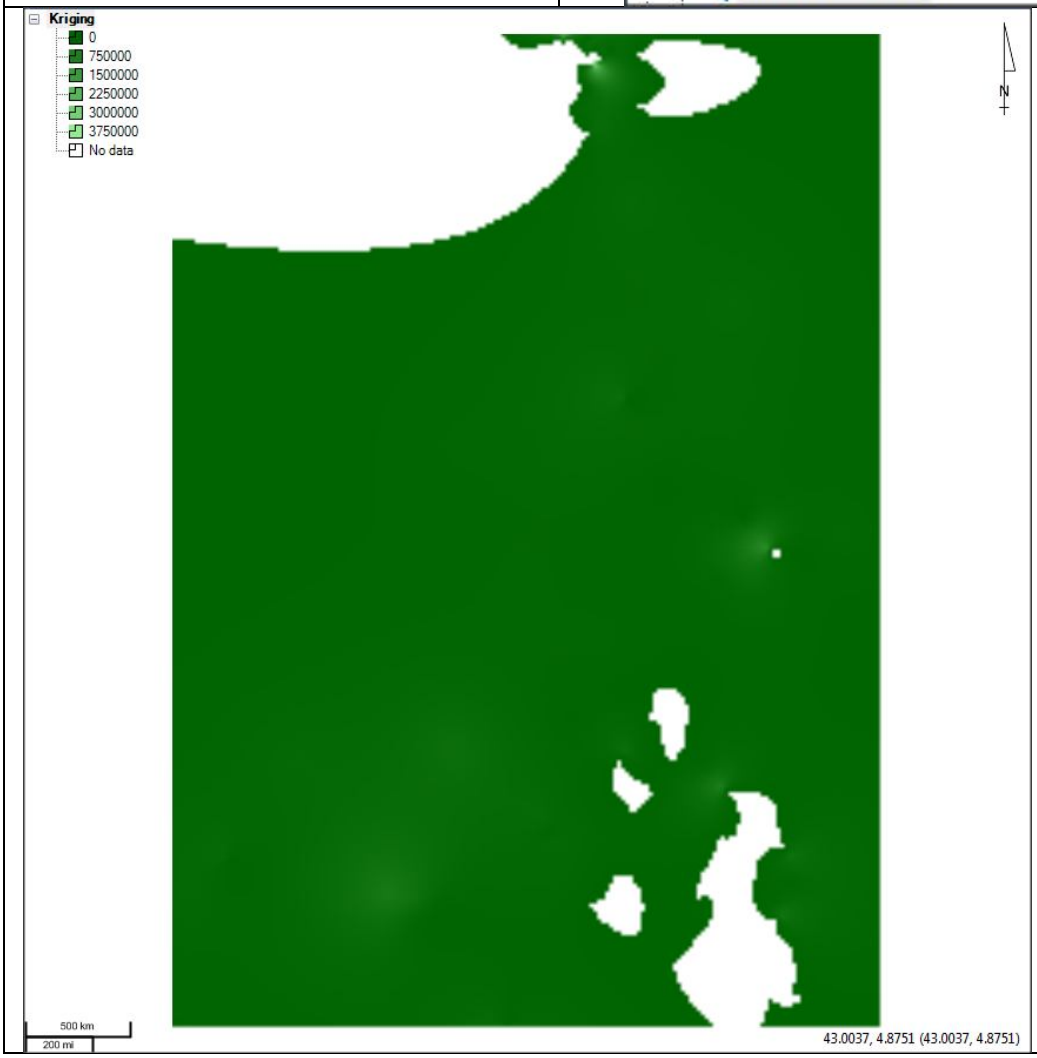




8- Repeat step 1-5 for “Kriging Interpolation” tool.

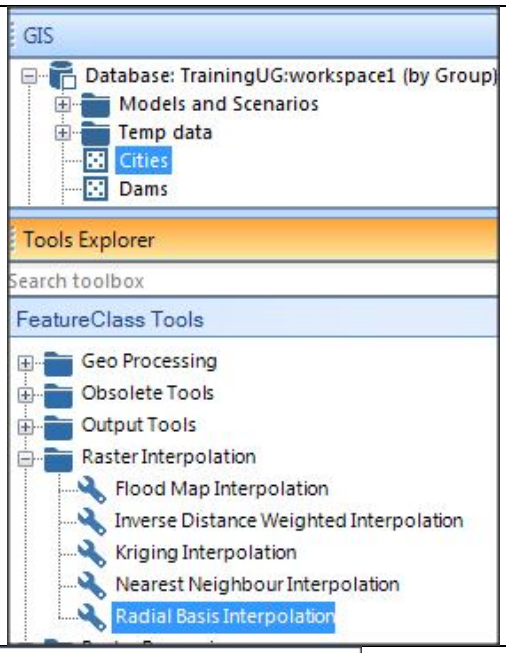
Map looks like what is shown below

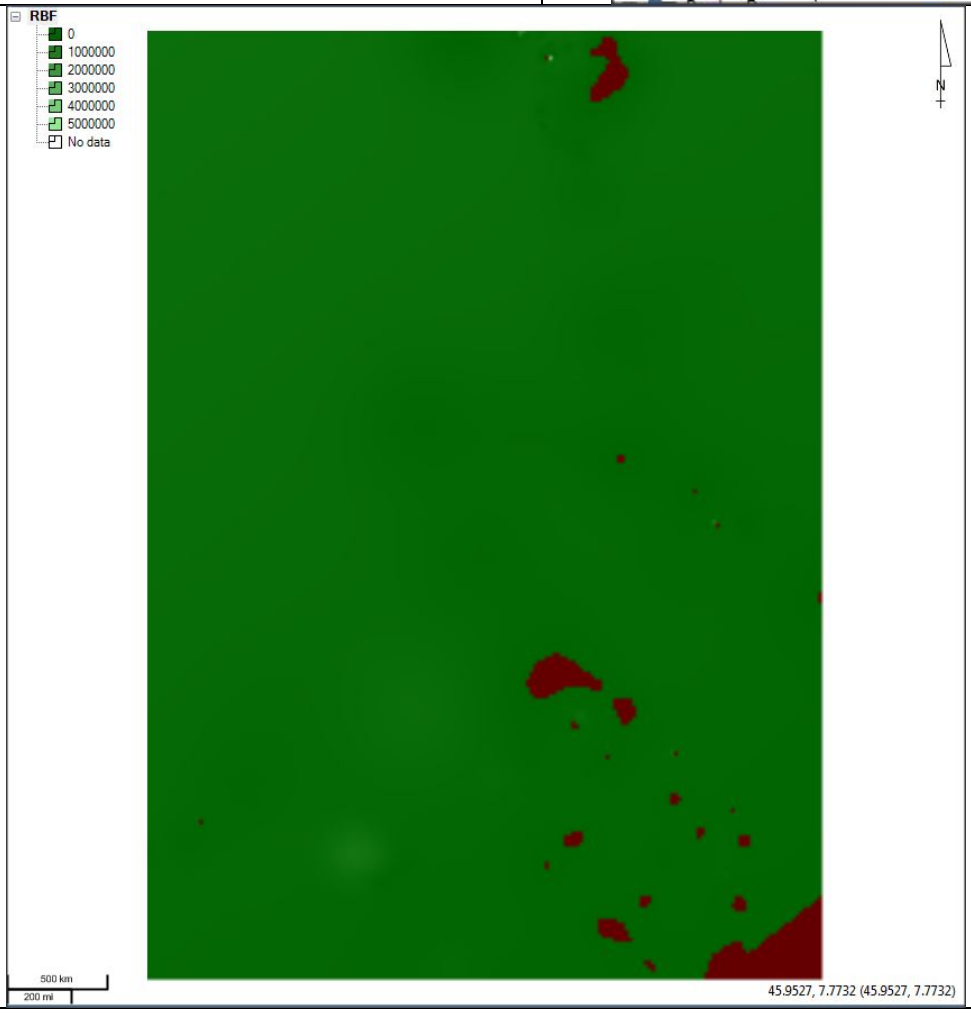




9- Repeat steps 1-5 for “Radial Basis Interpolation” tool

Map looks like what is shown below

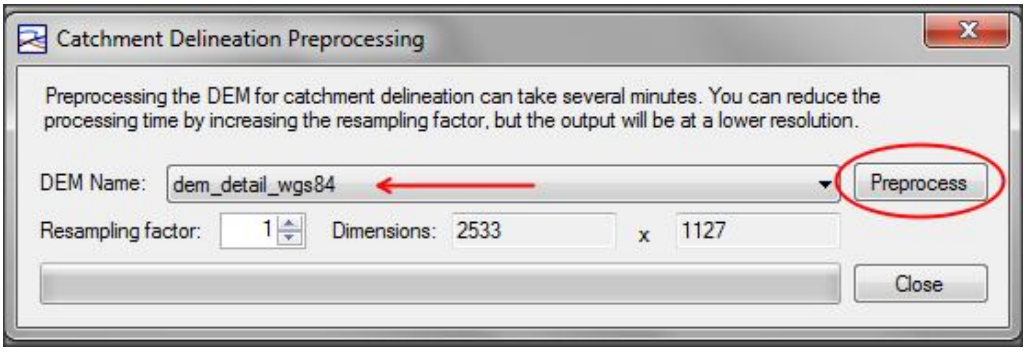




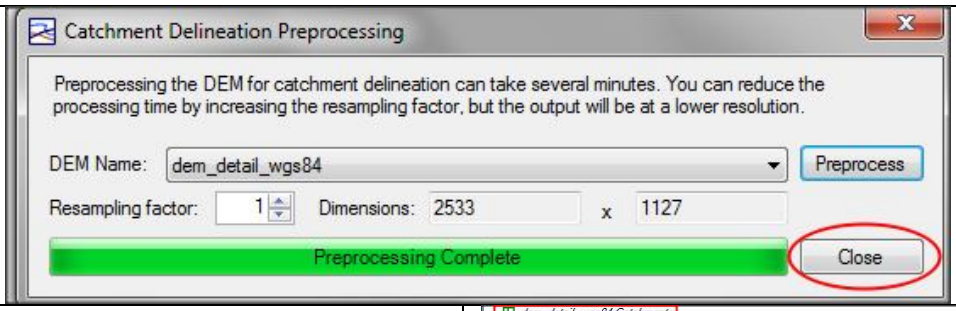
Catchment Delineation

1- Import the DEM file **'dem_detail_wgs84.asc'** located in the **..\GISExp\Data** folder GIS using the "Import from ASCII Grid" tool. Follow the steps explained in importing raster data section but set the coordinate system of the DEM to WGS 84 as it does not come with the raster.	
2- Add the DEM to a map. Go to the dropdown  icon at right end of the map toolbar and select  . The 'Catchment Delineation Preprocessing' box appears.	

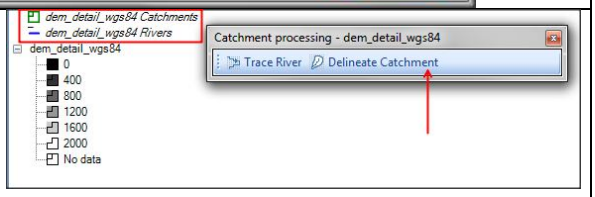
3- Select the DEM and click the  button. This can take several minutes depending on the size and resolution of the DEM. You can adjust the resampling factor to reduce the time needed but this has a negative effect on the accuracy – it is a trade-off.



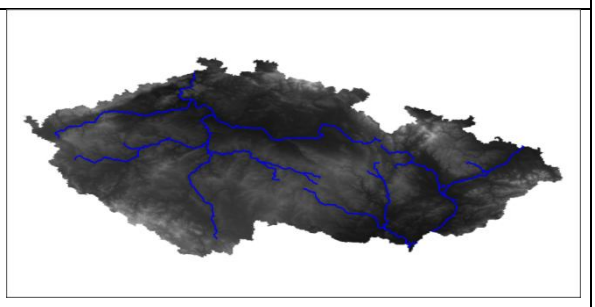
4- When preprocessing is complete press the  button.



Now notice that two items have been added to the legend These two new items are used to display the rivers and catchments that will be traced and delineated from the DEM. Note also that the 'Catchment processing' toolbar appears.

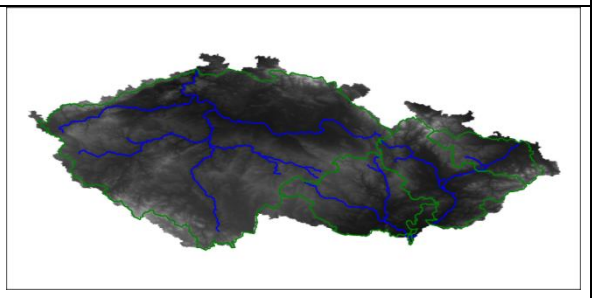


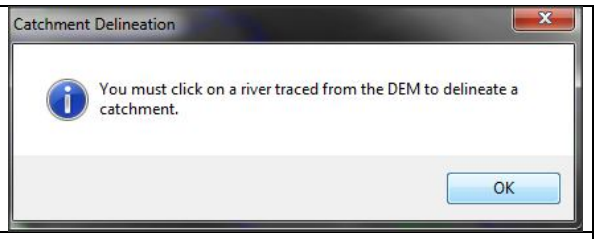
5- Click on the Trace River button to start tracing the river. On the map view click at the upstream end of the river you want to trace. This will add a river to the river feature class (blue lines). Click at other points to trace other rivers.



6- Once you have added at least one river, you can delineate catchments.

Click on the Delineate Catchment button on the toolbar. When clicking on a river, the catchment flowing down to that point on the river is then delineated (green polygons).



7- If you click on a point that is not on a river, you receive this warning message. Press 'OK' and carry on the work.	
8- Once the delineation is done save the vector data items to the database using the 'To Database' tool under the 'Output tools' Category. Before saving, select the item in the legend area.	

Temporal analysis

Review Questions

1. What are the available interpolation methods in the DSS?
2. Raster calculator needs at least two rasters to work
   - True
   - False
3. What do you understand by statistics in a raster? Which tools is used to calculate these statistics?

Answers

1. Four methods are currently available in the DSS: Nearest Neighbour, Inverse Distance Weighted, Kriging and Radial Basis Function.
2. False (A single raster can be used)
3. The minimum value in the raster, maximum value, mean of all values, and standard deviation. The ‘Zonal Statistics’ tool is used to calculate zonal statistics in a raster.

2.8. GIS data conversion

Introduction

This lesson introduces you to convert data between the raster and vector data formats within the DSS.

Topics covered in this lesson:

- Conversion of raster data to vector data
- Conversion of vector data to raster data

Lesson objective:

After completing this lesson, you will be able to:

- Convert rater to vector data and vice versa.

Lesson pre-requisites

You have to be familiar with GIS basics (See vector and raster data basics section for details) to take this lesson

Raster to Vector tool

As the name indicates, the raster to vector tool can be used to generate vector data based on raster data. A new vector data item is produced containing features of type polygon corresponding to the value ranges provided. This is useful when users need to work with vector tools for data that is in a raster format.

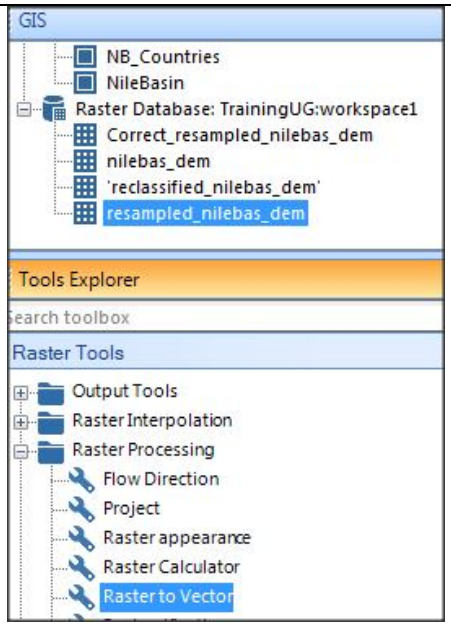
Vector to Raster tool

The Vector to Raster tool does the opposite of the Raster to Vector tool. It builds a raster based on vector data. Attribute values in the vector data are used to fill in the cell values in the raster.

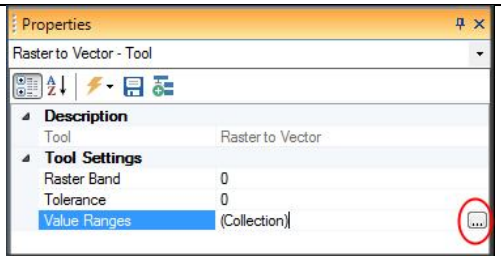
Exercises

Raster to Vector

1- Select the **'resampled_nilebas_dem'**. Look for the 'Raster Processing' category within the Tools Explorer and Select the 'Raster to Vector' tool.

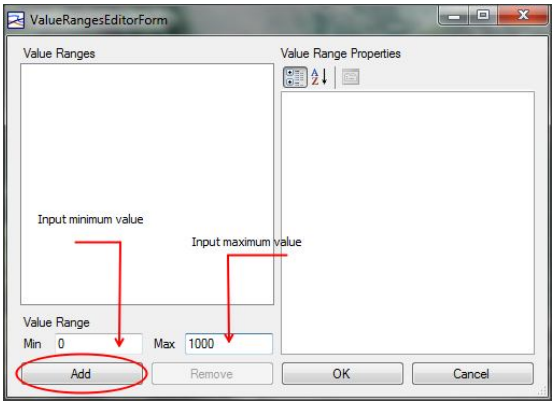


2- Once the tool is selected, its properties are populated in the Properties explorer. In this exercise, we will convert the selected raster into a polygon vector data.



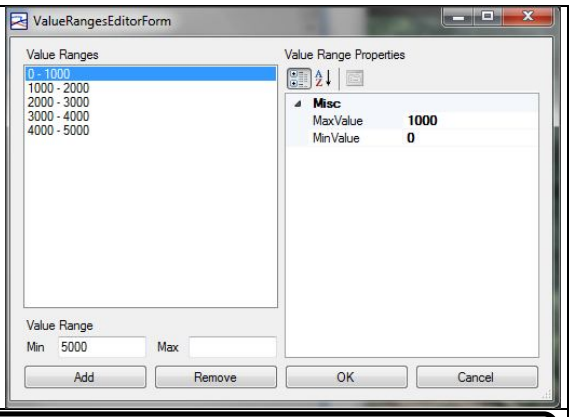
Click on  in 'Value Ranges' in property to bring the Value Range Editor Form and add the following 5 ranges:

- 0 – 1000
- 1000 – 2000
- 2000 – 3000
- 3000 – 4000
- 4000 – 5000



This is done by entering the minimum value in the 'Min' box and the maximum value in the 'Max' box then clicking the  button.

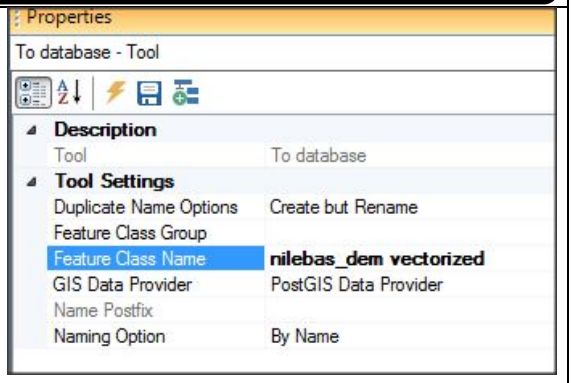
Repeat the above until all ranges are added then click 'OK'.



Ranges are used to reduce the number of polygons of the created vector. This is called 'generalization', which means clustering raster data into groups. If ranges are not specified each grid cell will be converted to a polygon.

3- Click  to run the tool and select Run (To Display (Feature Class)) (Note: the conversion process may take a few minutes to complete).

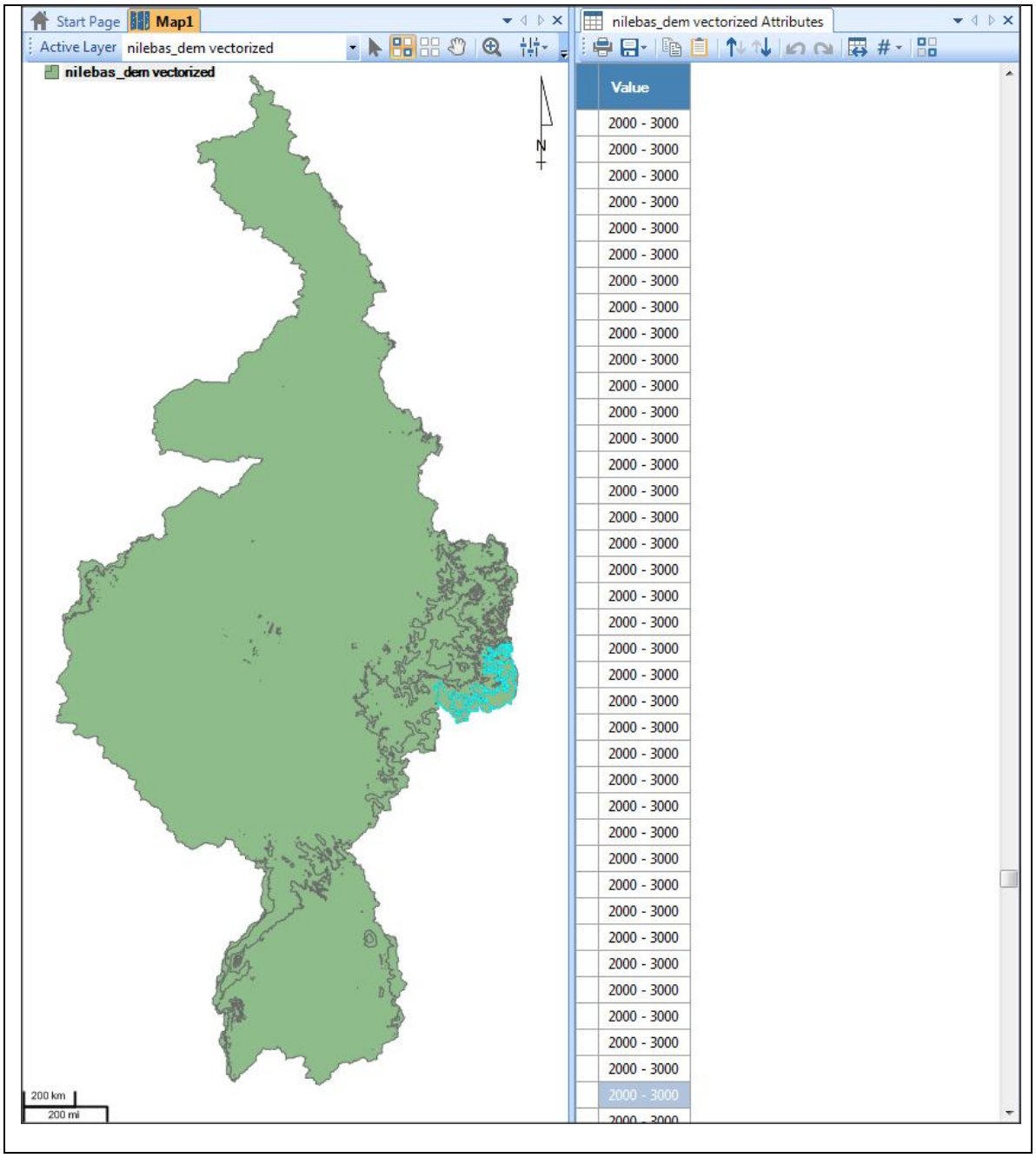
4- When finished, click on the produced feature class in the legend and save it to the database with the name **'nilebas_dem vectorized'** using the 'To database' tool



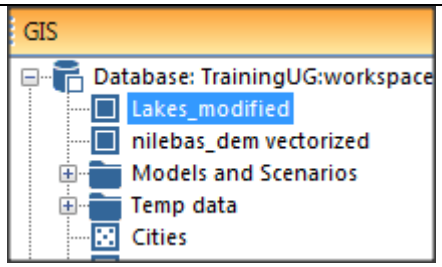
5- Right click the **'nilebas_dem vectorized'** in the GIS Explorer and add it to a data table.

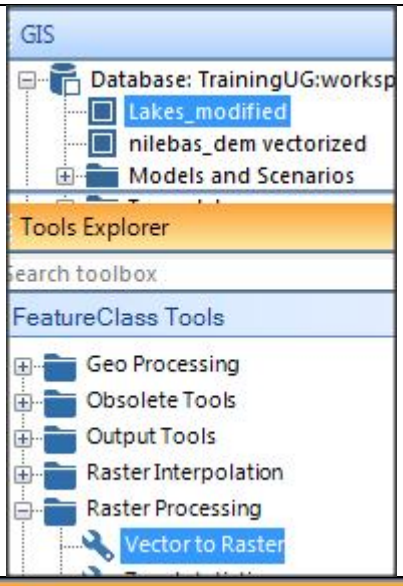
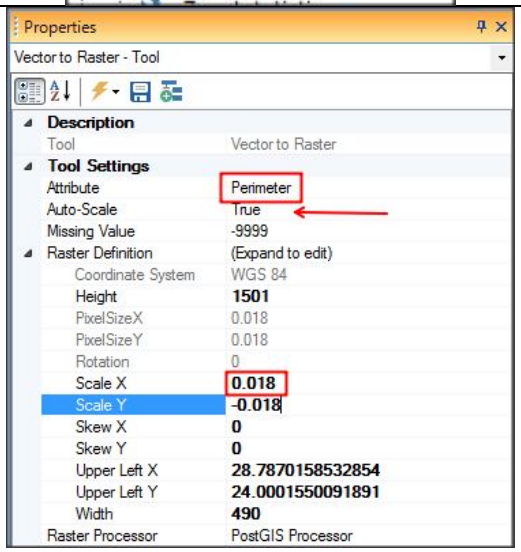
Organize the layout of the DSS so the map is displayed next and the data table.

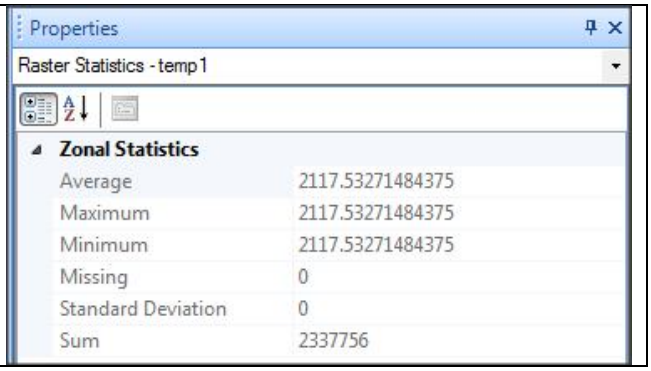
Use the  tool to select polygons on the map and see the corresponding value in the data table. Notice that the polygons will have a value attribute that corresponds to the range of data that was used to generate them.



Vector to raster

1- Start by preparing the Lakes vector data with some attribute data that can be used to fill in the raster by running the 'Measure' tool to add both the area and the perimeter as attribute values. To do this run the measure	

tool to the display and use 'To database' tool to save the new Lakes vector data as **'Lakes_modified'**.	
2- Select **'Lakes_modified'** vector data in GIS explorer. Select the 'Vector to Raster' tool under the 'Raster Processing' category within the Tools Explorer .	
3- Once the tool is selected, its properties are populated in the Properties explorer. In this exercise, we will convert the selected vector into a raster. Set the perimeter as Attribute and change the Raster Definition to have a resolution of 0.018 degrees the rest of the properties will be calculated automatically if the 'Auto-Scale' property is set to 'True'. Click  to run the tool.	

3- Check the output raster and save it into the database. 4- Run the 'Zonal Statistics' tool on, for example lake Victoria. Average, maximum and minimum values have to be identical and standard deviation has to be zero.	

Review Questions

1. What are the available GIS data conversion methods in the DSS?

Answers

1. Raster to vector and vector to raster.

3. References

- Nile Basin Decision Support System help file (DSS Ver. 2.0)
- Nile Basin Decision Support training material (developed in 2013 and 2014)
- DHI training material for the Nile Basin Decision Support (developed in 2012)
- WP2 Report: NB-DSS WP2 Stage 2 'Data Processing, Quality Assurance and Metadata' report (2012).
- Wikipedia web site - http://en.wikipedia.org/wiki/Main_Page (last accessed on 15/5/2014)