

ArcGIS Training Manual for PSNP Staff

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1. Introduction to GIS

1.1 What is GIS

- Geographic information systems (GIS) or geospatial information systems is a set of tools that captures, stores, analyzes, manages, and presents data that are linked to location(s)
- A geographic information system (GIS) is a system for the management, analysis, and display of geographic information.
- A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

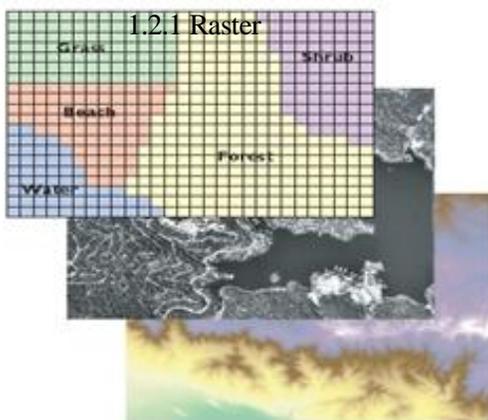
GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared.

A geographic information system supports several views for working with geographic information:

1. The Geodatabase view: A GIS is a spatial database containing datasets that represent geographic information in terms of a generic GIS data model (features, rasters, topologies, networks, and so forth).
2. The Geovisualization view: A GIS is a set of intelligent maps and other views that show features and feature relationships on the earth's surface. Various map views of the underlying geographic information can be constructed and used as windows into the database. to support queries, analysis, and editing of the information.
3. The Geoprocessing view: A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. These geoprocessing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.

1.2 Data representation in GIS

GIS data represents real objects (such as roads, land use, elevation, trees, waterways, etc.). Real objects can be divided into two abstractions: discrete objects (e.g., a house) and continuous fields (such as rainfall amount, or elevations). Traditionally, there are two broad methods used to store data in a GIS for both kinds of abstractions mapping references: raster images and vector.

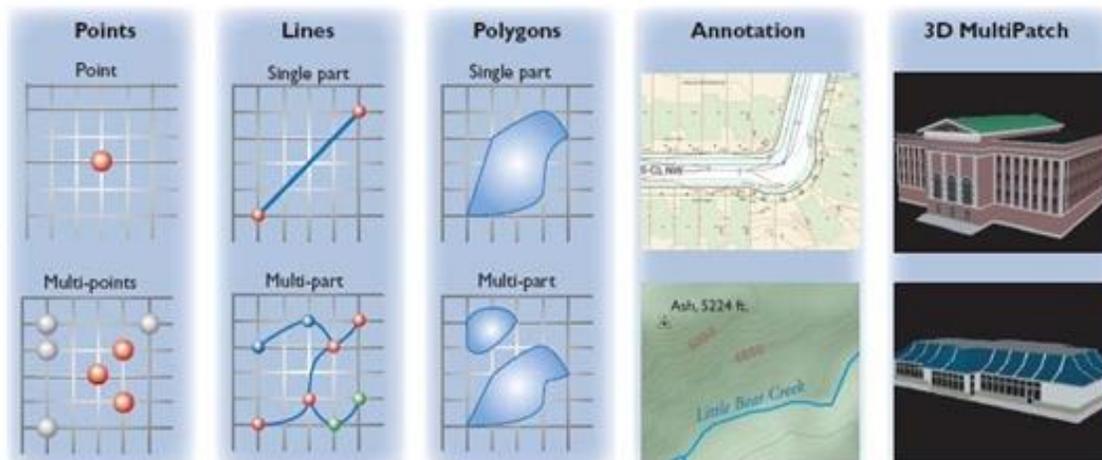


Rasters are used to represent continuous layers, such as elevation, slope and aspect, vegetation, temperature, rainfall, and so on. Rasters are most commonly used for the storage of aerial photographs and imagery of various kinds. In raster data format each object is represented in the form of cell /grid and it has separate reflectance value /color/.

Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images (raster images) with each pixel (or cell) containing a color value. The resolution of the raster data set is its cell width in ground units.

1.2.2 Vector

In a GIS, geographical features are often expressed as vectors, Vector data represent a discrete data but it can also be used to represent continuously data. Different geographical features are expressed by different types of geometry:



- Points

Zero-dimensional points are used for geographical features that can best be expressed by a single point.. Examples include wells, schools, Health post etc. Points can also be used to represent areas when displayed at a small scale. No measurements are possible with point features.

- Lines or polylines

One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads and trails,. Polygon features at a small scale will be represented as linear features rather than as a polygon. Line features can measure distance.

- Polygons

Two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface. Such features may include lakes, Watershed boundaries, buildings, city boundaries, or land uses. Polygon features can measure perimeter and area.

1.2.3 TIN

TIN (triangulated irregular networks) are used to represent elevation or other continuously changing values. TINs record values at point locations, which are connected by lines to form an irregular mesh of triangles. The face of the triangles represents the terrain surface.

1.2.4 Non spatial Data

Non-spatial data can also be stored along with the spatial data represented by the coordinates of vector geometry or the position of a raster cell. In vector data, the additional data contains attributes of the feature. For example, a forest inventory polygon may also have an identifier value and information about tree species. In raster data the cell value can store attribute information, but it can also be used as an identifier that can relate to records in another table.

Each of these geometries is linked to a row in a database that describes their attributes. For example, a database that describes lakes may contain a lake's depth, water quality, pollution level. This information can be used to make a map to describe a particular attribute of the dataset. For example, lakes could be coloured depending on level of pollution. Different geometries can also be compared. For example, the GIS could be used to identify all wells (point geometry) that are within one kilometre of a lake (polygon geometry) that has a high level of pollution.

Tabular data, also called attribute or descriptive data, is one of the most important elements in a GIS. It is statistical, numerical, or characteristic information that can be attributed to spatial features. Similar to spatial data the tabular data is stored by the GIS software in a method that allows it to be accessed and viewed, usually in a relational database format. The GIS software allows the attribute data to be linked to the spatial data in such a way that it gives the attributes a location.

1.3 Application of GIS

GIS can be used in most of fields it may be used in geography, cartography, remote sensing, land surveying, public utility management, natural resource management, agriculture, photogrammetry, urban planning, emergency management, navigation, asset management and location planning; archaeology; environmental impact study; infrastructure assessment and development; geographic history; marketing; logistics; population and demographic studies; applied statistical analysis; warfare assessments; and other purposes.

1.4 Components of GIS

GIS mostly can be divided into four components: People, Data, Hardware, and Software.

People

The people are the component who actually makes the GIS work. They are responsible for maintenance of the geographic database and provide technical support. People also need to be educated to make decisions on what type of system to use. People associated with a GIS can be categorized into: GIS users, and GIS specialists.

- GIS Users are people who use and View GIS data to browse a geographic database for referential material, performing professional services, and making decisions.
- GIS specialists are the people who make the GIS work. They are responsible for collecting, managing and analyzing the geographic data and giving technical support to others

Data

Data capturing is the most time consuming and costly component of GIS. There are several things to be considered before acquiring geographic data. Such aspect should be checked the quality of data, the cost of data, usefulness /in relation to time, completeness, scale etc./ of data additional Procedures should be considered in how the data will be collected, enter into the system, stored, managed, transformed, analyzed, and finally distributed to others.

Data input in GIS has three parts these are:- entering the spatial data, entering non-spatial data, and linking the two together. Spatial data can be acquired from existing data in digital or paper form, survey data by the use of Global Positioning System (GPS) and remotely sensed data /Aerial Photography and Satellite image/

Existing data printed on paper maps can be digitized or scanned to produce digital data. A digitizer produces vector data as an operator traces points, lines, and polygon boundaries from a map. Scanning a map results in raster data.

Hardware

Hardware consists of the technical equipment needed to run a GIS task. The hardware part divided in to two parts i.e. Input and Output

Input:-

- Computer with high capacity in terms of processor speed, memory and data storage capacity.
- GPS, Scanner and Digitizer

Output:-

- Color Printer, Plotter and Dicks

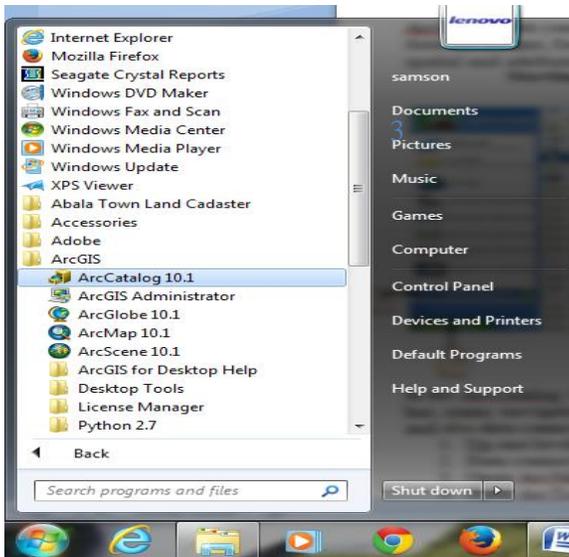
Software

The use of GIS software is for data input, storage, management, and analysis. Today there are many different GIS software packages available in the market. Their difference is in the ease of usage and price. The common software we are using are ESRI products like ArcView, ArcInfo and ArcGIS.

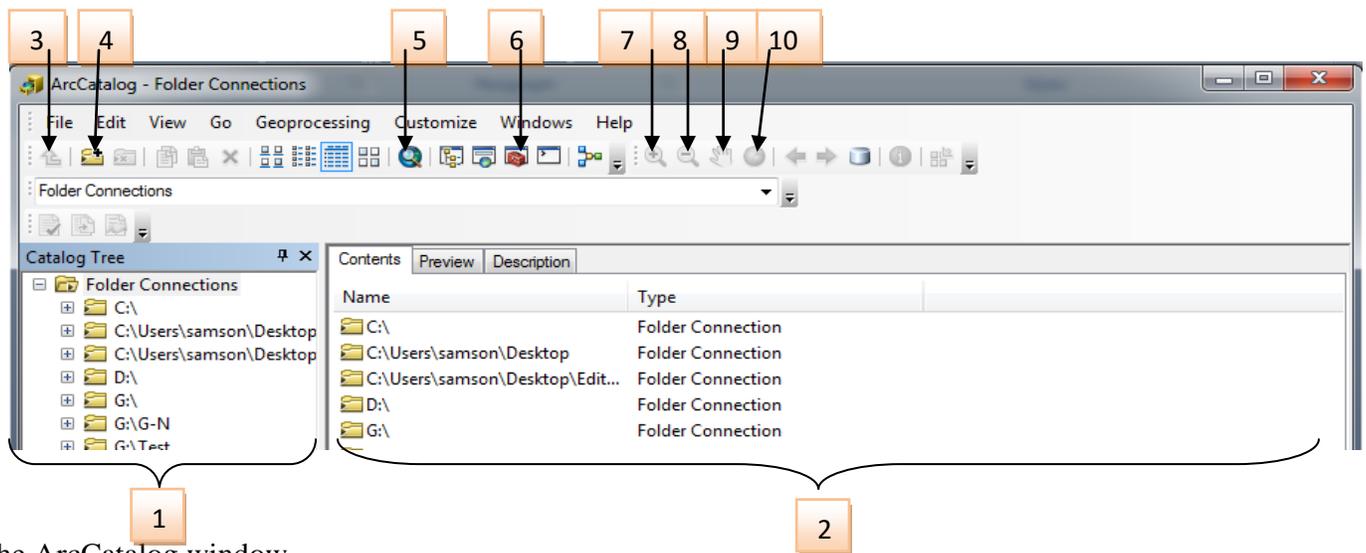
2. Managing ArcCatalog

ArcCatalog lets you explore and manage your data. The main use of ArcCatalog is to manage your spatial data holdings, database designs, for recording and viewing metadata. In other words it is like a file manager and used for a quick view of your spatial and attribute data behind the spatial data.

Starting ArcCatalog



1. Click Start button
 2. Click All Programs
 3. Click ArcGIS
 4. Click ArcCatalog
- The ArcCatalog window will open to you.



In the ArcCatalog window has some navigation tools and also data connector tools

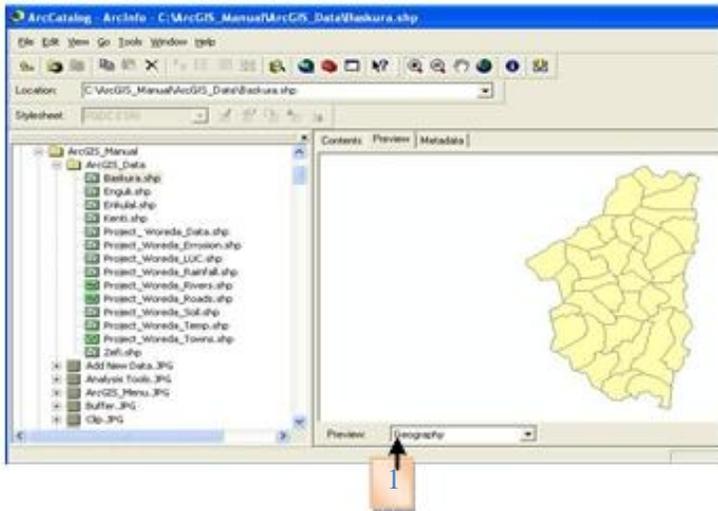
3. Up one level
4. Data connector
5. Open ArcMap
6. Open ArcTools
7. Zoom in
8. Zoom Out
9. Pan
10. Full extent

The left of the ArcCatalog window i.e. the Catalog tree it gives idea how your data is organized. The right tab lets you explore the contents of the selected item in the Catalog tree.

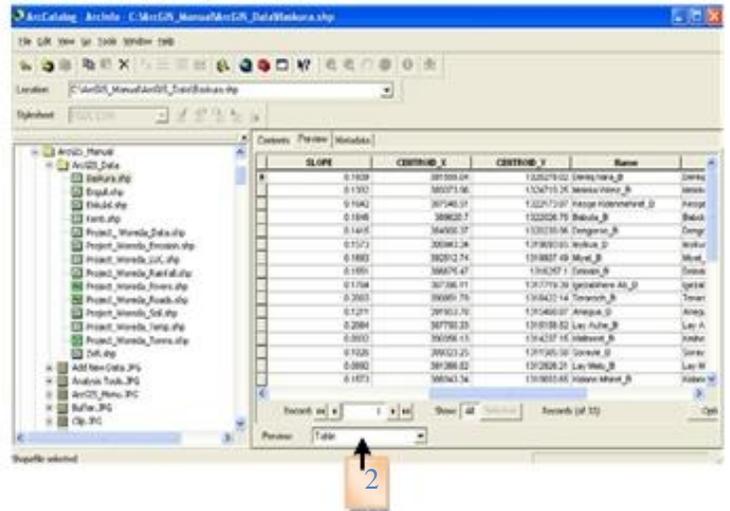
1. Catalog Tree
2. Data visualization

As we discussed previously, ArcCatalog helps to quickly viewing the spatial and non spatial data. Select on the map from the catalog tree and click the preview tap. For the non spatial data select the table option in the bottom of the ArcCatalog content.

1. Map /Geographic/ view



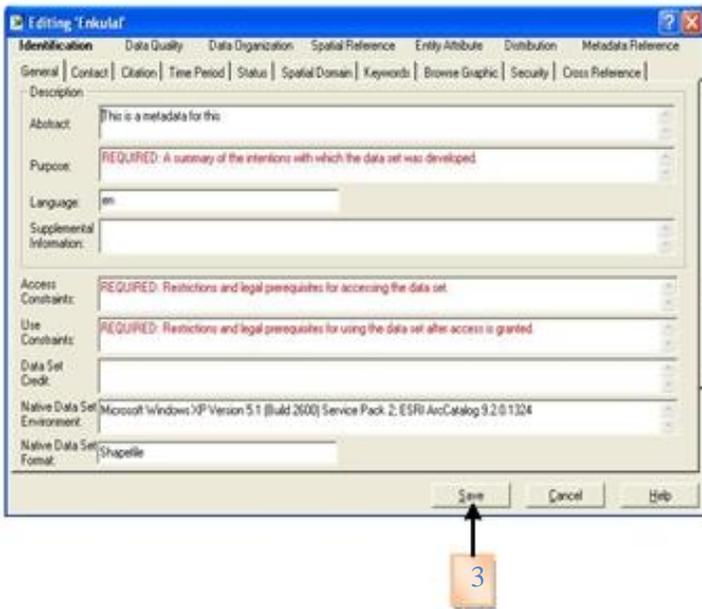
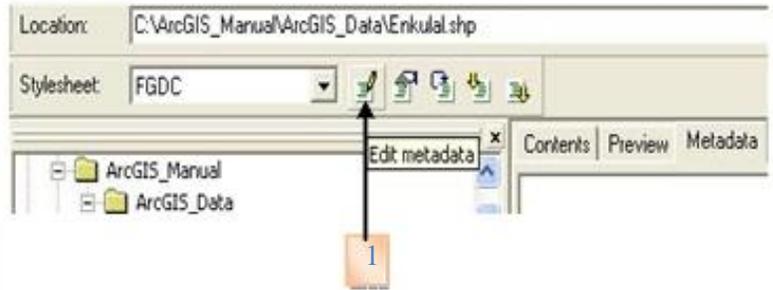
2. Table /Non Spatial data/ view



Metadata is data about the data. It gives information about the content, quality, use and origin of the data. In short it gives information how, when, where and by whom the data was collected. The automatic metadata can be generated by the ArcCatalog to show you the Name of the spatial data, projection type, attribute information and so on for the rest you can edit and add other necessary information.

To edit metadata

1. Click Metadata editor tool. The editor wizard will open to you.



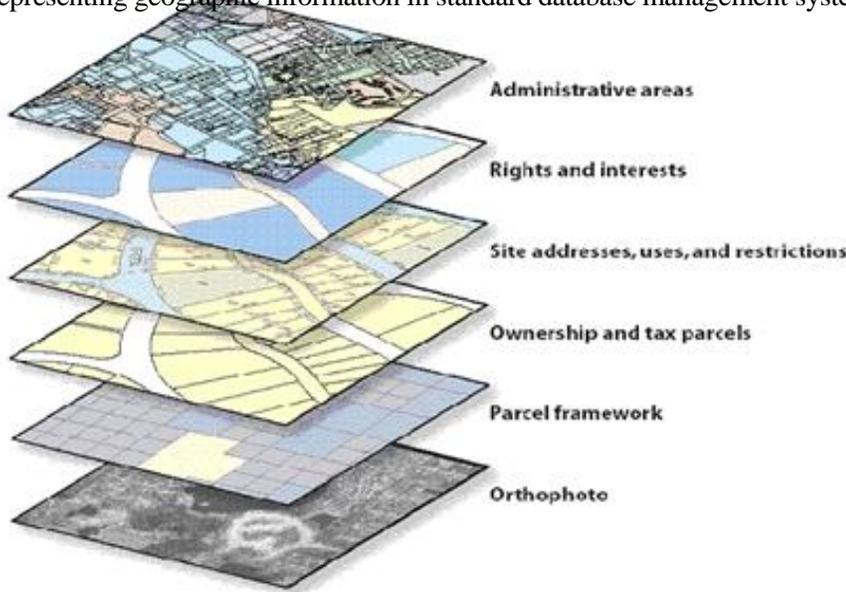
2. Fill all the required text boxes in the editor wizard
3. Click save button

Exercise:-

1. Explore the ArcCatalog window by viewing different maps from your ArcGIS training folder.
2. Try to edit metadata for one sub watershed /Baskura/

3. Geodatabase

A geodatabase (short for geographic database) is a physical store of geographic information (spatial, attribute, metadata, and relationships) inside a relational database management system (RDBMS). In other words it is a data model for representing geographic information in standard database management system tables.



There are two types of geodatabase architectures; these are Personal geodatabases and Multiuser geodatabases.

1. Personal geodatabases, which are freely available to all ArcGIS users. It uses the Microsoft Jet Engine database file structure /MS Access/.
 - o Personal geodatabases are much like file-based workspaces and hold databases up to 2 GB in size. o Microsoft Access is used to work with attribute tables in personal geodatabases.
 - o It is ideal for working with smaller datasets.
 - o It supports single user editing.
2. Multiuser geodatabases require the use of ArcSDE and work with a variety of DBMS storage models (IBM DB2, Informix, Oracle.both with and without Oracle Spatial.and SQL Server).
 - o Multiuser geodatabases are primarily used in a wide range of work o It uses to extremely large, continuous GIS databases.
 - o Many simultaneous users.
 - o Extremely large sizes.

Personal Geodatabase

ArcCatalog works based on file hierarchy. Folder is the top on the hierarchy. The second, third and fourth are Geodatabase, Feature Dataset and Feature Class respectively. Therefore, feature class can be stored in feature dataset, feature dataset can store in geodatabase and geodatabase can store in folder.

N.B There are a possibility to do without the use of geodatabase directly in folders but we strongly advise you to use a geodatabase approach.

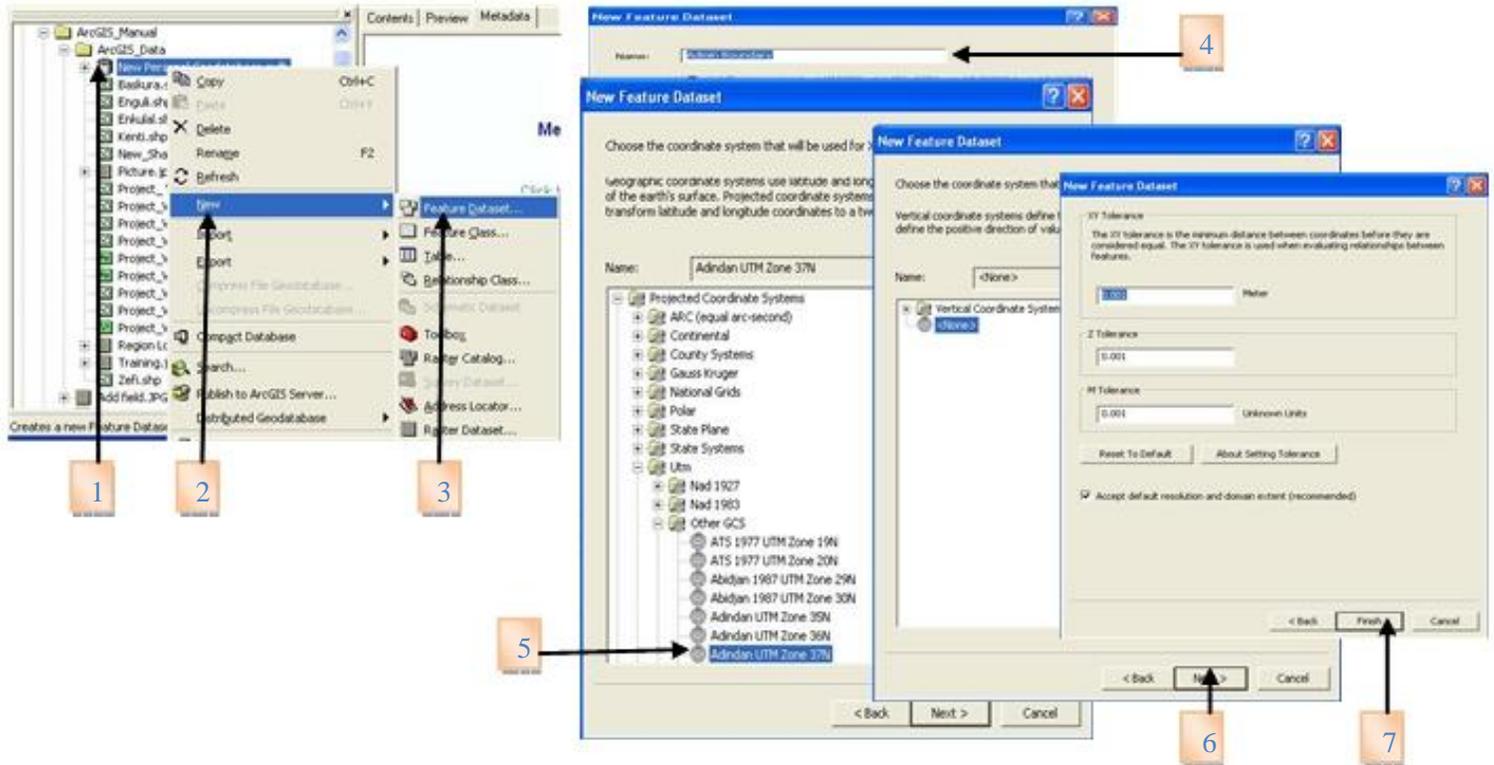


To create personal Geodatabase

1. Right click on the selected folder
2. Click New
3. Click on Personal Geodatabase.
4. Rename the name

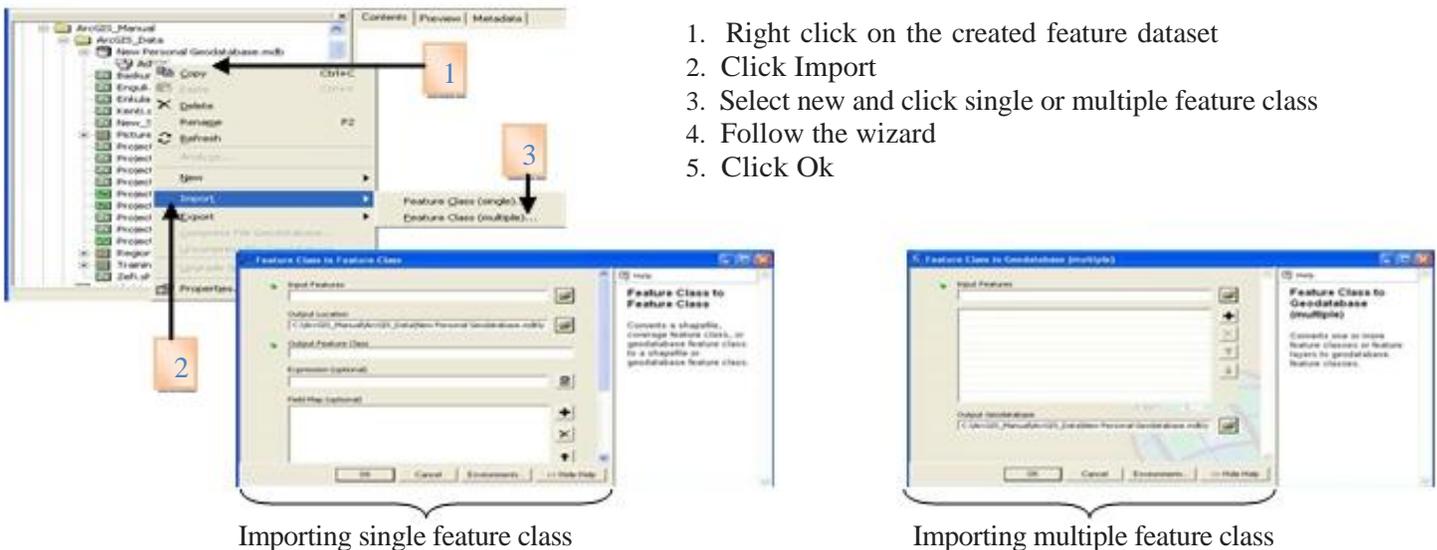
To create feature Dataset

1. Right click on the created geodatabase
2. Click New
3. Click on Feature Dataset
4. Write the name of your feature dataset and click Next
5. Select the projection and click /select, Projected coordinate system, UTM, Others GCS and Adindan UTM Zone 37N and Next
6. Accept the default and click Next
7. Accept the default and click Finish. The new feature dataset will added to your table of content



To Import Feature Class

1. Right click on the created feature dataset
2. Click Import
3. Select new and click single or multiple feature class
4. Follow the wizard
5. Click Ok



Importing single feature class

Importing multiple feature class

Importing single feature class needs the output name where as the multiple feature class does not an output data name it uses the input data.

Exercise:-

1. Create new geodatabase called Training
2. Create feature dataset called Watershed, Admin, Infrastructure
3. Import Baskura, Enguli, Enkulal, Kentai and Zefie community watershed in Watershed dataset, import Woreda and Kebele in Admin dataset and import Town and Road in Infrastructure Dataset
4. Create new shapefile under Watershed dataset called New_Watershed

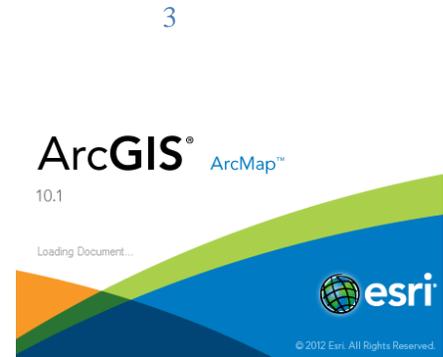
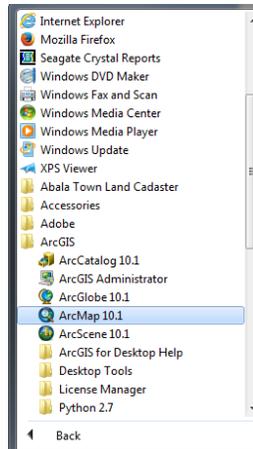
4. Starting ArcMap

4.1 Open ArcGIS

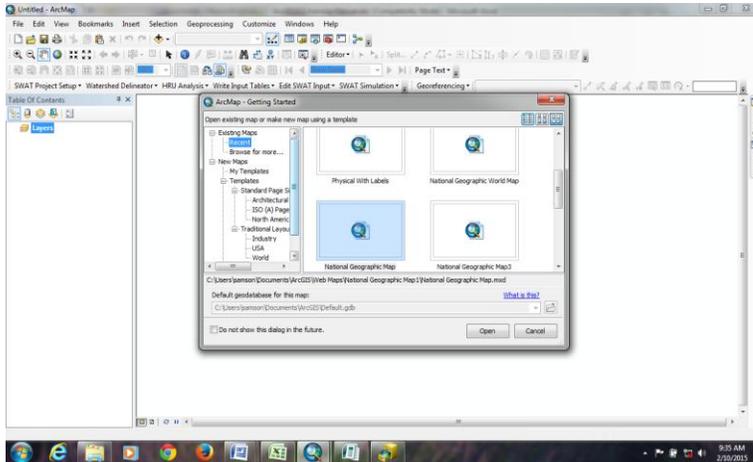
ArcMap lets you explore your geographic data and create maps for display.

To open ArcGIS 9.2

1. Click the Start button on the Windows taskbar.
2. Point to All Programs.
3. Point to ArcGIS.
4. Click ArcMap.



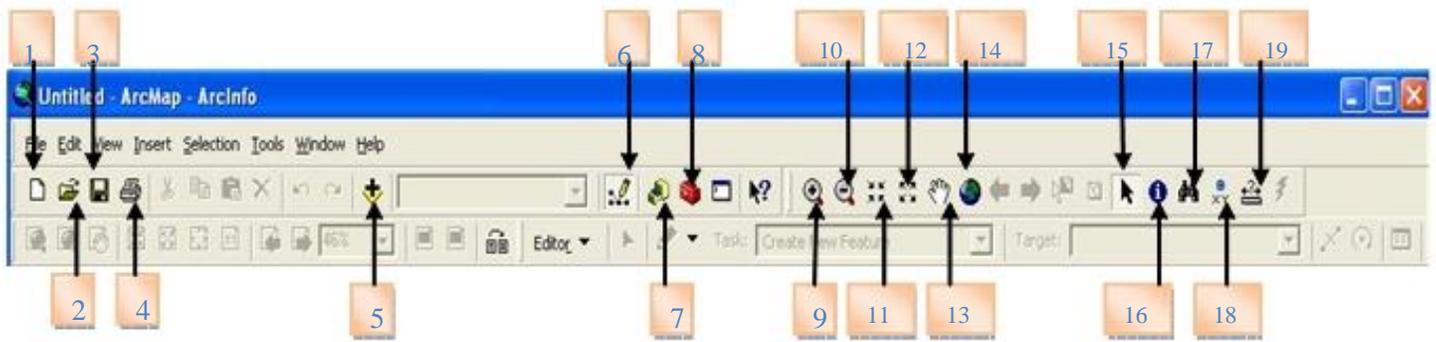
The ArcMap opening wizard can be opened. There are three options these are:-



1. A new empty map:- if you want to open a new project Click Cancel Button
2. A template:- if you want to use the existing readymade template click on template and select one template
3. An existing Map:- if you want to open the existing project click the one you want to open it
4. Click Ok

4.2 Exploring ArcMap:-

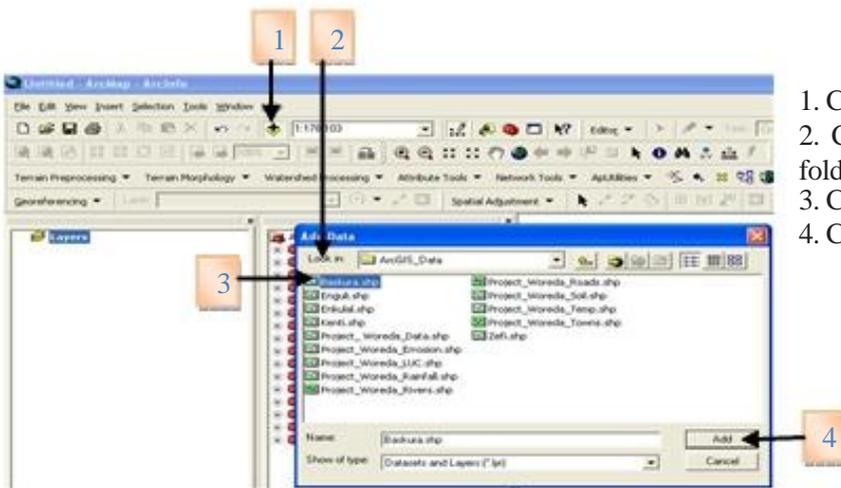
1. Open new project
2. Open existing Project
3. Save project
4. Print Map
5. Add Layer/Map
6. Edit Function
7. Open ArcCatalog
8. Open ArcTools
9. Zoom In
10. Zoom Out
11. Fixed Zoom Out
12. Fixed Zoom in
13. Pan
14. Full extent
15. Select element
16. Identify
17. Find
18. Add xy
19. Measurement



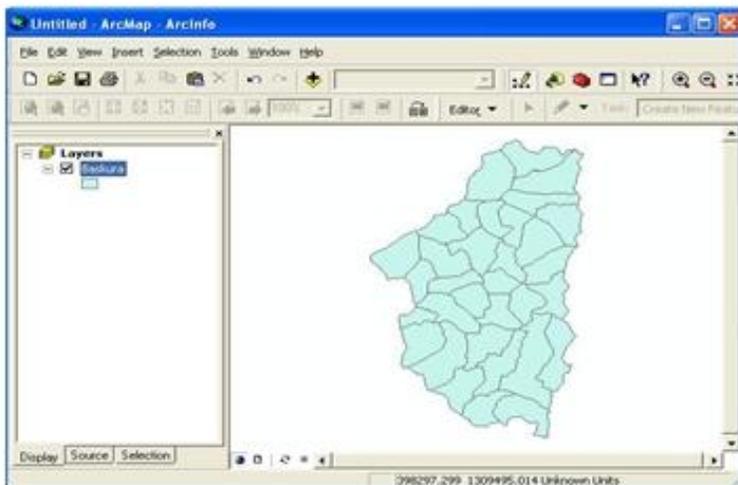
The above menu buttons are the default one if you can add other more buttons as far as you need for further analysis.

N.B. explore all the menu in your ArcGIS project by opening each of them

4.3 Adding a layer file in ArcMap



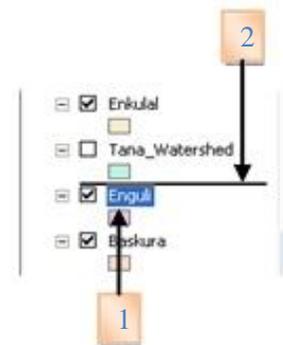
1. Click Add Data button
2. Click the Look in dropdown arrow and navigate to the folder /ArcGIS Data/ containing your layer file.
3. Click the layer file
4. Click Add.



ArcMap adds the layer to your table of contents using the special properties it was saved with. i.e if the layer is point you can get the point symbol, if the layer is line you can get a line symbol and if the layer is polygon you can get a polygon symbol.

4.3.1 Moving a layer to change its drawing order

1. In the table of contents, click the layer
2. Drag the layer up or down. A black bar indicates where the layer will be placed. This bar indents to reflect the position in the layer hierarchy where the drop will occur.
3. Release the mouse pointer to drop the layer in its new position.



4.3.2 Changing the name of a layer

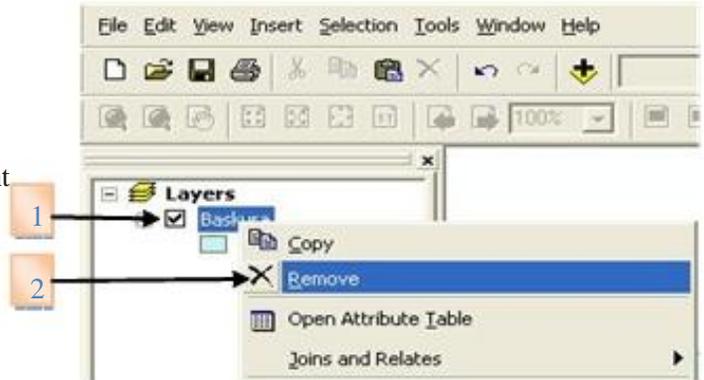


1. In the table of contents, click the layer to select it.
2. Click again over the name. This will highlight the name and allow you to change it.
3. Type the new name and press Enter.

N.B: This does not change the actual filename.

4.3.3 Removing a layer

1. In the table of contents, right click the layer or layers you want to remove.
2. Click Remove.



4.3.4 Removing several layers

1. In the table of contents, click the first layer you want to remove.
2. Hold down the Shift or Ctrl key and click to select additional layers.
3. Right-click the selection and click Remove.

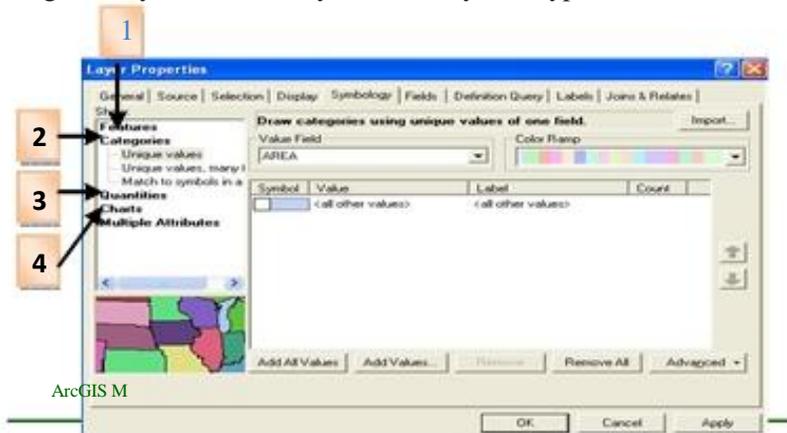
Exercise:-

1. Add Baskura, Enguli, Project woreda, town and road layer /try to see the watershed maps in your document
2. Rename Baskura and Enguli to Watershed boundary
3. Move Watershed boundary on top of project woreda layer
4. Remove Baskura from the map document
5. Remove town, road and Enguli at the same time

4.4 Coloring and Styling Features

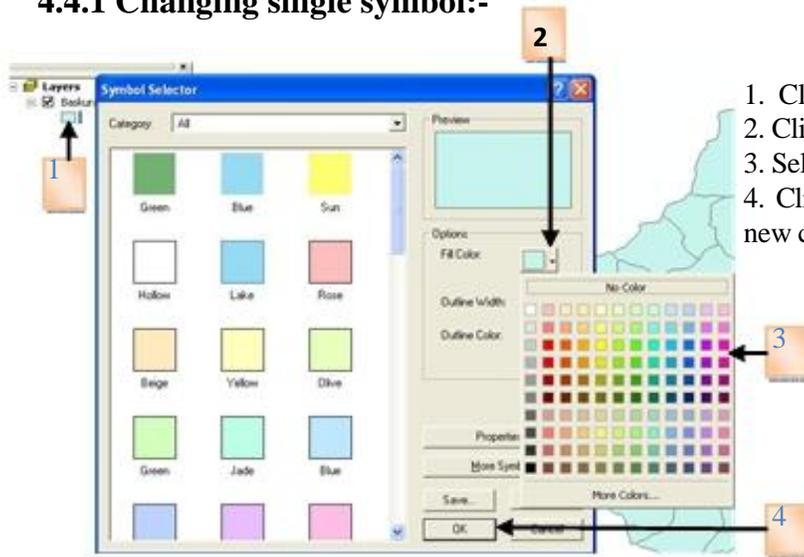
Choosing how to represent your data on a map may be the most important mapmaking task. How you represent your data determines what your map communicates. On some maps, you might simply want to show where things are. The easiest way to do this is to draw all the features in a layer with the same symbol. On other hand you need to display maps in different color or you might draw features based on an attribute value or characteristic that identifies them. For example, you could map roads by type, or map different landuse type etc.

In general, you can draw layers in four symbol type:-



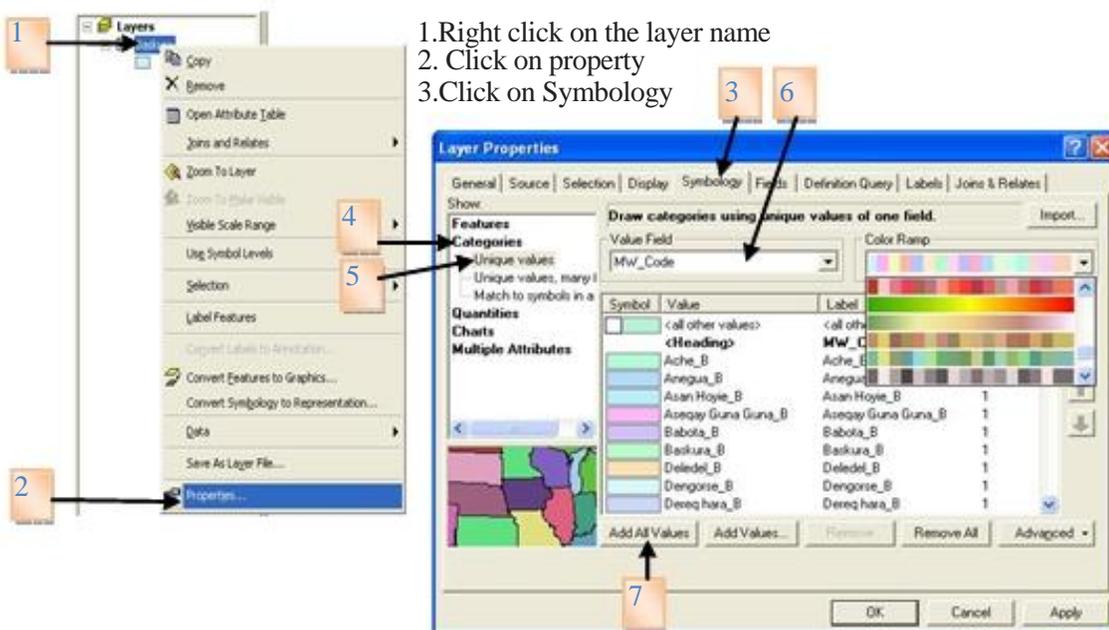
1. Features:- this uses for single symbol
2. Categories:- uses to get unique value
3. Quantities:- uses for graduated color, graduated symbol and proportional symbol
4. Charts:- uses to display in different symbols.

4.4.1 Changing single symbol:-



1. Click on the map symbol
2. Click on Fill Color button. The color panel will appear
3. Select your color from the color panel
4. Click Ok. The color symbol of your map changes to the new color.

4.4.2 Changing color by category:- it uses for qualitative and homogeneous or no rank /value data



1. Right click on the layer name
2. Click on property
3. Click on Symbology

4. Click on category
5. Click on unique values
6. Select the value field in the combo box
7. Click on Add All Values button

4.4.3 Changing color by Quantity:- to show value/rank

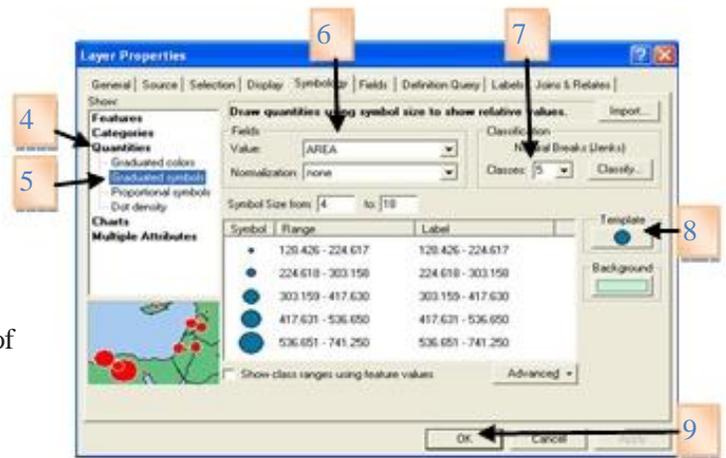
4.4.3.1 Graduated color

1. Right click on the layer name
2. Click on property
3. Click on symbology
4. Click on quantity
5. Click on graduated color
6. Select the field value. This field should numeric field.
7. You can change the number of class and class limits
To change the class limits:-
8. Click on classify button
9. Change the upper limit of each class except the last class.
10. Click ok

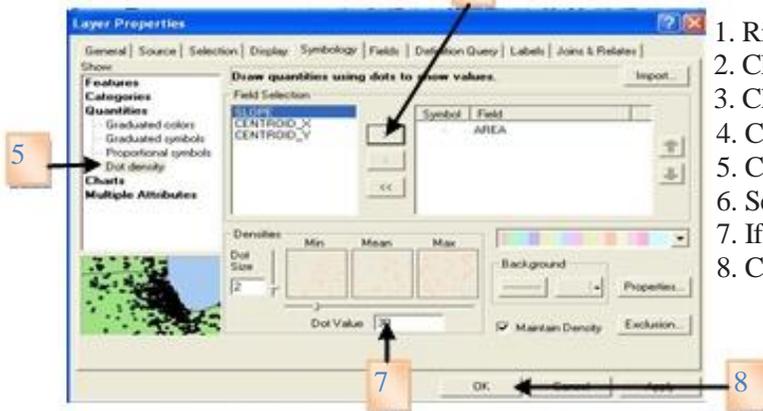


4.4.3.2 Graduated Symbol

1. Right click on the layer name
2. Click on property
3. Click on symbology
4. Click on quantity
5. Click on graduated symbol
6. Click on field value
7. Like graduated color if you want to change number of class and class limits, you can change here also
8. If you want change the min and max size of the symbol
9. Click ok



4.4.3.3 Dot Density Symbol

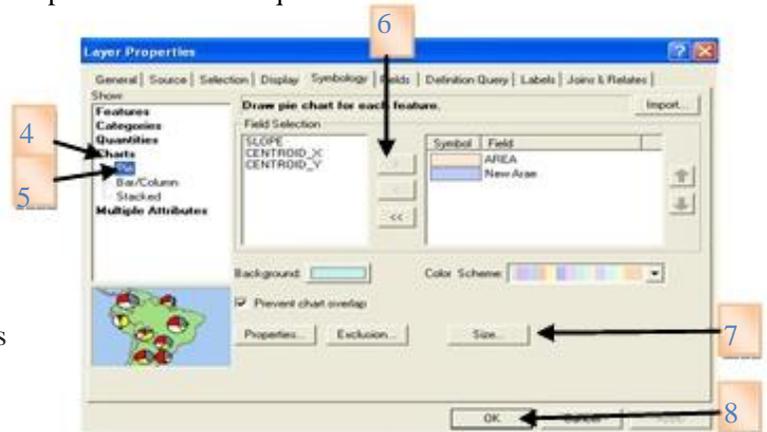


1. Right click on the layer name
2. Click on property
3. Click on symbology
4. Click on quantity
5. Click on Dot density
6. Select the field and click add arrow
7. If you want you can change the value of one point
8. Click ok

4.4.4 Changing color by Charts:- It uses to compare two and more quantitative field values

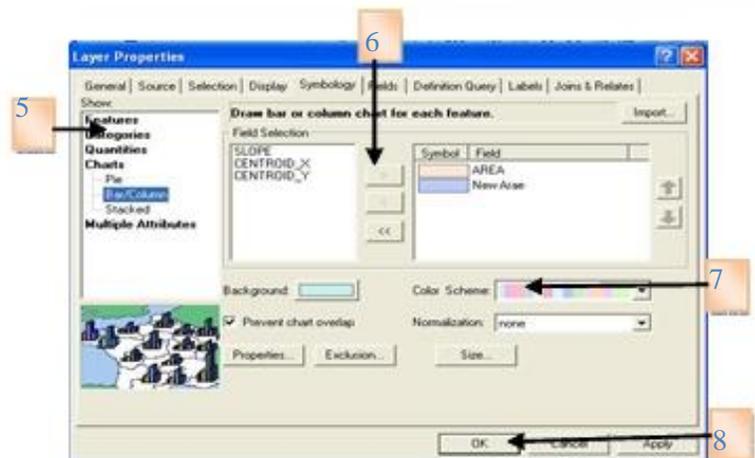
4.4.4.1 Pie Charts

1. Right click on the layer name
2. Click on property
3. Click on symbology
4. Click on Charts
5. Click on Pie
6. Select the field and click add arrow
7. If you want you can change the size of pie charts
8. Click ok

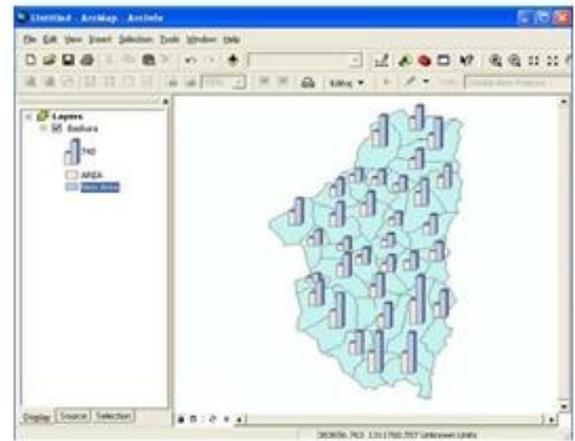
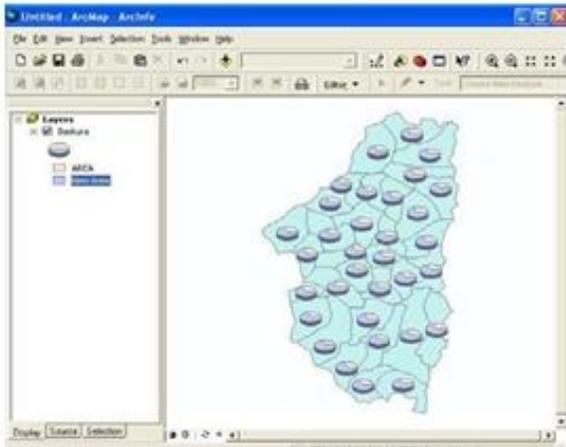


4.4.4.2 Bar/Column Charts

1. Right click on the layer name
2. Click on property
3. Click on symbology
4. Click on Charts
5. Click on Bar/column
6. Select the field and click add arrow
7. If you want you can change the size of Bar graph
8. Click ok



The following maps show the result of pie chart and bar /column graphs.



N.B The major Procedure Symbolizing Point and Line data are the similar to symbolizing polygon features

Exercise:-

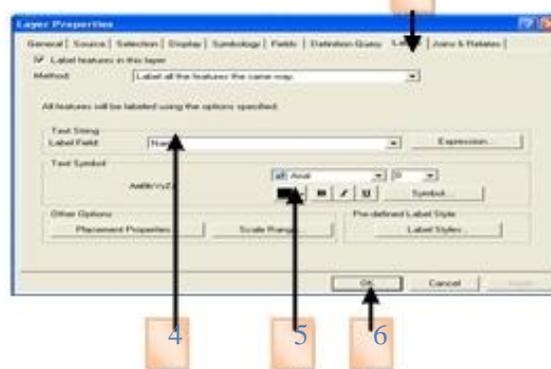
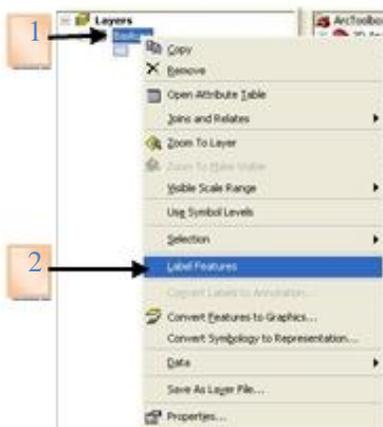
1. Add Enguli and Enkual Watershed on ArcMap.
2. Change the color of Enguli watershed to Light green
3. Symbolize Enguli by Community watershed name. change the color of Toma Community watershed in to black color
4. Add Baskura watershed and symbolize by graduated color based on area
5. Prepare the map of Population density using graduated symbol
6. Draw a bar/column graph that shows urban and rural population in each community watershed in baskura
7. Try show the Kebeles in Baskura Watershed
8. Symbolize the project woreda based on Waoreda Name
9. Draw a pie chart that shows urban and rural population in each community watershed in baskura
10. Classify Enguli Watershed area in 4 class.

4.5 Labeling Features

Labeling is the process of placing descriptive text onto or next to features on the map. It is useful to add descriptive text to your map for many features. Labeling can be a fast way to add text to your map, and it avoids you having to add text for each feature manually. In addition, ArcMap labeling dynamically generates and places text for you.

To label features:-

1. Right click on the name of the layer
2. Click on Label Features



N.B if you want to change the property of labels

3. Click Labels
4. Change the label field
5. Change the size and color of text symbol
6. Click ok

4.6 Maplex function

Maplex function helps to make your label readable automatically

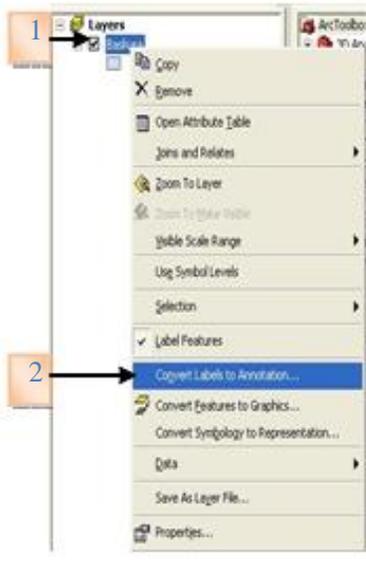
1. Right click on the top of your document and Click Labeling
2. Click on labeling and click Use Maplex Engine.



4.7 Convert labels to annotation

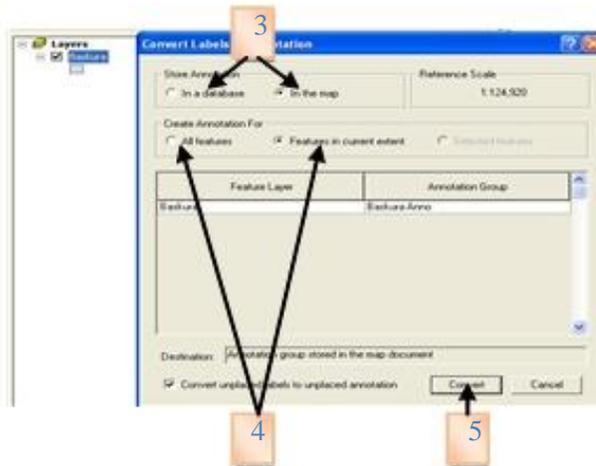
Annotation is one of a feature class in ArcGIS. If we are using the geodatabase features we can save as a layer. Otherwise we can convert labels as annotation on the map. If you need full control over where a given label is placed on your map, you should convert your labels to annotation. Text stored as annotation is editable, which means that you can select and move individual pieces of text, as well as change their display properties (font, size, color, and so on).

To convert labels to annotation:-



1. Right click on the name of the layer
2. Click on convert labels to annotation. This option is disabled if the map is not labeled.

N.B since Annotation a feature class the layer frame should have a coordinate system otherwise you will not able to convert labels to annotation



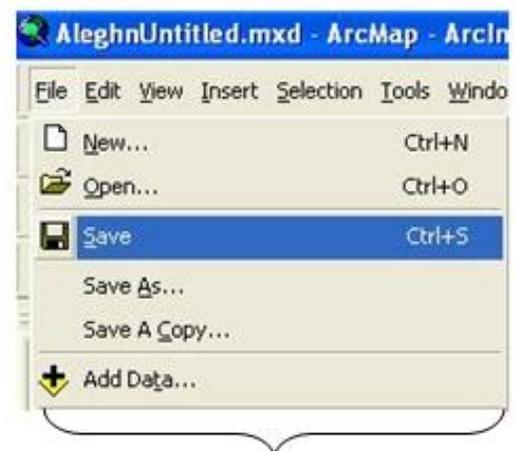
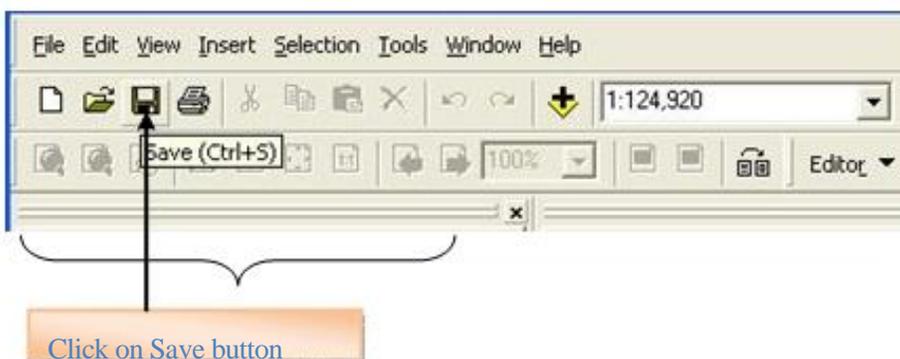
3. If you are working on geodatabase select In a database option otherwise select In the Map options
4. Select All features /if you want to change all labels in full extent/ otherwise select Features in current extent
5. Click Convert

Exercise:-

1. Label the name of towns
2. Change the label font color in to red, the style to Tahoma and the size 6
3. Convert the labels to annotation and change the Debere Tabor town font size to 10 and color to Dark green
4. Label Enkulal watershed by their name try to make readable.
5. Label project wordeda by their kebele and use Maplex function to make readable.

4.8 Save ArcMap Document

Like any other computer application, you can save your ArcMap document by clicking the save button or go to file then select save or save as option and give the appropriate drive and file name.

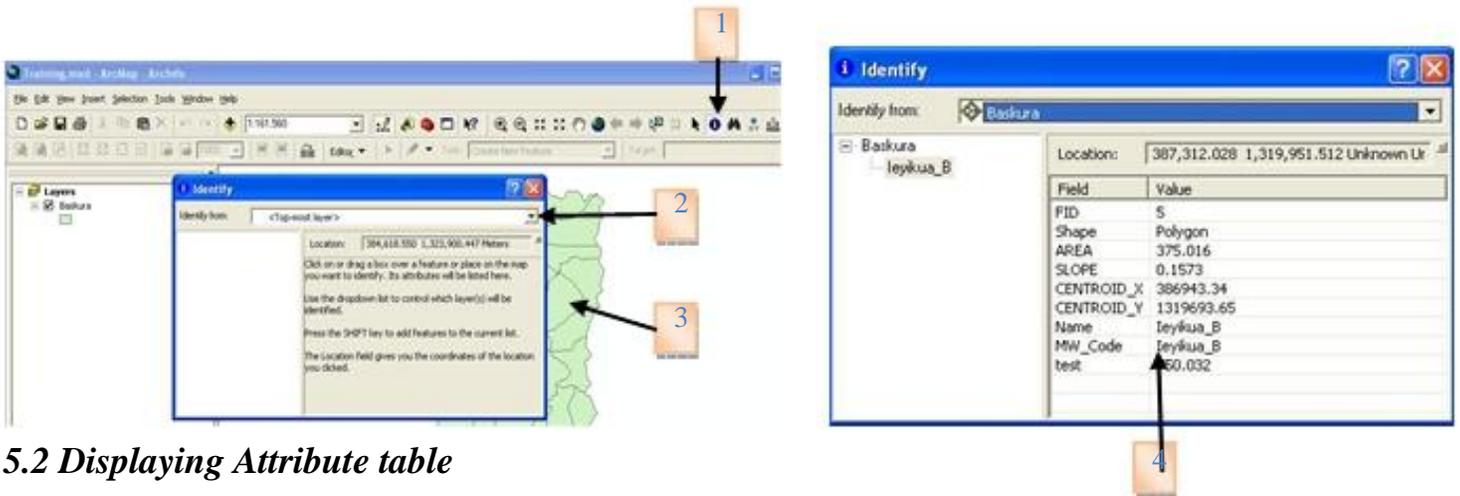


5. Attribute Data and spatial querying

5.1 Using identify button

Identify button uses to see individual features information from your map. To use identify button:-

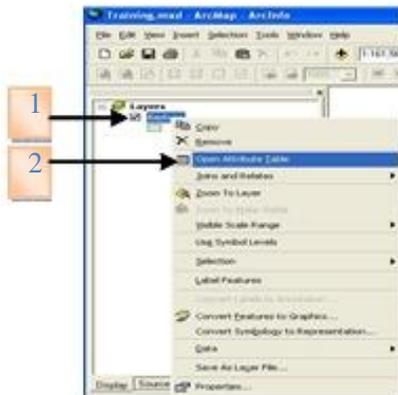
1. Click on identify button
2. Select the layer you want to see its information. /by default ArcMap shows information of the top layer./
3. Click on specific polygon, line or point of your interest
4. All the available information for that specific polygon. Line or point will display



5.2 Displaying Attribute table

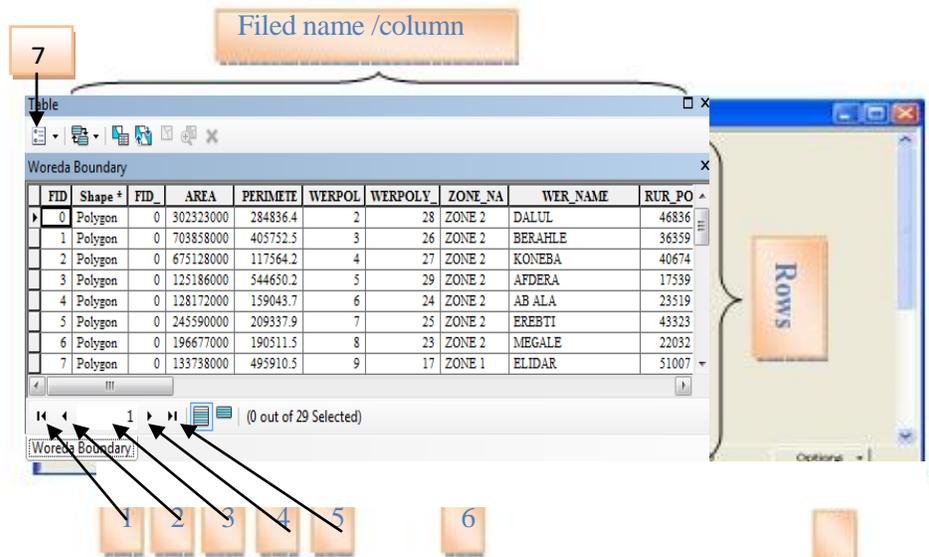
A table is a database component that contains a series of rows and columns, where each row, or record, represents a geographic feature—such as a Landuse, SWC structures, Soci-economic Infrastructures, and etc. each column, or field, describes a particular attribute of the feature—such as its Type, Name, depth, and so on.

To open Attribute table



1. Right click on layer.
 2. Click Open Attribute Table.
- The layer's attribute table opens.

1. Move to first record
2. Move to previous record
3. Current record
4. Move to next record
5. Move to last record
6. To show selected record
7. Table options /it help to perform different editing & selection tasks



5.3 Querying attribute table

Selecting records by attributes

1. Click Options in the table you want to query
 2. Click Select By Attributes.
 3. Click the Method dropdown arrow and click the selection procedure you want to use.
 4. Double-click the field from which you want to select.
 5. Click the logical operator you want to use.
 6. Click the Get Unique Values button, then scroll to and double-click the value in the Unique Values list you want to select.
 Alternatively, you can type a value directly into the text box.
 7. Click Apply and
 8. Click close
 Your selection is highlighted in the table. Use Apply if you intend to run more than one query or if you want to check your results before closing the Select By Attributes dialog box.

To select all attribute, to Clear selection and to switch selection

1. Click on Clear Selection option
2. Click on Select All option
3. Click Switch Selection option. This function uses to clear the selected attribute and select those previously unselected attributes

Exercise:-

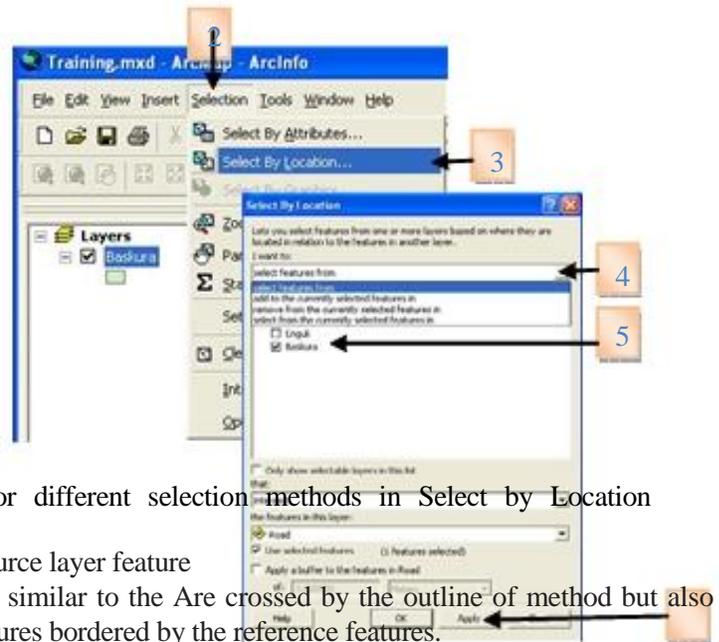
1. Open the attribute table of Enkulal Sub watershed and find Zeba community Watershed
2. Select Bahir Dar Town from the Town layer
3. Select roads owned by ARA and RRA
4. Select those community watersheds from kentai which has an area between 300 to 800
5. Select cultivation land use those have Eutric Cambisols, Erosion rate of 3.125 in Hana mariam kebele in East Estie woreda.

TIP:- Add Town layer, Road layer, Kentai subwatershed layer and Project_Woreda_Mostmerged_Da layer

5.4 Spatial query /Select by location

Select By Location dialog box, helps to select features based on their location relative to other features, so you need at least two features in your ArcMap document to use this select by location function. You can use a variety of methods to select the point, line, or polygon features.

1. Select your area of interest from the reference layer
2. Click Selection from the menu bar
3. Click Select by Location
4. Select the different option from the I Want to options
5. Select /thick mark on the targeted layer
6. Select one from the That option
7. Click Apply



Descriptions for different selection methods in Select by Location function

Intersect the source layer feature

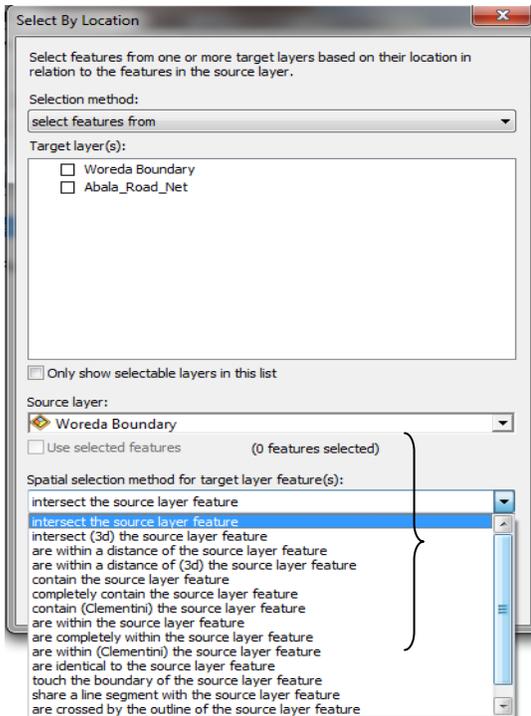
This method is similar to the Are crossed by the outline of method but also selects any features bordered by the reference features.

Are within a distance of the source layer feature

This method selects features near or adjacent to features in the same layer or in a different layer.

Have their center in the source layer feature

This method selects the features in one layer that have their center in the



Selection Options

features of another layer.

Are completely within the source layer feature

This method selects features in one layer that fall completely inside the polygons of another.

Completely contain the source layer feature

You can select polygons in one layer that completely contain the features in another layer.

Share a line segment with the source layer feature

This method selects features that share line segments, vertices, or nodes with other features.

Are identical to the source layer feature

This method selects any feature having the same geometry as a feature of another layer. The feature types must be the same—for example, you use polygons to select polygons, lines to select lines, and points to select points.

Contain the source layer feature

This method selects features in one layer that contains the features of another. This method differs from the Completely contain method in that the boundaries of the features can touch.

Are contained by the source layer feature

This method selects features in one layer that are contained by the features in another.

Touch the boundary of the source layer feature

If you are selecting features using a layer containing lines, this method selects lines and polygons that share line segments, vertices, or endpoints (nodes) with the lines in the layer. The lines and polygons will not be selected if they cross the lines in the layer. If you are selecting features using a layer containing polygons, this method selects lines and polygons that share line segments or vertices with the polygon boundaries. The lines and polygons will not be selected if they cross the polygon boundaries. You can't use this method to select point features.

Exercise:-

1. Select Community watersheds in Zefie those has main road
2. Select community watershed in Zefie 2 k.m away from the main road
3. List the name of towns in Kentai sub watershed
4. Select all towns with in 50 k.m from Bahir Dar
5. RPCU want to buy one flour mill for those community watersheds 5 k.m far away from Tikure weha Community watershed. List the possible candidate community watersheds in kentia sub watershed.

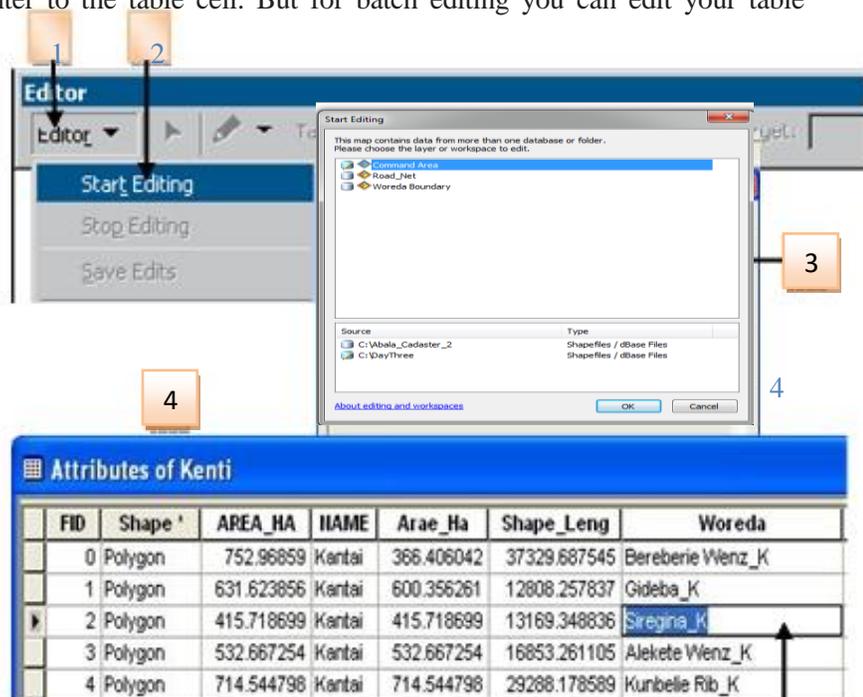
6. Data Management

6.1 Updating Attribute Table

You can make change or delete any data on your attribute table. To make change on specific record first the layer should be in editing mode, otherwise the cursor will not enter to the table cell. But for batch editing you can edit your table without entering to the edit mode.

6.1.1 Editing or adding text in records

1. If you haven't started an edit session, click the Editor menu on the Editor Toolbar and
2. Click Start Editing.
3. Select the layer you want to edit
4. Open the table you want to edit.
5. Click the cell containing the attribute value you want to change.
6. Type the new values and press Enter. The table is updated.

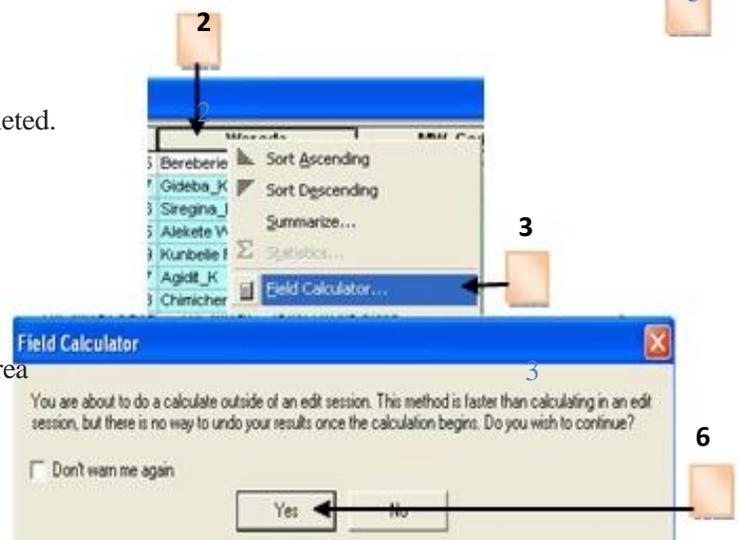


6.1.2 Deleting records

1. If you haven't started an edit session, click the Editor menu on the Editor Toolbar and click Start Editing.
2. Open the table you want to edit.
3. Select the records you want to delete. Press and hold the Ctrl key while clicking to select more than one record.
4. Press the Delete key on the keyboard. Any geographic features associated with the records are also deleted.

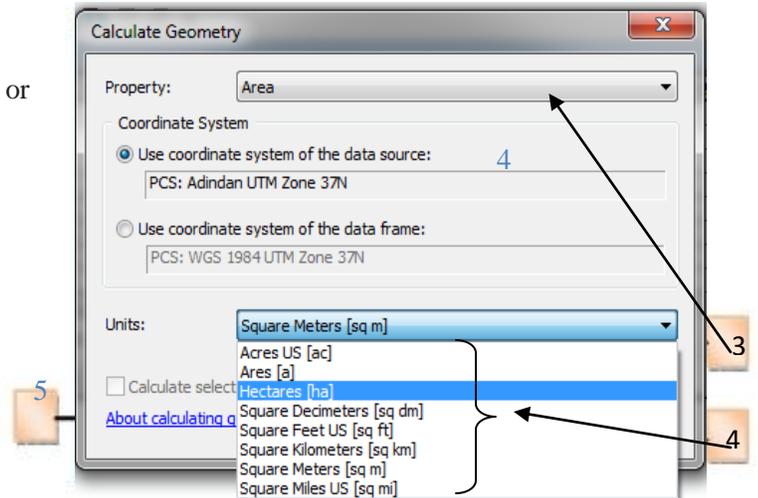
6.1.3 Editing or adding many text in records

1. Open the attribute table
2. Right click on the field/column name
3. Click on Field calculator
4. Accept the warning by clicking ok button
5. Enter the new value /calculation formula in white area
6. Click ok



To calculate Area or to get X, Y Coordinate value of a point data:

1. Right click on the field /column name
2. Click on calculate Geometry
3. Find the area calculation or the x coordinate select Area or X or Y coordinate from Property box.
4. Select the unit of measurement
5. Click Ok

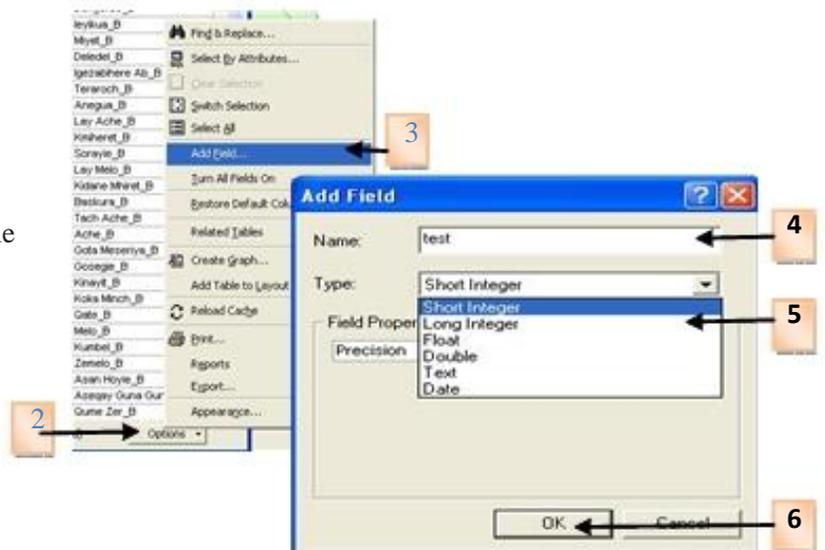


6.2 Creating, deleting and hiding Fields

If you want to add or delete fields from your table you should be out from edit session.

To Add new field in your table

1. Open the attribute table
2. Click on option in the top of the table
3. Click Add Field
4. Enter field name
5. Select the data type /for area choose Double for text select text type/
6. Click ok

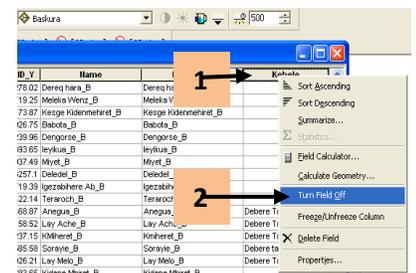


To delete the existing field
Make sure you are not in edit session.

1. Right click on the field /column you to delete
2. Click on delete field
3. Accept the warning by clicking on yes button

To hide the existing field

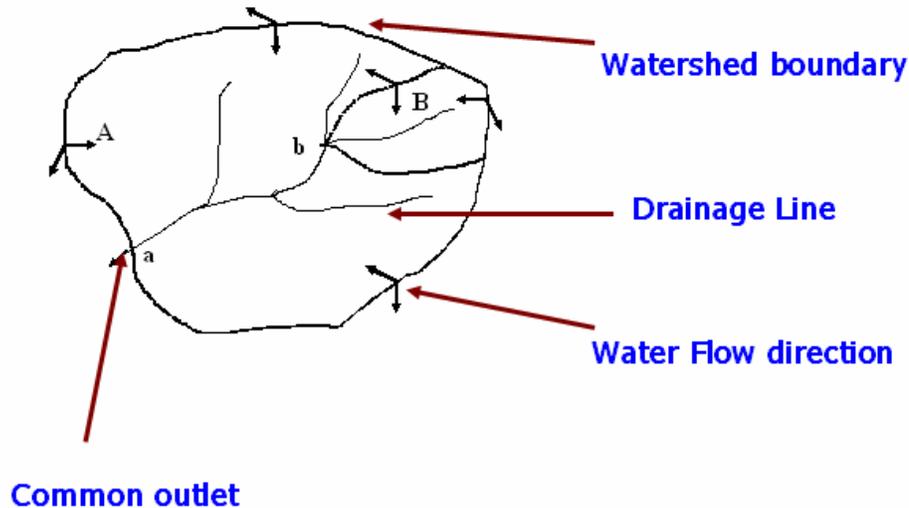
1. Right click on the field
2. Click on Turn field off



7. Watershed Delineation

What is a Watershed?

- Watershed is a topographically delineated area drained through a common confluence point on a stream or river,
- An area that drains rainfall runoff water to a common outlet,
- Drainage system - The area upon which water fall & the network through which it travels to an outlet.
- Pour Point - A location at which the rainfall runoff contributing area can be determined.



7.1 Watershed Delineation Methods

Different methods have been devised and are used to delineate watersheds. The following are some of the common watershed delineation methods: In this training we will see two of them in detail (watershed Delineation using GPS and topographic map).

1. Watershed delineation using Topographic map (contour, Drainage Patterns),
2. Watershed delineation using hand held GPS (Tracks, points),
3. Automatic delineation from DEM using ArcGIS software, ILWIS and ArcHydro,

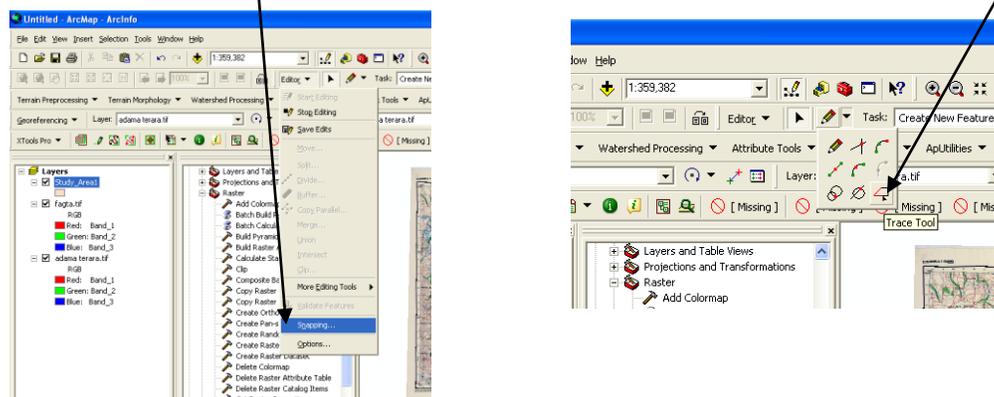
7.1.1 Watershed delineation from Topographic map

Topographic map can be used as a data source to delineate a watershed. In this method contour lines and drainage patterns/networks serve as starting points in delineating a watershed using ArcGIS software. It is the easiest method of watershed delineation as compared with field delineation using GPS. Before starting to delineate a watershed from topomaps, you should create new polygon shape file in ArcCatalog.

We can use the following steps to delineate a watershed, using topographic map in ArcGIS environment,

1. Open Arc catalog,
2. Create a polygon shape file under the created dataset
3. Open ArcMap,
4. Add the topographic map
5. Add the created shape file
6. Click on editor toolbar to start editing, the editor toolbar becomes ready to edit the existing ones or to create new features.
7. Start to delineate a watershed based on contours and drainage patterns using Sketch Tool,
11. After completing your delineation, calculate the area of the delineated watershed in hectare or km^2 ,

N.B. during digitizing use the snape tool and also if you are delinating common boundary use terrace tool to reduced topological error



7.1.2 Watershed delineation using GPS points

This is another alternative to delineate a watershed. This method is accurate but it is very difficult to do it and time taking. Mostly we can apply for verification /checking/ purpose and to delineate small size community watersheds. To apply this method;

1. GPS points should be collected on the field using hand held GPS,
2. The collected GPS points can be directly transferred into computers using GPS cables and software,
3. Add the transferred data to ArcMap and edit errors, if any.

Exercise

1. Go to the field,
2. Select a representative micro watershed,
3. Collect tracks and waypoints walking along the boundary of the watershed,
4. Watch carefully the different features in the watershed that will help you digitize land use/land cover, road network, drainage network, etc
5. Return back to your training room and import the collected tracks and waypoints into your computer using either the Garmin Software or Excel worksheet or both,
6. Open the collected tracks or waypoints in ArcMap,
7. Delineate your watershed and calculate its area in ha.

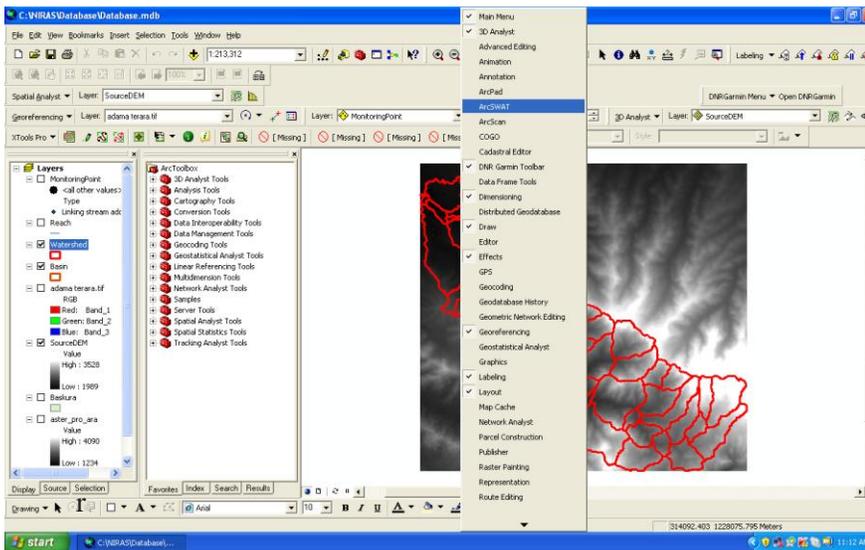
7.1.3 Delineating Watershed by using ArcSWAT Application

ArcSWAT is an extension for ArcGIS that help to perform all the watershed and hydrological tasks. You should install ArcSWAT software independently to use with the ArcGIS as extension. In this session we will concentrate on delineating watershed automatically form the ASTER 30 DEM.

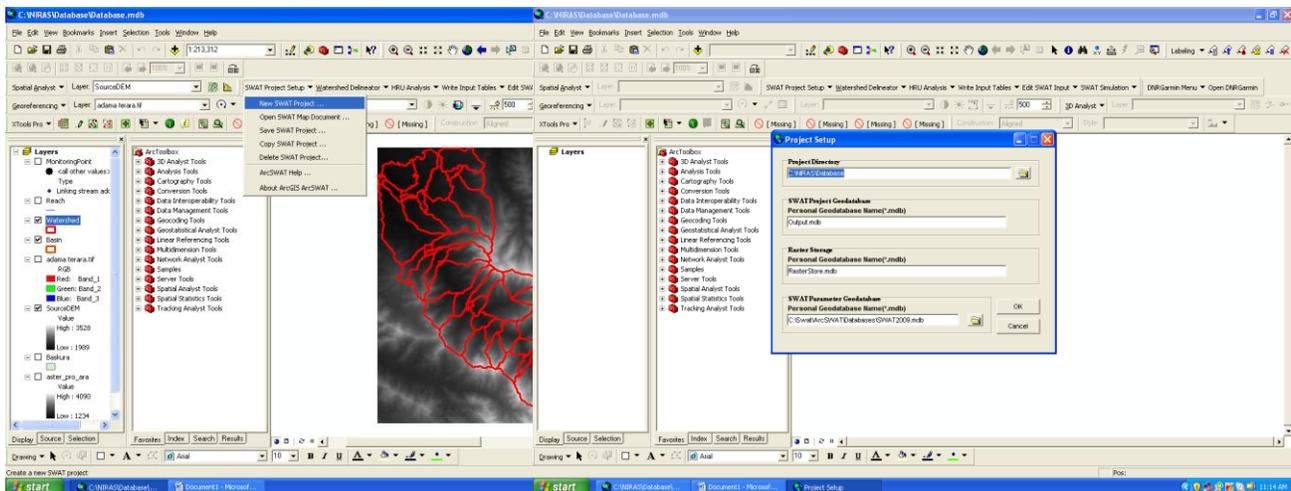
To delineate watershed in ArcSWAT

To perform an automatic delineation you should pass a series of steps/, before you get the actual watershed /catchment/. For example you should prepare your DEM by smoothing, creating flow direction, flow accumulation, stream definition and so on.

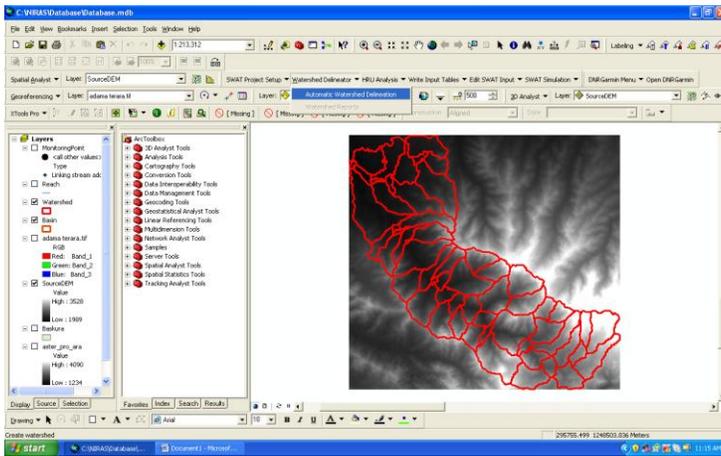
- Step one:- start new ArcMap and save your map document
- Step two:- right click on top of ArcMap and select ArcSWAT



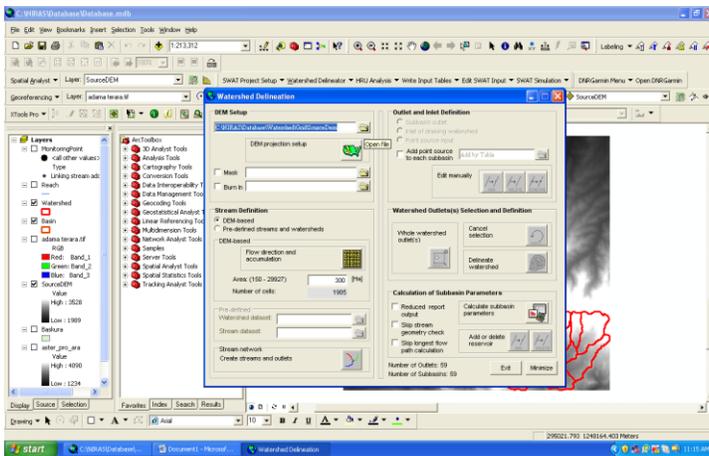
- Step three:- Setup your ArcSWAT project by clicking new SWAT project and select your folder



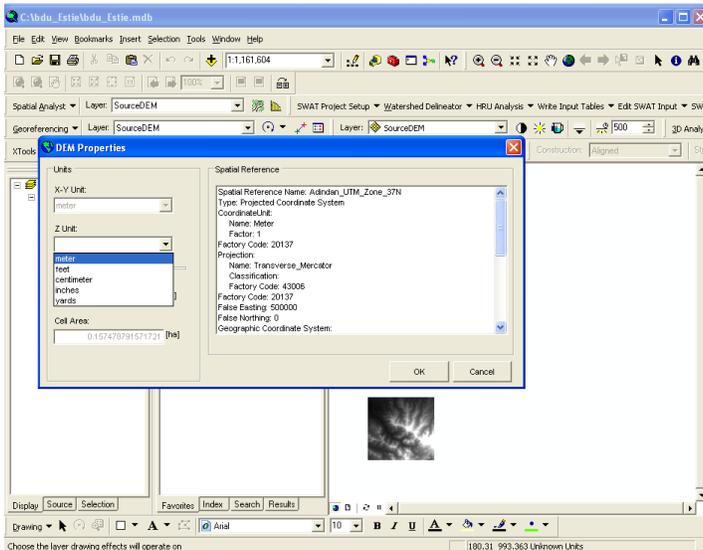
Step four:- click watershed delineator and click on Automatic watershed delineation.



Step five:- click the folder icon on DEM Setup and select DEM file.

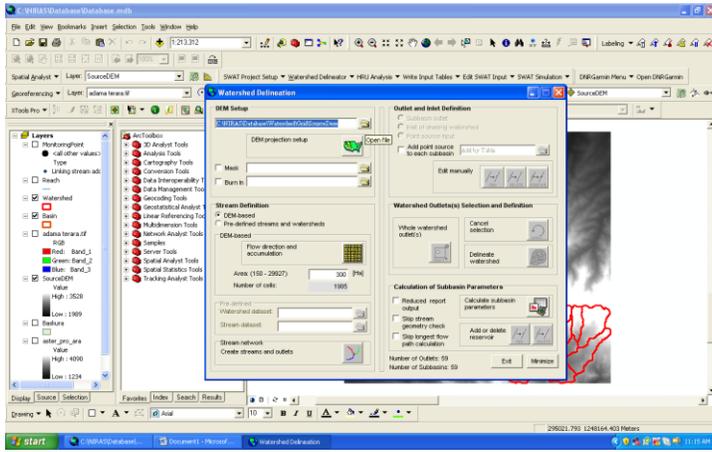


Step six:- click on the icon next to DEM projection setup and select “meter” in Z unit.



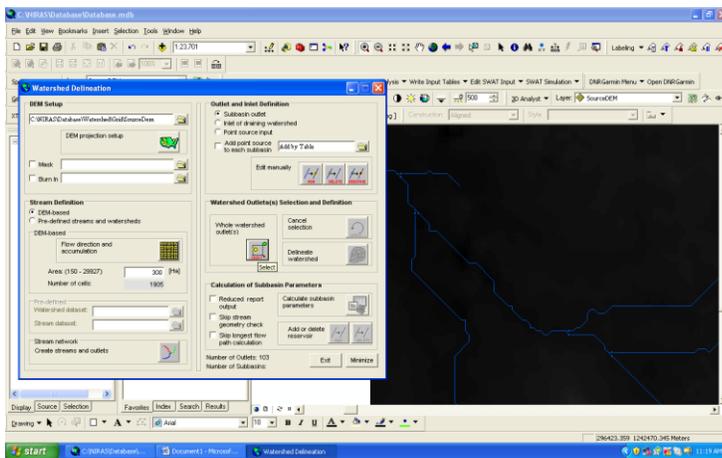
N.B If you are using big DEM you can use mask image to your interest

Step seven:- select DEM based in stream definition and click on the raster image in flow direction and accumulation



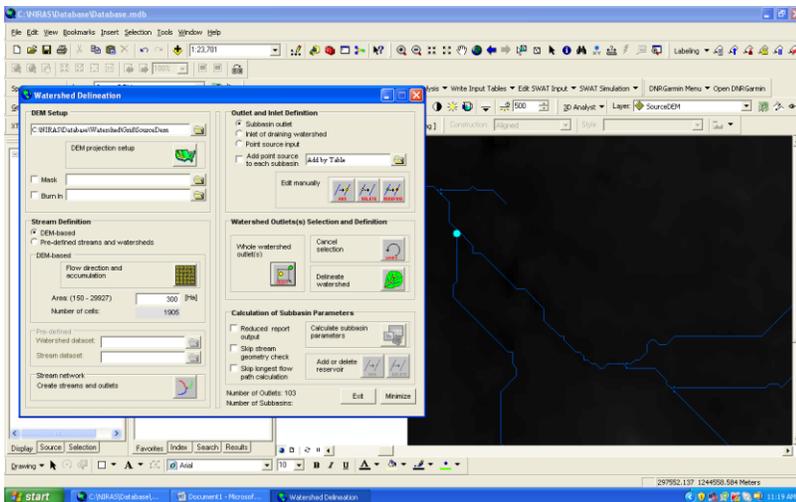
Step eight:- Click on the icon next to create streams and outlets

outlets

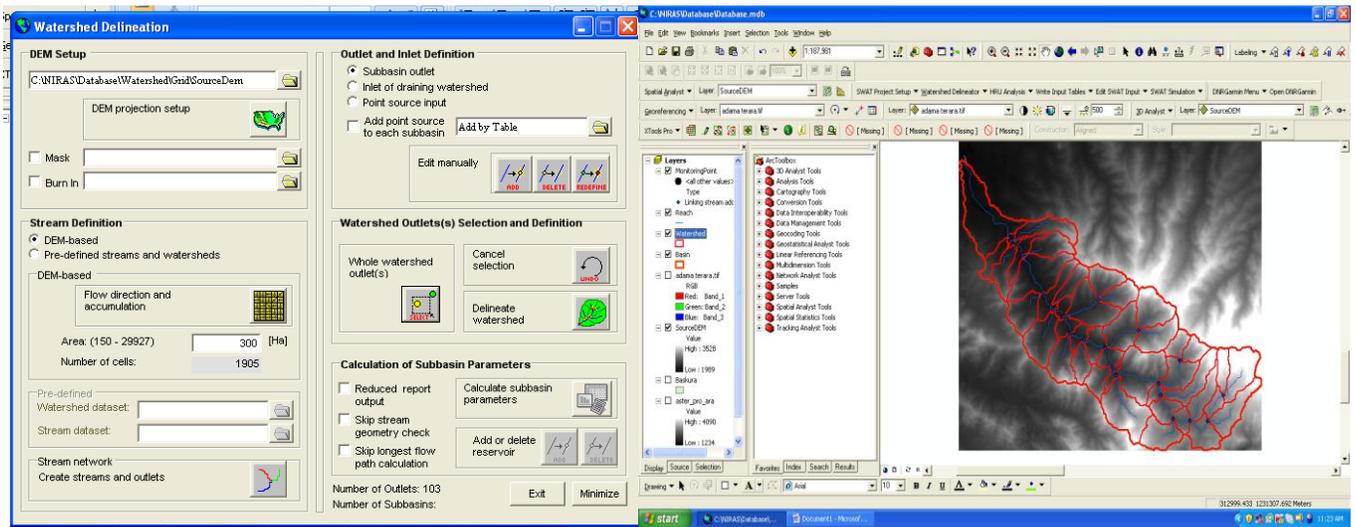


N.B if you want to change each outlet, you can change manually by clicking edit manually or add point table

Step nine:- Click on the icon next to whole watershed outlets and select one of the outlet



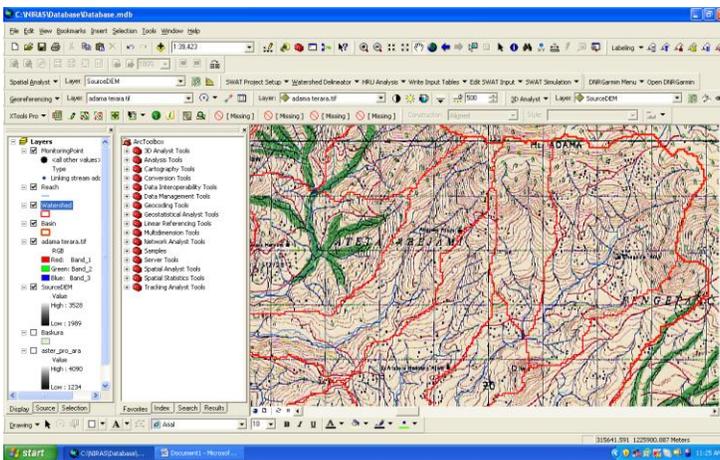
Step ten:- Click on the icon next delineate watershed



Step

eleven:-
of the

check and edit the delineated watershed according to the need
community

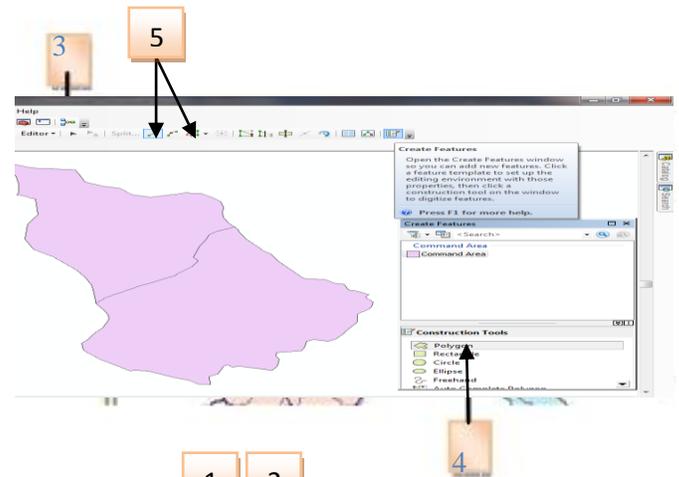


8. Editing and Updating Spatial data

Spatial data /Maps/ can be edited or deleted. In this section we will see how to digitize new data, edit/reshape, split and merge/ spatial data.

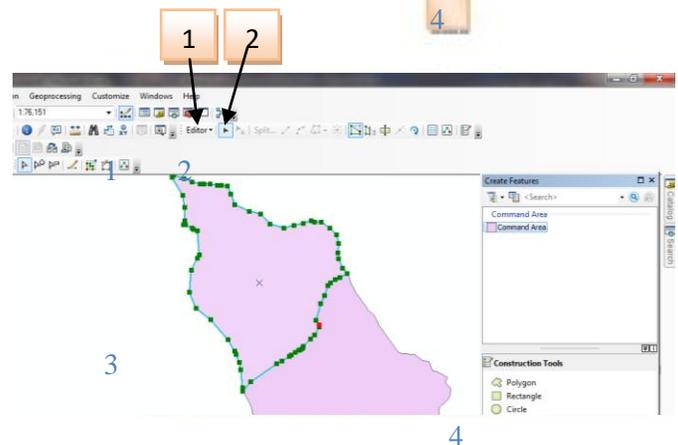
8.1 Digitize new data

1. Create new feature class in ArcCatalog by defining its shape type and its coordinate
2. Add the empty /new/ feature class in ArcMap
3. Start editing and select the new /empty feature class
4. Click polygon, line or point based on your feature type
5. Click the straight segment or Trace to start digitizing
6. Digitize on the map window where you want to digitize if you finish double click to stop digitizing
7. Stop editing by saving the edit
8. The new map will display on your Map document.



8.2 Edit exiting /Reshaping/ data

1. Start editing and select the target layer
2. Click edit tool
3. Double click on the feature that you want to edit
4. Drag the vertex /colored by green/ in the place you want
5. Click stop editing and save the edits



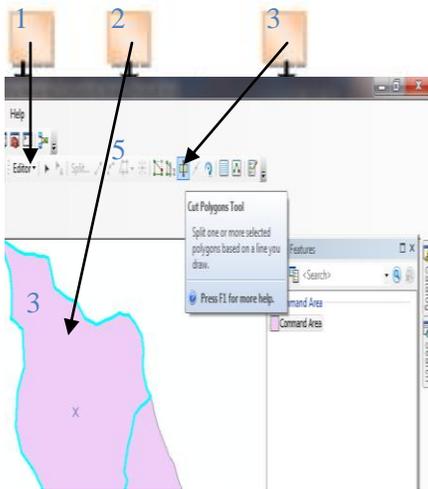
8.3 Delete the existing features

1. Start editing and select the target layer
2. Select the feature on the map
3. Click the Delete button from your keyboard

Exercise:

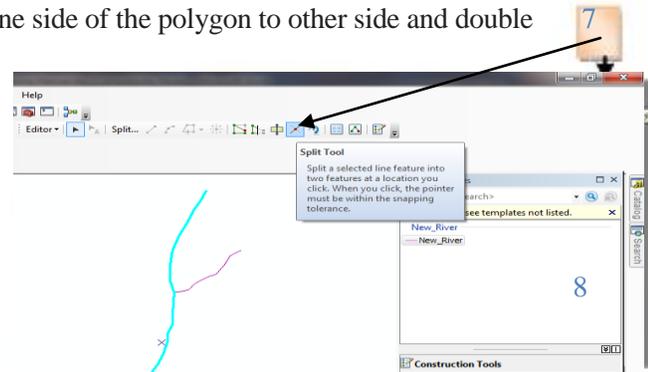
1. Add the new shapefile you created and digitize three watershed from Top Map and give name for it.
2. Reshape the new digitized data to fit the kebele boundary
3. Delete one of the newly created watershed.

8.4 Split the existing features



1. Start editing and select the target layer
2. Select the feature on the map
3. Select Cut Polygon features /if you are editing polygon features/
- 4 Click the straight segment or Trace
5. Start splitting by terracing from one side of the polygon to other side and double click when you finish
6. Stop editing by saving the edits

If you are editing line features
Follow step one to three
7. Click on split tool
8. Click on the place you want to split the line



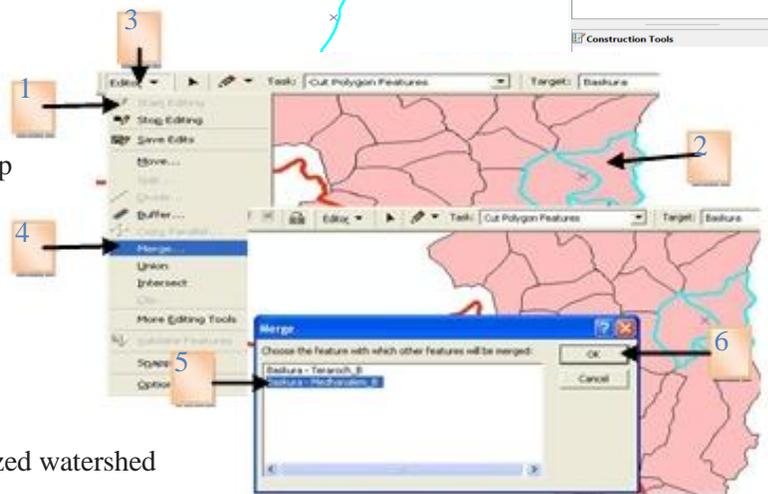
8.5 Merge features

1. Start editing and select the target layer
2. Select the feature you want to merge on the map
3. Click editor
4. Click on merge
5. Choose the one feature and
6. click ok

N.B follow the same procedure for merging to line features.

Exercise:-

1. Divide the big watershed from the newly digitized watershed in to two
2. Split the main road /D/Tabor - Gassi/ at Defegn town
3. Merge the above two roads and watersheds



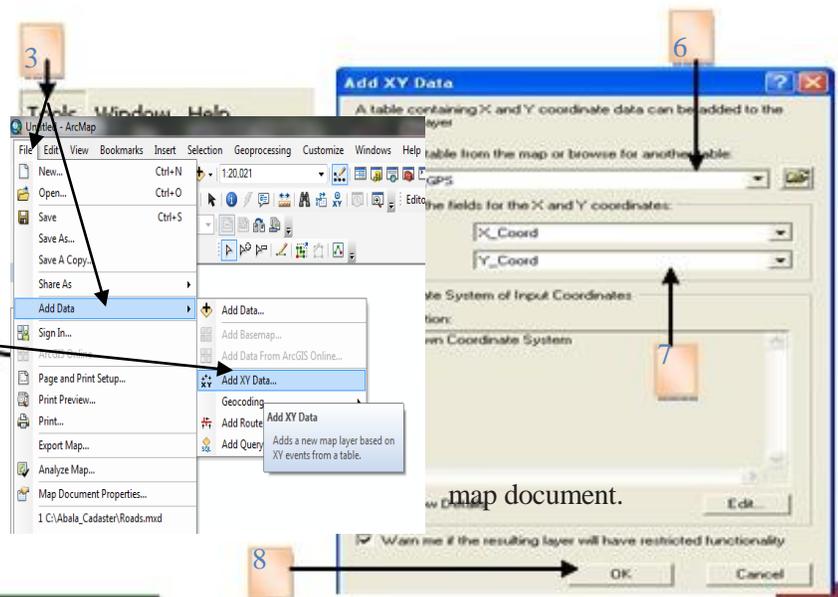
9. Transferring GPS Data to ArcGIS

You can collect different data such as socio-economic, landuse and other data by using GPS and then you can transfer this collected data to the GIS system.

To transfer the GPS Data to ARCGIS

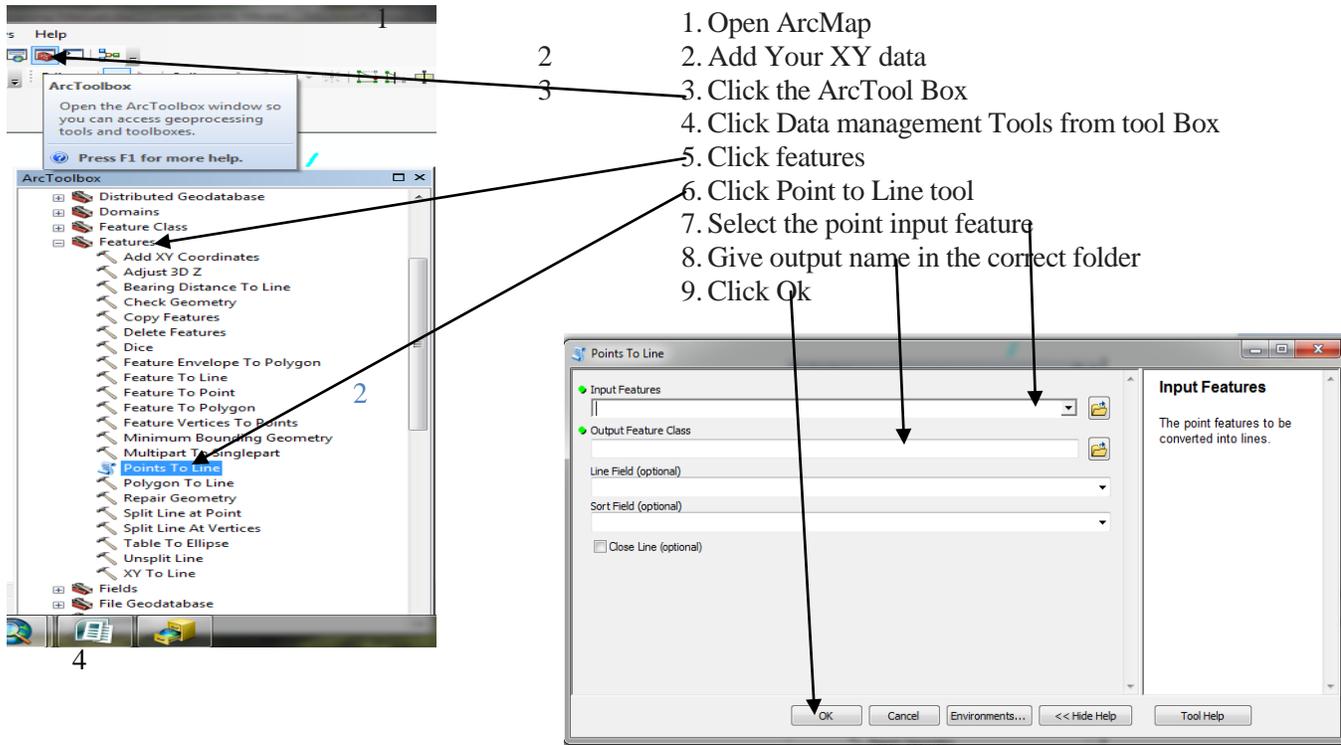
1. Copy all the collected GPS data to Microsoft Office excel application
2. Save the file
3. Open ArcMap
4. Click File menu and select Add data
5. Click Add xy data
6. Select the file name of your GPS data
7. Give the correct X and Y field.
8. Click ok

The system will add the map in to your



map document.

9.1 Convert GPS point data to Line and Polygon

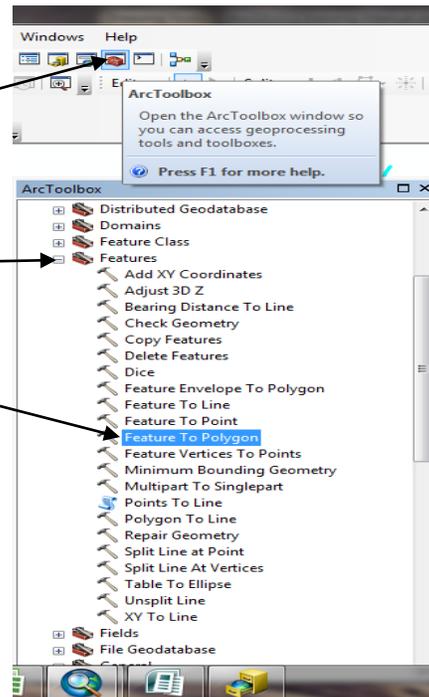


1. Open ArcMap
2. Add Your XY data
3. Click the ArcTool Box
4. Click Data management Tools from tool Box
5. Click features
6. Click Point to Line tool
7. Select the point input feature
8. Give output name in the correct folder
9. Click Ok

After converting Point to Line then convert the line feature to Polygon feature

To Convert Line feature to polygon feature

1. Click the ArcTool Box
2. Click Data management Tools from tool Box
3. Click features
4. Click Feature to Polygon tool
5. Select the Line input feature
6. Give output name in the correct folder
7. Click Ok



Exercise:-

1. Transfer the Exer_GPS data to your ArcMap document
2. Convert this data in to line and polygon data
3. Calculate the area for the converted polygon and find the length for the line

10. Data Frame

The data frame provides the principal display of geographic information as a series of map layers. It has a geographic extent and a map projection for displaying. The ArcMap document gives you one data frame as you open the document. But you can add additional data frame to create a location or index map in your map layout.

To Add data frame

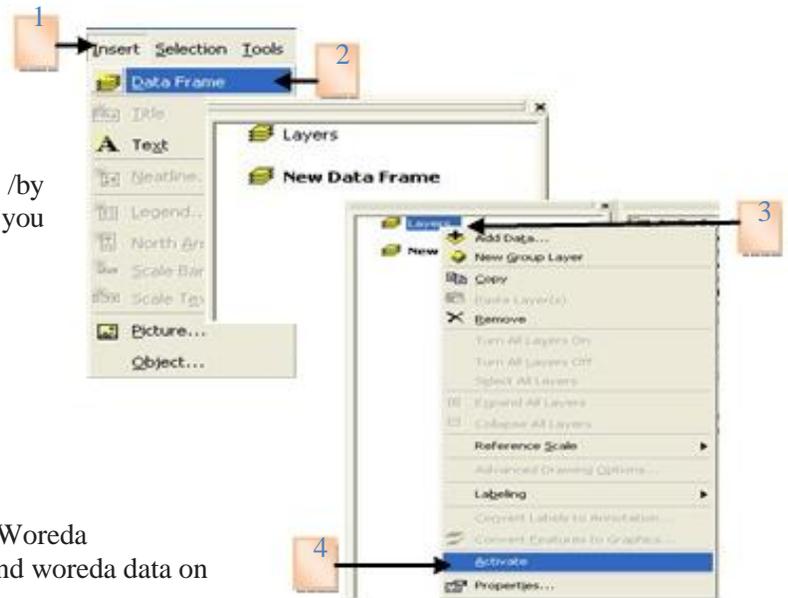
1. Click on Insert Menu
2. Click Data frame

N.B The system adds new frame on your map document /by the name New Data Frame you can change the name. As you add new data frame, the display is active for this new data frame. Therefore if add any data to your map document it goes to the new data frame. If you want to work on the old data frame:

3. Right click on the name of the data frame and
4. Click on Activate.

Exercise:-

1. Add two data field named Region and Woreda
2. Add region data to region data frame and woreda data on woreda frame
3. Delete the woreda data frame



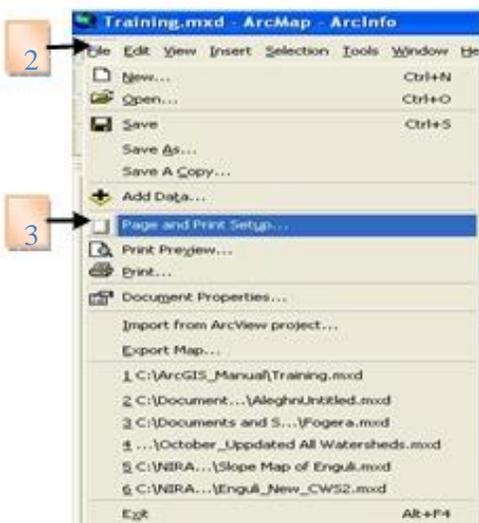
11. Creating Map Layout

A map layout is an ArcMap visualization tool. You can use the map layout to produce understandable map by adding all map elements /Scale, Title, Legend, North Arrow, Neat line etc./ in preparing map layout you have two options one is to use your own layout and the other is to use the existing templates.

11.1 Using Our own layout¹

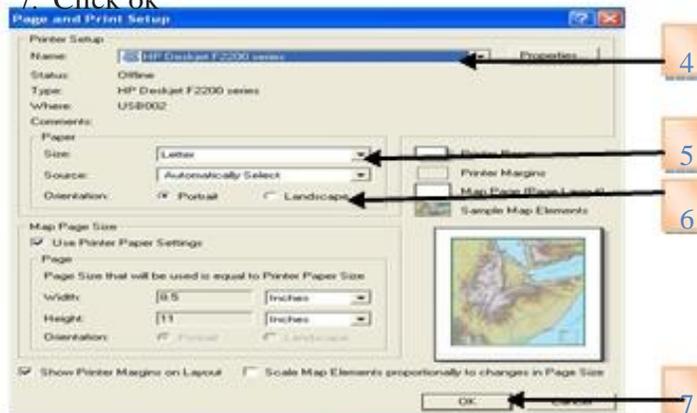


1. Click Layout view on the bottom of the ArcMap document. /The view will change from map document to layout view/



To Change, if you like, the Print setup option either portrait or Landscape.

2. Click file
3. Click Page and print setup.
4. Change the printer /if it is not the exact printer/
5. Change the paper size
6. Change the paper orientation
7. Click ok



11.1.1 Adding map element in map layout

11.1.1.1 Adding title

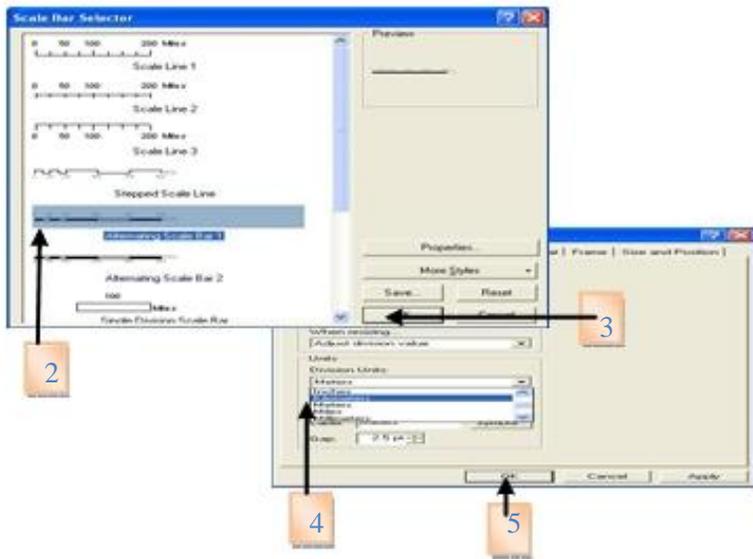
The screenshot shows the ArcMap interface with the 'Insert' menu open and 'Title' selected. A map layout is visible with a title box containing the text 'Training'. The Properties dialog box for the title is open, showing the 'Text' tab with the text 'Training', font 'Arial 23.00', and other formatting options. Numbered callouts 1 through 4 indicate the steps: 1. Click Insert in the menu; 2. Click title /The tile with the text box will add to your map/; 3. Change the default title to the appropriate title; 4. Double click to change the font style and size on the title text box.

1. Click insert in the menu
2. Click title /The tile with the text box will add to your map/
3. Change the default title to the appropriate title
4. Double click to change the font style and size on the title text box

11.1.1.2 Adding legend

1. Click Insert and click legend /refer the map in the previous discussion/
2. Select all the necessary maps you want to display.
3. Click the send add button
4. Click next
5. If you want to change the appearance of the legend you can change otherwise click next
6. If you want to add background color, frame etc you can add here.
7. Click next
8. Click Finish

The sequence of screenshots shows the Legend Wizard process: 1. Selecting layers (Township, Road, New_Shapefile, Engul, Baskara) in the 'Legend Wizard' dialog. 2. The 'Legend Wizard' dialog with 'Next' button highlighted. 3. The 'Legend Title' dialog where font properties (Color, Size, Font) are set. 4. The 'Legend Frame' dialog where background, drop shadow, gap, and rounding are configured. 5. The final 'Legend Wizard' dialog showing the legend preview and the 'Finish' button highlighted. Numbered callouts 2 through 8 correspond to the steps in the list above.

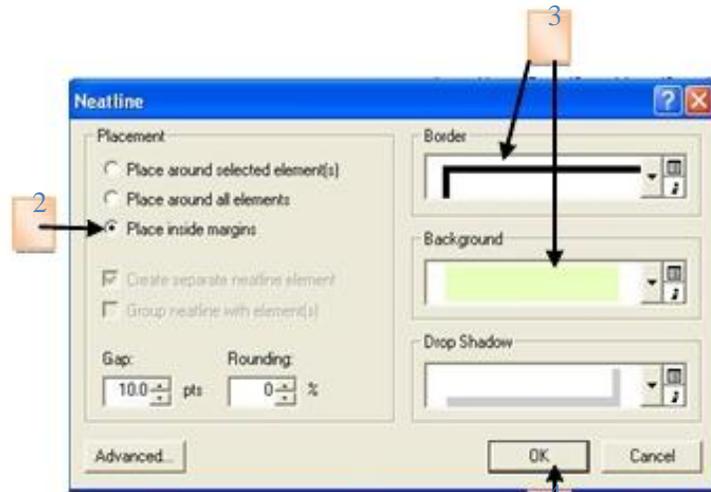
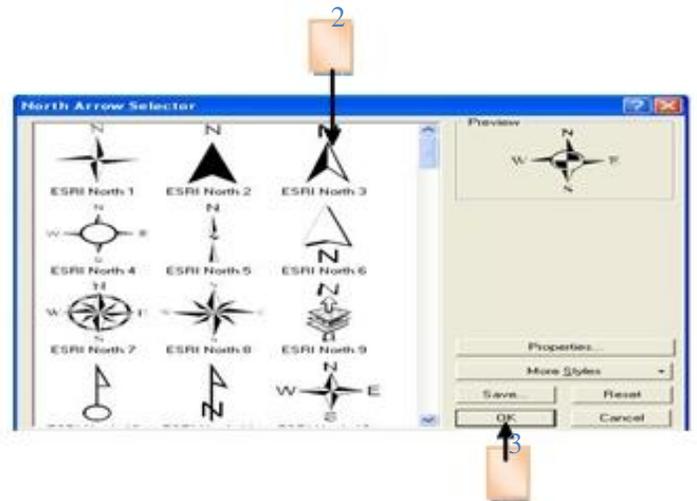


11.1.1.3 Adding scale

1. Click Insert and click Scale bar
2. Select your favorite type of scale bar
3. Click ok
4. To change the measurement unit, double click the added scale bar in your map layout and Change the meter unit to the kilometer unit
5. Click ok

11.1.1.4 Adding north arrow

1. Click insert and click North Arrow
2. Select your favorite type of arrow
3. Click ok /the north arrow will added to your map document/

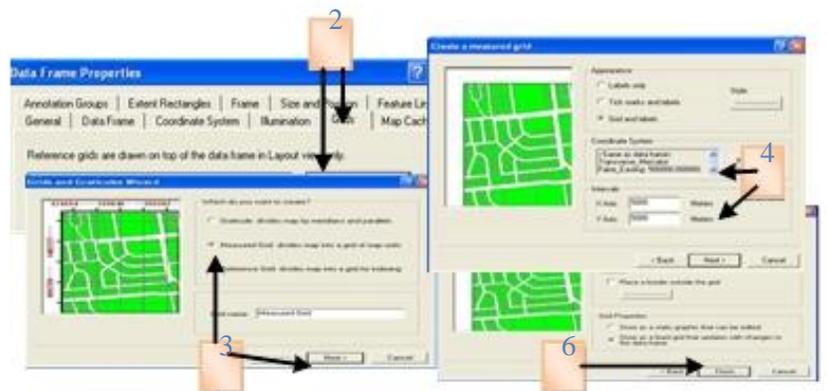


11.1.1.5 Adding Neatline /Frame/

1. Click insert and click add neatline
2. Select inside Please inside margins
3. If you need to define the size and background of border line, you can change here
4. Click ok

11.1.1.6 Adding Grid or Graticule:- Grid or measured grid uses for UTM or metric whereas graticule uses for latitude and longitude display

1. Right click on the data frame and select property
2. Click on Grid and Click New Grid
3. Select Measured Grid and click next
4. Adjust the x and y axis interval and click next
5. If you want to adjust the line do it here and click next
6. Click Finish /the grid will appear in your map



Exercise:-

1. Create map layout the shows only Kentai watershed
2. Add all Map elements including grid line
3. Add Top Map of Debere Tabor and make the two map visible
4. Add data frame and add Fareta Woreda map. Show this map in the left corner of your layout
5. Add town and road map and try to remove the Top Map from the legend /Not from the view/

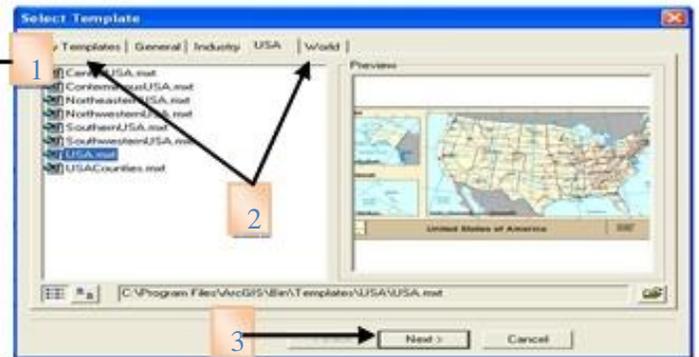
11.2 Using existing Template

There are a number of other existing template that helps you to create nice map layout. The only thing expected from you is to change /modify / some of map element attached to the existing map layouts.

1. Click change layout button
2. Select your favorite layout from the template



3. Click finish /if you are working in data frame follow the wizard by clicking the next button.



N.B Change all the unnecessary map elements by deleting and replacing by your own map element.

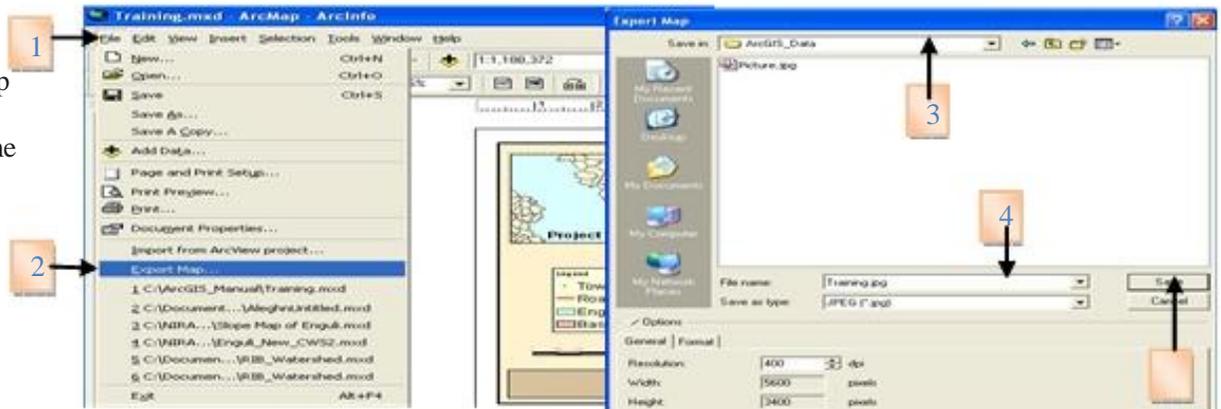
Exercise:-

1. Remove the newly added Data frame and select the USA template with portrait layout
2. Change all unnecessary map element to your own map element
3. Add two data frame called Region and Woreda and select the USA.mxd document from the USA template. Follow the wizard and change the order of your data frame that Layer should down to the third place, Region into two and Woreda to one.
4. Check your layout in the preview window and make the necessary adjustment
5. Change the grid to fit your data

11.3 Exporting the Map Layout

You can distribute your map layout to other people or for documentation purpose or to insert in any report. This can be done by exporting map layout in to the picture format. You have different image format, the JPEG is a compeered format it takes relatively little space.

1. Click File
2. Click Export map
3. Select the folder
4. Give the file name
5. Click save



Exercise:-

1. Export your map document in file name called My Map
2. Insert this map to a word document

12 Managing ArcTool Box

The ArcTools box helps to make a number of spatial analyses. For this training we will focus on the mostly used analyses tools, if you need to explore other tools you can use help.

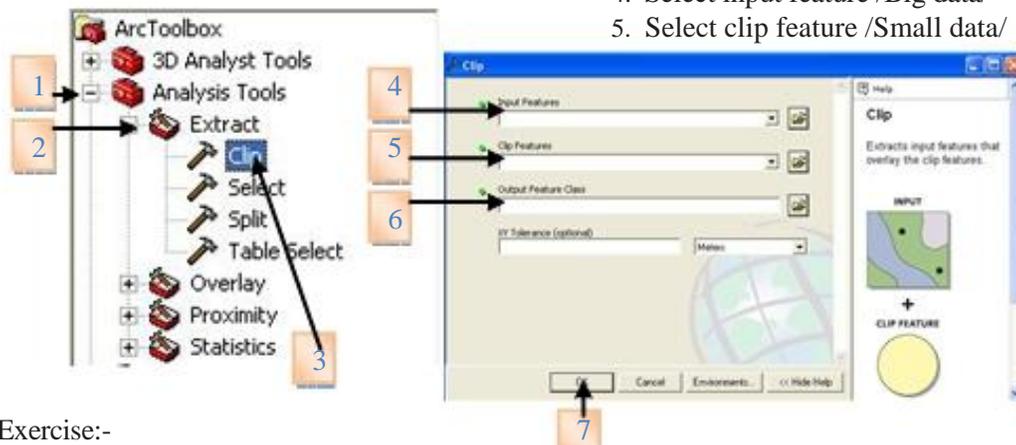
12.1 Analysis Tools

12.1.1 Extract

The extract tool box helps to get new data from the existing data. Under this tool you have a number of other functions such as Clip, select, split and table select. Here we will see the clip function.

- **Clip features**

1. Click the plus sign in front of the Analysis Tools
2. Click the plus sign in front of the Extract tool
3. Double click on the Clip function /this function helps you to extract small information from the big one/
4. Select input feature /Big data/
5. Select clip feature /Small data/



6. Change the folder and name of your new data
 7. Click ok
- The new file will added to your map document

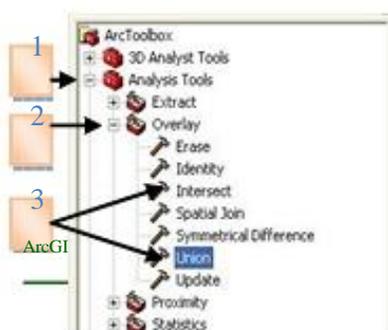
Exercise:-

1. Extract those kebele that contain Kentai sub watershed
2. Clip Town and Road by Baskura sub watershed

12.1.2 Overlay

Overlay analysis is one of the basic tools for GIS operation. A number of questions can be asked by the GIS users for example what type of landuse is exist in one community watershed, in which slope class the dominant forest land is exist, etc. in general the overlay analysis used to get new information from more than two other features. In this analysis tool we will see the union and the intersect function.

- **Union or Intersect function**



1. Click the plus sign in front of the Analysis Tools
2. Click the plus sign in front of the Overlay tool
3. Click on the union function /if you want to have the whole size of the feature. Otherwise Click Intersect /if you want to have an information equal to the smallest size of the feature/

prepared by WME TA Team /GIS and Database Advisor/



4. Select input features one by one
 5. Change the folder and file name of your data
 6. Click ok
- The new overlaid data will add to your map document.

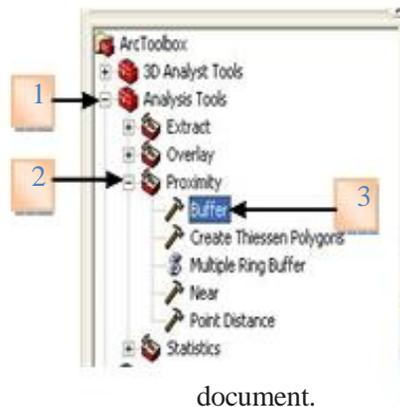
Exercise:-

1. Intersect Enkual sub watershed with Dera Woreda
2. List name of kebeles in Enguli sub watershed
3. Find landuse of Enkual sub watershed only in Estie side
4. Find those kebele in Mecha woreda which is not part of Tana Beles project
5. Find areas that have a slope > 50% and its landuse is Cultivated land

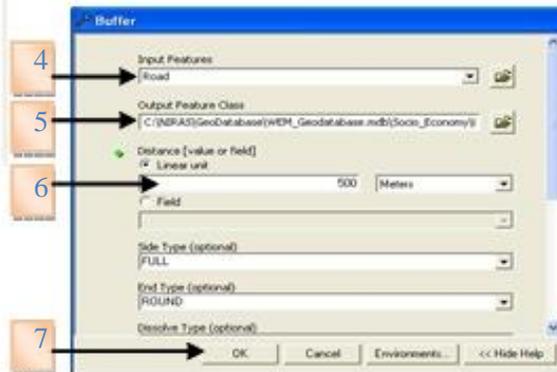
12.1.3 Proximity

The proximity analysis helps to know the neighborhood of one feature. From this analysis we will concentrate only on the buffer function.

- Buffer Function



1. Click the plus sign in front of the Analysis Tools
2. Click the plus sign in front of the Proximity tool
3. Double click on Buffer
4. Select the input feature
5. Change the folder and file name of your data



6. Give the distance in the text box next to distance and change the unit if you are working in other unit
7. Click ok /the polygon feature will added to your map

N.B The buffer function uses the given buffer distance in both side of the feature not in one side /it uses like a radius of a circle/

Exercise:-

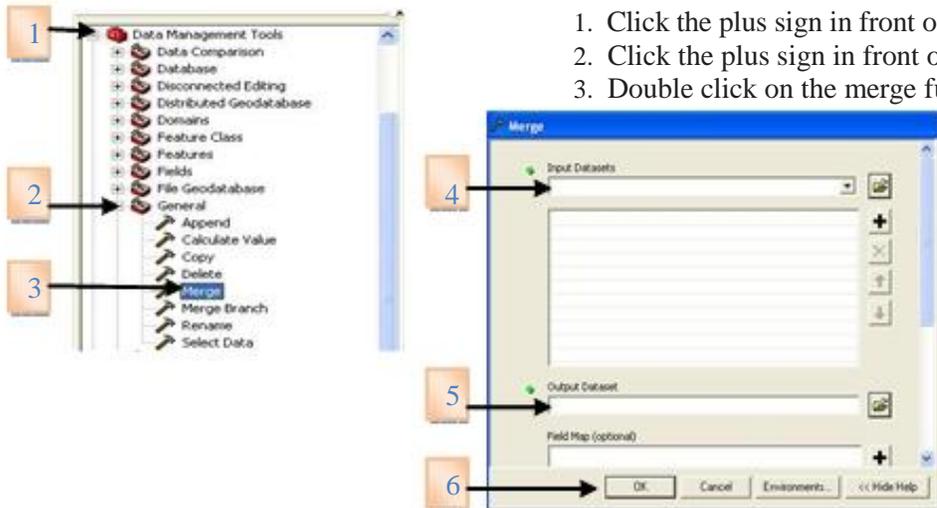
1. Create 1 km buffer from main road in Zefie sub watershed
2. Find community watersheds within 5 km from main road
3. List those community watershed five km far from towns.
4. If Melo river over flow 200 meter from its nature course, find the Settlement area affected by this overflow
5. D/tabor town want to distribute Hand tools for each kebele. The distribution program is two cover every two km from the town, so how many days will need to cover all kebekes.

12.2 Data Management Tools

Data management tools have a lot of sub tools and functionalities. The common ones are merge, Dissolve, Eliminate and Projection and transformation functions so we will focus on these functions.

12.2.1 Merge

The merge function helps to merge two and more feature class in to one feature class. Example when you transform a landuse map of one community watershed, the procedure is for transform is transform each landuse GPS point in separate file so after finishing separate data then you can merge to get one landuse map of that specific community watershed.



1. Click the plus sign in front of the Data Management Tools
2. Click the plus sign in front of general
3. Double click on the merge function
4. Select the input feature class
5. Change the folder and file the output data
6. Click ok

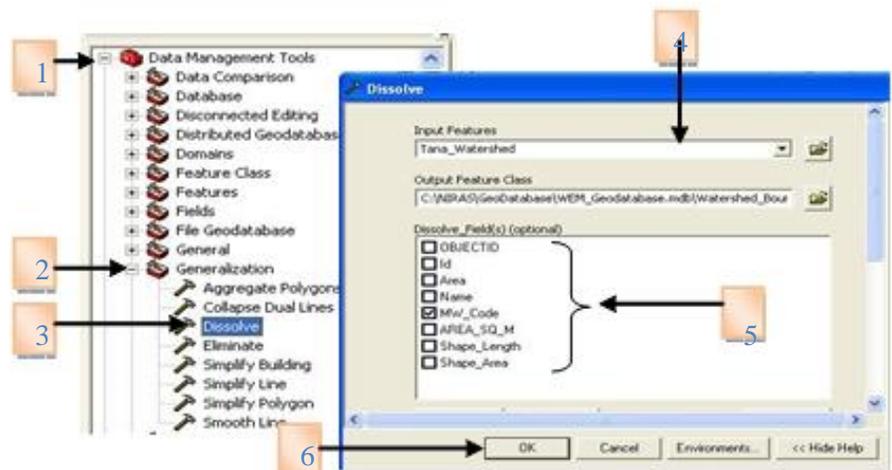
Exercise:-

1. Merge all the sub watersheds in Tana Beles project
2. Merge all sub watersheds found only in Fareta woreda

12.2.2 Dissolve

Dissolve used to aggregate/group/ the feature class based on their attribute data i.e you can group uniform/homogeneous/ attribute data in to one single data.

1. Click the plus sign in front of the Data Management Tools
2. Click the plus sign in front of generalization
3. Double click on the Dissolve function
4. Select the input feature class
5. Change the folder and file the output data
6. Click ok



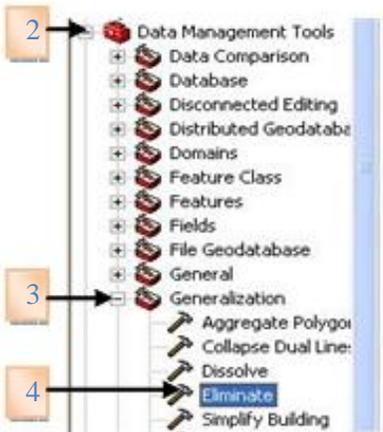
1. Click the plus sign in front of the Data Management Tools
2. Click the plus sign in front of generalization
3. Double click on the Dissolve function
4. Select the input feature class
5. Change the folder and file the output data
6. Click ok

Exercise:-

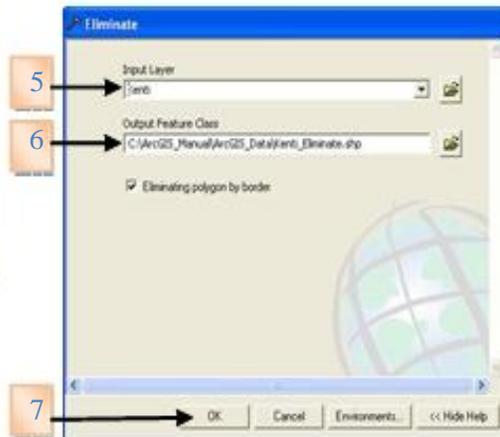
1. Dissolve Baskura Watershed based on its watershed name
2. Create the map shows only the sub watershed boundary /no need of community watersheds/
3. Create the woreda boundary without their kebele and show the boundary with the watershed boundary
4. Produce a soil map from Project woreda data
5. Show the soil type in each landuse in in Tana Beles project area

12.2.3 Eliminate

The eliminate function helps to combine selected polygons, often splinter /silver/ polygons that are smaller than a given size, with adjacent polygons to remove small and unwanted polygons from the dataset.



1. Use Select by attribute selection method to select area less than of your interest
2. Click the plus sign in front of the Data Management Tools
3. Click the plus sign in front of generalization
4. Double click on the Eliminate function
5. Select the input feature class
6. Change the folder and file name of the output data
7. Click ok



Exercise:-

1. Eliminate areas less than 300 ha. From Kentai sub watershed

12.3 Projection and Transformation

Every spatial dataset has a coordinate system, which is used to integrate it with other geographic data layers within a common coordinate framework. Coordinate systems enable you to integrate datasets within maps as well as to perform various integrated analytical operations such as overlaying data layers. When you obtain spatial data from different places, sometimes it does not fit to your coordinate system so it needs to be transformed or projected before doing any analysis.

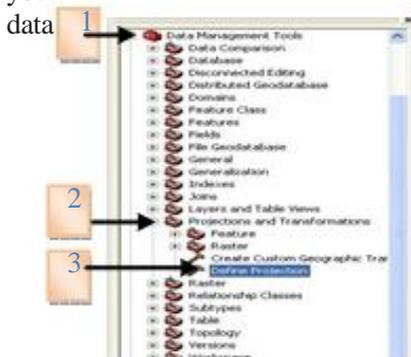
There are two common types of coordinate systems. These are:

1. A global or Geographic coordinate system such as latitude-longitude.
2. A projected coordinate system based on a map projection such as transverse Mercator. It project maps of the earth's spherical surface onto a two-dimensional /on paper /.

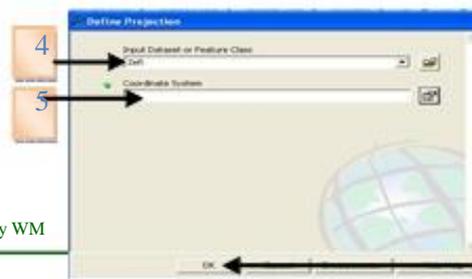
The projection system used in Ethiopia /Mapping Authority /is UTM Zone 37N and the map datum is Adindan. Therefore you have to use this projection system for your GPS setting and for your spatial data when you are working in ArcGIS. Otherwise if you are using other projection system your data will not fit with the Topmap data.

12.3.1 Define Projection

The define project function helps to inform /introduce / the ArcGIS about the coordinate system/ the projection type/ of your data. This process can be done if and only if you are sure about the projection of your otherwise you will create mess in your database.



1. Click the plus sign in front of the Data Management Tools
2. Click the plus sign in front of Projection and transformation
3. Double click on the Define



- projection function
4. Select the input feature class
5. Select the projection system
6. Click ok

Exercise:-

1. Define Enguli sub watershed by the projection used by Ethiopian Mapping agency
2. Define Gumara 6 infrastructure data to UTM zone 37 and Map datum to WGS84

12.3.2 Project

The project function helps to transform coordinate system from one projection type other projection type. This is useful if you get data that is different from your projection environment. By changing the new projection system to your coordinate system you can do any spatial analysis. Here you have to options for transforming or projecting Vector and Raster data

1. Click the plus sign in front of the Data Management Tools
2. Click the plus sign in front of Projections and transformation
3. Click the plus sign in front of feature or raster /if you are using vector or raster data respectively/
4. Double click on the project function
5. Select the input feature class
6. If the input coordinate system is not define, select the coordinate system for the input feature class
7. Change the folder and file name of your output feature class
8. Select the output coordinate system
9. If you are transforming data between two different datum, select the geographic transformation
10. Click ok

Exercise:-

1. Project the Gumara 6data /which is defined by WGS 84 to map datum Adanidn
2. Project the road map to WGS 84 and check with the Top Map

12.4 Spatial Analyst Tools

Spatial analyst Tools helps to work with raster data. It has a number of functionalities, for a moment we will concentrate only on extract by mask function and surface analysis.

12.4.1 Extract by mask function /Clip Raster data/

1. Click the plus sign in front of the Spatial Analyst Tools
2. Click the plus sign in front of Extraction
3. Double click on extract by mask function
4. Select raster input map
5. Select raster or feature mask data
6. Change the name of the folder and file name of your output data
7. Click ok

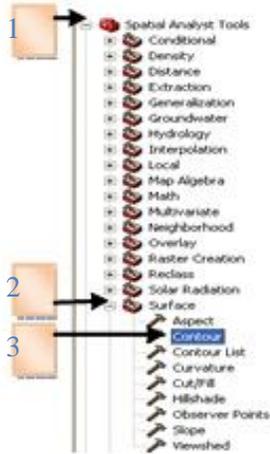
Exercise:-

1. Extract DEM data for kantai from ASTER 30 DEM
2. Extract hillshad for kantai
3. Change the display of the DEM to elevation color and try to see the hillshade as well

12.4.2 Surface Analysis

Surface analysis helps to analyze /to extract/ data from DEM /Digital Elevation Model. Using surface analysis you can create contour, slope, hillshad, aspect etc. for this training we will focus on the contour and slope calculation.

12.4.2.1 Creating Contour

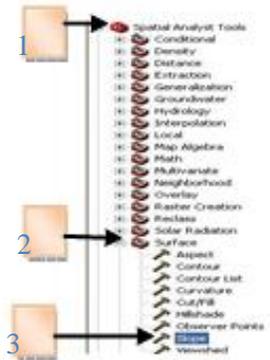


1. Click the plus sign in front of the Spatial Analyst Tools
2. Click the plus sign in front of Surface
3. Double click on extract by Contour function



4. Select raster input file
5. Change the name of the folder and file name of your output data
6. Determine the contour interval
7. Click ok

12.4.2.1 Creating Slope



1. Click the plus sign in front of the Spatial Analyst Tools
2. Click the plus sign in front of Surface
3. Double click on extract by Slope function



4. Select raster input file
5. Select PERCENT_RISE option
6. Change the name of the folder and file name of your output data
7. Click ok

Exercise:-

1. Create contour for Baskura sub watershed with the interval of 50 meters.
2. Create contour for Baskura sub watershed with the interval of 20 meters
3. Label the 50 meter contour
4. Calculate slope for Zefie watershed and classify in to six class i.e 0 - 3, 3 - 8, 8 - 15, 15 - 30, 30 -50, >50
5. Show slope map of zefie sub watershed which found in Estie Woreda
6. Reclassify the slope map of Zefie and convert to Vector data.
7. From the vector map find areas that has slope less than 30%

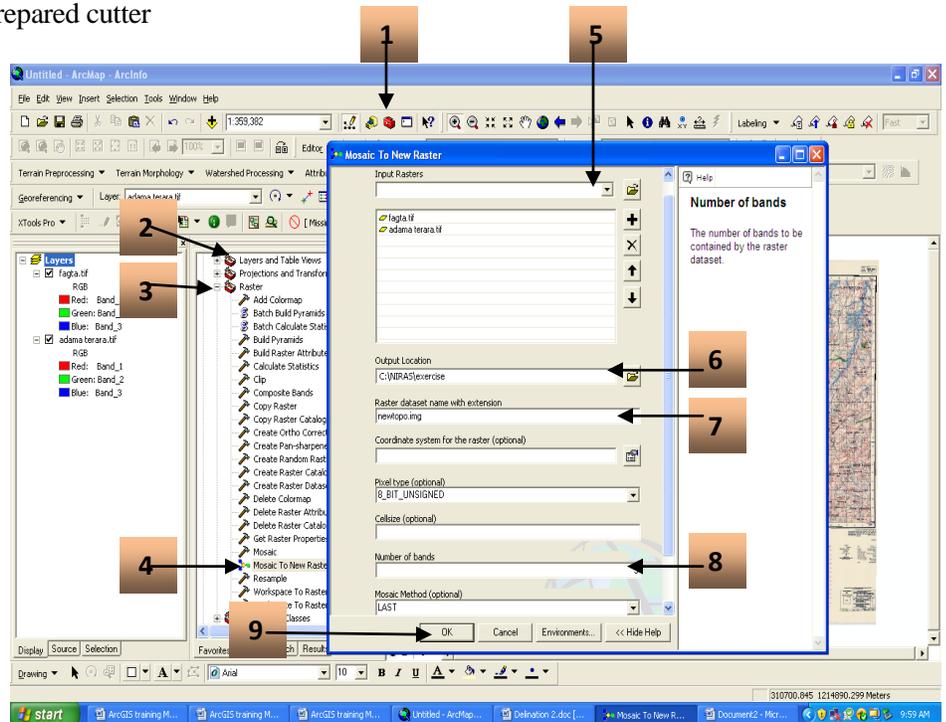
12.5 Mosaic two or more topomaps

Mosaic is the process of joining two or more raster images together. It is very important for watershed delineation from topographic maps using contours and drainage networks because our watershed could be found in more than one topographic maps. In this case, we should mosaic the topographic maps. In this training, we will see how to mosaic two or more topographic maps for watershed delineation purposes.

Please follow the following steps in order to mosaic two or more topomaps together;

- Prepare a topomap cutter (i.e create a polygon shape file in ArcCatalog),
- Open ArcMap,
- Add both the created topomap cutter and two adjacent topomaps,
- Draw a topomap cutter based on one topo map (to draw follow the border of the topomap)
- Extract new topomap based on the prepared cutter
- Mosaic the two topomaps using mosaicing tools in ArcMap;

1. Open ArcToolbox,
2. Click on Data Management tool,
3. Click on raster,
4. Click on Mosaic to New Raster,
5. Add the two topomaps that you prepare for mosaicing, in Input Raster dialog box
6. Provide the required folder name
7. Write 3 on the number of bunds dialog box
8. Click on OK.



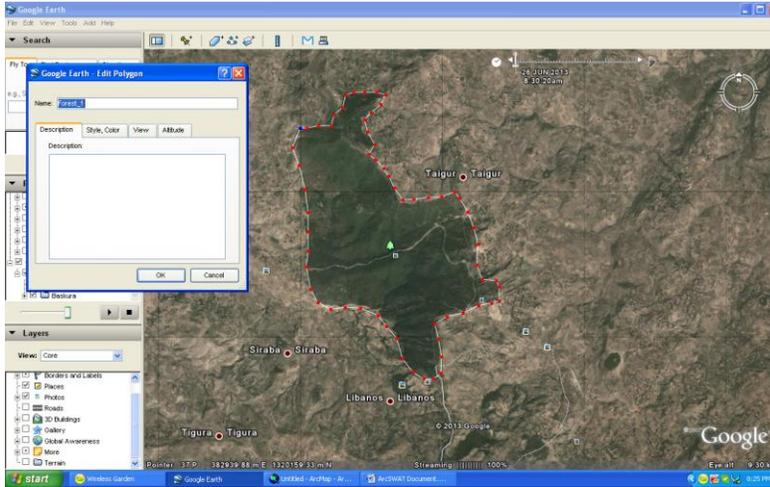
Exercise:-

1. Create topo cutter on the boundary of fageta topo
2. Extract fageta topo based on the cutter.
3. Mosaic Adama terara and Fageta topomap in to one and give name as newtopo.img use the same folder i.e. C:\Training data for output location dialog box.

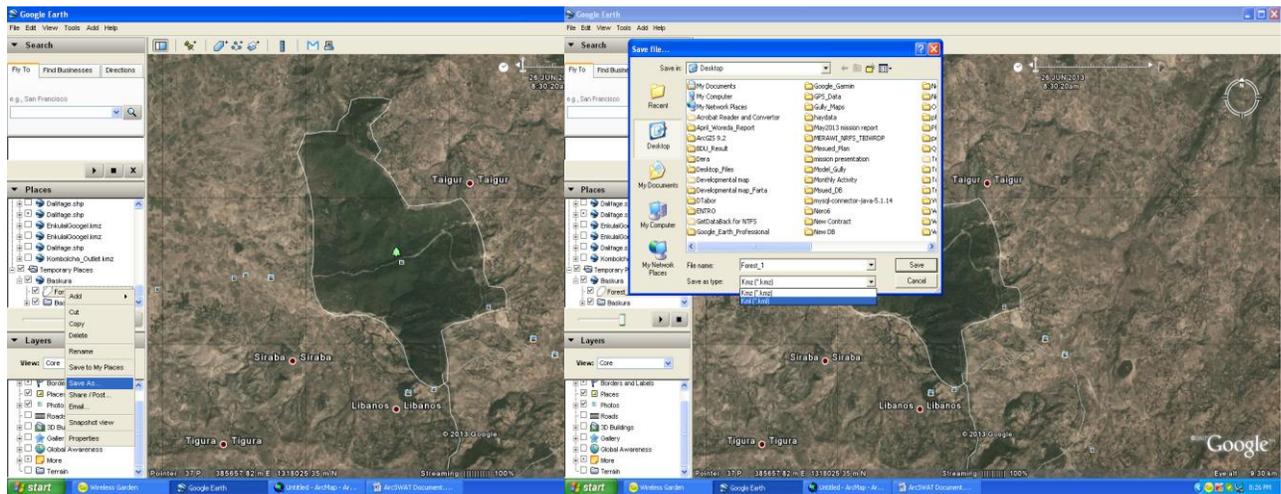
13. Landuse Classification

13.1 Landuse preparation based on Google earth map

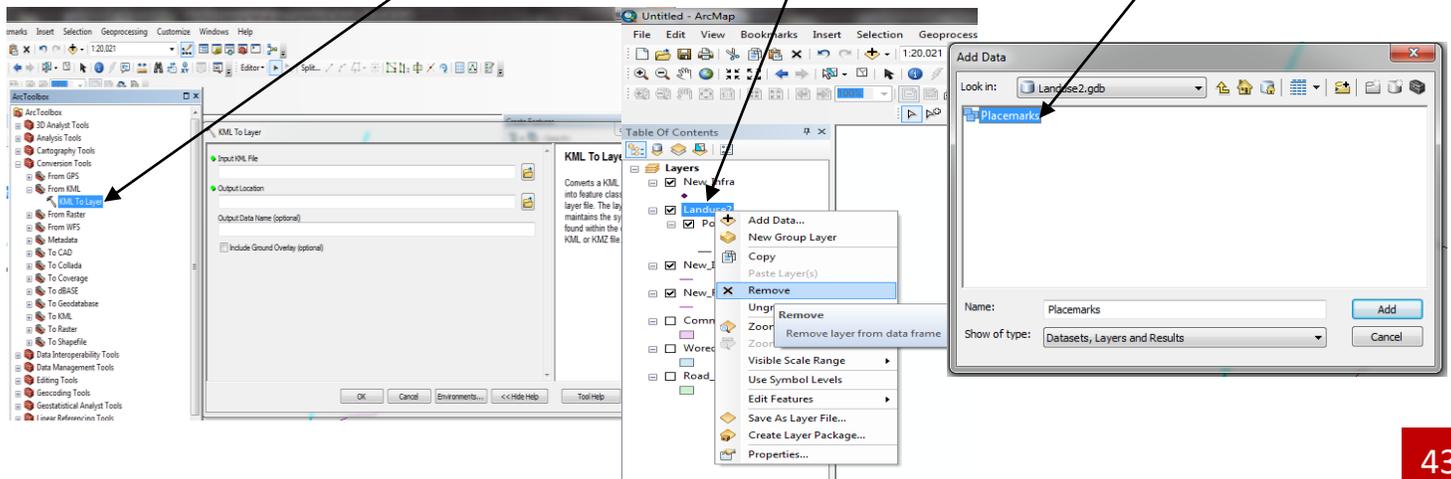
- Start Google earth map and click on add Folder and, then right click on the folder and click on path
And digitize the area of interest



- Right click on the folder and click on Save as in Kml/Kmz format



- Open ArcMap and Convert Kml file to Layer, Remove the add layer and Add the converted Placemarks



13.2 Automatic Landuse classification

You can use automatic landcover classification from Landsat image.. To do these follow the following steps:

Types of Image Classification

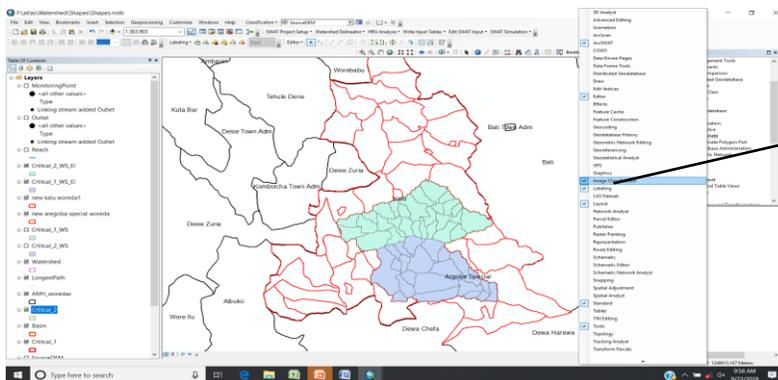
- **Supervised classification:** provide the computer with some examples of known features in multi-dimensional feature space. The computer will first analyze the statistical parameters for the training data and then assign all other pixels to one of the classes in the examples based on statistical similarity.
- **Unsupervised classification:** Instead of providing the computer with examples of features in multi-dimensional feature space, the users let the computer to identify pre-specified number of spectral clusters among which the difference between clusters are maximized and within clusters are minimized. It is the users' responsibility to assign a class label to each of the clusters. Note: one class may have many clusters.

Types of Image Classification • **Hybrid Classification:** It takes the advantage of both the supervised classification and unsupervised classification. • **Collect training sets.** • **Unsupervised classification** to identify spectral clusters within the training sets. • **Classify image with the clusters.** • **Regroup the clusters into original classes**

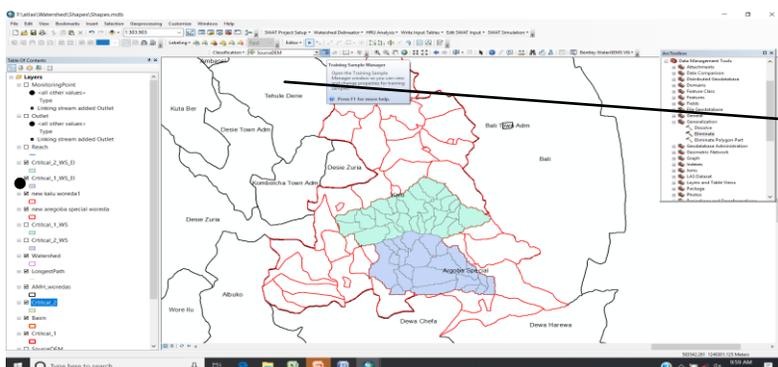
Example of Image Classification: Land use/Land cover

- **Land cover:** the type physical feature present on the surface of the Earth. For example, corn fields, lakes, forests, concrete highways.
- **Land use:** refers to human activity or economic function associated with a specific piece of land. For example, land use of agriculture can include corn, rice, sugar cane, tobacco, orchards, ... and so on, all of which are different land cover types.
- A knowledge of both land use and land cover can be important for land planning and land management activities. Ideally, land use and land cover should be presented on separate maps. In practice, it is often most efficient to mix the two systems when remote sensing data for the principal data source for such mapping activities.

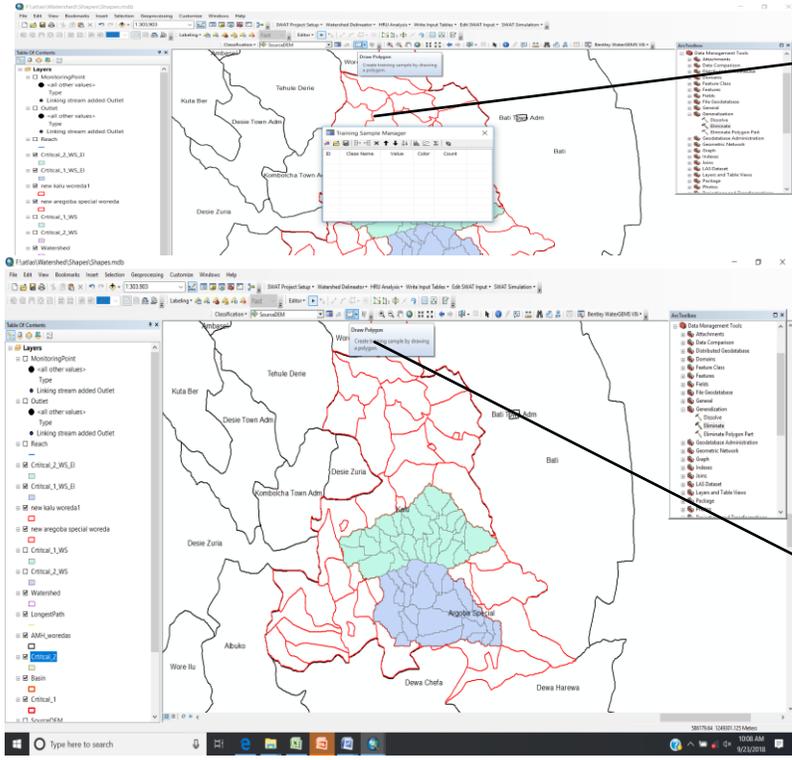
1. Open ArcMap and add the image



- Right click on top of ArcMap and choose image classification

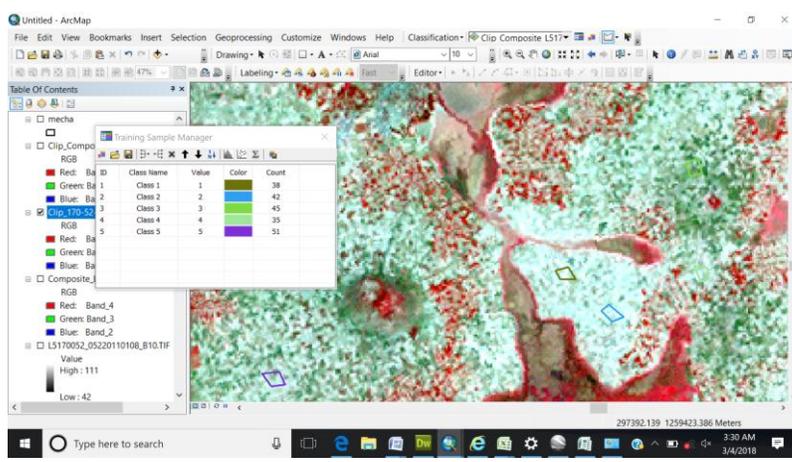


- New menu will come on your ArcMap
- Click on training sample manger

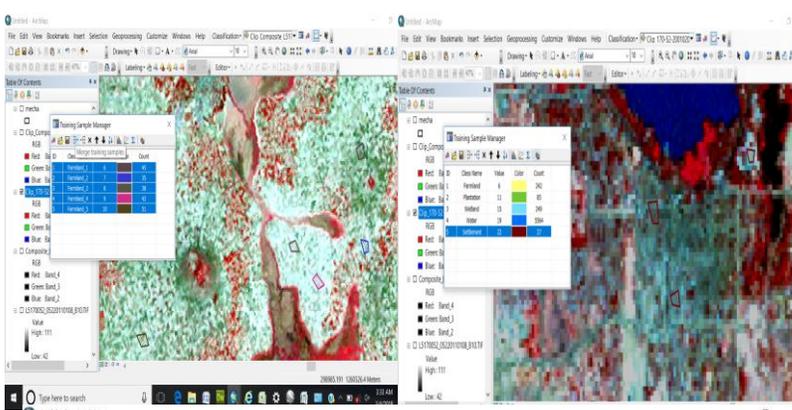


• New Training sample manager window will appear on ArcMap

• click on create signature file button



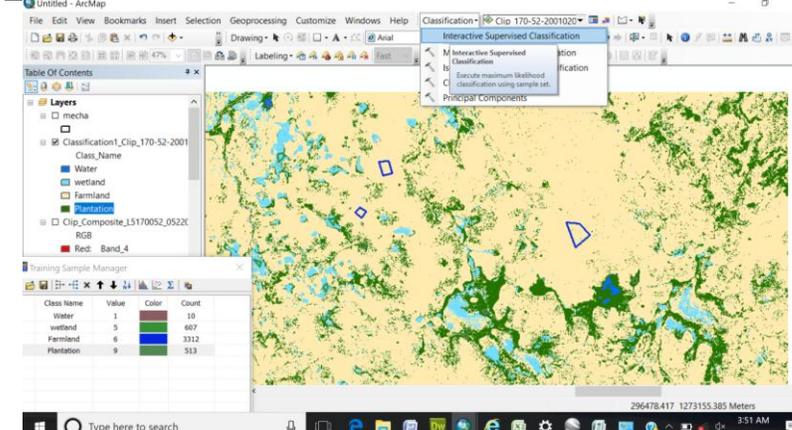
• Digitize clearly identified landcover type on the image as much as possible by clicking on create polygon button



• After digitizing the same types of landcover

• Click on merge training sample button

• do for all landcover type and merge the same landcover and save the signature file by click on save button



• Click on Classification icon and click on maximum likelihood classification

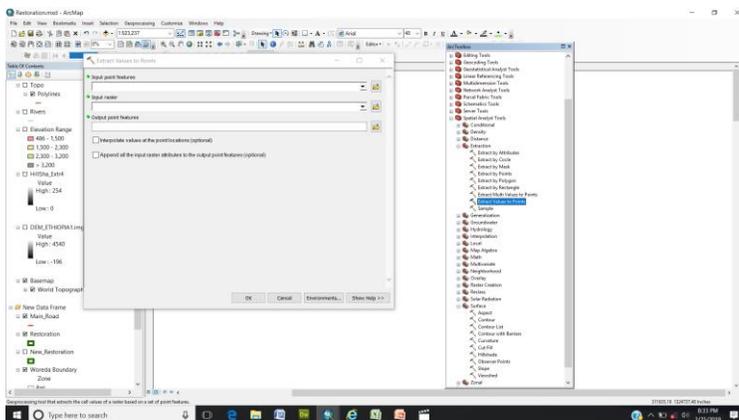
• New dialog window will open, give the image file as raster input and give the saved sample signature in the input signature file then the system will automatically classifies the landcover map

13.3 Ground Truth Data Collection from Google After automatic classification there must be an accuracy assessment method to know the quality of your classification, so

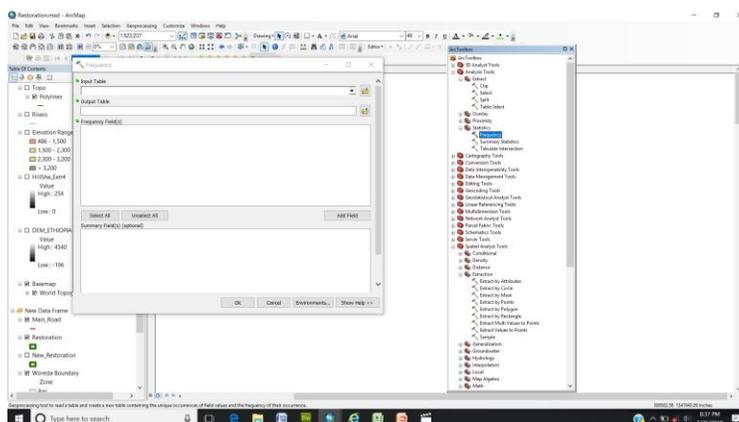
Open Google earth Pro

- File..... Import your watershed boundary data into Google earth pro
- Add folder called GCP /Ground Control Point/
- Explore your area of interest and click on add place mark to take ground truth
- Click on the place you selected.....name it and save.
- Finally open your .kml file into ArcGIS through Conversion tool (from kml to layer)
- Change the output in to shape file by right click at the output file.... Data.... Export data....
- Now you can use your points as a ground truth in ArcGIS.

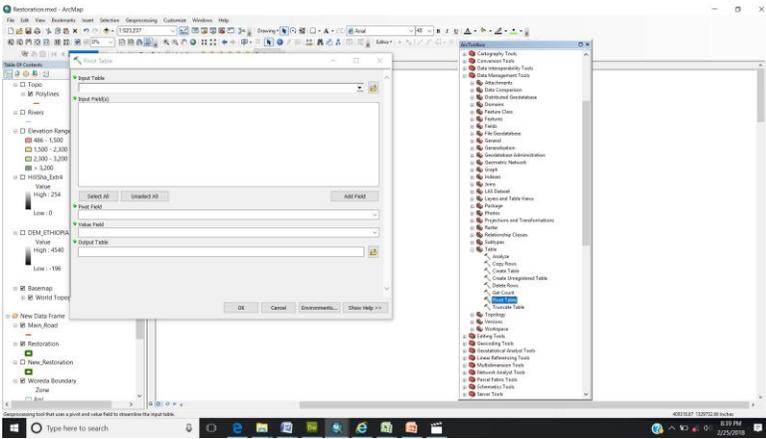
4. To test the accuracy follow the following steps



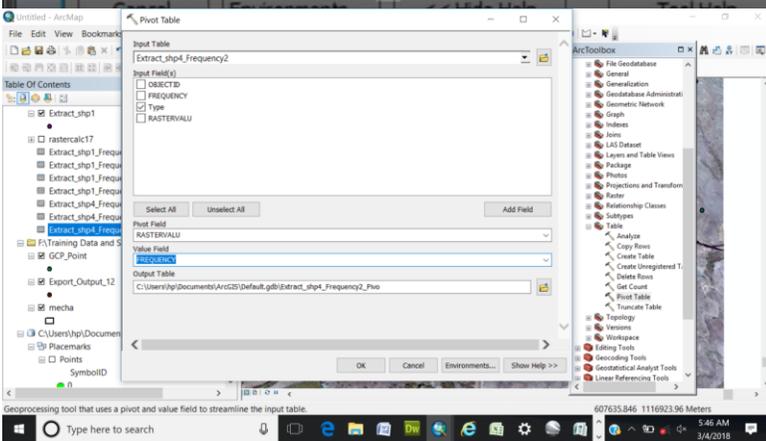
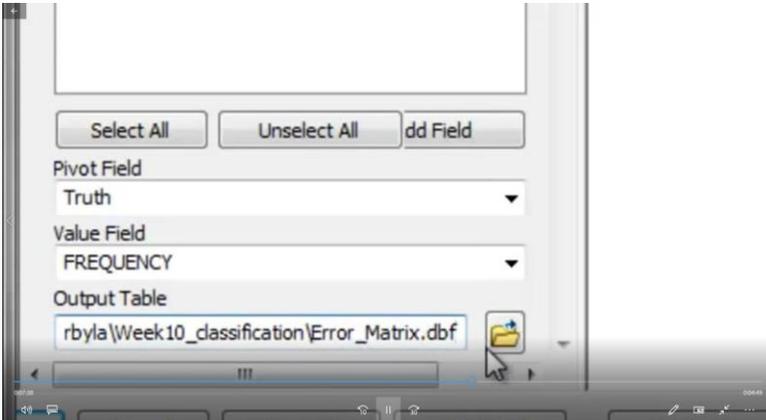
- Extract data from your classified image to the ground truth point



- Calculate frequency for ground truth and classified data



Create pivot table to summarize your ground truth



| FID | Type | Irrigation | Farm | Settlement | Plantation | Degraded | Water | Gully | Value |
|-----|----------|------------|------------|------------|------------|----------|-------|-------|---------|
| 1 | 1 | Degraded | 0 | 1 | 1 | 0 | 10 | 0 | 12 |
| 2 | 2 | Farmland | 0 | 9 | 0 | 0 | 1 | 0 | 10 |
| 4 | 3 | Gully | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| 5 | 4 | Irrigation | 7 | 0 | 0 | 0 | 0 | 0 | 7 |
| 6 | 5 | Plantation | 1 | 1 | 0 | 3 | 0 | 0 | 5 |
| 7 | 6 | Road | 0 | 1 | 0 | 0 | 3 | 0 | 2 |
| 8 | 7 | Settlermer | 0 | 0 | 10 | 0 | 1 | 0 | 10 |
| 9 | 8 | Water | 2 | 0 | 12 | 0 | 1 | 3 | 6 |
| 10 | | | 10 | 12 | 11 | 3 | 16 | 3 | 65 |
| 12 | OBJECTID | Value | Class_name | Red | Green | Blue | | | 50 |
| 13 | 1 | 1 | Irrigation | 163 | 255 | 115 | | | |
| 14 | 2 | 2 | Gully | 254 | 164 | 156 | | | 76.9231 |
| 15 | 3 | 10 | Farm | 255 | 235 | 175 | | | |
| 16 | 4 | 11 | Settlement | 115 | 0 | 0 | | | |
| 17 | 5 | 16 | Plantation | 38 | 115 | 0 | | | |
| 18 | 6 | 19 | Degraded | 255 | 0 | 0 | | | |
| 19 | 7 | 23 | Water | 0 | 112 | 255 | | | |
| 20 | 8 | 27 | Road | 255 | 0 | 197 | | | |

Calculate your accuracy on MsExcel sheet

14. Revised Universal Soil Loss Equation (RUSLE)

RUSLE computes average annual erosion from field slopes in tons/acre/year (Renard, 1997)

$$A = R * K * (LS) * C * P$$

A = Computed Average Annual Soil Loss

R = Rainfall-Runoff Erosivity factor

K = Soil Erodibility Factor

L = Slope Length Factor

S = Slope Steepness Factor

C = Land Cover-Management Factor

P = Conservation Practice

RUSLE – R Factor :- The R-Factor is the rainfall and runoff factor spatially distributed by geographic location, The greater the intensity and duration of the rain storm, the higher the erosion potential. An empirical equation to determine R factor developed by Kurt Cooper (2011).

P is mean annual precipitation(mm). □ In ArcGIS follow the step ◦ Extract the rainfall stations in your project area ◦ Use Thiessen polygon methods to convert it to point rainfall to areal rainfall; if you use Thiessen polygon convert it to raster, the raster areal rainfall will be your input data ◦ Goto Spatial analysis tools – map algebra – raster calculator ◦ In the raster calculator use the following equation to compute R-factor ◦ $0.1523 * \text{Power}(\text{RF_raster}, 1.36)$
 $36.11523.0 \text{ PR} * =$

RUSLE – K Factor:- The K-Factor is the average soil loss in tons/acre per unit area for a particular soil in cultivated, continuous fallow with an arbitrarily selected slope length of 22.1 m and slope steepness of 9%. Texture is the principal factor affecting K, but structure, organic matter and permeability also contribute.

where

- fcsand is a factor that gives a low soil erodibility value for soils with high coarse-sand contents and high values with less sand,
- fci-si is a factor that gives a low soil erodibility value for soils with high clay to silt ratios,
- forgc is a factor that reduces the soil erodibility for soils with high organic carbon content, and
- fhisand is a factor that reduces the soil erodibility for soils with extremely high sand contents. Williams (1995) adopted by Berhanu et al. (2013) hisandorgcsiclsandUSLE ffffK *** ==

RUSLE – K Factor in ArcGIS

- Input data ET_SWAT_soil
- Extract the soil data with your project/target area
- Convert the polygon to raster with USEL_K as conversion value
- Keep the converted raster as you input for RUSLE computation

RUSLE – LS Factor :- The LS-Factor represents a ratio of soil loss under given conditions to that at a site with the "standard" slope steepness of 9% and slope length of 22.1 m.

Procedure:-

- Calculate Flow Direction from clipped Watershed DEM layer Using Flow Direction Tool
- Calculate Flow Accumulation with Flow Accumulation Tool
- Calculate slope of watershed in degrees using Slope Tool
- Compute the LS-factor using the formula below with Raster Calculator:
- $\text{Power}(\text{flowacc} * [\text{cellresolution}] / 22.1, 0.4) * \text{Power}(\text{Sin}(\text{sloperasterdeg} * 0.01745) / 0.09, 1.4) * 1.4$

RUSLE – C Factor:- The C-Factor is used to determine the relative effectiveness of soil and crop management systems in terms of preventing soil loss.

It is a ratio comparing the soil loss from land under a specific crop and management system.

Important Note: The C factor resulting from this calculation is a generalized C factor value for a specific crop that does not account for crop rotations.

| Cover type | C-value | Cover type | C-value |
|--|---------|--------------------------------------|---------|
| Bad land hard | 0.050 | Sorghum-maize | 0.10 |
| Bad land soft | 0.400 | Cereals, pulses | 0.15 |
| Dense grass | 0.010 | <i>Teff</i> | 0.25 |
| Degraded grass | 0.050 | Fallow hard | 0.05 |
| Dense forest | 0.001 | Fallow ploughed | 0.60 |
| Other forest (with modest ground cover) | 0.010 | Continuous fallow (without cover) | 1.00 |

C-values suggested by Hurni (1987)

RUSLE – C Factor in ArcGIS:- Extract project/target area land use/cover from the available data set.

Assign C-values for the different land use/cover for the project area using raster calculator

go to Spatial Analysis tools – Map algebra-raster calculator

In raster calculator use the following conditional equation : $\text{Con}(\text{"Land_Lcover"} == 1, 0.001, \text{Con}(\text{"Lnad_Lcover"} == 2) | (\text{"Land_Lcover"} == 3) | (\text{"Land_Lcover"} == 5) | (\text{"Land_Lcover"} == 6), 0.01, \text{Con}(\text{"Land_Lcover"} == 7), 0.4, \text{Con}(\text{"Land_Lcover"} == 8), 0.05, 0))$

Revised Universal Soil Loss Equation (RUSLE) RUSLE computes average annual erosion from field slopes in tons/acre/year (Renard, 1997)

$A = R * K * (LS) * C * P$ Procedure in ArcGIS □ go to Spatial Analysis tools – Map algebra-raster calculator

In raster calculator use the following multiplication equation

Rfactor*Kfactor*Lsfactor*Cfactor*1 Save the raster as annual soil loss

15. Model Builder

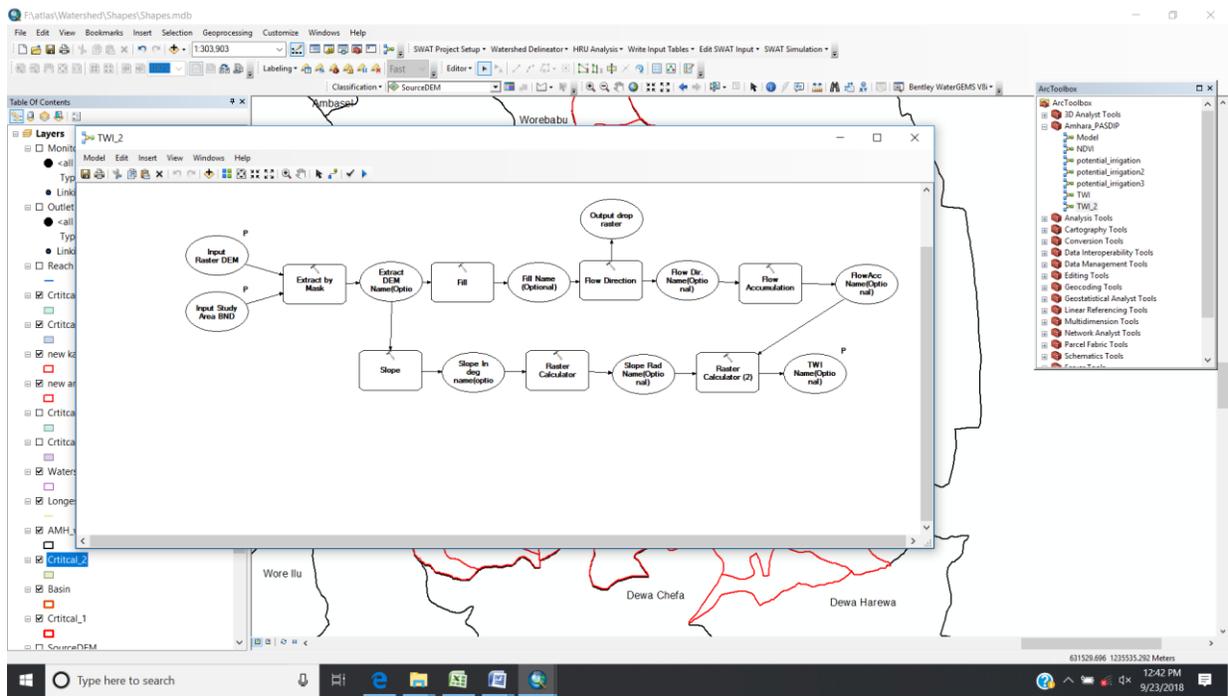
Creating a New Toolbox:- Creating your own Toolbox is not just for organizational purposes. It allows you to share your models with others.

Default location for a New Toolbox created inside ArcToolbox is: C:\Documents and Settings\\Application Data\ESRI\ArcToolbox\My Toolboxes.

Create a new Toolbox by right clicking in ArcCatalog and selecting New Toolbox.

How Model Builder Works

- Drag layers you want to participate into the model
- Drag tools you want to use into the model
- Output layers, tables, objects shown in green
- Connect the features using arrows
- Order matters to certain tools (Clip)
- Multiple workflows in one Model



16. Daily Exercise for GIS Training

Day one Exercise

1. List the components of GIS and describe the importance of each component.
2. Discuss on the major sources of GIS data and how can we obtain it.
3. Describe the difference and similarity between vector and raster data.
4. Create new Geodatabase called Training
5. Create feature dataset called Watershed, Admin, Infrastructure
6. Import Amhara region by zone in Admin feature dataset and import Town, Road in Infrastructure feature dataset and river in watershed dataset
7. Create Feature class under Watershed dataset called Watershed
8. Create Feature class under Watershed dataset called Landuse
9. Create Feature class under Watershed dataset called River_1
10. Create Feature class under Infrastructure called Road_1
11. Create Feature class under Infrastructure called school_1
12. Create Feature class under Infrastructure called church_1
13. Open ArcMap window and explore and familiarize yourself with ArcMap menus and tools;
14. Add Amhara region by zone layer to your ArcMap project
15. Add towns, roads and river data from your training folder
16. Symbolize Amhara Region by Zone based on area using graduated color. And also classify into four classes with the class of less than 500, 500 – 1200, 1200 – 1600, greater than 1600 with a color ramp of orange light to Dark.
17. Symbolize road map based on Admin,.
18. Symbolize only selected towns and give different symbol for region, zone and woreda towns.
19. Label all zones name and change the color of the label into purple heart, font type into times new roman and font size 12.
20. 15. Save your project as Day Two Exercise

Day Two Exercise

1. Open the attribute table Amhara region by zone and select all zones with population of less than or equal to 500.000.
2. Select all towns which has a status of woreda seat and zonal Seat and make it independent layer
3. Select all towns which are found within North Gondar zone
4. Select only woreda towns within East Gojjam Zone
5. Create a graph based on the total population of Amhara region by zone layer
6. What is the total area of Amhara region, and also identify the smallest and largest zones.
7. In the towns' layer add a new field called X_ coordinate and another field called Y- coordinate and calculate the coordinates of each town.

8. Select towns 100 away km from Debre Berehan town
9. Select all Amhara region towns within 200 km from Bahir Dar town.
10. Select Woreda Towns 5 km Away from roads
11. Select Roads that intersect East Gojjam Zone
12. Add Ex_image and Ex_watershed
13. Digitize, landuse (forest, and Grassland), from the image
14. Union digitized landuse and Ex watershed and name cropland of the given watershed
15. Digitize river1, and road1 of the watershed
16. Make all the different forestland polygons that you have digitized as one
17. Save all you have done as Day Three Exercise.

Day Three Exercise

1. Prepare Landuse Map of Dera Woreda
2. Prepare Soil Map of Dera Woreda
3. Find Total Area of Chromic Luvisols in Dera Woreda
4. Find total area of Chromic Luvisols only within cultivated Land of Dera Woreda
5. If Lake Tana back flows 500 meter, find the total area of land and total population affected by flow within every woreda
6. Generate the slope of Dera woreda based on FAO classification standard.
7. Reclassify the slope map and convert the reclassified data into Polygon
8. Overlay Soil, Landuse, converted slope and Dera Woreda
9. Organize your result you have got in the above questions in excel by soil type, landuse, and slope class and kebele name.
10. Find cultivated land with slope > 30%, affected soil type and Name of Kebele.
11. Project Amhara Temp to Adindan UTM zone 37N
12. Make the projection of Amhara Temp data WGS84 UTM Zone 37N.
13. Save your Results as Day Four Exercise

Day Four Exercise

1. Delineate watershed from the newly mosaic topographic maps based on the following coordinates:
 - 325825, 1264891;
 - 325450, 1270961
 - 325438, 1270970
 - 324316, 1267251
 - 324264, 1267240.
2. Calculate the area of each watershed
3. Convert river network from flow accumulation raster.
4. Delineate automatic watersheds using ArcSWAT
5. Name and calculate area in hectare for all watersheds.

Day Five Exercise

1. Create map layout for Dera Woreda
2. Add all Map elements including grid line
3. Add two data field named Ethiopia and Region
4. Add Ethiopia data to Ethiopia data frame and Amhara Region data on Region frame
5. Prepare location map
6. Check your layout in the preview window and make the necessary adjustment
7. Change the grid to fit your data
8. Export your map document in file name called My Map
9. Save your project as **Day five exercise**

Day Six and Seven Exercise

1. Digitize land use/cover from Google earth (Exclude the major landuse).
2. Open the digitized kml formats into ArcGIS, convert it into GIS compatible format and edit it.
3. Prepare landuse map based on automatic classification
4. Digitize roads, rivers and other infrastructure data of your watersheds
5. Prepare base map for your watershed
6. Open the digitized kml formats into ArcGIS, convert it into GIS compatible format and edit it.
7. Calculate the area of each land use/ cover type.

Day Eight Exercises

1. Prepare all parameter for calculating Soil loss for your watershed
2. Calculate soil loss for your watershed

Day Nine and Ten Exercises

1. Create and run Model for data preparation for developmental map
2. Create and run Model for soil loss