TVET CERTIFICATE IV in LAND SURVEYING

GIS BASIC PRINCIPLES

LSVBP401

Perform GIS basic principles

Competence

Learning hours: 60

REQF Level: 4

Credits: 6

Sector: Construction and Building services

Sub-sector: Land surveying

Module Note Issue date: September, 2020

Purpose statement

This is a core module which describes the performance outcomes, skills, knowledge and attitude required to perform GIS basic principles.

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Total Number of Pages: 48

Learning Unit 1 – Identify GIS components

Introduction

Concepts of ArcGIS

There are different explanations of *GIS, but mainly* we can define GIS as follows:

- Geographic Information System *(GIS)* is an important tool in decision making with useful applications in various fields;
- A Geographic Information System *(GIS)* is a computerized system that facilitates the phases of data entry, data analysis and data presentation especially in cases when we are dealing with georeferenced data;
- A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world.
- A system for capturing, storing, checking, manipulating, analyzing and displaying data which are spatially referenced to the Earth.
- An information technology which stores, analyses, and displays both spatial and non-spatial data.
- A decision support system involving the integration of spatially referenced data in a problem-solving environment.
- A computer system capable of holding and using data describing places on the Earth's surface.
- A Geographic Information System *(GIS)* is a computer-based system that provides four sets of functions to handle georeferenced data.
- Those functions are data capture and preparation, data management including storage and maintenance, data manipulation and analysis, and data presentation.
- According to its components, *GIS* is an organised collection of computer *hardware*, *software*, *geographic data* and *personnel designed to capture*, *store*, *update*, *manipulate*, *analyse* and *display* geographically referenced data.
- In general, GIS constitutes four major components such as , computer hardware, set of application software , data, methods and people.

IMPORTANCE OF GEOGRAPHIC INFORMATION SYSTEM

- ***Geography*** is the study of the world and all that is in it: its people, its places, its environment, and all the connections among them.
- When you are investigating the physical world and its events, you are dealing with geography.
- Knowing where something is located, how its location influences its characteristics and how its location influences relationships with other phenomena are the foundation of geographic thinking.
- Geographic inquiry is a process which helps you to see the world and all that is in it in spatial terms.
- The following are the steps of the process of geographic inquiry and are the foundation of GIS investigations:

Steps	**What to do?**

1. Ask geographic questions	Ask questions to learn about the world around you
2. Acquire geographic resources	Identify data and information you need to answer your questions
3. Explore geographic data	Turn data into maps, tables and graphs and look for patterns and relationships
4. Analyse geographic information	Go deeper into geographic exploration and draw conclusions to answer your questions
5. Act upon geographic knowledge	Take your work to others to educate, make a decision or solve a problem

Table 1: Steps of the process of geographic inquiry

- A ***Geographic Information System (GIS)*** uses computers and software to organize, to develop, and communicate geographic knowledge.
- In simple terms, GIS takes the numbers and words from the rows and columns in databases and spreadsheets and puts them on a map.
- GIS is a tool that simplifies and speeds up geographic investigations. Like any tool, GIS has no answers packed inside it.

Instead, for those who engage the tool and the process of geographic inquiry, it provides a means to discover pathways through our remarkable world of unending geographic questions (Malone et al., 2005).

LO 1.1 – Identify GIS data

- Topic 1: GIS data types

Spatial data or geographic data. All data in GIS can be linked to a point line or area on the ground line or area on the ground of which the geographical location is known.

- Data are facts about reality that have been observed or measured.
- Data stringed together forms information
- ***Eg.*** Easiest school route look at distance gradient, traffic, all together make information
- The availability and the accuracy of data affect the result of any query or the analysis.

Spatial data

Spatial data depend on **location** and **shape** of the feature.

SPATIAL DATA CRITERIA

The spatial data criteria are the following:

- X-Y Coordinate System
- Shape
- Area/Size

- Perimeter
- Distance
- Neighborhood

Non spatial data

This goes with (ATTRIBUTES VALUES).

The ***attributes*** data explain about spatial data. They provide information about the ***location*** or ***area. Examples:*** Names of geographic objects, temperature of area, landscape, etc

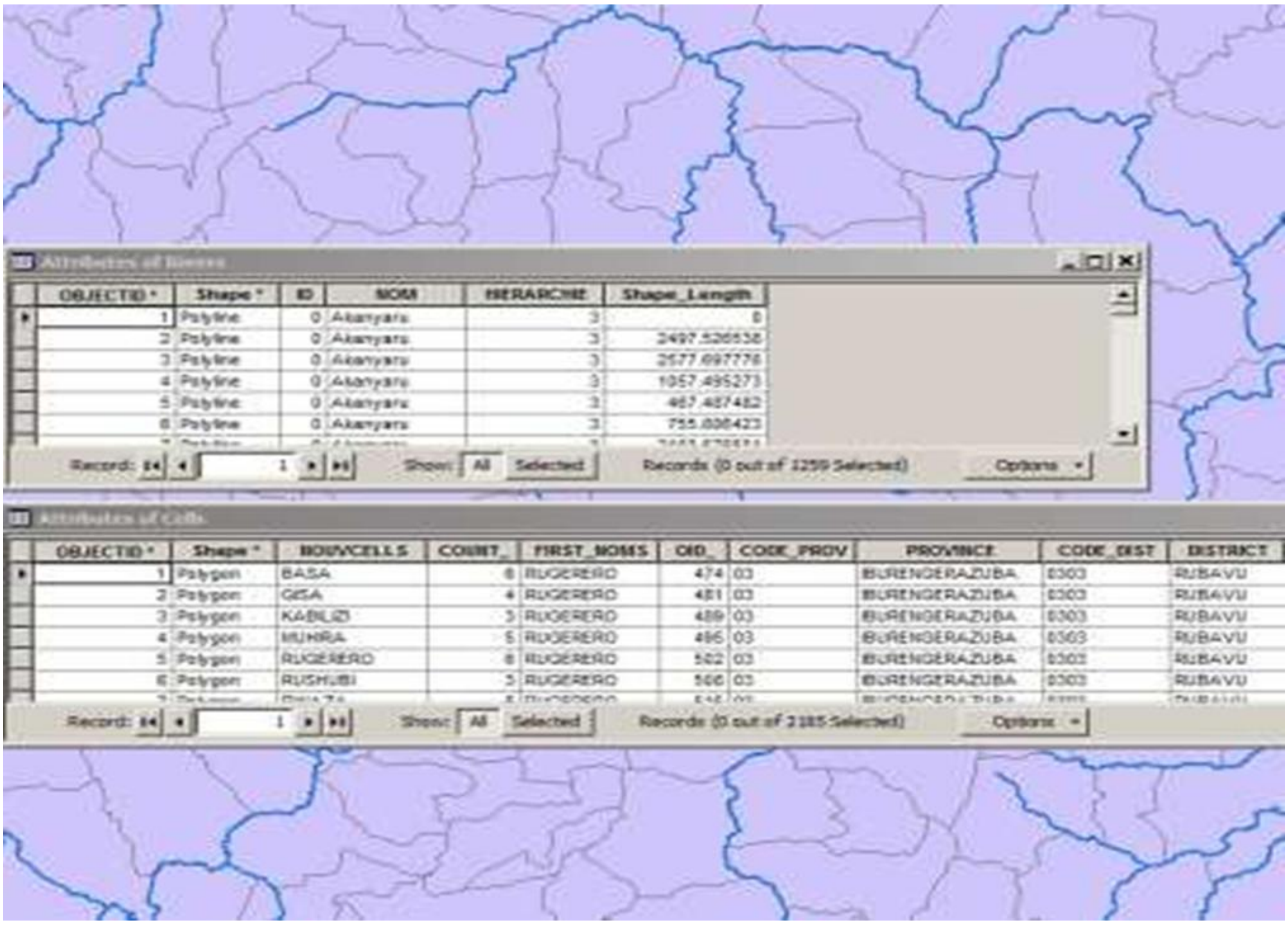


Figure 1: Attributes values

Attributes values are into two *(2)* types: ***categorical data*** and ***quantitative data****.*

Categorical data

The *categorical data* can be used to label based on *type* or *kind.*

Attributes of Roads_All

OBJECTID_1 *	Shape *	OBJECTID	TYPE
21647	Polyline	23023	District road
21648	Polyline	23024	District road
21649	Polyline	23025	District road
16	Polyline	22115	National road
17	Polyline	22116	National road
18	Polyline	22117	National road
19	Polyline	22118	National road

Figure 2: Categorical data

QUANTITATIVE DATA

The *quantitative data* can be used to symbolize based on *amount* or *rank.*

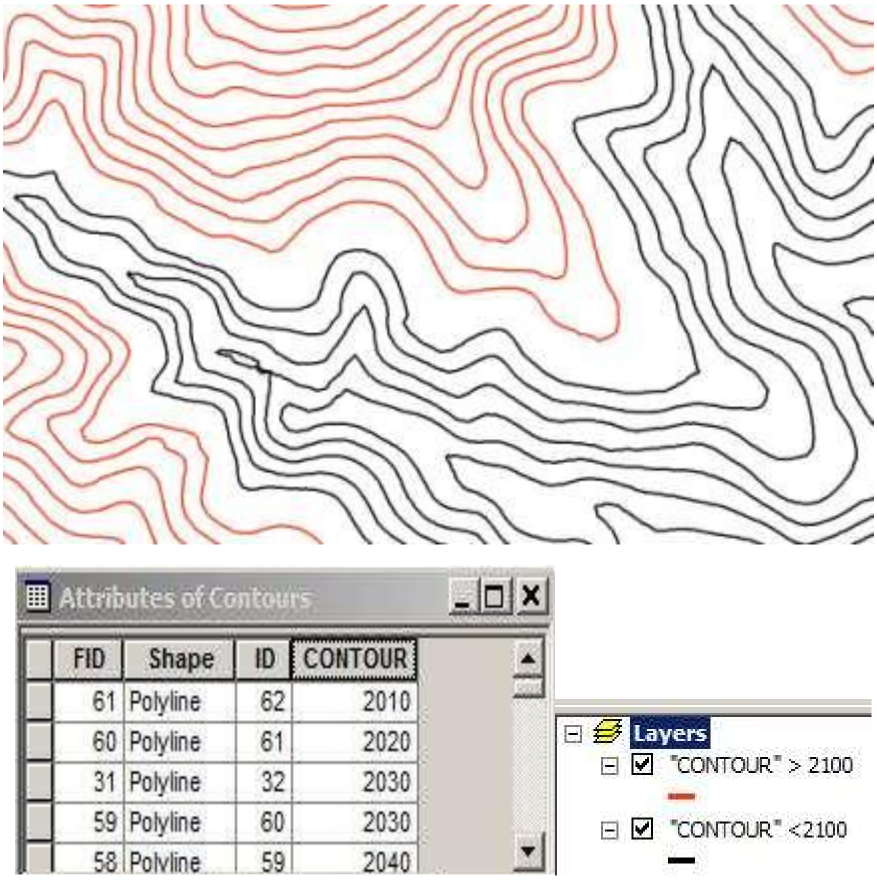


Figure 3: Quantitative data

Exercise

Attribute field	Categorical/Quantitative
Residential house	Categorical
Street number	Categorical
Total surface area of Rwanda	Quantitative
Urban or rural area	Categorical
Number of parcels	Quantitative

Table 2: Categorical\ Quantitative data

- Content/Topic 2: Sources of GIS data

GIS data can be accessed from various sources, including *maps*, *scanned paper*, *satellite images*, etc. By categorizing sources of data, we can put them into two categories: ***acquired data (Primary data)*** and ***existing data (Secondary data)***, and for each category the user must know which accuracy of data he is working on.

Primary data

Primary data: are original data, which were collected at the first time and have never been used anywhere else. Those data are relatively hard to collect and are obtained on high cost.

The *acquisition* or *primary data* is done in different approaches as described below:

Remote sensing

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to in situ observation. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation). It may be split into active remote sensing (when a signal is first emitted from aircraft or satellites) or passive (e.g. sunlight) when information is merely recorded.

Photogrammetry

Photogrammetry is a science, art and technology of making measurements from photographs, especially for recovering the exact positions of surface points.

Round surveying (field survey)

In ground surveying, various instruments and equipment such as GPS, DGPS, tapes, theodolites, levels and total stations can be used to measure distances, angles, elevations and coordinates of points, etc.

Use of images (satellite image, aerial photos)

Features on Earth can also be imaged or photographed using special sensors in satellites or aircrafts. These images can be used to collect data on field (image can be used either on printed maps or digitally after stored in tablet PC). The following example shows the case of data collection using printed maps:

Figure 4: Cadastral boundaries demarcation

After field data collection (when using printed maps), the paper map is scanned. After scanning, the map is georeferenced (Georeferencing means to associate something with location in physical space. In other words, georeferencing is describing data to their correct location on the earth's surface). After geo-referencing, vectorization process can be performed following what is delineated on map.

Secondary data

Secondary data: are those, which have already been collected by someone else and passed through the statistical process. These data are relatively available and obtained on low cost from different publication:

- Digital (Existing geodatabase)
- Map and plan (Hard copy maps and plans that can be scanned and georeferenced)
- Paper files (documents with information which can be typed into computer system and used
- Further spatial data (shapefiles of administrative boundaries of the study area) was used in order to produce the needed maps.
- Electronic sources, dissertations and other public or private institutions.

- <u>Content/Topic 3: GIS Data model</u>

Vector data

Points/Nodes

A **point** is a zero (0) dimensional object and has only the property of location (x,y). **Points** can be used to Model features such as a **well**, **building**, **power**, **pole**, **sample location** etc. Other names for a point are **vertex**, **node**, **0-cell**.

Lines/Arcs

A **line** is a one-dimensional object that has the property of length. **Lines** can be used to represent **road**, **streams**, **faults**, **dikes**, **maker beds**, **boundary**, **contacts** etc.

Polygons/Areas

A *polygon* is a two-dimensional object with properties of area and perimeter. A *polygon* can represent a city, geologic formation, dike, lake, river, ect. Other names for polygons are face, *zone 2-cell*.

Figure 5: Polygons: Districts and sectors of Kigali City

Figure 6: Polygons: Parcels

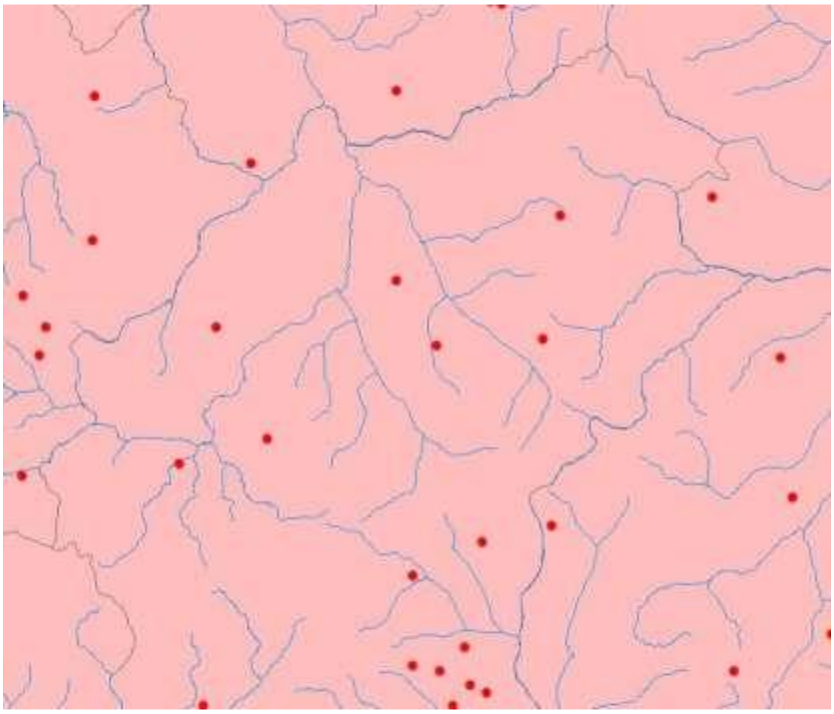


Figure 7: Points and lines: Health centers and rivers

Raster data

Rectangular array of cells or pixel

We define a matrix to be a rectangular array of numbers (called its elements) for which various operations are defined. The elements are arranged in horizontal rows and vertical columns; if a matrix has rows and columns, it is referred to as an m × n matrix.

Digital numbers

Digital number in remote sensing systems, a variable assigned to a pixel, usually in the form of a binary integer in the range of 0–255 (i.e. a byte). The range of energies examined in a remote sensing system is broken into 256 bins.

Resolution

The spatial resolution of a raster refers to the size of the cells in a raster dataset and the ratio of screen pixels to image pixels at the current map scale. For example, one screen pixel can be the result of nine image pixels resampled into one—a raster resolution of 1:9.

- Content/Topic 4: GIS data format

Digital data

Digital data are information in computer readable form.

Examples: Digital photographs, satellites image data, GPS and existing computer databases are some forms of digital data.

Digital data can be obtained from digital cameras, satellites sensors, using the GPS etc. You can also get digital data by digitizing existing maps using digitizers.

Analogue data

Analogue data are a physical product displaying information visually on the paper.

Examples: Maps on paper, aerial photos and reports are some forms of analogue data.

- Content/Topic 5: GIS Data structure

Spaghetti structure

The spaghetti data model is a simple GIS model where lines may cross without intersecting or topology and usually no attributes are created.

Polygonal structure

A polygon is defined by the lines that make up its boundary and a point inside its boundary for identification. Polygons have attributes that describe the geographic feature they represent. There are different models to store and manage vector information. Each of them has different advantages and disadvantages.

Topological structure

In GIS, topology is implemented through data structure. An ArcInfo coverage is a familiar topological data structure. A coverage explicitly stores topological relationships among neighboring polygons in the Arc Attribute Table (AAT) by storing the adjacent polygon IDs in the LPoly and RPoly fields.

LO 1.2 – Identify GIS users

- Content/Topic 1: GIS Data generators

Companies

Geospatial data is just about everywhere. It includes imagery, features, and base maps. This information changes our perception of what we know and what is happening.

Being the best aid in problem-solving, geographic information systems turn out to be powerful decision-making tools for any business. Customer addresses, service areas, utility networks, real estate, and so much more can help companies advance.

Professionals

Organizations rely on geographic information science (GIS) for applications ranging from navigation in autonomous vehicles to mobile games played in real-world spaces. GIS specialists reveal valuable insights by employing best practices of spatial data collection, analysis and visualization. Their discoveries fuel problem solving and strategic decision making in organizations such as scientific and technical services firms, government agencies, humanitarian nonprofits and the military. As GIS techniques continue to evolve, users can leverage spatial data to deepen our understanding of patterns and relationships in the world around us. To make the most of this potential, professionals must hone their capacity for spatial thinking and GIS technical skills. If you're interested in pursuing a career at the forefront of geospatial thinking, exploring the GIS skills that are most needed in today's organizations could be a vital step.

- Content/Topic 2: GIS users

System users

A geographic information system (GIS) is a conceptualized framework that provides the ability to capture and analyze spatial and geographic data. *GIS applications* (or *GIS apps*) are computer-based tools that allow the user to create *interactive queries* (user-created searches), store and edit spatial and non-spatial data, analyze spatial information output, and visually share the results of these operations by presenting them as maps. The scientific study of geographic concepts, applications, and systems is commonly initialized as *GIS*, as well.

Geographic information systems are utilized in multiple technologies, processes, techniques and methods. It is attached to various operations and numerous applications, that relate to: engineering, planning, management, transport/logistics, insurance, telecommunications, and business. For this reason, *GIS* and *location intelligence applications* are at the foundation of *location-enabled services*, that rely on geographic analysis and visualization.

End users

Geographic information systems (GISs) are in wide use by city planners, landscape architects, natural resource managers, and other specialists who have the expertise or the trained staff to use them. Many non-specialists also like to be able to use GIS. However, GIS software is not accessible to them, because, in its current incarnation, it requires knowledge of geography, cartography, and database systems. Despite an enormous pool of potential non-specialist users, GIS is not at this time a mainstream, mass marketed application.

LO 1.3 – Identify GIS Softwares

- Content/Topic 1: ArcGIS

ArcMap

ArcMap is where you display and explore GIS datasets for your study area, where you assign symbols, and where you create map layouts for printing or publication. ArcMap is also the application you use to create and edit datasets.

ArcMap represents geographic information as a collection of layers and other elements in a map. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text, a symbol legend, and so on.

ArcCatalogue

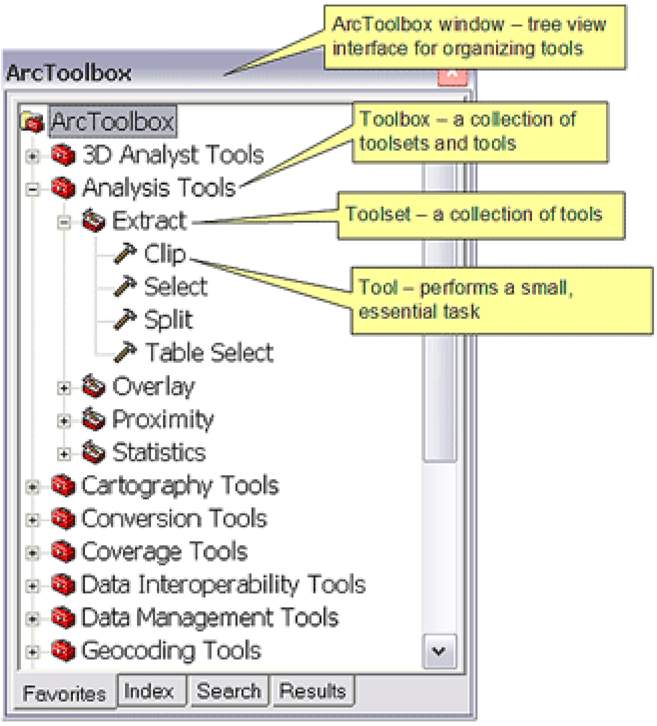
The ArcCatalog application provides a catalog window that is used to organize and manage various types of geographic information for ArcGIS for Desktop. The kinds of information that can be organized and managed in ArcCatalog includes:

- Geodatabases
- Raster files
- Map documents, globe documents, 3D scene documents, and layer files
- Geoprocessing toolboxes, models, and Python scripts
- GIS services published using ArcGIS for Server
- Standards-based metadata for these GIS information items
- And much more

ArcCatalog organizes these contents into a tree view that you can work with to organize your GIS datasets and ArcGIS documents, search and find information items, and to manage them.

ArcToolbox

The ArcToolbox window is the central place where you find, manage, and execute geoprocessing tools. Tools can also be managed and executed from ArcCatalog. The ArcToolbox window contains toolboxes, which in turn contain tools and toolsets (a toolset is just an organizational device, like a system folder). Tools must be contained in a toolbox—they cannot exist outside a toolbox.



ArcView

ArcView is the entry level licensing level of ArcGIS Desktop, a geographic information system software product produced by Esri. It is intended by Esri to be the logical migration path from ArcView 3. x. ArcView is now referred to as ArcGIS for Desktop Basic.

- Content/Topic 2: MapInfo

MapInfo Pro helps you use geospatial analytics to create insightful models of multiple location centric scenarios enabling you to simulate different outcomes to optimize your organizations actions.

- Content/Topic 3: ERDAS

ERDAS IMAGINE is a raster graphics editor and remote sensing application designed by ERDAS, Inc. The latest version is 9.3. It is aimed primarily at geospatial raster data processing and allows the user to prepare, display and enhance digital images for use in GIS or in CAD software. It is a toolbox allowing the user to perform numerous operations on an image and generate an answer to specific geographical questions.

- Content/Topic 4: ENVI

ENVI is an off-the-shelf software program used to visualize, process, and analyze geospatial imagery. ENVI's algorithms have been scientifically proven, are easy to use, and tightly integrated with the ArcGIS platform from Esri. Automated workflows in ENVI help users accurately extract information to make decisions.

- Content/Topic 5: IDRISI

The IDRISI Image Processing System in TerrSet is comprised of an extensive set of procedures for image restoration, enhancement, transformation and classification of remotely sensed imagery. For over 30 years, Clark Labs has been involved in the development of geospatial technologies, supplying the community with the most comprehensive image processing system on the market. The tools available for classification offer the broadest procedures in the industry including both hard and soft classification procedures based on machine learning (such as neural networks) and statistical characterization. These tools are integrated within TerrSet and accompany the IDRISI GIS Analysis tools, saving effort, costs and resources.

- Content/Topic 2: Quantum GIS

Quantum GIS is a free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. QGIS functions as geographic information system (GIS) software, allowing users to analyze and edit spatial information, in addition to composing and exporting graphical maps. QGIS supports both raster and vector layers; vector data is stored as either point, line, or polygon features. Multiple formats of raster images are supported, and the software can georeference images.

- Content/Topic 2: Sulfer 10

LO 1.4 – Identify GIS hardware

- Content/Topic 4:Identication of GIS hardwareElements

Computer/Laptop elements

Screen

Central processing unit

Keyboard

Mouse

External devices

Scanner/Digitizer

Printer/Plotter

Hard drive

Camera

Figure 8: GIS hardware elements

- Hardware capabilities affect processing speed, ease of use, and the type of output available.
- The basic computer hardware components are given in the table

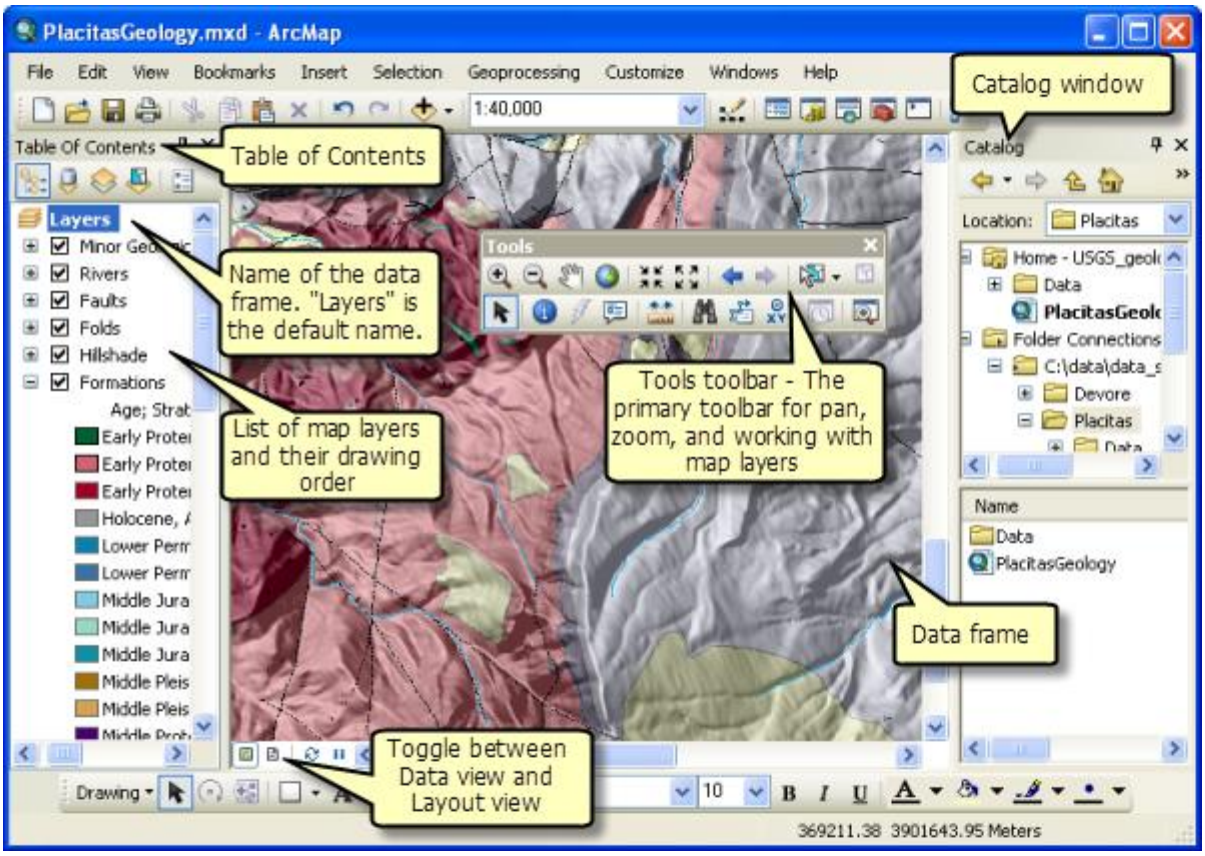
Item	Usage
Hard disk drive	Storing data and programs
Digital tape cassettes, Optical CD-ROM's etc.	Storage of data
Digitizer or Scanner	Converts maps and documents into digital form
Plotter, Printer or any other display device	Gives the output of data processing
Local & Global electronic network with either of the following; 1. Optical fibre data lines 2. Telephone lines with 'modem'	Provides Inter-Computer communication
Computer screen, Keyboard & mouse or other pointing device	To control the computer and the peripherals such as the digitizer, plotter, printer etc. which are linked to the computer.

LO 1.5 – Identify GIS methods

- Content/Topic 1:ArcGIS

ArcMap

ArcMap is the main component of Esri's ArcGIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data. ArcMap allows the user to explore data within a data set, symbolize features accordingly, and create maps. This is done through two distinct sections of the program, the table of contents and the data frame.



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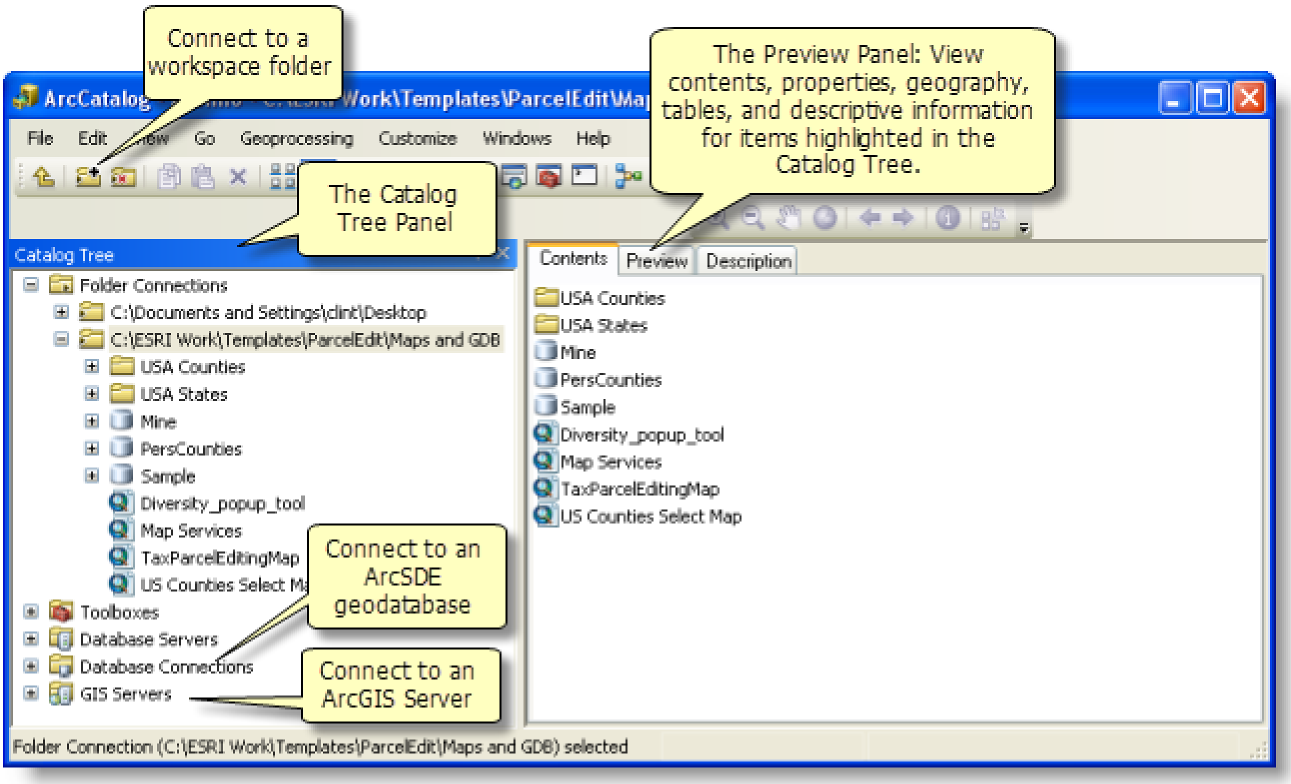
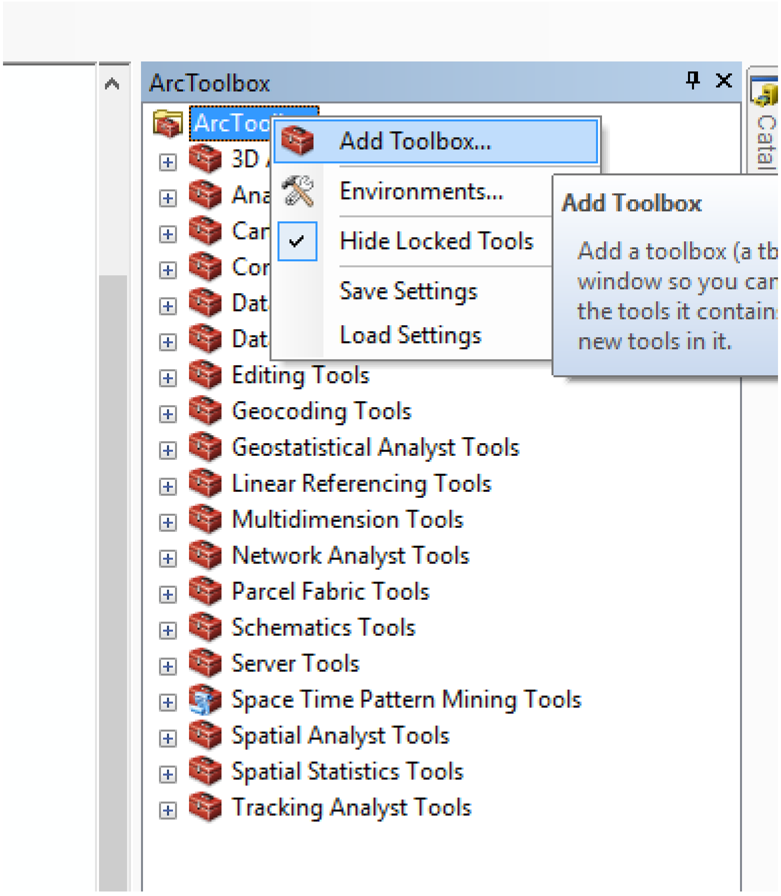


ArcToolbox

ArcToolbox is a collection of geoprocessing tools for analyzing, editing, and converting data. ArcGIS and ArcGIS Pro have 20 or so common toolboxes for **ArcToolbox**. Each toolbox has a unique set of specialized tools for spatial analysis. Some toolboxes are available as part of the default ArcGIS installation.



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- Content/Topic 2: MapInfo

  (CDA International Corp):
  –low cost, but low market share

- Content/Topic 3: ERDAS

Long established leader

Acquired by Leica Geosystems in 2001

- <u>Content/Topic 4: ENVI</u>

  Relative newcomer, radar specialization

  Acquired by Kodak in 2000

- <u>Content/Topic 5: IDRISI</u>

  Pioneering, university-developed package.

- <u>Content/Topic 6: Quantum GIS</u>

  Quantum GIS is a cross-platform free and open source desktop geographic information system (GIS) application that provides data viewing, editing, and analysis capabilities.

- <u>Content/Topic 7: Sulfer10</u>

The Arc GIS, Winglink, Sulfer 10, Ms Excel, Origin Pro 8 software's were employed for the study.

The Arc GIS software was used to convert the data in a format the WingLink can recognize. Thereafter the data imported into the WingLink software environment and the raster map produced. The raster map was transformed into its contour format.

Learning Unit 2 – Determine GIS Functions

LO 2.1 – Identify data collection methods

- Content/Topic 1: Methods of primary data collection

Ground survey methods

The importance of collecting meaningful and timely ground data for resource inventories which employ remote sensing techniques is often discussed, and appropriately.

Ground data is used in all three phases of an agricultural resource survey. First, some field work may be necessary in the survey planning stage. At this point, preliminary evaluations are made to determine how the survey might best be organized. Secondly, ground data must be used to train image interpreters (both human and electronic) and to judge their competence. Finally, accurate ground data is crucial for evaluating operational survey results and adjusting interpretation estimates.

Photogrammetric methods

The analysis and measurements were performed with the aid of photogrammetric methods, which allow numerical determination of geometrical data with higher geometrical quality than do graphical tracing methods. It is also possible by photogrammetric methods to analyze separate parts of the procedure and in this way reduce the errors. Roentgen photogrammetry is the science of measuring objects with the aid of roentgenograms in order to determine primarily geometrical qualities such as the size, position and shape of the object.

The photogrammetric method is the application of terrestrial photogrammetry to trench logging, and may be required for very large, irregular fault exposures that cannot be accessed everywhere.

Remote sensing methods

Remote sensing is used in numerous fields, including geography, land surveying and most Earth science disciplines (for example, hydrology, ecology, meteorology, oceanography, glaciology, geology); it also has military, intelligence, commercial, economic, planning, and humanitarian applications, among others.

Remote sensing makes it possible to collect data of dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the Cold War made use of stand-off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed.

- Content /Topic 2: Methods of Secondary data collection

Acquisition of GIS datasets

GIS users can rely on many sources of GIS data and some of the data is already available in different format or it can be created. Some of the most common source of GIS projects are hard copy maps. The maps can be digitized or scanned and integrated into GIS as a digital data. A feature **dataset** is a collection of related feature classes that share a common coordinate system. Feature **datasets** are used to spatially or thematically integrate related feature classes. At its simplest this can mean the basic topographical information found on a map, but also includes different location-related datasets combined into complex layers that show information such as land use and population density.

Acquisition of Paper maps

A paper map is a simple, time-tested means for connecting you to your surroundings, spatially and directionally. Using an atlas or a fold-out paper map, I can estimate mileage extremely accurately and get a better sense of travel time, obstacles, and how long various legs of the trip will take.

Using a paper map, I can mark out my preferred route and, especially important, landmarks and intersections along the way. Roadways, railroad tracks, bridges, lakes, and rivers that cross or run parallel to my route all form important indicators that I'm going the right way and, as importantly, they tell me how close or far I am to my destination.

Acquisition of Orthophotos

An orthophoto is an aerial photograph that has been geometrically corrected or 'ortho-rectified' such that the scale of the photograph is uniform and utilized in the same manner as a map. An ortho-photograph can be used to measure true distances of features within the photograph. The **orthophoto** removes the effects of tilt and relief and shows the true, straight path of the pipeline. Unlike the aerial photo, the orthoimage is a photographic **map** with a uniform scale. The orthoimage can be directly laid over other **maps** (and vice versa). **Orthophotos** are **created** by using a digital elevation model of the area covered by the image to "rubber sheet" the image to a regular network of closely spaced control points.

Acquisition of Satellite images

Satellite images (also Earth observation imagery, spaceborne photography, or simply satellite photo) are images of Earth collected by imaging satellites operated by governments and businesses around the world. Satellite imaging companies sell images by licensing them to governments and businesses such as Apple Maps and Google Maps. It should not be confused for astronomy images collected by space telescope. Satellite images have many applications in meteorology, oceanography, fishing, agriculture, biodiversity conservation, forestry, landscape, geology, cartography, regional planning, education, intelligence and warfare. Less mainstream uses include anomaly hunting, a criticized investigation technique involving the search of satellite images for unexplained phenomena. Images can be in visible colors and in other spectra. There are also elevation maps, usually made by radar images. Interpretation and analysis of satellite imagery is conducted using specialized remote sensing software.

LO 2.2 –Identify data processing methods

- Content/Topic 1: Methods of data processing

Editing

ArcGIS allows you to create and edit several kinds of data. You can edit feature data stored in shapefiles and geodatabases, as well as various tabular formats. This includes points, lines, polygons, text (annotations and dimensions), multipatches, and multipoints. You can also edit shared edges and coincident geometry using topologies and geometric networks.

Coding

In the social sciences, coding is an analytical process in which data, in both quantitative form (such as questionnaires results) or qualitative form (such as interview transcripts) are categorized to facilitate analysis. One purpose of coding is to transform the data into a form suitable for computer-aided analysis.

Tabulation

After editing, which ensures that the information on the schedule is accurate and categorized in a suitable form, the data are put together in some kinds of tables and may also undergo some other forms of statistical analysis. Table can be prepared manually and/or by computers.

Re-projecting& Coordinate transformation

Data usually comprises an array of numbers. Spatial data is similar, but it also includes numerical information that allows you to position it on earth. These numbers are part of a coordinate system that provides a frame of reference for your data, to locate features on the surface of the earth, to align your data relative to other data, to perform spatially accurate analysis, and to create maps.

All spatial data is created in a coordinate system, whether it is points, lines, polygons, rasters, or annotation. The coordinates can be specified in many different ways, such as decimal degrees, feet, meters, or kilometers; any form of measurement can be used as a coordinate system. Identifying this measurement system is the first step to choosing a coordinate system that displays your data in its correct position in ArcGIS Pro, in relation to your other data. **Coordinate system**: Data is defined in both horizontal and vertical coordinate systems. Horizontal coordinate systems locate data across the surface of the earth, and vertical coordinate systems locate the relative height or depth of data. Horizontal coordinate systems can be of three types: geographic, projected, or local.

Projections: A projection is the means by which you display the coordinate system and your data on a flat surface, such as a piece of paper or a digital screen. Mathematical calculations are used to convert the coordinate system used on the curved surface of earth to one for a flat surface.

Transformations: After defining the coordinate system that matches your data, you may still want to use data in a different coordinate system. This is when transformations are useful. Transformations convert data between different geographic coordinate systems or between different vertical coordinate systems. Unless your data lines up, you'll encounter difficulties and inaccuracies in any analysis and mapping you perform on the mismatched data.

Georeferencing

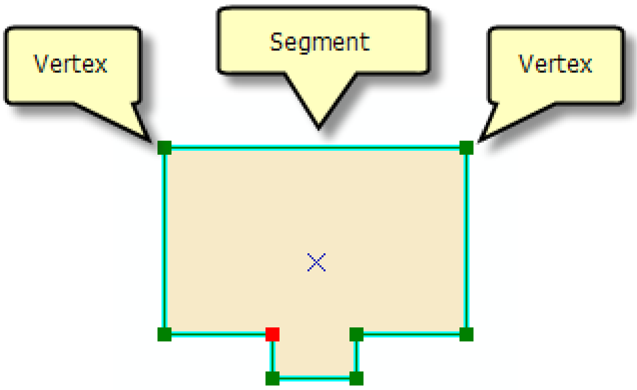
Georeferencing is the process of taking a digital image, it could be an airphoto, a scanned geologic map, or a picture of a topographic map, and adding geographic information to the image so that GIS or mapping software can 'place' the image in its appropriate real world location. This process is completed by selecting pixels in the digital image and assigning them geographic coordinates. In rare instances, one may already know the geographic coordinates of certain pixels in an image; more frequently, a non-georeferenced image is georeferenced to an existing image that already has embedded geographic information, such as a DRG, DLG, or DEM.

Polygon and line making

To create segments in lines or polygons, you will most commonly use the Line tool (with line templates) and the Polygon tool (with polygon templates). While these tools are used with different template types, they behave similarly. To create segments, simply click the map where you want to place vertices. You digitize a new line or polygon feature's shape by drawing an edit sketch, which is the underlying representation of the feature's geometry. As you sketch, you see a

WYSIWYG preview with the actual symbology used for that template, with vertices symbolized as green and red squares.

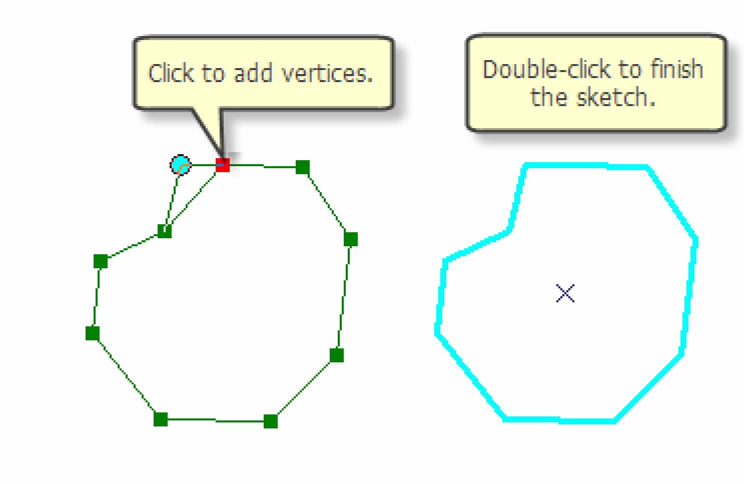
A sketch is composed of all the vertices and segments of the feature. Vertices are the points at which the sketch changes direction, such as corners; segments are the lines that connect the vertices.



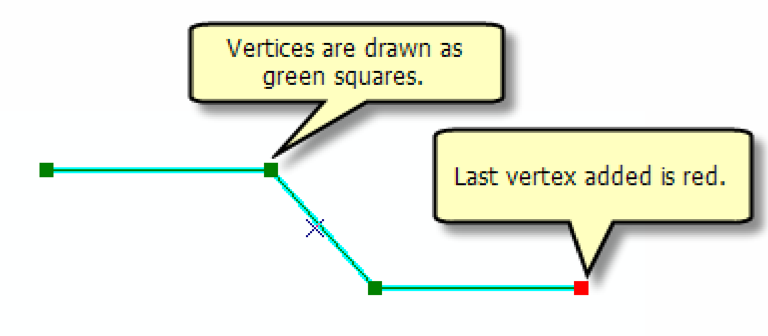
When you want to create features, you'll most commonly use the Create Features window's construction tools and the construction methods on the Editor toolbar. With those tools, for example, you can create lines, arcs, tangent curves, vertices at intersections or midpoints, vertices based on distances and directions from other features, or new segments by tracing along existing ones.

By default, the Line and Polygon tools create straight segments between the vertices you click. These tools have additional ways to define a feature's shape, such as creating curved lines or tracing existing features. These are construction methods, which are located on the Editor toolbar. To create a curved segment, click that construction type from the palette on the Editor toolbar and draw the curve on the map. You can even switch among construction types after each segment, allowing you to build the exact shape you want. For example, if you are drawing a road with a bend in it, you may want some of it to be straight and some to be curved. To do this, start with Straight Segment, digitize the straight segment, then click a curved segment construction method and create the curve.

Once you are satisfied with the shape of the sketch, you need to finish the sketch to complete the feature's geometry and actually create the feature with the attributes specified in the template. There are several ways that you can finish a sketch, including double-clicking with your mouse, choosing the command from a shortcut menu, or using a keyboard shortcut (F2). The left graphic below shows the polygon feature being constructed from an edit sketch. Once all the desired vertices are added, the sketch is finished and becomes a feature. You can double-click a feature with the Edit tool to modify the sketch, thereby changing the shape of the polygon.

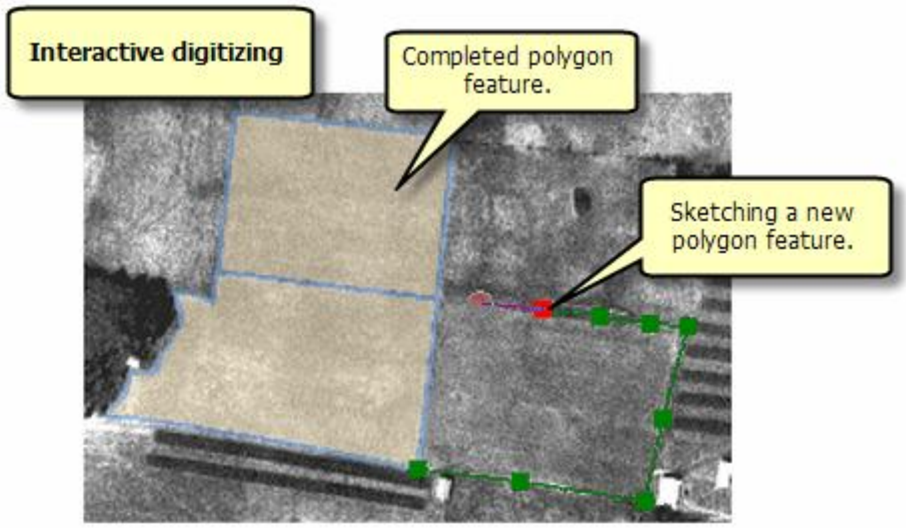


To create a new line, at least two vertices—the start and end points—are required to finish the sketch, and therefore, create the feature. To create a new polygon with the Polygon tool, for example, at least three vertices are required. A sketch of a line records the direction it was digitized, which is important if you need to trim or extend the line or perform an operation on it that uses measurements originating from the start or end point. Vertices are marked in green, with the last vertex added marked in red. (You can change the colors of the edit sketch on the Editing Options dialog box.)



Digitizing

Digitizing, the process of converting features into a digital format, is one way to create data. There are several ways to digitize new features. These include digitizing on-screen or heads up over an image, digitizing a hard copy of a map on a digitizing board, or using automated digitization. Interactive, or heads-up digitization, is one of the most common methods. In this method, you display an aerial photograph, satellite image, or orthophotograph on-screen as a basemap, then you draw features, such as roads, buildings, or parcels, on top of it.



In hard-copy digitizing, you use a digitizing table connected to a computer that converts positions on the table surface into digital x,y coordinates as you trace them with a handheld puck (a pen or mouselike device).

Automatic digitization is another method of digitizing features. The ArcScan for ArcGIS extension enables you to perform automatic or interactive raster-to-vector data conversion with high precision and little or no operator intervention during the data capture stage.

Modeling

The basic steps used for model-building are the same across all modeling methods. The details vary somewhat from method to method, but an understanding of the common steps, combined with the typical underlying assumptions needed for the analysis, provides a framework in which the results from almost any method can be interpreted and understood.

The basic steps of the model-building process are:

1. model selection
2. model fitting, and
3. model validation.

- Content/Topic 2: Techniques of Data storing

Geo-database

At its most basic level, an ArcGIS geodatabase is a collection of geographic datasets of various types held in a common file system folder, a Microsoft Access database, or a multiuser relational DBMS (such as Oracle, Microsoft SQL Server, PostgreSQL, Informix, or IBM DB2). Geodatabases come in many sizes, have varying numbers of users and can scale from small, single-user databases built on files up to larger workgroup, department, and enterprise geodatabases accessed by many users.

But a geodatabase is more than a collection of datasets; the term geodatabase has multiple meanings in ArcGIS:

- The geodatabase is the native data structure for ArcGIS and is the primary data format used for editing and data management. While ArcGIS works with geographic information in numerous geographic information system (GIS) file formats, it is designed to work with and leverage the capabilities of the geodatabase.
- It is the physical store of geographic information, primarily using a database management system (DBMS) or file system. You can access and work with this physical instance of your collection of datasets either through ArcGIS or through a database management system using SQL.
- Geodatabases have a comprehensive information model for representing and managing geographic information. This comprehensive information model is implemented as a series of tables holding feature classes, raster datasets, and attributes. In addition, advanced GIS data objects add GIS behavior; rules for managing spatial integrity; and tools for working with numerous spatial relationships of the core features, rasters, and attributes.
- Geodatabase software logic provides the common application logic used throughout ArcGIS for accessing and working with all geographic data in a variety of files and formats. This supports working with the geodatabase, and it includes working with shapefiles, computer-aided drafting (CAD) files, triangulated irregular networks (TINs), grids, CAD data, imagery, Geography Markup Language (GML) files, and numerous other GIS data sources.
- Geodatabases have a transaction model for managing GIS data workflows.

Online Web

ArcGIS Online allows users to easily make and share their maps and data in an open and standards-based environment. Anyone can access this platform to make maps; combine these maps with other layers to form new maps; and share these maps via e-mail or embed them in applications, websites, or blogs. **ArcGIS Online** is a cloud-based mapping and analysis solution. Use it to make maps, analyze data, and to share and collaborate. Get access to workflow-specific apps, maps and data from around the globe, and tools for being mobile in the field.

External devices

As a GIS analyst, you work with A LOT OF data – almost all geospatial in nature.

You do everything with data. You display, capture, edit, share, visualize, manage, delete GIS data. If you're in the market to buy or build a GIS workstation from scratch… You're essentially investing in your career.

Here is what you should look for in an ideal GIS workstation:

- Dual Monitors – Seeing Double
- Central Processing Unit (CPU) – Your Workhorse
- Random Access Memory (RAM) – Temporary Memory
- Hard Disk Drives (HDD) – Permanent Storage
- Graphics Processing Unit – Visualize Smoother
- Flash Drives – Quick External Storage
- CD-ROM, DVD and Blu-Ray – Permanent External Storage
- GIS Personal Computers Options (Desktops, Laptops, Notebooks, Notebooks, Tablets, Mainframes, Servers, …)

LO 2.3 – Determine data analysis methods.

- Content/Topic 1: 3D Analysis

Functional surface

One of the fundamental properties that defines how a GIS handles features, objects, and surfaces in space is its ability to render in three dimensions (3D). The term three dimensional is widely misused in that many software applications today store and display data in two and a half dimensions (2.5D). The ArcGIS 3D Analyst extension has the ability to store raster, TIN, terrain dataset, and LAS dataset data as functional surfaces, which are actually 2.5D. **A functional surface** is continuous, and all locations on the surface can have only one elevation, or z-value, per x,y coordinate. True 3D surfaces are sometimes known as solid model surfaces, and ArcGIS handles these through multipatch features. In contrast to a functional surface, which has surface continuity, are solid model surfaces that can model and store true 3D, or multiple z-values, per x,y coordinate.

Triangulated surface

The Triangulated Surface toolset offers a set of surface analysis tools that operate on terrain, TIN, and LAS datasets. They provide the ability to extract surface properties, such as slope, aspect, and contour isolines, identify outliers in the data points, make volumetric computations, and create 3D feature classes that model the surface.

- Content/Topic 2. Data conversion

Conversion from raster

Open ArcMap and create a new, blank map document. Add the raster file to be converted to the map using the Add Data tool and ensure that an appropriate coordinate system has been applied to the data frame (right-click the data frame name and select Properties > Coordinate System). Open Arc Toolbox and expand the Conversion Tools > From Raster toolbox. Double-click the Raster to Polygon tool to open its dialog and enter the parameters as follows.

1. Set the Input raster to the DEM or other raster file that you wish to convert to vector format.
2. Set the Field value to the field that you wish to use to assign values from the raster cells to the resulting polygons. Note that this is an optional input, and should only be used if you have a specific string or integer field set up for the conversion. We have left this option blank for the example shown here.
3. Set the Output polygon features to your working directory and give the output a descriptive name.
4. The Simplify polygons option will be checked as the default choice. Simplifying the polygons means that polygon shapes will be smoothed into simpler shapes rather than conforming exactly to the edges of the raster cells. If the option is unchecked, then the resulting polygons will conform exactly to the input raster's cell edges.

A portion of the input DEM and the resulting polygon file produced with the Raster to Polygon tool are shown below. Note that this example shows the output with the Simplify Polygons option turned on. Have a look at the converted polygon file in ArcMap. Use the Identify tool to see the attributes for specific polygons and note that the GRIDCODE field from the original DEM has been maintained in the output file. Thus, each individual polygon in the new file represents a discrete elevation value. This is important for the next step in our example – isolating specific altitude intervals.

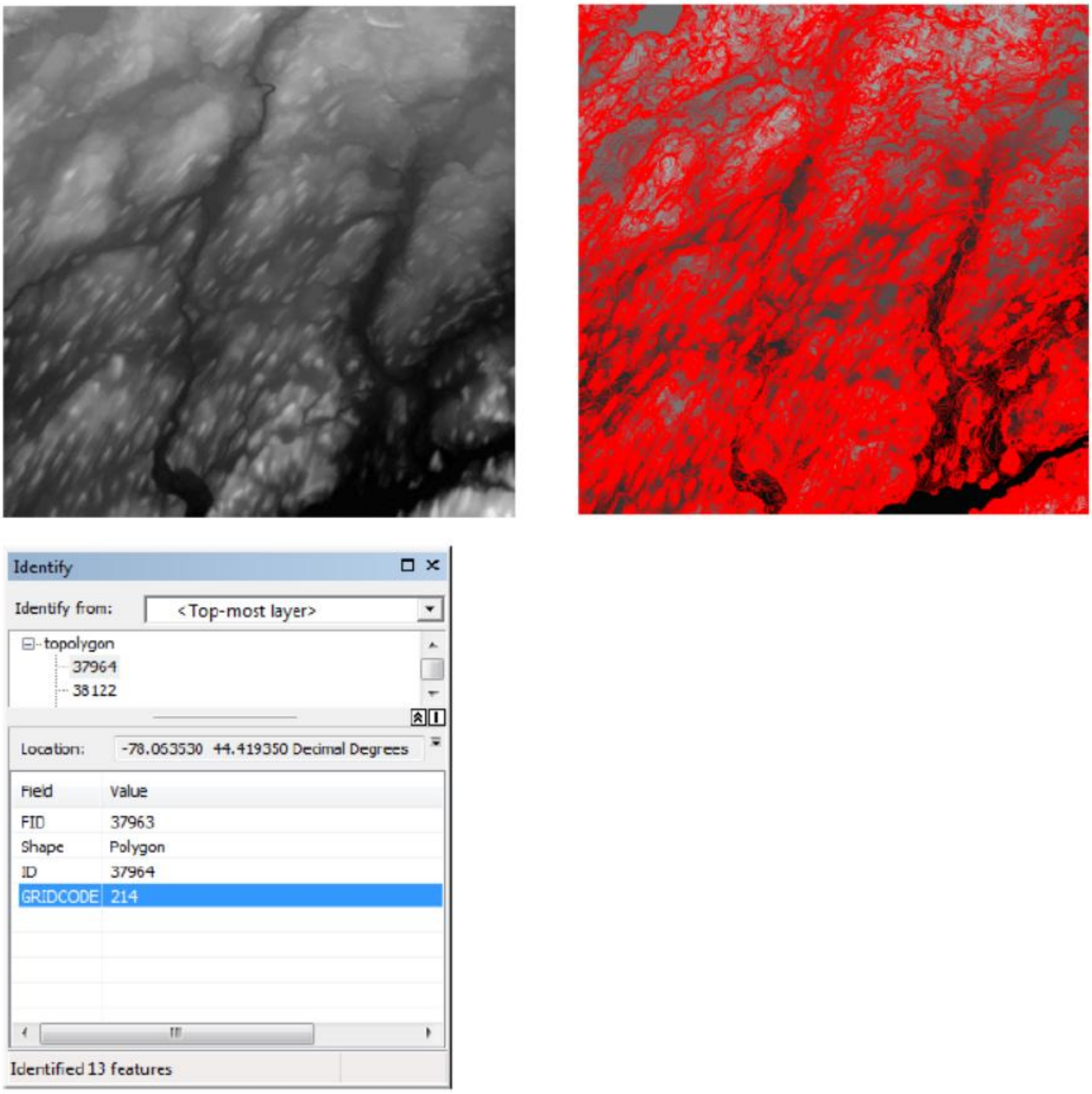
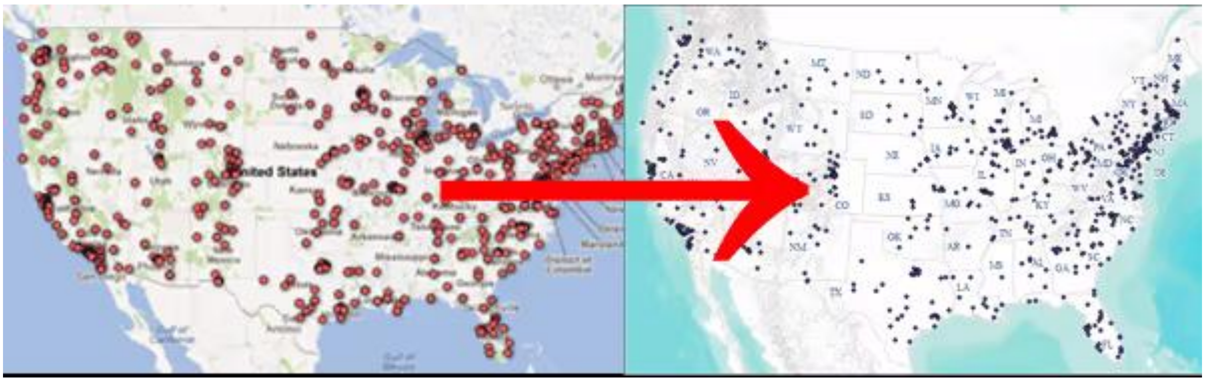


Figure 1: (Conversion)Raster

Conversion from KML

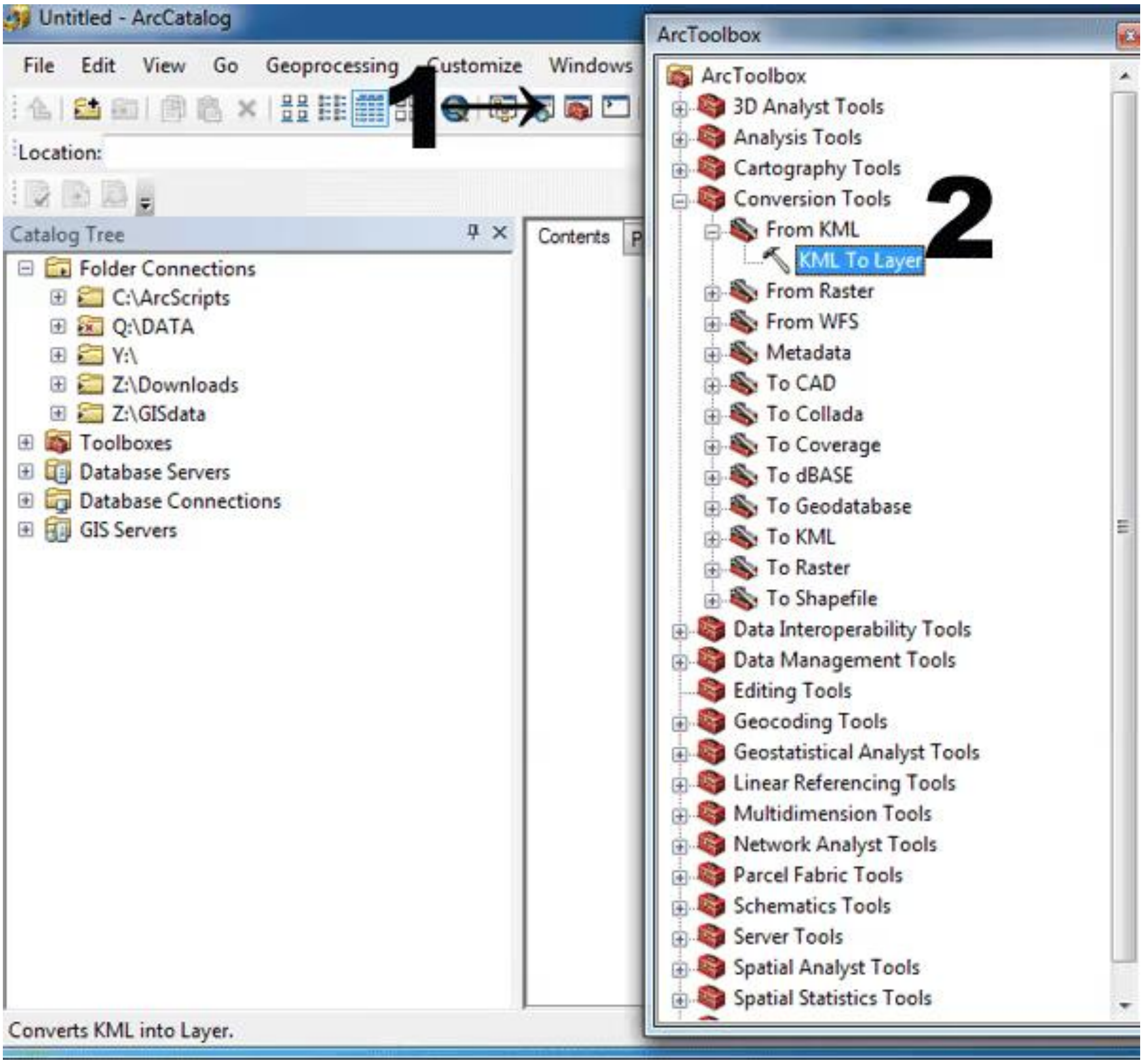
Use the KML To Layer tool to convert a .kml or .kmz file to a file geodatabase containing all features and imagery from the source KML and a layer file that maintains the colors and symbols of the source KML. In addition to the KML feature and imagery data and symbology, several other properties of the KML will also be included in the converted ArcGIS data, such as pop-up information, snippets, and other attributes. After performing this conversion, you can use the geographic data from your KML in the same ways you would any other GIS data: edit, analyze, and map it.

The steps and screenshots in this tutorial were done using ArcGIS 10.0.



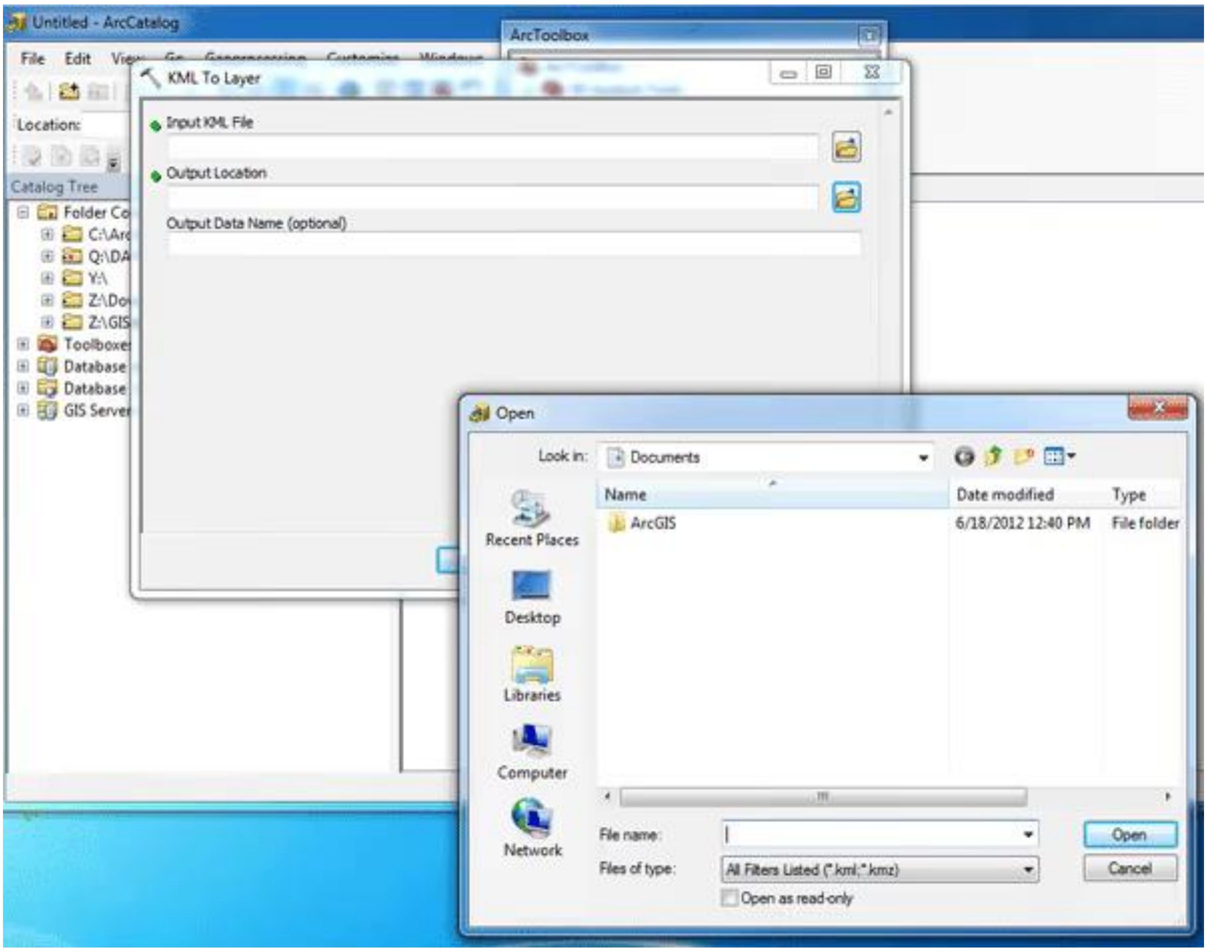
Converted KML file in ArcGIS

Open up ArcCatalog. Click on the ArcToolBox icon (1) to open up the tools section. Then click on the Conversion toolbox (2) to open up the data conversion options. Select the “From KML” toolkit to access the ‘KML to Layer’ tool.



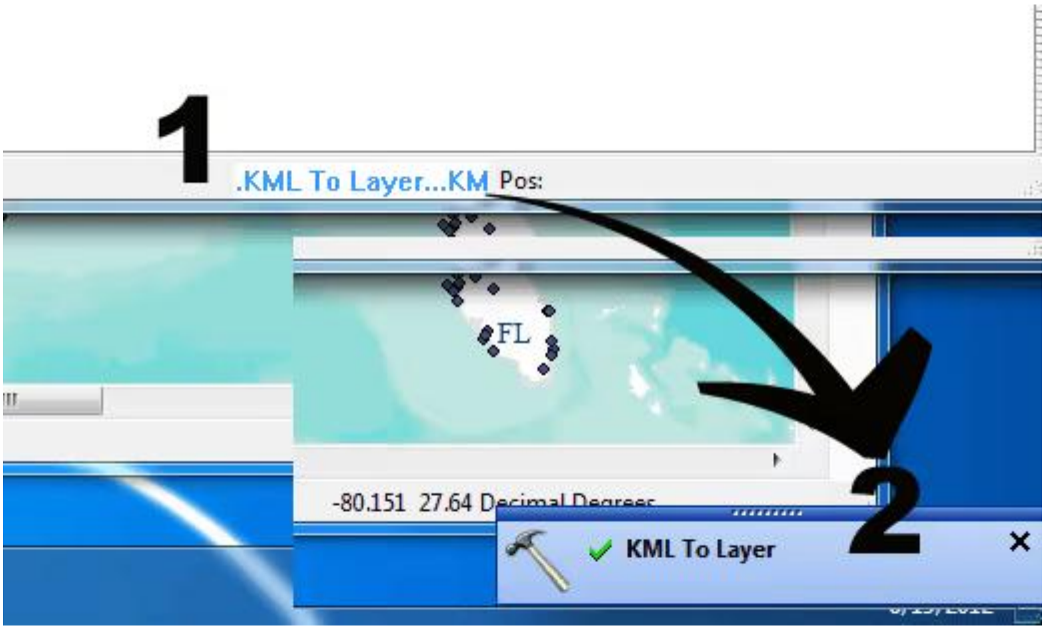
ArcGIS has a KML to layer conversion tool.

In the "KML to Layer" dialogue box, select the folder icon next to the Input KML File box. Navigate to the location on your hard drive where the KML is stored. In the Output Location select the folder where you want the personal geodatabase (.gdb) to be stored. In the Output Data Name either type in the name that you want the geodatabase to have or accept the default (which retains the name of the KML file.



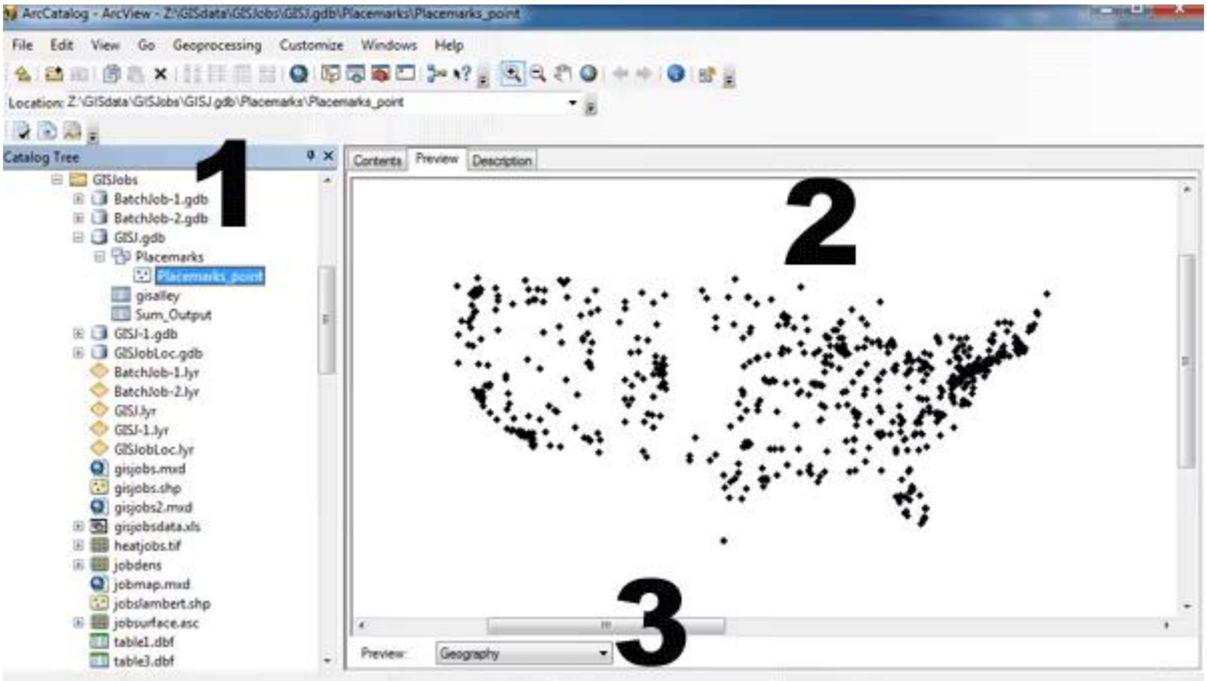
KML to Layer Conversion Settings

A scrolling text indicated located in the lower right hand corner of ArcCatalog (1) will indicate the conversion is in process. Depending on the size of the KML file, this conversion process can take seconds or several minutes. Once the KML to ArcGIS layer has completed, a small window (2) in the lower right hand corner of your desktop will pop up with a green check mark announcing the completion of the conversion. If the conversion fails, the window will have a red check mark.



A successful KML to layer conversion is indicated by a green check mark

Now you're ready to view the converted file. In the catalog tree section (1) of ArcCatalog, navigate to the folder you designated in the KML to Layer dialogue window as the output location. Find the .gdb file containing the same name you selected as the Output Data Name. Click on the geodatabase to open it and drill down to the file you converted. The geographic dataset will be housed within "Placemarks" and will have an appendage of _point, _line or_polygon depending on the type of vector data converted. A preview of the file can be viewed in the preview section (2). You can toggle back and forth between the geographic data and the attribute table (3). The converted file can now be loaded into an ArcMap session.



Converted KML file as a geodatabase.

The output geodatabase file will be in the WGS84 coordinate system. If needed, the resulting geodatabase can be be reprojected after the conversion process. As noted in the beginning of this tutorial, if the KML file doesn't contain valid geographic features, the conversion will fail.

- Content/Topic 3. Spatial analysis

Generalization

There is a toolset in the Spatial Analyst toolbox in ArcGIS that allows for several different methods of generalization on raster data. The generalization tools in the toolset are grouped into three categories: Aggregating zones of data (Nibble, Shrink, Expand, Region Group, and Thin), smoothing data edges (Boundary Clean and Majority Filter), and reducing the resolution of a raster (Aggregate). For vector data, ArcGIS has a Generalize tool in the Editing toolset which uses the Douglas-Peucker simplification algorithm to simplify lines. For additional generalization methods, the Generalization toolset found in the Cartography toolbox offers a range of tools for simplifying and reducing resolution of vector data for cartographic purposes.

Surface analysis

Using ArcGIS Spatial Analyst, users can build and analyze complex surfaces to identify patterns or features within the data. Many patterns that are not readily apparent in the original data can be derived from the existing surface. These include shaded relief, contours, angle of slope, aspect, hillshade, viewshed, curvature, and cut/fill.

These topographic derivatives give you the power to effectively relate your data to real-world terrain and analyze how variations in the topography will affect the problem in question.

- **Content/Topic 3. Data management**

Geo-database administration

The Geodatabase Administration toolset contains tools for a variety of geodatabase management tasks. Specific geodatabase data management tools as well as geodatabase upgrade, management, and maintenance are covered by the tools in this toolset. There is at least some amount of administration needed for every type of geodatabase. The tasks you perform to administer a geodatabase vary depending on the type of geodatabase you are using.

- **File or personal geodatabase administration**

  There are a few administration tasks involved in the use of a file or personal geodatabase. Some of these tasks, such as compacting a geodatabase or setting the spatial grid index, help maintain performance. Others, such as compressing vector data in file geodatabases or moving geodatabases, are optional. See A comparison of file and personal geodatabase management for more information.

- **Database server administration**

  You can think of the geodatabases stored in SQL Server Express instances that are used as database servers as mini enterprise geodatabases. As such, they require some of the same administration as enterprise geodatabases.

  Other than installing the SQL Server Express instance and creating Windows logins, all administration tasks are performed through ArcGIS for Desktop.

Projection and transformation

Checking for a Coordinate System:

1. Right click on the title of your Map Layer in the Table of Contents of ArcMap. Choose Properties at the bottom of the pop up menu.
2. Click on the Source tab.
3. In the Data Source section, there should be a label that says Geographic Coordinate System or Projected Coordinate System. This tells you which Coordinate System this map layer uses.
4. Check all of your other Map Layers to make sure that they are using the same Coordinate System. If not, use the directions below to change the Coordinate Systems to match one another.

Change a Coordinate System in a Map Layer:

1. Open ArcToolbox
2. Open Data Management Tools → Projections and Transformations → Feature → Project. The Project dialog box will appear.
   a. Under Input Data Set or Feature Class, choose the Map Layer for which you want to change the Projection. It can be an entirely new Map Layer or Shapefile or one that is already being used in a Map Project.
   b. Under Output Data Set or Feature Class, check to make sure that the file is being saved in the same folder as the rest of your Map and Data Layers. If you have your data in a Geodatabase, you can save the newly projected Map Layer directly into the Geodatbase by browsing to its location. Rename the new Map Layer so that you will recognize it and be able to distinguish it from the Map Layer you are changing.
   c. Under Output Coordinate System, click on the Properties button (looks like a sheet of paper with a pointing finger hovering over it). The Spatial References Properties dialog box will appear. Click the Select button. The Browse for Coordinate System dialog box will appear.
3. Choose the Projected Coordinate System folder or the Geographic Coodinate System folder, depending upon the Coordinate Systems of your other files and how you want to match them.

a. For assistance in chosing a Coordinate System, contact Dr. Catherine Riihimaki at x3349 or via email. .

b. Choose the correct Coordinate System from the available options and appropriate region. Once you've selected the desired Coordinate System, you'll be taken back out to the Spatial References Properties dialog box.

4. Click the Apply button to apply the chosen Coordinate System. Then click OK twice.

By changing the name of the Shapefile/Map Layer in the Projection process, you've created a new Map Layer/Shapefile with the desired Coordinate System. You will need to add this new Map Layer to your map and/or Geodatabase, and remove the old Map Layer that uses the incorrect Coordinate System.

LO 3.1 – Identify GIS application in land use

- Content/Topic 1: GIS application in agriculture

Irrigation and drainage

Irrigated agriculture is important to the national economy of a country as it contributes significantly to the production of food. The main objective of irrigated agriculture is to enhance crop production for food sufficiency, particularly in semi-arid and arid zones. It is a combined method to GIS and remote sensing. Remote sensing and GIS are well established information tools, since they give reasonable pictures of the entire process in spatial and temporal terms. They both provide a cost effective and adequate understanding of landscape dynamics, detect, identify, map, and monitor differences in land use and land cover pattern over long period of time. The application of Satellite Remote Sensing (SRS) and GIS has been proved useful and successful in many fields such as natural resources management, agriculture, and environmental issues and water resources. Remote sensing approaches are very effective for detecting, monitoring and control of soil salinity.

The use GIS application in agriculture sector such as GIS agriculture for improving present method of acquiring and generating agricultural and resources data.

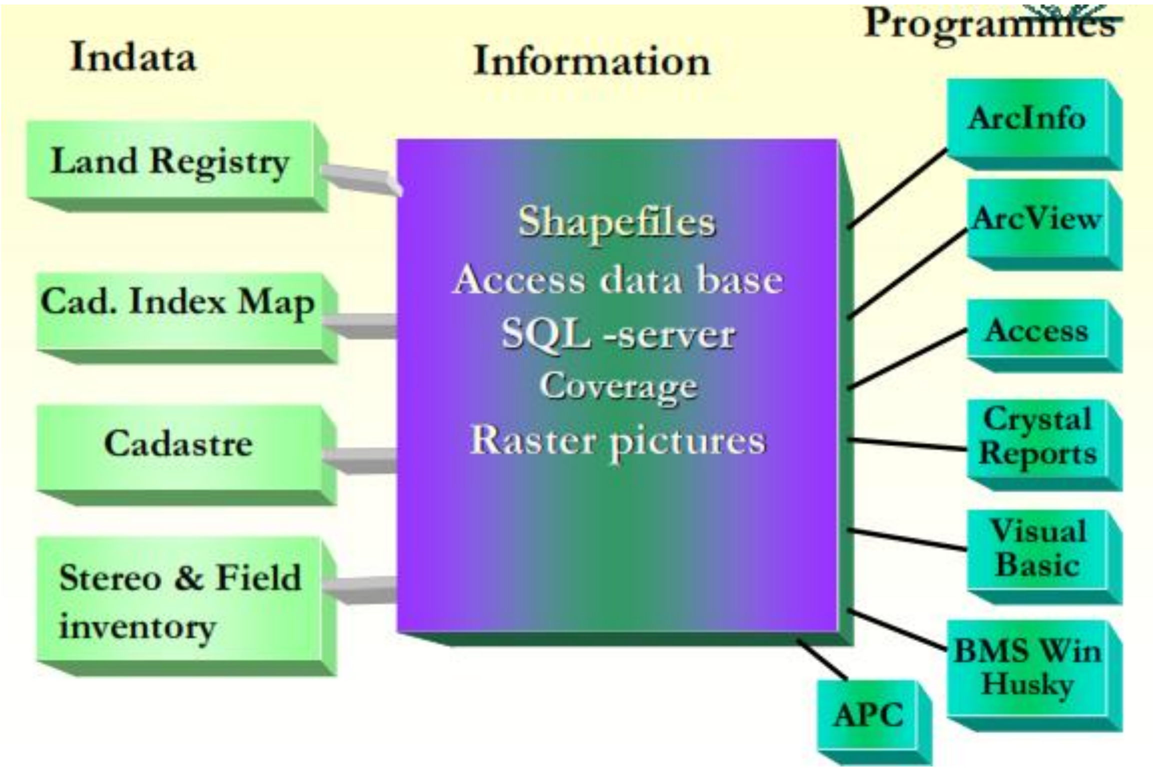
The company uses different spatial, spectral and temporal resolutions for:

- Crop mapping yield estimation
- Crop assessment and Crop health
- Irrigated landscape mapping
- Application development for GIS agriculture
- Soil and irrigation amendment analysis
- Suitability assessment studies
- Erosion identification and remediation
- Agricultural mapping for detailed vegetation cover and monitoring
- Change detection studies and developing crop models
- Damage and land degradation assessment studies
- Elevation models for efficient drainage

These studies and projects can be executed on any standard GIS formats using high end software such as ArcGIS, ERDAS Imagine/ER Mapper, MapInfo and AutoCAD Map, and ArcFM.

Land consolidation

- Access to cadastral register and maps, land register and to keep the this information up-to-date.
- Calculation of the values of stands, properties and land owners
- Calculation of the economical settlements for the land owners
- The elaboration of the re-allotment design by GIS-technique and the analysis of alternative designs.



- Content/Topic 2: GIS application in settlement planning

Settlement location

The site of a settlement is the actual land that the settlements is built upon. The situation is the location of a settlement in relation to the things that are around it. The purposed of GIS here is to classify and mapping of the area in two main classes, settlement and non-settlement area based on earthquake management consideration and using the remote sensing and geography information system method. The settlement is the most essential part which include the human so it should be saved more than other area. The mapping considered some parameters, which every parameter has to be scored to classify the area.

Furthermore, GIS is used to identify neighborhoods, thus allowing for characterization of the settlements regarding proximity to other features. Second, data from different sources are integrated through the GIS, and established as a single data matrix. In this respect, GIS is used to make the data accessible for analysis using statistical tools and database management.

Physical plan

GIS provides the capability for dynamic query and analysis, display of information and a more understandable representation. By introducing GIS, the authors analyze the social and infrastructure possibilities of the squatter settlements. They determine areas with inadequate public services and infrastructure, and provide basic solutions.

The problems of large metropolitan cities have been comprehensively studied by many researchers. Nevertheless, a country that just consists of a few very large urbanized areas arbitrarily embedded in a rural context is not viable and not optimally sustainable. A network of medium-sized cities that are evenly distributed over the territory is more feasible. Therefore, it is important to also investigate the problems of these smaller cities. Planning involves determining appropriate future decisions and actions through a series of choices. Making choices requires, in addition to thorough planning knowledge, comprehensive (geo-)data about the past, present and future. The information may be descriptive, predictive or prescriptive in nature. Appropriate and efficient management of information greatly improves the quality of planning. Generation of the proper type of information is very difficult with manual methods. GIS provides many basic functions for appropriate and efficient management of geo-information. Essentially, GIS supports the collection, maintenance, analysis and display of spatially related information. GIS data enable multiple viewpoints to be considered and provide the capability for dynamic query and display of information, and a more understandable representation. On the other hand, the accessibility of digital data may cause abuse and misuse, raising fundamental issues of data security, responsibility and reliability.

- Content/Topic 2: GIS application in urbanization

Master plan

Master Plan/Development Plan is the major tool for urban land management, providing detailed land use allocation for the sustainable development of city/town. Most master/development plans are made for 20-year periods, in phases of five years for periodic review and revision. The most crucial information for formulation of Master Plan is an accurate and updated Base Map of the planning area, showing roads and building layouts, spatial extent of development and information on the use of each parcel of land etc. Preparation of base maps from Very High-Resolution Satellite (VHRS) Images and Geographic Information System (GIS) technology can be time and cost-effective solution. Although State Town and Country Planning Departments (STPDs) had initiated the utilization of NUIS database at 1:10000 scale for Master Plan formulation on given area, it was felt that 1:10000 scale database content and accuracy was inadequate for this purpose.

The master plan aims at developing sustainable land management, which should lead to a decrease of poverty. The Food and Agricultural Organization (FAO) (1995) underlines that sustainable land management is of key importance to develop a country. They indicate that “an integrated physical and land-use planning and management is an eminently practical way to move towards more effective and efficient use of the land and its natural resources. That integration should take place at two levels, considering on the one hand all environmental, social and economic factors and on the other all environmental and resources components together”. Geographical Information System (GIS) technology is an important part of the Master Plan development process.

Zoning

Zoning is a method of urban planning in which a municipality or other tier of government divides land into areas called zones, each of which has a set of regulations for new development that differs from other zones. GIS technology is employed not only to edit and display maps as conventional GIS applications, but also to enhance work quality. These enhancements include an exploration of hidden information, the production of tentative zoning maps, recognizing potentially problematic areas, conducting crucial site investigations, facilitating informative public hearing, and presenting potential policies.

LO 3.2 – Identify GIS application in mapping

- Content/Topic 1: Soil mapping

Erosion map

Soil erosion is the removal, transport and deposition of soil particles by water or wind from their original place to another location. Factors that influence soil erosion are topography (slope steepness and length), soil erodibility (determined by properties such as texture, structure, moisture, organic carbon content, etc.), vegetation cover and management practices.

Geographical Information Systems (GIS) and Remote Sensing are combined together to provide the Universal Soil Loss Equations (USLE) model's parameters used in this study. The USLE model required annual rainfall data, digital elevation models (DEM), landuse classification map, and soil series map for extracting five parameters needed that are rainfall erosivity (R) factor, length-slope (LS) factor, soil erodibility (K) factor, vegetation cover (C) factor and erosion control (P) factor. The output soil erosion rate is classified into five classes, each is assigned to different soil loss rate. Based on the result produced, major soil erosion is assigned to class which the soil erosion rate is less than 10 t/ha/y. Class 1 is considered very low soil erosion rate, while Class 2 (10-50 t/ha/y), Class 3 (50-100 t/ha/y), Class 4 (100-150 t/ha/y) and Class 5 (>150 t/ha/y) are low, moderate, high and critical soil erosion rate respectively. From the study conducted showed that, the soil erosion are very low even though the study area is located in high elevation area as others parameters such as land use types, rainfall intensity and soil types are included to give better soil erosion estimation.

Geological map

Almost all digital or topographic mapping and most mapping projects require the digital maps generated using the integrated geographic information systems (GIS) and remote sensing techniques with geospatial databases. The use of remote sensing (RS) and radar images to produce geological maps is seen as making it possible to reveal those elements of geological features from images which should be reflected in the geo-spatial databases and digital maps. This study presents a way to incorporate digital data handling with both GIS and remote sensing techniques combined with geospatial databases and thus contribute to filling the gap between traditional geological mapping and modern geological studies performed with GIS and remote sensing techniques. The main part of this research relates to the development of a new and detailed geological mapping system that has been constructed to present geological and topographic information in a geo-databases frame in an easy-to-use way. The methodology and legend of the mapping system and geospatial databases which are suggested in this study have been successfully applied to various types of landscapes in the study area. The study area in the southeast of Libya has been mapped during the period of geological mapping system development.

- Content/Topic 2: Forest mapping

Natural forest mapping

Firstly the data are collected from the land cover, vegetation, soil and geology which are the parts of natural forest resources and then they are mapped using GIS technology. These data are collected using remote sense technique through aerial photographs or satellite image for study.

Maps that reflect the location and the qualitative and quantitative characteristics of forests. They are divided into current, reference, and educational types. The most important type is the current map, because such maps are needed in order to manage and plan the exploitation of forests.

The evolution of GIS, the Global Positioning System (GPS), and Remote Sensing (RS) technologies has enabled the collection and analysis of field data in ways that were not possible before the arrival of computers. GIS has proven to play a vital role in the following • Resource Management • Harvest planning • Fire Management • Map production • GIS for strategic planning and modeling. The range of applications reviewed in this essay is clear evidence to the significant value of forests and the potential of GIS to aid in their management. Despite the diversity of applications, however, a number of broad conclusions can be reached about the role of GIS in forestry.

Artificial forest mapping

The optimal and efficient management of Artificial forest resources call for reliable technologies with a provision to store, update, retrieve and analyze data. Towards this, tools like Geographic Information System (GIS) and Remote Sensing (RS) have been used for decision making and to derive meaningful outputs for plant resources conservation and management. The potential application of GIS is illustrated through various case studies ranging from development of Artificial Forest Resources Information System at divisional level to micro-level planning in Joint Artificial Forest Management areas. The studies related to plant diversity prospecting, inputs for Artificial forest working plans, etc. have also been discussed in the paper.

Touristic map

Tourist maps are one of the most common groups of cartographic documents. Their variety in terms of content, subject matter and publication titles is a result of growing popularity of diverse forms of tourism. Development of tourism is also driven by society's growing desire to travel and encounter new places and cultures, which is in turn most often inspired by mass media. Tourist trips and holiday travel became part of "lifestyle" of many people. The number of people who use non-traditional (not printed) forms of tourist maps has also been growing steadily. The non-traditional forms include all kinds of digital maps published on-line and maps created to be used on mobile devices, which allow for using electronic tourist maps directly in the area they represent.

Travel agencies use our mapping tool for catalogs and travel brochures. They can there point out their travel offer location by creating a locator map or round trips. Our tool provides print-ready files. You can export your maps in 10 different languages.

A geographic map designed for tourists. A specific requirement of tourist maps is that they be cle arly drawn and legible—

a requirement that applies to such supplementary map features as drawings, photographs, index ed guides, explanatory text, and various information and reference material.

Generalpurpose tourist maps, as distinguished from specialized ones, include such common geogr aphic features as road networks, population centers, rivers, lakes, forests, and land relief, as well as items of special tourist interest, including architectural and historical landmarks, preserves, nat ional parks, museums, hotels, tourist centers, and camping sites. Such maps serve to acquaint tou rists with a given district and provide information on possible travel routes, on the location of spe cific landmarks, and on the availability of tourist services.

- Content/Topic 3: Habitation High risk zone mapping

Wetland map

A **wetland** is a place where the land is covered by water, either salt, fresh or somewhere in between. Marshes and ponds, the edge of a lake or ocean, the delta at the mouth of a river, low-lying areas that frequently flood—all of these are **wetlands**.

Wetland maps are a prerequisite for wetland inventory and for wetland development planning, management, protection, and restoration. Maps provide information on wetland type, location, and size.

Wetlands are recognized as one of the world's most valuable natural resources. With the increasing world population, human demands on wetland resources for agricultural expansion and urban development continue to increase. In addition, global climate change has pronounced impacts on wetland ecosystems through alterations in hydrological regimes. To better manage and conserve wetland resources, we need to know the distribution and extent of wetlands and monitor their dynamic changes. Wetland maps and inventories can provide crucial information for wetland conservation, restoration, and management. Geographic Information System (GIS) and remote sensing technologies have proven to be useful for mapping and monitoring wetland resources. Recent advances in geospatial technologies have greatly increased the availability of remotely sensed imagery with better and finer spatial, temporal, and spectral resolution.

High slope area map

This map provides a colorized representation of slope, generated dynamically using server-side slope function on Terrain service. The degree of slope steepness is depicted by light to dark colors - flat surfaces as gray, shallow slopes as light yellow, moderate slopes as light orange and steep slopes as red-brown. A scaling is applied to slope values to generate appropriate visualization at each map scale. This service should only be used for visualization, such as a base layer in applications or maps.

LO 3.3 – Identify GIS application in infrastructures

- Content/Topic 1: Locating utilities

Road

Roadway construction planning processes involve a large amount of information on design and construction. GIS (Geographic Information System) is a strong tool for integrating and managing various types of information such as spatial and non-spatial data required for roadway construction planning. The roadway design process has been improved greatly by using CAD/CAE tools. Therefore, most design data are created and stored electronically. However, the digitized design data have not been fully utilized for construction planning purposes. In recent years, in the architectural engineering field, there has been lots of improvement in integrating design and construction information for using design data at construction planning stage [Yau 1992 ; Marir et al. 1998 ; Koo and Fischer 2000 ; Cheng 2001]. Attempts to utilize the digitized design data for construction planning was also taken up in civil engineering field recently [Hassanein and Moselhi 2002]. A GIS-based system for improving roadway construction planning is presented in this paper. The proposed system supports the roadway construction planning with 'Information Integration', 'Spatial Analysis' and 'Visualization' functions. The application of the proposed system is limited to road construction among the highway construction components that include roads, bridges and tunnels.

Pipelines

During operations phase GIS is expected to support pipeline Integrity Management by logging "events", inspections, activities and providing trending capabilities. As response GIS team has recently been implementing a HCA Calculation tool, designing an operations and maintenance monthly map report and shared geographic information through a Silverlight GIS website based on ArcGIS server. the facts demonstrated that GIS is a key tool for pipeline Management during pipeline life cycle.

Electrical line

GIS technique is used to create database and develop map which can show the spatial relationship between Company asset and their customers in the study area. The production of digital map and functional geo-database about the facilities will be able to show utility transformer and the rating of the transformer which can be used to determine the capacity of energy it can distribute and the current energy demanded on it. This will also show the numbers of customer attach to each transformer and the energy consumed by each customer.

GIS Application in Electrical line has the following objectives:

- Create electricity distribution network map that shows the spatial location of the transformer, low tension poles and low-tension lines of the study area.
- Create a map that will show the spatial relationship between transformer and consumer's connectivity to the transformer.

- Content/Topic 2: Road network

Road demarcation Bus stop

The study of identification and determination of bus stop locations and passengers boarding and alighting positions through the application of Global Positioning System (GPS) and Geographical Information System (GIS) methods. Previously, the locations of bus stop were designed without much consideration to the access and egress points of prospective passengers and other users. Using the case study of public bus operation in different world wide public transportation area, GPS method captured the locational points during on-board surveys while the GIS method produced the points mapping. As a result, the possible bus stop locations can be recorded and validated based on the passengers access and egrees points and volume patterns.
The aim of GIS is to analyse these empirical data to estimate the possible location of new bus stops within certain distance ratios. From this findings, public bus operators and authorities can determine/allocate/distribute the bus stop locations that may reduce the waiting time.

Road reserve mapping

All Road Reservers are traced from cadastral boundaries. Where the road reserve fall across District and Division boundaries, Road Reservers are also used to create the casements.

The geocoded address provides the spatial location of the address (point) and the conventional description of a block or group of blocks in the ACT generally consisting of a street number, street name, division (urban only) and district.

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