Chapter 4 Building a Digital Map

So far, you have been provided with the appropriate data files for cities such as Kathmandu, Kirtipur, so you could start working with a GIS without worrying about other issues. However, in practice, geographic data comes in different formats. This chapter introduces you to some of them, then helps you to put these diverse formats together to make an even more powerful map.

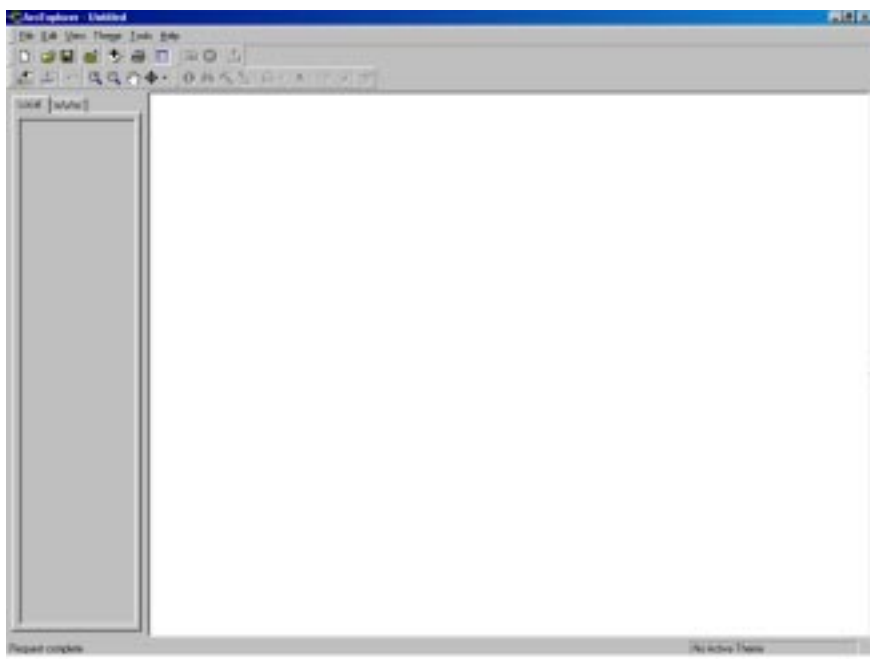
Exploration 9–Make a map of Kathmandu from digital data

Your new boss from the USA is coming to Kathmandu to work at ICIMOD. You have to find a place for him to live. Your new boss wants a house that is close to ICIMOD, not located in a highly air-polluted zone, and near to a hospital. After he arrives in Kathmandu, you have to present him with a map, so that he can decide where to stay.

You have several shape files such as location of ICIMOD, highways, major roads, city roads, hospitals and rivers. You have a satellite image that will make an interesting background. You also have an Arc/Info coverage of air pollution zones.

Step 1

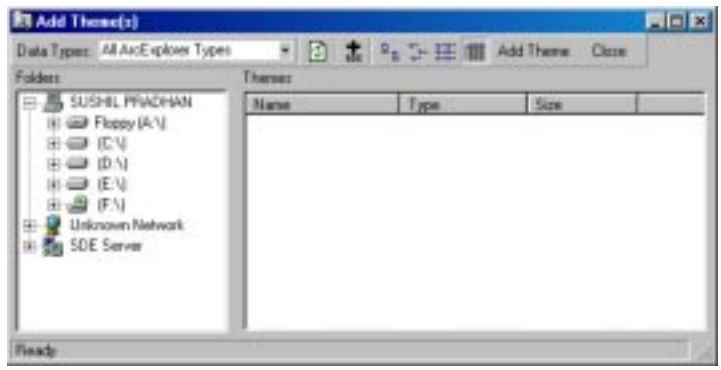
Start ArcExplorer, if necessary.



You see a blank map view and a blank legend.

Step 2

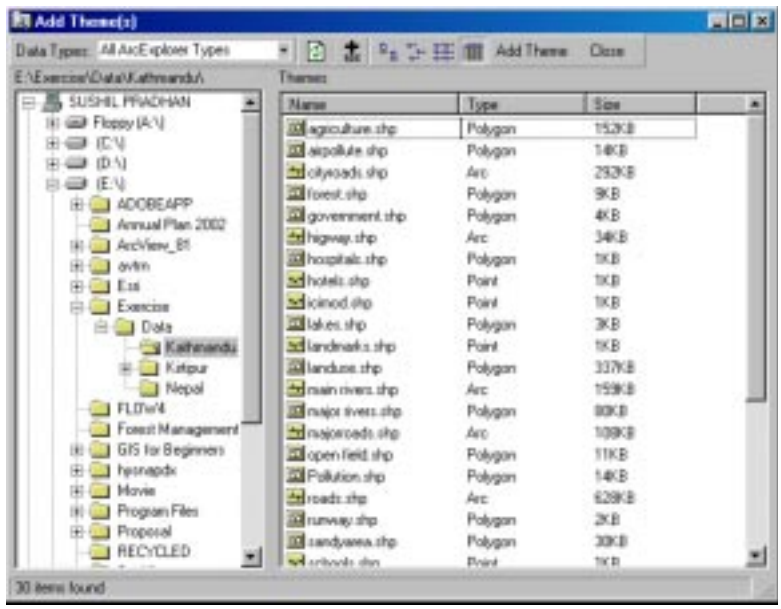
Click the Add Theme button. The Add Theme(s) dialogue box is displayed.



In this box, there are two windows. On the left is a list of all the drives and directories on your computer. This is where you find your data.

Step 3

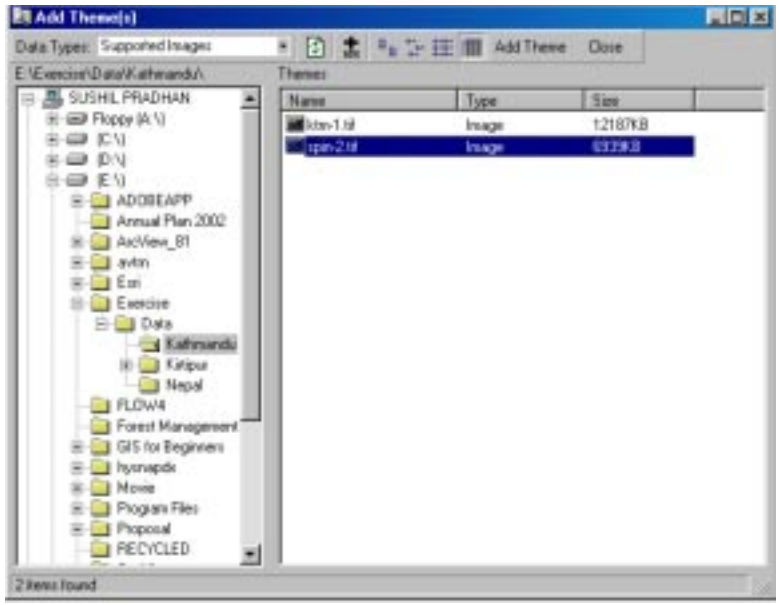
On the left side of the dialogue box, find your local drive where the data is stored. Then go to the *GIS Basics\Exercise\Data\Kathmandu* directory.



When you open the folder, you will see several themes with different formats listed in the right window. At the top of the box, in the Data Types window, All Arc Explorer Types is the default choice. For this selection, the right window shows shape files or image files.

Step 4

Using the Data Types pull-down menu, choose Supported Images.



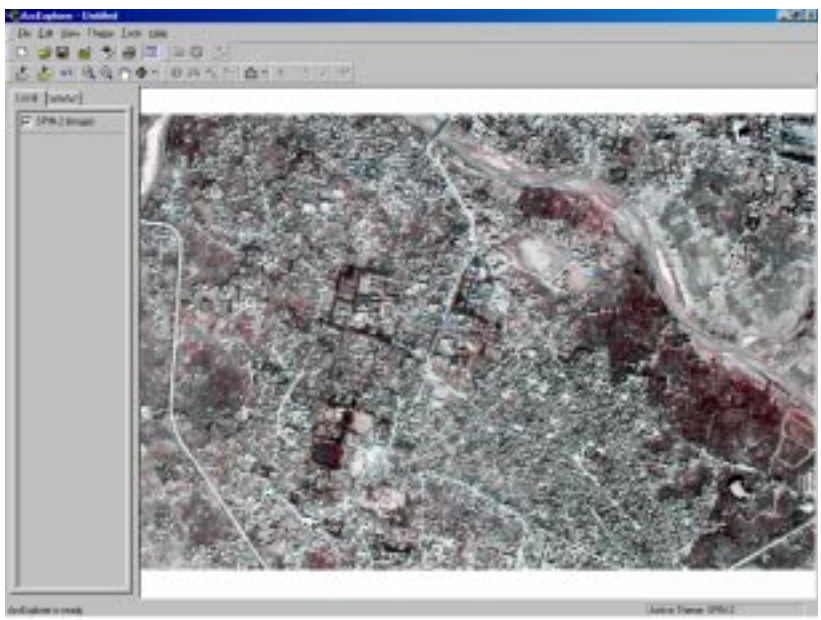
You see an image called spin-2.tif listed. You will add this image to the map view.

Step 5

Click on the file name spin-2.tif. Click Add Theme, then click Close. The theme is added to the legend as SPIN-2 (IMAGE).

Step 6

Turn on the theme SPIN-2.



Now you will add your shape files to the map view.

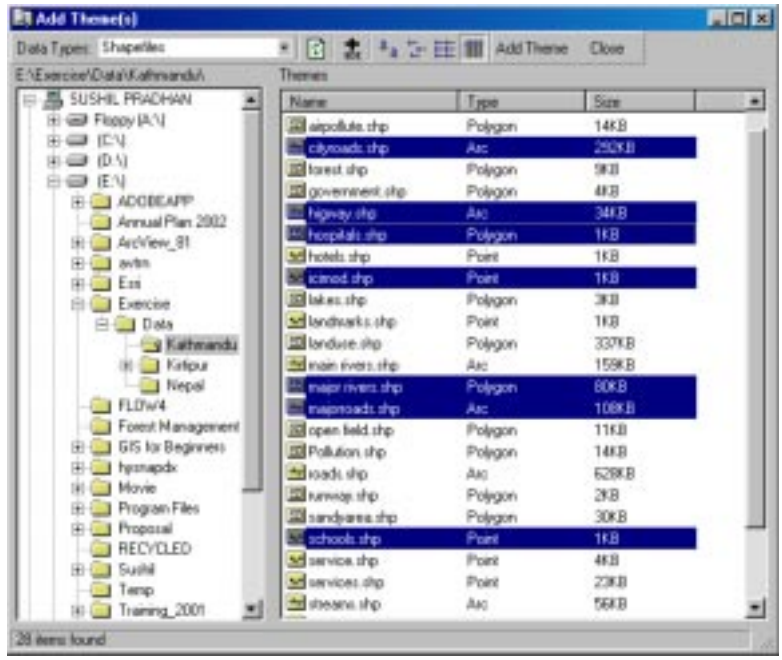
Step 7

Click the Add Theme button. In the Add Theme dialogue box, choose Shapefiles as the data type.

Only shape files appear in the Theme list.

Step 8

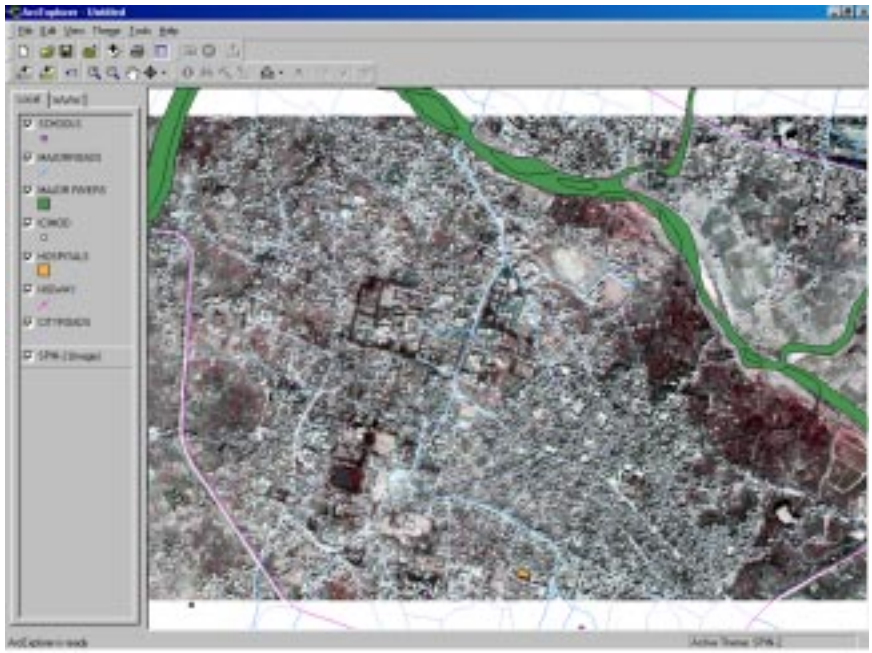
Click on highway.shp and Add Theme. To add more than one theme at a time, hold down the control key, click on cityroads.shp, majorroads.shp, major rivers.shp, icimod.shp and hospitals.shp. Then click Add Theme.



All the selected themes will be added to the legend. Then click Close in the Add Theme dialogue box.

Step 9

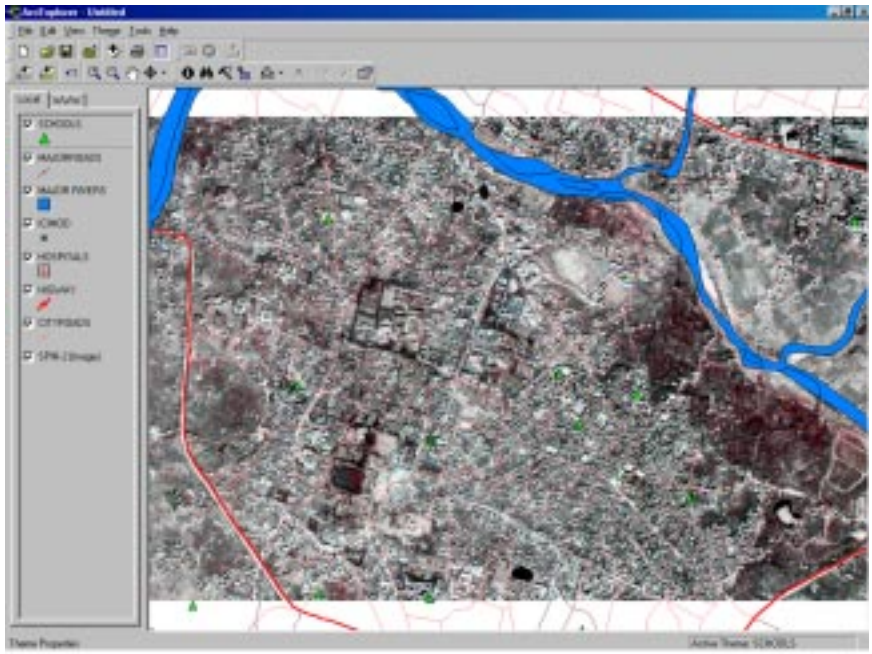
Turn on all new themes in the legend.



Since ArcExplorer assigns random colours to the new themes, you may need to assign more appropriate colours.

Step 10

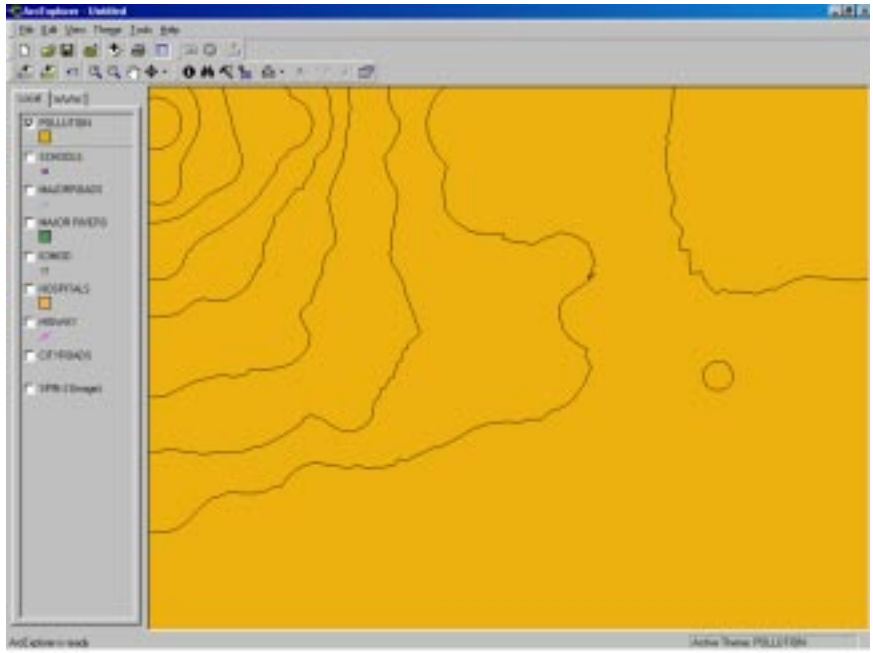
Use Theme Properties in turn for each theme to assign appropriate colours and symbols as shown below.



Your map looks better. All that you need now is the air pollution zone.

Step 11

Use the Add Theme button to add the Pollution.shp. Then turn on the POLLUTION theme.



ArcExplorer displays the themes in the order they appear in the legend from bottom to top. Since the POLLUTION theme is on top of the list, it covers all the other themes. You will move it down the list.

Step 12

Click on the name of the POLLUTION theme in the legend and, holding down the mouse button, drag the mouse pointer until it is above the SPIN-2 (Image), then release the mouse button.

Now you will need to symbolise the POLLUTION theme to show polluted zones.

Step 13

Make the POLLUTION theme active. Click the Theme Properties button.

In the Theme Properties dialogue box, select Unique Values under Classification Options. Select Zone as the field.

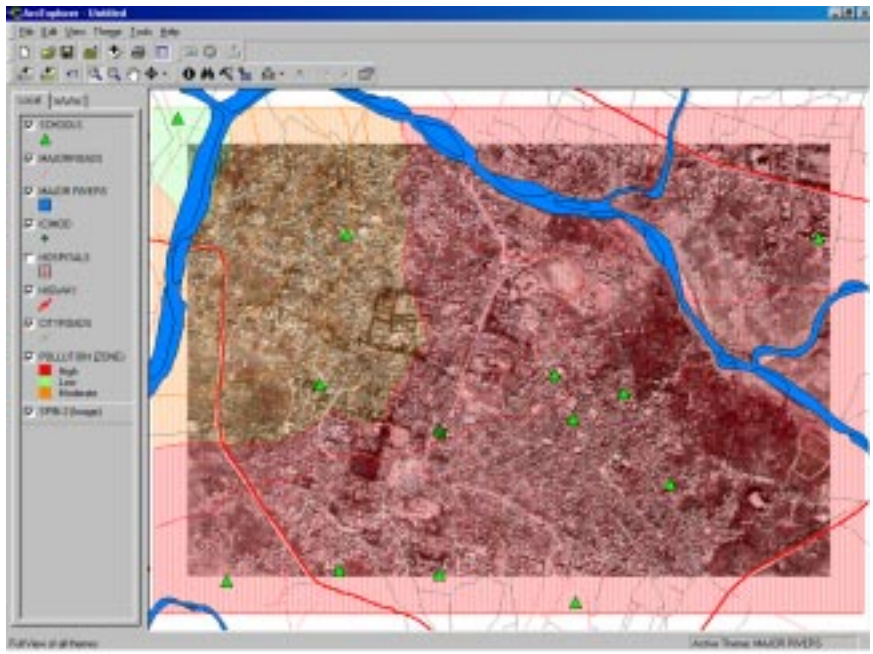
You see that ArcExplorer automatically assigned a random colour to each unique classification—high, moderate, low.

Step 14

Under discrete values and symbols, click on the colour box next to 'High'. In the Symbol Properties dialogue box, select dark red for both the colour and outline colour, and Light Gray Fill as the style. Click OK.

Step 15

Similarly select light orange and light green for 'Moderate' and 'Low' for both the colour and outline colour. Choose Light Gray Fill as the style for both 'Low' and 'Moderate'.



Your map view looks great. With this map, your new boss can decide where to stay. Now go ahead and explore your map. Use the pan and zoom to have a closer look.

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GIS Software

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Clark University. *http://www.idrisi.clarku.edu* IDRISI

Earth Resource Mapping Inc. *http://www.ermapper.com* ER Mapper

ERDAS Inc. *http://www.erdas.com* ERDAS IMAGINE

ESRI. *http://www.esri.com* ATLAS GIS, Arc/Info, ArcView GIS, ArcCAD

Intergraph Corporation. *http://www.intergraph.com/* Intergraph MGE, GeoMedia

ITC. *http://www.itc.nl* ILWIS

MapInfo Corporation. *http://www.mapinfo.com* MapInfo

PCI Geomatics *http://pcigeomatics.com* SPANS, EASI/PACE, PAMAP GIS

Glossary

Analogue maps	Maps in paper form
Aspect	The compass direction towards which a slope faces; measured clockwise in degrees from North.
Attribute	Non-spatial descriptive characteristic of a real-world phenomenon. Often a measurement or value associated with spatial locations.
Band	One layer of a multispectral image representing data values for a specific range of the electromagnetic spectrum of reflected light or heat (e.g. ultraviolet, blue, green, red, near- infrared, infrared, thermal, radar, etc.). Also, other user-specified values derived by manipulation of original image bands.
Base map	A map containing geographic features used for locational reference. Roads, for example, are commonly found on base maps.
Buffer	A corridor of a specified width defined parallel to lines or around polygons. Buffering is the process of defining the corridor and drawing the new geometry to delimit it.
CAD or Computer-Aided Design	Computer systems for drawing design graphics
Column	The vertical dimension of a table–a column has a name and a data type applied to all values in the column.
Connectivity	Describes whether sets of points (nodes) or lines are connected to each other.
Contour	A line connecting points of equal surface value
Control segment	A world-wide network of GPS monitor and control stations that ensures the accuracy of satellite positions and their clocks.
Co-ordinate pair (X, Y)	A pair of co-ordinates describing the location of a point feature on x and y axes. Sets of co-ordinate pairs are used to define lines and polygons.
Database Management System (DBMS)	A collection of computer software used for organising and accessing information in a database.
Data conversion	The translation of data from one format to another

Data dictionary	This contains information about definition, structure and usage of data in a database. No data are actually held here.
Data integrity	Maintenance of data values according to data model and data type, for example, to maintain integrity, numeric columns will not accept alphabetic data.
Data model	An abstraction of the real world that incorporates only those properties thought to be relevant to the application in hand. Also, a set of guidelines for the representation and logical organisation of data in a database, consisting of named logical units of data and the relationships between them.
Data quality	The quality of the data measured in relation to the actual phenomena measured at source
Database	An organised, integrated collection of data related by a common fact or purpose
Differential positioning	Measurement of the relative positions of two receivers tracking the same GPS signals
Digitiser	A device (usually electronic) for coding point locations on a graphic image or map to plane (x, y) coordinates
DTM or Digital Terrain Model	A digital representation of ground surface relief enhanced by the addition of topographic information
Electromagnetic spectrum	The spectrum of wavelengths of electromagnetic radiation (including infrared, visible and ultraviolet light)
Feature	A real-world phenomenon, named and classified– often used in cartography to name classes of elements shown on a map.
File	A collection of records, each of which can be referenced according to its position in the file
Format	The pattern into which data are systematically arranged for use on a computer–a file format is the specific design of how information is organised in the file.
Generalise	Reduce in detail, simplify or resample to change the level of information in a data set. The most common generalisation operation is line-thinning by discarding coordinates.
Geographic information	Information that can be related to a location (defined in terms of point, line and area); particularly information on natural phenomena, cultural or human resources.
Geographical Information System	A set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of circumstances.

Global Positioning System (GPS)	A GPS is a position-fixing system that uses the time taken for signals to travel from at least three GPS satellites in a known orbit to a receiver on the ground.
Grid	A geographic data model representing information as an array of equally sized square cells arranged in rows and columns.
Hardware	The physical device used to process a computer programme and display the results.
Image processing	The various operations that can be are applied to image or raster format data. These include image compression, restoration, enhancement, rectification, pre-processing, quantisation, spatial filtering and other image pattern recognition techniques.
Image	A graphic representation or description of a scene, typically produced by an optical or electronic device. Common examples include remotely sensed data (e.g. satellite data), scanned data and photographs.
Index	Special data structure used in a database to speed searching for records in tables or spatial features in geographic data sets.
Interactive	Describes a process of two-way communication between the user and the computer.
Interpolation	The procedure of estimating the values of unknown points on a surface from the values of a number of points of known value.
Isoline	A line on a surface connecting points of equal value
Latitude–longitude	A spherical reference system used to measure locations on the Earth's surface. Latitude and longitude are angles measured from the Earth's centre to locations on the Earth's surface. Latitude measures angles in a north-south direction. Longitude measures angles in an east-west direction.
Layer	Usually represents a theme or feature type within the database. Layers that are registered to the same co-ordinates as other layers can be integrated in different ways to create a new layer.
Line	The shortest distance between two points (sometimes called a line segment). In some GIS, many connected line segments are also referred to as a line. A one-dimensional object.

Map	An abstract representation of the physical features of a portion of the Earth's surface graphically displayed on a planar surface. Maps display signs, symbols and spatial relationships among the features.
Map algebra	A set of operations for manipulating, filtering and combining raster maps.
Map projection	A transformation from a spheroid to a flat plane representing the parallels of latitude and the meridians of longitude of the Earth.
Map query	The process of selecting information from a GIS by asking spatial or logical questions of the geographic data. Spatial query is the process of selecting features based on location or spatial relationship.
Map scale	The reduction needed to display a representation of the Earth's surface on a map. A statement of a measure on the map and the equivalent measure on the Earth's surface, often expressed as a representative fraction of distance, such as 1:24,000 (one unit of distance on the map represents 24,000 of the same units of distance on the Earth).
Meridian	A line running vertically from the north pole to the south pole along which all locations have the same longitude.
Model	A representation of reality used to simulate a process, understand a situation, predict an outcome or analyse a problem. A model is structured as a set of rules and procedures, including spatial modelling tools available in a geographic information system (GIS).
Multipath error	Errors caused by the interference of a signal that has reached the receiver antenna by two or more different paths. Usually caused by one path being bounced or reflected.
Network analysis	Analytical techniques concerned with the relationships between locations on a network, capacities of network systems and the best location for facilities on a network.
Overlay	The process of integrating digital representations of various spatial data registered to a common coordinate system.
Pixel	Short for picture element, i.e. the smallest discrete element that makes up an image. It may represent either a small square or portion of the Earth's surface, scanned by satellite or aircraft, a portion of a graphics image sensed by an optical scanner or an individual dot on a screen.

Point	The position or location of an object in a spatial reference system. A zero-dimensional object.
Polygon	An area with three or more sides intersecting at the same number of points. A two- dimensional object.
Projection	The procedure for transferring features from the spherical earth to a flat plane using mathematical transformations.
Query	A structured enquiry made on a map or database using a formal language.
Raster	A cellular data structure composed of rows and columns for storing images. Groups of cells with the same value represent features.
RDBMS	A database management system with the ability to access data organised in tabular files that can be related to each other by a common field (item). An RDBMS has the capability to recombine the data items from different files, providing powerful tools for data usage.
Record	A set of observations on a real-world phenomenon as described by attributes.
Remote sensing	The technique of obtaining data about the environment and surface of the earth from a distance, e.g. from an aircraft or satellite.
Resolution	Resolution is the accuracy at which a given map scale can depict the location and shape of geographic features. The larger the map scale, the higher the possible resolution. As map scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified or not shown at all.
Row	A record in an attribute table. The horizontal dimension of a table composed of a set of columns containing one data item each. Also a horizontal group of cells in a grid or pixels in an image.
Satellite constellation	The arrangement of a set of satellites in space.
Scale	The ratio or fraction between the distance on a map, chart or photograph and the corresponding distance on the surface of the Earth.
Scanner	The electronic device used to convert analogue information from maps or images into a digital format usable by a computer.
Selective Availability	A policy adopted by the Department of Defense in the USA to introduce some intentional clock noise

	into the GPS satellite signals thereby degrading their accuracy for civilian users.
Slope	A measure of change in surface value over distance, expressed in degrees or as a percentage.
Software	A system of programmes used to execute tasks written for the computer.
Space segment	The part of the whole GPS system that is in space, i.e. the satellites.
Spatial analysis	Analytical techniques associated with the study of locations of geographical phenomena together with their spatial dimensions.
Spatial resolution	Measure on the ground represented by each pixel in the image.
Table	A set of data elements that have a horizontal dimension (rows) and a vertical dimension (columns) in a relational database system. A table has a specified number of columns but can have any number of rows. A table is often called a relation. Rows stored in a table are structurally equivalent to records from flat files in that they must not contain repeating fields.
Theme	A user-defined perspective on a geographic data set, if applicable, by a name and feature class or data set name, attributes of interest, a data classification scheme and theme-specific symbology for drawing.
Topographic map	A map showing the features that describe the surface of a particular place or region. It contains contours indicating lines of equal surface elevation (relief), often referred to as topo maps.
Transformation	Mathematical conversion of coordinates between alternative referencing systems (e.g. as in map projection).
Triangulation	The interconnection of all points within an area to form a set of reproducible triangles
User segment	The part of the whole GPS system that includes the receivers of GPS signals
Variable	A discrete measurement on a parameter.
Vector data	A description of spatial phenomena based upon geometry (e.g., point, line and area)