CHAPTER III BASIC GIS CONCEPTS

3.1 GIS and Decision Making

Environmental management related decision-making is becoming increasingly complex due to decreasing natural resources and more demanding economic priorities. In spite of ever increasing environmental awareness, our nature and environment is still not well understood because of complexity of nature and many inter-related effects. In developing countries, addressing environmental problems is complicated by limited information, thus demanding for adequate and reliable data that can be used for understanding the environment and making environmental-friendly decisions in relation to conflict management, examine environmental impacts of the development projects, and so on.

Geographic Information Systems (GIS) can be defined as a computerized system that deals with spatial data in terms of their collection, storage, management, retrieval, conversion, analysis, modeling, and display/output. It evolved as means of assembling and analyzing diverse spatial data. The development of GIS is the result linking parallel developments of several other spatial data processing disciplines, such as cartography, computer aided design, remote sensing technology, surveying and photogrammetry. Due to increasing complexity of the real world situations, more challenges emerge in knowing about the precious earth, and also in planning and decision making processes. Today, GIS is considered as an important tool in planning and decision-making. It has been found applied in many fields, such as cadastral mapping, land use planning, forestry, wildlife management, infrastructure planning, zoning, military, environmental monitoring, network planning, facility selecting, including socio-economic applications (taxation, census, marketing, health planning). Some of the advanced applications at present involve air traffic monitoring, road navigation, crime analysis, and so on. At present, GIS has become the accepted and standard means of utilizing spatial data. Likewise, the use of spatial data is growing very rapidly in diverse fields.

The success with which a GIS can be used is determined by several factors that can be grouped as follows:

The Dataset – We cannot use the data if we do not have. Getting the relevant data is important for an efficient GIS and the most cost effective data collection would be to collect only the data we need. The optimum data quality is the minimum level of quality that can be satisfactorily used for intended purpose.

Data Organization – Data is of no value unless the right data can be in the right place at the right time.

The Model – A good model is the simplest model that correctly and consistently predicts the behavior of the real world for the phenomena of interest.

The Criteria – the criteria used should be such that is understandable to a same level by all involved, such as analyst, decision-makers, other stakeholders, etc.

3.2 Primary Data and Secondary Data

Data and information representing the real world can be stored in simplified forms and processed to facilitate decision-making (Figure 3.1) or it can also be presented later in simplified forms to suit specific needs. Geographical data come in many different forms. A basic distinction can be made between primary and secondary data.

Primary data refers to the sorts of information that can be collected first hand by fieldwork and questionnaire survey. The primary geo-spatial data can be collected from the sources, such as Geodetic Surveying and Geodetic Control Networks; Surveying; Photogrammetry; and Remote Sensing.

Secondary data are those found in published sources, such as official statistics, maps and aerial photographs, or are gathered by some agency other than you. Secondary data acquisition refers to the process of converting existing maps or other documents into a suitable digital form. This can be achieved by various techniques, which is discussed in detail in Section 4.4. There exists lot of secondary data but sometimes not all of them are available for use. Sometimes no convenient secondary data source exists and one has collect the necessary data conducting field survey which can be time consuming and expensive.

There are number of important points relating to why we collect data in the first instance and this should be considered on the ground of sound scientific approach of the problem before the real data collection process start. Depending upon the objectives, there may be two approaches. The *Inductive* approach, also called as classical method, involves observation and collection of data in the first stage followed by statement of theory and verification, where as the *Deductive* approach, also called as critical rational method, involves setting up the problem at the first stage followed by collection of necessary data and statement or theory at later stages.

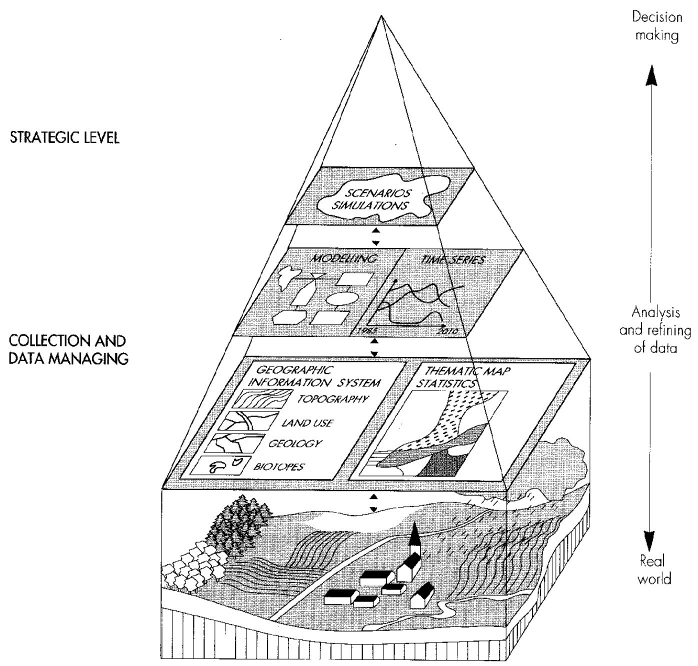

Figure 3.1. A Decision-making Pyramid.
Source: Bernhardsen, 1992 after Grossman, 1983.

3.3 Data, Dataset and Database

Data is information represented in the format of digit, letter and symbol used to describe status, behavior and their consequence of geographical object. There are some inner relations and different between data and information, as defined above, data indicates those value recorded and stored in computer, the meaning of the value represented is information.

Dataset is the minimum body of data used for data transform, storage, manipulation, copying, and other activities. Usually, there is one type of spatial data feature as point, line or polygon employed to represent one kind of geographical object such as river or topography or building. In most cases, data layer have the same meaning with dataset, but a few data layer can be organized into one dataset in some special occasions.

Database, as the word per se means data and base, is the combination of dataset according to the defined logical principles. Usually, the dataset in one database share the same data structure, data storage method, data format and similar data management interface. Except the dataset contained, database itself has some functions as data updating, data manipulation (extracting, clipping, overlaying, statistics), and user propriety definition. For geo-spatial database, database management system is often one part of GIS software package or some other DBMS database connected to GIS software package with some inter software component such as Arc SDE of ESRI. Figure 3.2 shows the concept idea of the Nam Chuen Watershed Database implemented by the Natural Resources and Environmental Management Project in Thailand (NREM, 2000).

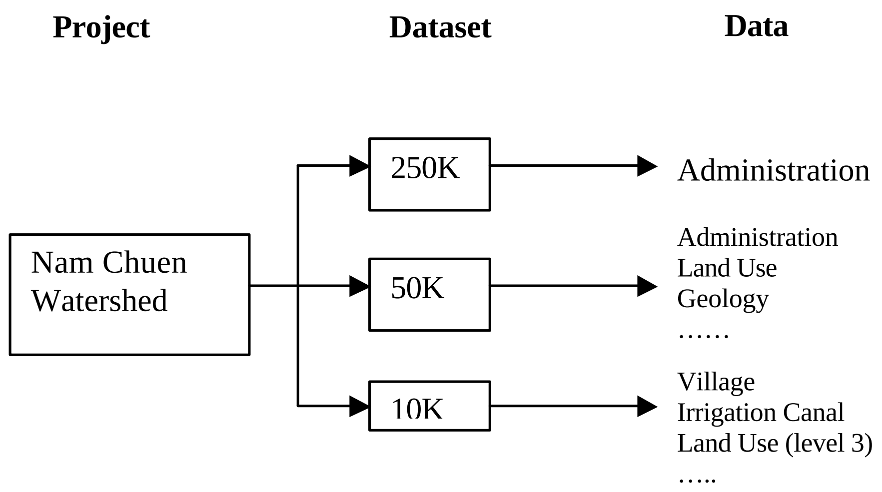

Figure 3.2 Example of the structure of database, dataset and data, Nam Chuen Watershed Project in Thailand (NREM, 2000)

The Nam Chuen GIS Database comprised of three datasets: scale 1:250,000; scale 1: 50,000; and scale 1: 10,000. These three datasets were stored in a common database structure that supported natural resources management. For each dataset, there were a number of layers, lookup tables and attributes depend upon mapping scales and availability of information.

3.4 Geo-Spatial Data

Geo-spatial data are also called as *Geographical data, Geographic data, Geographic Information, GIS data, Earth-sciences data or Geo-scientific data*, and *spatial data*. Geographical data are information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. The main difference between geographical data and other data is that the later helps answer question like, what? or where? as the former answers both what? and where? It is because that it contains *Geometric* or *Spatial* data for spatial elements and *Attribute* data (Figure 3.3). *Spatial data* is used to describe the location of geographical object, and attribute data describe the fundamental characteristics of the phenomena involved. For instance, the objects classified as buildings may have a number stores attributes with legitimate values of 1 to 10, etc. *Attribute data* can in turn be sub-divided into *Qualitative* and *Quantitative* data.

Historically several terms have been used to describe the data in a GIS database, among them *features, objects, or entities*. The term *feature* derives from cartography and is commonly used to identify "*features shown on a map*," while *entity* and *object* are terms from computer science used to identify the elements in a database. The normal dictionary definitions of these terms are:

Object: a thing that can be seen or touched; material thing that occupies space characterized by type, attribute, geometry, relation and quality.

Entity: a thing that has definite, individual existence in reality (e.g. house number)

Feature: the make, shape, form or appearance of a person or thing (e.g. circle, linear)

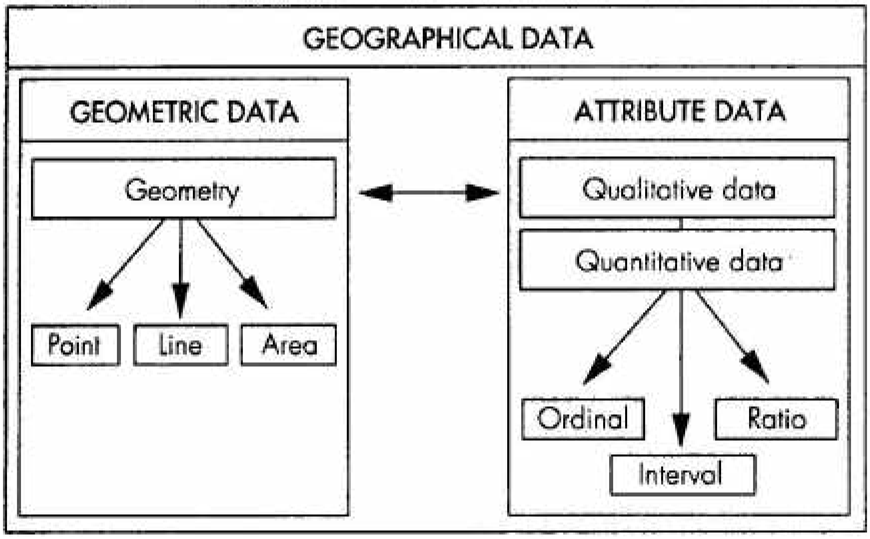

Figure 3.3 Geographical data can be divided into geometric data and attribute data (Bernhardsen, 1992)

3.5 Spatial Elements

Spatial objects in the real world can be thought of as occurring as four easily identifiable types: *Points*, *Lines*, *Areas*, and *Surfaces* (Figure 3.4). Collectively, they can represent most of the tangible natural and human phenomena that we encounter on an everyday basis. In general, points, lines, and areas are used to explicitly represent real-world objects, where as surfaces are mostly used for volumetric representation, such as to represent hills, valleys. Thus, all data can be considered to be explicitly spatial.

Point features are spatial phenomena each of which occurs at one location in space. Each feature is said to be discrete in that it can occupy only a given point in space at any time and considered to have *no spatial dimension* – no width or length. Example of such feature would be a house or a village. But a village can be represented by point feature or area feature as well depending upon the resolution of data.

Line features are conceptualized as occupying only a *single dimension* in coordinate space. They are represented as the series of single coordinates connected to each other. Roads, rivers, are the examples of linear features. The resolution or scale of given dataset once again places a fundamental limitation to conceive them as having any width. Linear features, unlike point features, allow us to measure their spatial extent/length.

Area features have *two dimensions* both length and width dimensions. Area is composed of series of lines that begin and end at the same location. We can describe their shapes and orientations, and the amount of territory occupied as well. In database, the term polygon is often used instead of area. Again, physical size in relation to the scale determines whether an object is represented by an area or by a point.

It is often that area is divided into regular squares or rectangles so that all objects are described in terms of areas. This entire data structure is called a *grid*. Each square or rectangular is known as a cell and represents a uniform value.

Adding the dimension of height to area features allows us to observe and record the existence of *Surfaces*. Surfaces have *three dimensions* – length, width, and height. For instance, hills, valleys, and ridges can be described by citing their locations, amount of area they occupy, how they are oriented, and by noting their heights.

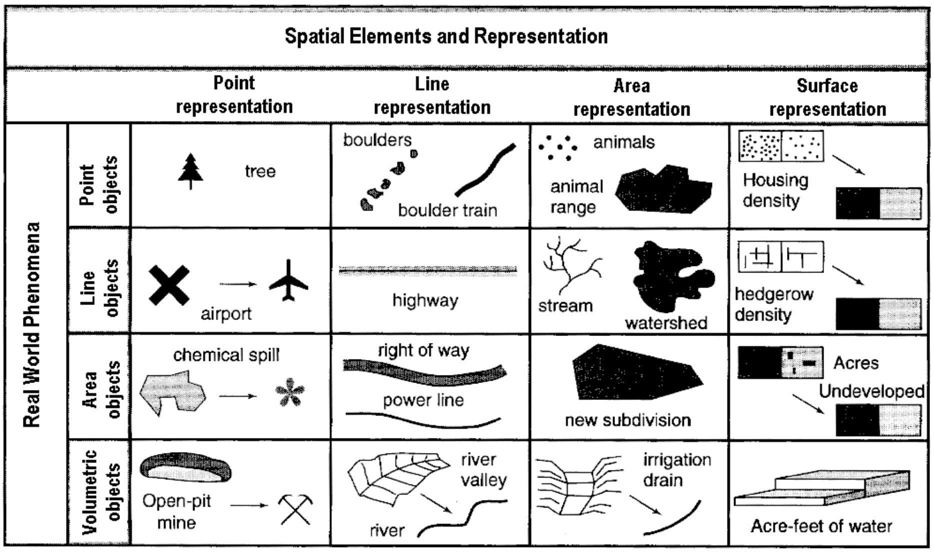

Figure 3.4. Spatial Elements and Representation.
Source: DeMers, 2000.

3.6 Spatial Measurement Levels

All these spatial feature or entities or objects we observe contain information not only about how they occupy space but also about what they are and how important they to what we are studying. For example a tree, viewed as a point in the landscape, might be classified based on age class: seedling, sapling and tree. The additional non-spatial information that helps us describe the objects we observe in space comprises the feature's attributes. However before we assign these properties or attributes, we must know how to measure them. There are four levels of measurement in terms of commonly used geographic features (Figure 3.5). The first two are the *nominal* scale and the *ordinal* scale, in which observations are simply classified mutually exclusive categories. The final two scales, the *interval* and *ratio*, are those we ordinarily think of as "*measurements*" because they involve determination of a classification of observation (Davis, 1986).

Nominal scale - is based upon classification of data into mutually exclusive groups or categories. This falls in *qualitative* category of attribute data. These categories may be identified by names, such as "red", "green" or "blue", as well as by types for examples "swamp", "desert" or "forest". Number may be used simply as identifiers, for instance village code. These can be no connotation that "2" is twice as much as "1" or "5" is greater than "4". Therefore, no attempt is made to quantify the size of the groups.

Ordinal scale – allows to rank the classes in a hierarchy of states, but not to distinguish between them on the basis of the size of a measured variable. For example, the minerals on the scale, which extends from one to ten, increase in hardness with higher rank, the successive states are not equal.

Interval scale – *Interval* scale of measurement is used when we have equal intervals between the measurement units. However, an interval scale has *no natural zero or no true starting point*. Such data can be compared, as in the case of ordinal data but yet more precise. A good example of spatial data consists of soil temperatures across a study area containing widely different soil types. Say for example, the soil types measured at the same time exhibit a difference of 40^0 F (i.e. 80^0 F for dark and 40^0 F for light soil). But one limitation remains, i.e. can we say the dark soil is twice as warm as the light soil? This is not the case, when we convert these values to Kelvin scale.

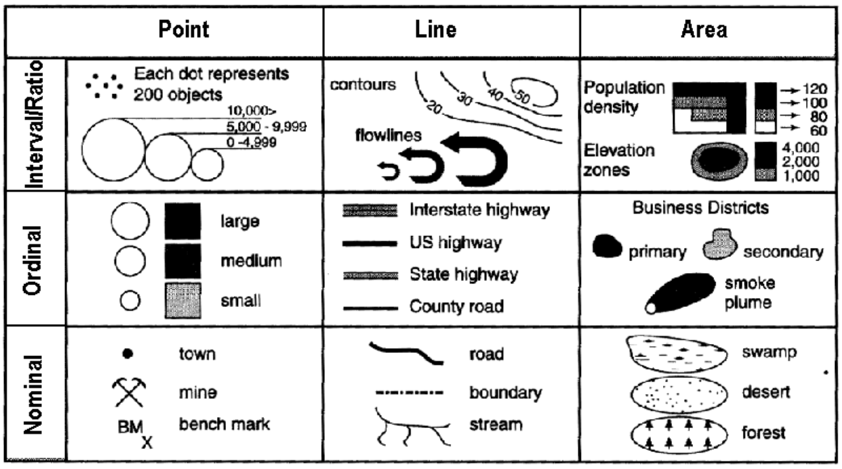

Figure 3.5 Measurement Levels.
Source: DeMers, 2000.

Ratio scale – Ratio scale is the highest form of measurement. It not only has interval scale between steps, but also has a *true zero point*. Measurements of length or conversion of Fahrenheit temperatures to Kelvin scale are of this type. Therefore, *ratio* scale allows us to make a direct comparison between two spatial variables. For example, a tree ten meters high is twice the height of a tree 5 meters high. And a tree is zero height does not exist because it has no length at all.

3.5 Basic Data Models

Spatial elements can be represented in two models: *Vector* and *Raster/Grid (*Figure 3.6). In the vector model, the spatial locations of features are defined on the basis of coordinate pairs. These can be discrete, taking the form of points (POINT or NODE data); linked together to form discrete sections of line (ARC or LINE data); linked together to form closed boundaries encompassing an area (AREA or POLYGON data). Attribute data pertaining to the individual spatial features is maintained in an external database. The data model used by the software, like Arc/Info, ArcView is Vector model.

In raster model, one or group of cell/grid/pixel depending upon the grid resolution represents spatial elements. Most of raster models adhere strictly to a single attribute per cell structure although some raster models support the assignment of values to multiple attributes per discrete cell.

Table 3.1 presents the advantages and disadvantages of Vector and Raster model. Vector data sets can have topology, i.e. in addition to the position of every feature; the spatial relationships of adjacency and connectivity between features are also maintained. Topological relationships are stored in a series of relational databases. Each database stores information about a feature. For example, a database would store the information about each individual arc, such as Number of the arc, Beginning node number, Ending node number, Polygon to its left, and Polygon to its right.

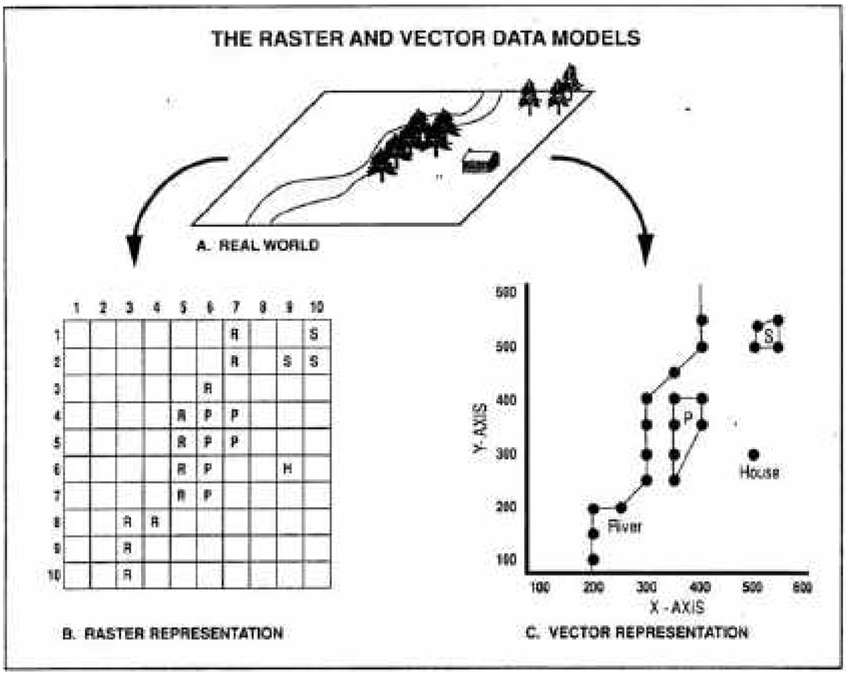

Figure 3.6 Comparison of the raster and vector models (Aronoff, 1991)

Table 3.1: Vector vs Raster data model

Vector	Raster
Advantages	
Compact data structure (less data volume)	Simple data structure
Efficient topology encoding, good for operations, such as network analysis	Easier and efficient overlay operation
Better graphics for precise expression	High spatial variability is efficiently represented
	Efficient in manipulation and enhancement of digital images
Disadvantages	
Complex data structure	Large data volume (data compression technique can overcome this problem)
Implementation of overlay operations is difficult	Difficult to represent topological relationships
Inefficient representation of high spatial variability	Less aesthetic graphic output
Not effective for manipulation and enhancement of digital images	Not good for some operations, such as network analysis

Within this model spatial data is not continuous but is divided into discrete units. In terms of recording where individual cells are located in space, each is referenced according to its row and column position within the overall grid. To fix the relative spatial position of the overall grid, i.e. to *geo-reference* it, the four corners are assigned planar co-ordinates. An important concept concerns the size of the component grid cells and is referred to as grid-resolution. The finer the resolution the more detailed and potentially closer to ground truth a raster representation becomes. Unlike the vector model there are no implicit topological relationships in the data. The following information should always be recorded when assembling, compiling and utilizing raster data:

- Grid size (number of rows and columns)
- Grid resolution
- Geo-referencing information, e.g. corner co-ordinates, source projection.

3.8 Scale and Resolution

Scale refers to spatial or temporal dimension of an object or a process, characterized by both grain and extent (Turner et al., 2001). But in geography, *cartography scale* is the ratio of the distance measured on a map to that measured on the ground between the same two points. For example a quoted scale of 1:100,000 implies that a distance of 1 cm on the map translates to a distance of 100,000 cm (or 1000 meters) on the ground. Often, the difference between large and small map scales is confused. The larger the ratio, the smaller the map scale.

Grain or resolution refers to the finest spatial resolution within a given data set. For example, grain refers to the cell size for grid maps or the minimum mapping unit of maps drawn with polygon. For example on a 1:100,000 scale map the smallest distinguishable distance is 0.5 mm which equates to a distance of 50 m on the ground. It is worth noting that the accuracy of a map cannot be 'better' than its resolution, but it can often be much 'worse'. *Extent* refers to the size of the overall study area.

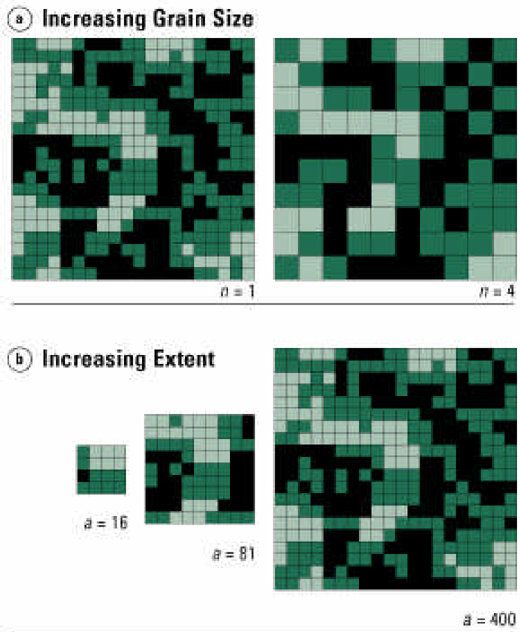

Figure 3.7 Grain and extent of cartographic scale (Turner et al., 2001)

Grain and extent are easy to think of when considering remote imagery. Different satellite sensors have different cell size, or grain. For example, there is a cell size of 10 m by for SPOT pachchromatic imagery, 30 m by 30 m for Landsat TM. Extent can very independent of grain, although there is some degree of correlation. For example, a small extent or small study area will require a small grain size, and a larger study area will require a larger grain size (Figure 3.7). The recommended mapping scale and mapping units used in hierarchical ecosystem classification is shown in Table 3.2.

It is very important to be aware of the scale of a given spatial data source as the degree of simplification and reduction involved in the representation of spatial features tends to increase as scale decreases. As map scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified, or not shown at all. This process is referred to as generalization. To give an arbitrary example, a map of an area produced at a scale of 1:5,000 may show villages and towns as discrete areas, whereas at a scale of 1:500,000 they will be portrayed as little more than dots. It is important to note that in a GIS where spatial data sets from a range of sources are integrated and the spatial resolution of a given data set can be altered at will, it is vitally important to be aware of such issues and not to analyze spatial information at a scale greater than that of the data source.

Table 3.2 Overview of hierarchical ecosystem classification at various scales

General Ecosystem Level	Ecosystem Unit Name	Mapping Scale	Size of Basic Mapping Unit
MACRO	Ecozone	1: 50,000,000	>62,500 km2
ECOSYSTEM	Ecoprovince	1: 10,000,000 – 50,000,000	2,500 – 62,500 km2
	Ecoregion	1: 2,000,000 – 10,000,000	100 – 2,500 km2
MESO ECOSYSTEM	Ecodistrict	1: 500,00 – 2,000,000	625 – 10,000 ha
	Ecosection	1: 100,000 – 500,000	25 – 625 ha
	Ecoseries	1: 25,000 – 100,000	1.5 – 25 ha
MICRO ECOSYSTEM	Ecotype	1: 5,000 – 25,000	0.25 – 1.5 ha
	Eco-element	< 5,000	<0.25 ha

Source: Turner et al. (2001)

3.9 Precision and Accuracy

Precision expresses the repeatability of the measurement, whereas *accuracy* expresses how closely a measurement represents the quantity measured (Figure 3.8). For the measurements normally of interest in GIS, precision is limited only by the instruments and methods used. In physical measurements, the number of significant figures carried in quantity expressed customarily indicates precision. For instance, a figure of 98.76 cm indicates that the distance is measured with a precision of a fraction of a millimeter.

Accuracy should be stated in terms of an interval in which a true value is assumed to lie. For instance, 98.76 ± 0.03 cm indicates that the true value is assumed to lie between 98.73 and 98.79.

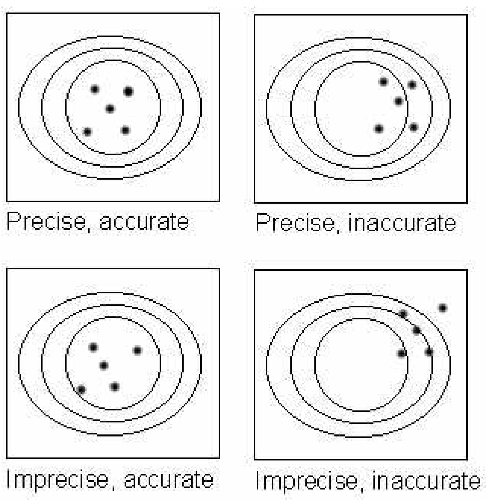

Figure 3.8 Precision vs accuracy

Map accuracy is the degree toward which any given feature(s) on a map conforms to its true position on the ground. *Horizontal* and *Vertical* accuracies are expected to conform to the U.S. National Mapping Standards (US-NMAS). For horizontal accuracy, US-NMAS require that at scales of 1:24,000 and smaller (for example, 1:100,000, 1:500,000) that 90% of a randomly chosen sample of well-defined map features will be on the map within 1/50 or 0.02 inches (at scale) of their true location on the ground. Table 3.3 illustrates the positional accuracy of several relevant scales.

Table 3.3 Desired horizontal accuracy for different scales**.**

Scale	Accuracy
1:12,000	± 20.3 feet or 6.09 meters
1:24,000	± 40 feet or 12.2 meters
1:63,360	± 105.6 feet or 32.2 meters
1:100,000	± 166.7 feet or 50.8 meters
1:250,000	± 416.7 feet or 127 meters
1:500,000	± 833.3 feet or 254 meters
1:1,000,000	± 1666.7 feet or 508 meters
1:2,000,000	± 3333.3 feet or 1016 meters

Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. For example, if you are testing the integrity of mapping with 2’ contours, 90 percent of the tested contour errors must fall within 1’ (Hohl, 1997). In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

3.10 Coordinate Systems and Map Projection

To analyze, manipulate, measure and store reasonably, geo-spatial data must be put into one certain spatial coordinate system. There are two kinds of coordinate system for geo-spatial data, *Spherical* and *Cartesian* coordinate system (Figure 3.9).

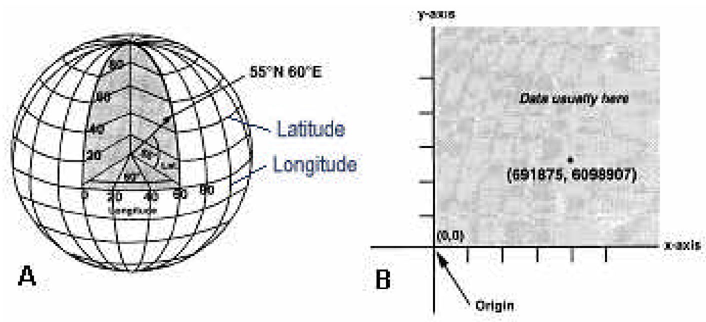

Figure 3.9 Spherical and Cartesian Coordinate Systems.

In *spherical coordinate* system, each point feature can be described uniquely with a pair of latitude and longitude value although latitude and longitude are not uniform across the Earth’s surface. In *Cartesian* or *Planar* coordinate system, each point feature on the Earth will be projected onto a flat surface by a pair of x and y coordinates on a grid. Using this system, the coordinates at the origin are x = 0 and y = 0. On a girded network and equal spacing, the horizontal line in the center of the grid is call the x-axis, and the central vertical is call y-axis. Therefore, coordinate value; measures of length, angle and area are uniform in this coordinate system.

The main co-ordinate reference systems for describing a geographic position mathematically are geodetic reference systems and map projections. *Geodetic reference systems* are used for describing the figure of the Earth and positions on it: *ellipsoids* (and the *sphere*) are used for describing the horizontal position. The shape of an ellipsoid is defined by a Semi-major and Semi-minor axis, and there are several spheroids available for use in different parts of the world. Each of them assume different semi-major and semi-minor axis. *Geoids* are the gravity related model for referencing the elevation. Geodetic reference systems have a *datum*, which defines the position of the spheroid relative to center of the earth. It defines the origin and orientation of latitude and longitude lines. There are two types of datum. *The latitude and longitude of a point, the azimuth of a line from that point, and the two radii needed to define the geometric reference surface that best approximates the surface of the earth in the region of the survey define horizontal datum. Vertical datum* ensures that elevation and depth measurements are held to a common vertical standard.

When we try to transform the location information on three-dimensional earth surface onto a two-dimensional map, *projection* is needed. In other words, *Map projections* are used to map the curved surface of an ellipsoid to a plane. This achieved by transforming the values with mathematical expressions. There are three major projection types, namely Planar (also know as Azimuthal), Conic, and Cylindrical projections depending on the shape of the developable surface (Figure 3.10).

Azimuthal projections, points are projected from the surface of the Earth to the plane. A commonly used projection of this type is the stereographic conformal projection. This type of projection includes Gnomonic, Stereographic, Orthographic, Azimuthal Equal Area, Azimuthal Equidistant, and Globular projection. Planar or Azimuthal Projections are used most often to map Polar Regions.

Conic projections result from conceptually transferring the earth's coordinates onto a cone. This family of projection includes Simple Conic, Two-Standard Parallel Conic, Lambert's Conformal, Albert's Equal Area, Conic Equidistant, Polyconic, and Bonne Projection.

Cylindrical projections are a family of projections resulting from conceptually transferring the earth's coordinates onto a cylinder. Cassini or Cassini-Soldner, Gall's Cylindrical, Mercator, Lambert's Cylindrical Equal-Area, and Transverse Mercator projection. *Universal Transverse Mercator (UTM)* projection system is one of the commonly used projection systems.

The two most commonly used projection system are Geographic and Universal Transverse Mercator (UTM). These coordinate systems can successfully be used in the context of GMS countries.

Geographic Coordinate System – In this system, all horizontal lines are called *latitude or parallels* and the vertical lines are called longitude or *meridians*. As the meridians line toward the poles, the distance represented by one degree of longitude decreases unit it equals zero at the North Pole and the South Pole. The origin of the Spherical coordinate is defined by the intersection of 0^0 latitude or the equator and 0^0 longitude

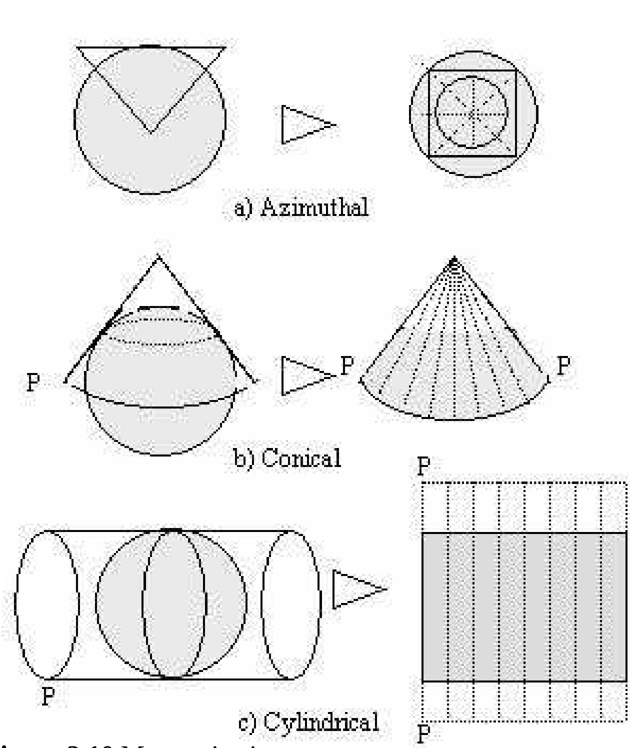

Figure 3.10 Map projections
(Redraw from Bernhardsen, 1992)

or the Prime Meridian passing through the Greenwich in U.K.

Latitude and longitude are angled measured from the Earth's center (not perpendicular) to a point on the Earth's surface. And they are measured in degrees, minutes and second (DMS) or decimal degree (DD). For example latitude 0° is located at the Equator, 90° is at the North Pole, and -90° is at the South Pole. The position of a point is uniquely defined by two angles: Latitudes 0° is the Prime Meridian, and longitude moving east from the Prime Meridian is measured positive up to 180°. On the other hand, longitude moving west from the Greenwich is measured negatively to – 180° (Figure 3.10). It is note that the Spherical or Geographic Coordinate System is a projectionless that may be used for the input, storage, and exchange of digital map data. Although it may also be used for the output of hardcopy maps, it is not, however, structurally suited for that purpose for smaller areas.

Universal Transverse Mercator (UTM) - is an international plane (rectangular) coordinate system developed by the U.S. Army. In this system, the world is divided into 60 zones, each covering 6 degrees of longitude. In latitude, extends from 84^0 N to 80^0 S (Figure 3.11). The origin of each zone is the intersection of the central meridian at the equator. High degree of accuracy is possible due to separate projection for each UTM zone. UTM values are calculated in meters. To eliminate negative coordinates, the projection alters the coordinate values at the origin. The value given to the central meridian is the *false easting*, and the value assigned to the Equator is the *false northing*. For locations in the Northern Hemisphere, the origin is assigned a false easting of 500,000 meters, and a false northing

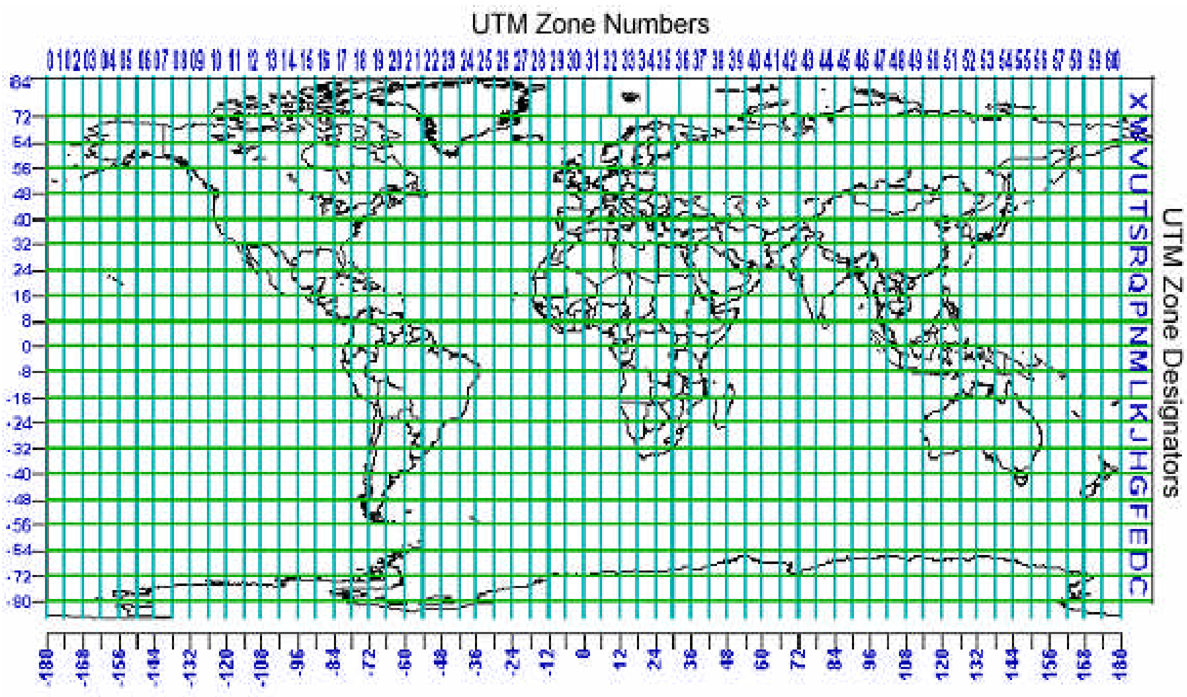

Figure 3.11 UTM System
Source: http://everest.hunter.cuny.edu/mp/cylind.html

of 0. For locations in the Southern Hemisphere, the origin is assigned a false easting of 500,000 meters and a false northing of 10,000,000 meters (10,000 km). In addition to minimize geometric distortion across each zone, the scale at the central meridian is reduced by a *scale factor* equal to 0.9996. This produces two parallel lines of zero distortion approximately 180 km either side of the central meridian.

The UTM system is consistent for the globe and is universal approach to accurate geo-referencing by preserving the local shape of the area (conformal type), thus frequently used. Of the disadvantages, the problems arise in working across zone boundaries and also there does not exist simple mathematical relationship between coordinates of one zone and an adjacent zone. UTM projection should preferably be used within the limits of any given zone. For example, the Kingdom of Thailand has been divided into two vertical zones (zone 47 and 48). Thus, projecting whole country in either zone is not desirable. This system may be used for the input, storage, and exchange of digital map data, as well as for the output of hardcopy maps.

Selecting a map projection depends on the location of area to be mapped. Virtually any map projection is acceptable while mapping a relatively small area. The choice of map projection becomes more critical while mapping larger areas. Building or storing of data in the context of GMS can be done using Geographic Coordinate System. Data can also be projected to (tropical region); the cylindrical map projection (e.g. UTM) gives the best result with minimum distortion. For transforming Geographical coordinates to other projection system, cylindrical map projections (e.g. UTM) are the appropriate systems as the GMS lies in the tropical region. For the purpose of transforming, we need to use spheroid and datum. In case of GMS countries, the spheroid called ‘Southeast Asia’ (semi-major axis 6378155 km., semi-minor axis 6356773.3205) is suitable one. The other global use spheroid called ‘Modified Everest’ (semi-major axis 63777304.063, semi-minor axis 6356103.039) can also be used. It is suggested to use the local datums for each countries whenever available.