UNIT 8  DATA STANDARDS AND TOPOLOGICAL CONCEPTS

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8.1  INTRODUCTION

Now, you are familiar with the concept of GIS and also how to input data in GIS format with various data models. It is essential to know about the data standards and topological modelling before creating a GIS database. GIS is capable of spatial analysis and it is possible only when the data are as per standards. Similarly, spatial analysis is possible only when there is topological data or there are topological relations among various spatial features in a data. In this unit, we will discuss about the data standards, topological concepts and modelling in GIS. Within the topological concepts you will learn about the connectivity, area definition and contiguity, and topological models and modelling.

We study about the spatial data standards for data creation in such a way that all the data are integrated seamlessly and without loss of information for further integrated viewing with spatial relations and analysis.
Objectives

After studying this unit, you should be able to:

• define data standards and topology;
• describe spatial data standards and infrastructure;
• describe importance of topology in GIS; and
• explain types of topological modelling in GIS.

8.2 SPATIAL DATA STANDARDS

Spatial data standards are the set of parameters required for data creation, sharing and usage where there is full compatibility in all the data during integration and usage. GIS integrates the disparate datasets together to get the real picture of any situation or place to make better decisions based on the spatial relationships, connections and patterns, which is possible through dataset of same standard. Spatial data standard also includes data source, format, coordinates and projection systems, scale, themes, attributes, methodology/technology, quality control, deliverables or final output, data exchange/sharing formats, metadata, documentation and certifications, which are commonly agreed by all data creators and users. Standards provide the yardstick against which quality can be evaluated, quantified and documented (Lo and Yeung, 2009).

8.2.1 Definition and Concepts

Standards as defined by the International Organisation for Standardisation as “documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose” (ISO/IEC Guide 2, 1996). The standards have also been developed and defined for various aspects of Geographical Information System through ISO/TC 211 GEOGRAPHIC INFORMATION/GEOMATICS which says that “the foremost aim of international standardisation is to facilitate the exchange of goods and services through the elimination of technical barriers to trade” (www.isotc211.org). Standards facilitate easy data integration, data sharing and increase interoperability among GIS. Some of the standards recorded in GIS literature (Bolstad, 2008; Lo and Yeung, 2009) are discussed below:

• **Standards for Data Creation** are the file formats like shape, .E00, dwg, dlg, dgn, etc.

• **Data Quality Standards** include the spatial, logical, attribute, etc. accuracies which are set for particular applications.

• **Spatial Reference Standards** are projection and coordination system and accuracy standards comprise positional, thematic and attribute accuracy.

• **Analysis Standards** define the methodology for data analysis and data transfer formats are like Spatial Data Transfer Standards (SDTS), DXF™ and GML.

• **Professional or Certification Standards** ensure data quality and certification standards.
• **Delivery Standards** are media standards like CD/DVD-ROM, magnetic tape, external/pocket hard disk drive, pen drive for soft copy and paper type and size for hard copy data.

• **Documentation Standards** capture the whole process ranging from beginning to end like project details, data source, methodologies, quality check and certification procedures, and delivery formats, etc.

Normally, the individual departments require databases of other departments for their use in planning and administration. For instance, land record and land use/land cover data are central to many departments for their functions. These are even shared with the banks for agricultural credits and other loans. Similarly, disaster management department may require database from various agencies to cope-up with the man-made and natural disasters. The biggest problem in data sharing is the incompatibility of diverse databases prepared by different agencies as these maps or data are prepared at different scales, times and projections. Similarly, different GIS software used to create database for various purposes also lead to conversion problems.

These examples make it obvious that different data formats and standards (scale and time) make GIS very difficult to integrate databases for analysis and end goal. Hence, until and unless all databases are created in uniform standard, they cannot be used seamlessly by various departments for different purposes. To overcome the problem of data integration and interoperability, international and national level data standards have been defined to make data seamless such as Global Spatial Data Infrastructure (GSDI), Spatial Data Infrastructure (SDI) and National Spatial Data Infrastructure (NSDI). The major international standard for GIS was developed by the International Organisation for Standardisation (ISO) in the form of STANDARDS GUIDE - ISO/TC 211 GEOGRAPHIC INFORMATION/GEOMATICS in 2009 (www.isotc211.org). For high accuracy and seamless data sharing, today the most widely used reference system is UTM WGS 84. For example, placing ones data on its own interest on Google Earth is possible only by following the data standards.

Therefore, by using the central spatial data infrastructure important information can be shared by various organisations because such information is created with the same standards. It is important for GIS to be shared among various users and also to be interoperable. Hence, one has to define the open standards for high interoperability across different platforms, databases, development languages and applications.

### 8.2.2 Interoperability

**Interoperability** means the flexible mobility of GIS database in terms of its usage where it can be opened and analysed in any software by any GIS professional. Interoperability in its strict sense is the hurdle free mobility of GIS database from one computer environment or software to other without losing its quality and quantity. Interoperability allows GIS database to be opened, edited and analysed in any GIS software in addition to the software in which the data was created.

In initial phase of GIS development, GIS database used to be proprietary, where none other than creators were able to use the data. Gradually, a non-profit organisation was constituted in 1994 known as Open GIS Consortium (now Open Geospatial Consortium (OGC)) to develop a common GIS standard for database creators, software providers and others involved in the use of GIS.
GIS Database Creation

Hence, data created anywhere by anyone in any open standard software may be used by others.

### 8.3 SPATIAL DATA INFRASTRUCTURE

Spatial Data Infrastructure (SDI) can be defined as an umbrella of standards, policies and procedures under which various organisations and technologies interact to promote more efficient use, management and production of spatial data (Ryttersgaard, 2001). Further, it facilitates optimum and rational use/sharing of data for national, regional, public and private users and such sharing of data depends on the effective management of data, metadata and web services. Because of extensive uses of SDI, many countries are developing SDIs through state, national and regional levels to the global level to better manage and utilise the spatial data.

The basic idea of having SDIs at different levels such as Global Spatial Data Infrastructure (GSDI), Spatial Data Infrastructure (SDI) and National Spatial Data Infrastructure (NSDI) is to have seamless GIS database as infrastructure for development, planning and other applications at various levels. Once database is created, it is disseminated for all categories of users through web GIS or geoportals. Data is not only created, maintained and disseminated but also analysed through services provided by geoportals.

**Global Spatial Data Infrastructure:** It is defined by GSDI Steering Group in 1997 as the “policies, organisational remits, data, technologies, standards, delivery mechanisms and financial and human resources necessary to ensure that those working on the global and regional scales are not impeded in meeting their objectives” (Ryttersgaard, 2001). It defines a framework for data creation, maintenance and data sharing by the users across the globe.

**National Spatial Data Infrastructure:** NSDI is the spatial data infrastructure unique to a particular country and which is typically based on the requirement of the country. It defines the procedures for data acquisition, capturing and processing, management and sharing. In India, it was created in the year 2006 and various organisations are made responsible to create the database on defined guidelines. Based on these specifications metadata is prepared.

### 8.4 TOPOLOGICAL CONCEPTS

Let us now learn about the topological concepts. Topological concepts are the storage and management of spatial data with their spatial relations.

Topology is a concept involving mathematical formula and procedures which establishes spatial relations like connectivity, adjacency and coincidence among geographical features. In other words, topology is the spatial relation among geographical features, e.g., point, line and polygon in GIS. It determines the relationship between connecting or adjacent features. These are complex elements with coordinates. It contains the information on how points, lines and polygons are spatially arranged in terms of location, distance and direction. It also defines the common boundaries of different areas or polygons. Spatial queries based on adjacency with left and right locations and connectivity like distance between two points or locations, buffering, intersecting, union, etc., are possible only with topological data as these data are spatially related to each other.
You will learn about the three basic components of topology – connectivity, area definition and contiguity in the following sections.

**Check Your Progress I**

1) Why data standards are required?
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2) Describe topology. How relations are established among spatial features?
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**8.5 CONNECTIVITY**

Connectivity is a topological relationship that enables arcs to connect to each other through nodes. It has *arc-node* topology, where vertices define the shape of the arc and nodes define the start and end point of an arc or intersections of the arc (Fig. 8.1). Connectivity is primarily used to find out the shortest path or best route (route optimisation) in terms of distance, time taken, traffic volumes, impedance, etc. Apart from transport analysis and fleet management, it is also applied to all linear features like hydrological features (rivers and streams), telephone network, power line network, sewerage network, etc. for planning, monitoring and management.

**Fig. 8.1: Arc-node topology; line features share end points (i.e. nodes)**
Area definition and contiguity are the concepts defined by topology. An area definition is done by delineating a particular area which is different than other surrounding space. It is defined by a closed polygon. The contiguity is defined as the continuity of space without any gap sharing a common boundary as obvious component. In the following subsections, you will learn about these concepts in detail.

### 8.6.1 Area Definition

Strictly speaking, the area is a contiguous homogeneous space where the homogeneity is found in terms of physical, political and/or socio-economic factors. In GIS, various geographical features are delineated separately based on some homogeneity criteria or some uniqueness. For example, based on physical features like land use (built-up area, agricultural fields, forest area, waterbodies), land parcels, or administrative boundaries, etc. In GIS, an area is represented by the vector model in which a polygon enclosed by one or more boundary lines (arcs) using polygon-arc topology as shown in Fig. 8.2.

![Fig. 8.2: Polygon-arc topology showing an area (e.g., polygon 1 and 2)](image)

### 8.6.2 Contiguity

Contiguity is the geographical concept where areal features are continuous. In GIS and topological sense, contiguity is the spatially continuous areas without any gap or disjoint. It basically defines the adjacency in topological data model. Contiguous areas must be connected to each other spatially. For example, two areas are contiguous if they have or share the common boundary. This concept of adjacency or contiguity enables many neighbourhood and overlay operations in GIS. Based on this concept, contiguous areas are dissolved on certain common properties. For example, the continuous areas with common soil type may be dissolved into one area based on the contiguity. If arcs and polygons are taken together, the adjacent areas are separated by a common boundary (arc), which is topologically defined as left and right polygons of the common boundary arc.
In contiguity, every arc has a direction, the spatial information maintains the polygons on the left and right side of each arc and this way the spatial relations are established. The direction of arc defines the left and right place of a polygon. It has already been illustrated in the Fig. 8.2.

Check Your Progress II

1) What is arc-node topology? How does it define the connectivity?

2) What are area definitions and contiguity? Discuss their importance?

8.7 TOPOLOGICAL MODELLING

In GIS, topology contains a set of rules/guidelines that describe how points, lines and polygons share geometry. It is employed to manage share geometry, define data integrity rules, aid topological relationship queries and navigation, support editing tools and construct features from unstructured geometry. Whereas topological modelling is systematic flow of processes and commands with defined conditional parameters involving multilayer GIS database to get desired results in spatial format. Let us discuss topological modelling in detail.

8.7.1 Definition

Topological modelling is a well organised cluster of functions to process spatial and non-spatial data in GIS platform to get results of questions of various types. It involves many data layers along with statistical data while modelling process. In other words, topological modelling are GIS modelling which refers to the use of GIS in building analytical models with spatial data (Chang, 2002).

The capability to solve the complex issues by answering spatial questions such as where, how and what, if based on several layers of spatial data and their attributes in GIS is termed as **topological modelling**. These spatial analyses are reiterative, where a set of systematically arranged commands process the data stage-wise to provide answers spatially or in the form of maps. The modelling tools may be endless and created as per the requirements. The modelling (static and dynamic) may be network, surface and 3D modelling. Hydrological, geo-statistical, forest fire, flood and traffic flow modelling are the some of the common types of modelling.
The flow chart of GIS modelling from database creation to the final output is shown in Fig. 8.3:

![Flow chart of GIS modelling](image)

**Fig. 8.3:** Flow chart of a typical GIS modelling

The modelling procedure is illustrated below in Fig. 8.4:

![Enlarged view of modelling procedure](image)

**Fig. 8.4:** Enlarged view of modelling procedure shown in Fig. 8.3. Where 1 and 2 are input data for processing, 3 is a processing tool of GIS like overlay or buffering and 4 is the result of the process (source: http://webhelp.esri.com)

### 8.7.2 Topological Models

Models are the simplified representations of real world phenomena in pictorial, graphic and mathematical forms. Models simplify the real world retaining the real situations with their functional relationship of reality in an ordered manner, which are put in mathematical terms while processing for some results in virtual manner. In the case of topological modelling, topological properties of spatial database are used for deriving desired result.

GIS models can be categorised differently based on their characteristics and functions as broadly given below:

- descriptive and prescriptive
- spatial and analytical
- static and dynamic
• stochastic and deterministic, and
• inductive and deductive.

**Descriptive model** is the representation of existing situation while **prescriptive model** answers “what could be” after applying certain conditions. For example, what is the present extent and situation of Delhi city is a descriptive model whereas the model showing the characteristics of Delhi city after 20 years is a prescriptive model.

**Spatial data model** represents the data structure and distribution of features in geographical space, which you have read in the previous sections. An analytical model replicates the interaction of processes of spatial features as closely as possible and enhances the decision-making capabilities of the decision-makers.

**Static models** are like locational or site suitability analysis dealing with static information while **dynamic models** are associated with dynamic information like hydrological flow or real time traffic flow, wildfire, flood, epidemics, etc. Cartographic representations are the best examples of static model, which represents the geographic data for a particular time or year. The **dynamic models** use spatio-temporal information, where what if types of modelling are done.

The deterministic and stochastic models are mathematical models with equations combining parameters and variables. **Deterministic model** is a type of spatial modelling, which gives the known result based on the known input. The **stochastic models** are known as probabilistic or statistical models, which involve interpolation and randomisation of variables like kriging interpolation.

**Deductive models** draw results based on scientific theories and physical laws (flood modelling) whereas **inductive models** draw results based on the observations and empirical data (disaster impact caused by flood using data).

Modelling is done by iterative methods where same activity is done multiple times and in different stages also. The strength of GIS modelling is its spatio-temporal modelling using various models where one can see the changes in particular feature or phenomena based on its dynamic characteristics. For example, GIS answers the questions like “what will be the submerged area after 10 days depending on physiography, predicted rainfall, runoff and inundation”. This way forest fire, impact of epidemics, oil spill, migration of people to certain area due to some pull factor, etc., may be fit into the spatio-temporal model based on several spatial layers and non-spatial information. There are various approaches and techniques of modelling known as binary, index, regression (linear or logistic) and process models.

### 8.8 EXAMPLES OF TOPOLOGICAL MODELLING

Topological modelling may be purely based on contiguity and area definition or connectivity or mixture of both. In the following sub-sections you will be familiarised with some examples of modelling.

#### 8.8.1 Network Modelling

You have studied the network data model in Unit 6 of MGY-003. In network modelling, the locations are interconnected with routes and lines, which indicate source and destination path, distance from one location to other, the best, optimal and shortest route path, property of the route, optimal cyclic path, resource allocation/distribution analysis, location or site selection of utilities, searching closest facility, impedance/hindrance and so on.
The network modelling is based on the geometrical data (graph) and its associated properties related to network connectivity like turns, stops, facility points, blocks (dead end from where nothing can flow) and other features like overbridge or underpass, intersections (nodes) and stops. All these properties are assigned to the GIS network data model as per real world situation. And, finally, a simulation model is run using geospatial tools supplemented by complex statistical/mathematical tools and results are obtained. Network data modelling further includes following models:

**Shortest Path Model:** Within network modelling, shortest path is one model, which determines the shortest route between two locations (points) of origin and destination. The model uses a set of mathematical expressions and logical rules systematically ordered which calculates the distances with respect to all nodes and gives the output based on the shortest length of the arcs in the network. It uses the algorithms like minimal spanning trees. One such mathematical model ‘**Dijkstra Algorithm**’ for shortest path has been developed by a Dutch computer scientist Edsger Dijkstra in 1959 using shortest path tree. To find the shortest path from the origin node to the destination node, the procedure starts with finding the first and closet node to the origin and continues in iterations till it reaches the destination location or node. It is used in many of the decision making process like travel, service delivery, emergency response, business, etc. You may see in Fig. 8.5 how the shortest path has been defined using the above said process.

![Fig. 8.5: Path trace for shortest path between the origin and destination nodes](image)

**Dynamic Segmentation:** Dynamic segmentation is a process of modelling routes and events where events are located on route networks linear references. In other words, it is the process of computing the location of events along a route network based on the distance of the event from the origin (Fig. 8.6). The routes contain the distance parameter in the attribute table attached to the geometry. Locations of the events are identified by calculating the distance of events from any known reference point on the route. For your clarity, the routes are the transport networks, drainage network/rivers, pipeline, power supply network, telephone network, sewerage line; and events are the attributes associated to them like broken road, location of damaged bridge, accident site, pools in river, pipeline leakage position, location of power transformer, etc. All these events are linearly referenced with route’s geometry.

Dynamic segmentation combines both the measuring systems – linear reference system and projected coordinate system – together by using routes, measures
and events as projected coordinate system uses $x,y$ coordinates (latitude-longitude) for locating geographical features or events.

**Scenario 1:** In this example, an event table containing information on a highway repaving project was edited following partial completion of the project. These changes in From and To measures are reflected in the map.

**Scenario 2:** An intersection sign was assigned to the wrong street in the database. When the sign location was corrected using GPS data, the route identifier was changed to the appropriate value in the table and the sign is now displayed in the correct location.

**Fig. 8.6:** Examples showing the process of dynamic segmentation in the map and table (source: Jennifer, 2002)

**Location-Allocation Model:** Location-allocation modelling is the process of determining the optimal locations for services and facilities. It helps in answering the questions like ‘which site for a new fire station would provide the best response times for the community’ or ‘where a factory should be built to minimise the distance to distribution centers’. A very common example may be the locating a new school at such a place which is within one kilometer of all the settlement/houses of that locality minimising the travel distance time of children and making the school accessible to all children. It responds to the demand supply gap (Fig. 8.7).

There are two elements in this model, namely:

i) **Location** - which is the target to be identified for locating the service point minimising the travel time; and

ii) **Allocation** - which is the area to be served or service area for the maximisation of coverage.

**Fig. 8.7:** Elements of location-allocation model; (a) travel distance from the demand points and (b) maximum coverage of supply point
Fig. 8.7 shows the optimal location of service point which is equally accessible from all points of the area defined by radius optimising the travel time as equal for all. In this model, three data inputs are essential - demand, supply and distance measures. In this model, the shortest travel distance is calculated in the distance matrix where the service location or point is in the centre and demand around it is scattered or linear. This model uses two common algorithms which are:

- minimum distance model, and
- maximum covering model.

The **minimum distance model** is also called *p*-median location model, which minimises the distance to be travelled to a nearest supply (service/facility) centre from all demand locations.

The **maximum covering model** maximises the coverage of demand within specific distance with minimum time. In this model, both aspects are taken care of – minimum travel distance from the interest of beneficiaries and maximum coverage from the interest of service providers. Based on these principles along with other associated parameters, the site selections are done for service or business points like health or educational facilities, recreation facilities, commercial centres, emergency response centres, etc.

### 8.8.2 Spatial Interaction and Gravity Model

The term **spatial interaction** is coined by E.L. Ulman in 1980. It represents the interdependence between geographical areas. In other words, it is the flow of people, products and information due to the diversity or differences of locations on the Earth in terms of availability of resources in various forms. It involves interaction between the demand and supply as mentioned in the location-allocation model, which are arranged in a complex but systematic flow of relationships. It exhibits a combination of adjacency or spatial proximity in spatial autocorrelation and distance in nearest neighbour analysis.

**Gravity model** is used to estimate the spatial interaction resultant from human process. It is a mathematical model based on the Newton’s gravitational equation given below (Johnston et al., 1994):

\[
G_{ij} = g \frac{M_i M_j}{d_{ij}^2}
\]

Where, \( G_{ij} = \) Gravitational force,
\( g = \) Gravitational constant,
\( M_i = \) Mass (location) 1,
\( M_j = \) Mass (location) 2,
\( d_{ij} = \) Distance between two masses.

This equation explains that the gravitational force between two masses or locations is proportional to a gravitational constant and to the product (volume/size) and inversely proportional to the square of the distance between them. Same principle was applied by E.G. Ravenstein in Law of Migration (1885) where the population size has been considered as mass. As per this the masses or locations closer to each other have greater chance of interaction than other.
and the larger mass has greater magnetic/attracting effect than the smaller ones following the Tobler’s First Law of Geography—“everything is related to everything else, but near things are more related than distance things”.

The identification of interaction between two places in terms of transport flow, migration of population, flow of service and information, business area based on flow of goods and capitals, site selection of market centre, etc. may be done by the interaction model as shown in Fig. 8.8:

![Spatial interaction between masses (urban centres). Note: The spatial interaction depends on the size of places and distance between them. In this example, the level of interaction between Y and Z is the same as between X and Z despite X is larger than Y, because of greater distance between X and Z. P stands for population (source: Hartshorn and Alexander, 1992)]](image)

**8.9 SURFACE MODELLING**

In GIS, surface modelling is a process of representing Earth surface in digital form taking the information of X, Y and Z dimensions or latitude, longitude and altitude. It converts the discrete points into continuous surface to develop a dummy surface creating infinite number of points as the surface in real world is continuous. It is done not only for surface but also for temperature distribution, rainfall distribution, etc. Since it is created in 3 dimensional (3D) space, it gives the representation of Earth surface. This 3D surface is developed by applying algorithms. GIS creates the 3D surface using interpolation and triangulation surface models which takes X and Y values as latitude and longitude and Z values as height (altitude).

There are three types of surfaces developed by GIS such as raster surface, TIN surface and terrain surface.

**Raster surface** represents a surface by equally sized grid cells arranged systematically in rows and columns where each grid cell contains the details of the space it occupies along with X, Y and Z values (Fig. 8.9).

![Digital elevation model showing the raster surface; (a) high precision, (b) low precision grid and (c) high resolution (source:http://webhelp.esri.com/arcGISDesktop/9.3/index.cfm?PropertyName=about3dsurfaces)](image)
A **TIN (Triangular Irregular Networks)** surface is composed of points (nodes), lines (edges), triangles (faces), hull polygons and topology. It creates the terrain with the help of triangle. The triangles define the gradients where size and frequency of the triangles are the representations of flat or undulating or hilly terrain. The larger size and less number of triangles are the symbols of relatively flat land and vice-versa (Fig. 8.10). The TIN model is used for terrain mapping and analysis as DEM or contour lines.


Digital Terrain Model (DTM) and Digital Surface Model (DSM) are also elevation models but slightly different from the Digital Elevation Model (DEM) as DEM represents only elevation data (Fig. 8.11a) while DTM represents topographic features also like slope, aspect, gradient and landforms like saddle, ridges, etc. (Fig. 8.11b). The DTM data are derived from ground surveys, photogrammetric data and digitised vector data.

![DTM and DSM surfaces](source: www.glcf.umd.edu/data/srtm/gallery.shtml)

DSM provides the heights of features above the ground showing all features on the surface. DTM is called bare Earth elevation model representing only surface elevation whereas DSM is known as first reflective surface model representing all objects on the Earth such as the vegetation and cultural features like buildings (Fig. 8.12).
Check Your Progress III

1) What is a GIS model?
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8.10 ACTIVITY

1) You have already studied about the concept of data standardisation, topological concepts and GIS modelling, you should create GIS database and build topology using a GIS software.

2) Using GIS software try to do some analytical modelling - like buffering, intersecting, clipping, etc., to some multi-thematic iterative analytical model like site suitability.

8.11 SUMMARY

In this unit, you have learnt about the following:

- Data standards and topology for the creation of GIS data for multiple usage and seamless sharing of the data.

- SDI is the bundle metadata standards, policies, technologies to create, maintain, share and use of spatial database on standard platform which is like any other infrastructure used by government, citizens and private partners for achieving various goals. Recently, its application has increased manifold, as a result many countries are developing spatial data
infrastructures at the state, national and global level to manage and utilise their spatial data.

- Topological modelling is a process of getting results out of the relevant spatial and non-spatial database for achieving certain goal through simple as well as complex reiterative approaches. For instance, modelling may be done to find out a suitable site for the location of an industry or land suitability for growing various crops. Network model and spatial interaction and gravity model are important types of topological modelling.

- Surface modelling is a process of representing Earth surface in digital form taking the information of latitude, longitude and altitude. Various surface models are digital terrain model (DTM), digital surface model (DSM) and digital elevation model (DEM). Each of these models has their own limitations and advantages.

8.12 UNIT END QUESTIONS


2) Explain the concept of topology. Discuss in detail the important components of topology.

3) What are GIS models? How is modelling done?

4) Explain some common types of GIS modelling.

8.13 REFERENCES


- lesami.geog.buffalo.edu/projects/initiatives/lidar-visualization/

Data Standards and Topological Concepts

- www.glcf.umd.edu/data/srtm/gallery.shtml
- www.isotc211.org

The data from all the above web pages was retrieved between 12th September 2011 to 3rd July 2012.

8.14 FURTHER/SUGGESTED READING


8.15 ANSWERS

Check Your Progress I

1) Data standards are required for seamless integration of various themes and also for data sharing.

2) Topology defines and maintains the spatial relations among the geographical/spatial features. Spatial relations are established by arc-node and polygon-arc topology. General data models do not retain the spatial relations among the geographical features while topological data model establishes and maintains the spatial relations among the geographical features.

Check Your Progress II

1) Arc-node topology maintains the relations among the lines which are connected by nodes. It defines the connectivity by identifying the arc or line number, node number, from node and to node.

2) Area is a continuous homogeneous space defined by polygon-arc topology. Contiguity is the continuity of spatial areas joined together over the space. These are important to decide the adjacency and neighbourhood.

Check Your Progress III

1) GIS model is the representation of real world in computer language and also the analytical processes to achieve certain objectives.

Unit End Questions

1) Refer to section 8.2.

2) Refer to sections 8.4, 8.5 and 8.6.

3) Refer to section 8.7.

4) Refer to section 8.8.