Geographic Information System as Knowledge & Technology Integration

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Abstract

This paper exhibits the process of Geographic Information Systems (GIS) ability to separate great quantities of information about the environment into layers, explore each layer with a powerful suite of analytical tools, and then combine the layered information to use it in an integrated fashion which makes the GIS a powerful and effective decision-support tool. This tool generally used for any computer based capability for manipulating and organizing geographic data with different techniques. With the extent of this, this paper deals with some GIS applications and Informative examples which furnish better understanding of GIS integrative techniques with respect to relational data which can be used for different purpose appliances. Especially rapid developments in remote sensing, Science and technology play a major role in the growth of GIS, through this gathering of spatial information by means of proper management about earth and its environment into vast storehouse is a very important process for any GIS application.

Keywords: Geographic Information Systems (GIS), remote sensing, geographic data.

Introduction

Computerization has opened a huge new potential in the way society communicate, evaluate surroundings, and make decisions based on the available data. Here data describes the various features which can be presented in maps may relate to physical, chemical, biological, environmental, social, economic or other earth surface properties. Information which representing the real world can be stored and processed in a form of knowledge so that it can be obtainable later in the simpler form to suit specific requirements. Such information is called geographical because it helps us to distinguish one place from another and to make decisions. With collaboration of all this, new technology invented in 60s which is Geographic Information System (GIS) data. GIS combines layers of information about a place to give users a better understanding of that place. A GIS is a computer-based technology that associates geographic data (like where the things are) with descriptive information (what things are like) related and it will continue to create and display digital maps through Knowledge based information or it can be think as an integrated set of hardware and software tools used for the manipulation and management of digital spatial (geographic) and related attribute

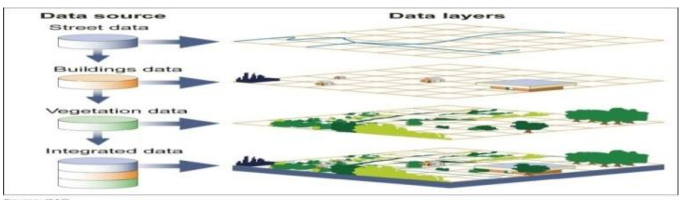

Fig 1.1: Layered Structure

1. **GIS Data Types**

   There are two basic types of GIS Data. By linking maps to databases, GIS enables users to visualize, manipulate, analyze, and display data which is called as geospatial data and.

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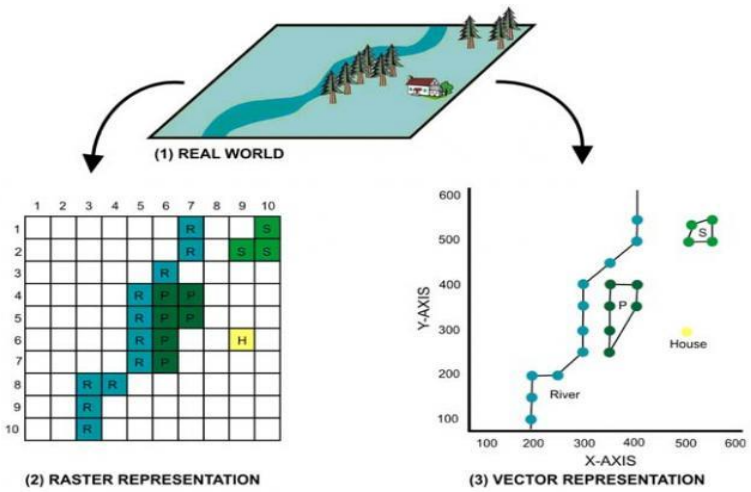
second is attribute data which are descriptions, measurements, and/or classifications of geographic features in a map which reflects established data on a map

2.1 Spatial or Geospatial data

It is a data about a physical object which can be represented by numerical values in a geographic coordinate system. Generally spatial data represents the size, shape, location of an object on Earth such as a temples, buildings, lake, river, mountain or township. Traditionally spatial data has been stored and presented in the form of a map.



Two basic types of spatial data models have evolved for storing geographic data digitally which referred as:

- Vector
- Raster

This diagram reflects main spatial data encoding techniques

Fig 1.2 .Representation of the real world and showing differences of a vector and a raster.

2.1. A Vector Data Model

Vector data model supports representation of the real world using points, lines, and polygons. These models are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets, roads, cities.
The three main geometric shapes used in the vector data model, to represent real world features are:

- Point: Single coordinates
- Line: Strings of coordinates
- Polygon: A closed string of coordinates (often composed of multiple lines).

All vector objects are created from the general graphic primitives of single x, y coordinates. Each of these geometries is linked to a row in a database that describes their attributes. For example, a database that describes lakes may contain a lake's depth, water quality, pollution level. This information can be used to make a map to describe a particular attribute of the dataset. Such as, lakes could be colored depending on level of depth.

2.1. b Raster Data Model

Raster data models include the use of a grid-cell technique where the geographic area is divided into cells identified by row and column. Each cell has a unique data value and explicitly has area coverage proportional to the cell size for this raster applied square cells and a uniform cell size.Data stored in a raster format represents real-world phenomena:

- Thematic data (discrete) represents features such as land-use or soils data.
- Continuous data represents phenomena such as temperature, elevation, satellite images and aerial photographs.

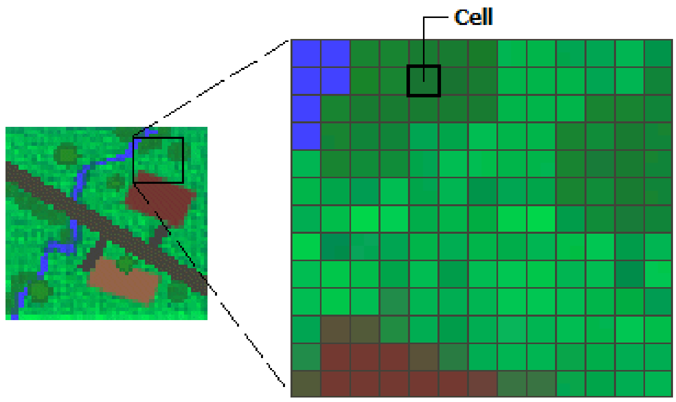


Fig.1.3: Representation of Raster (Grid System)

The major use of raster data involves storing map information as digital images, in which the cell values relate to the pixel colors of the image. To reproduce the image the computer reads each of these cells values one by one and applies them to the pixels on the screen.

2.2 Attribute data

Attribute Data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. This is often referred to as tabular data also.

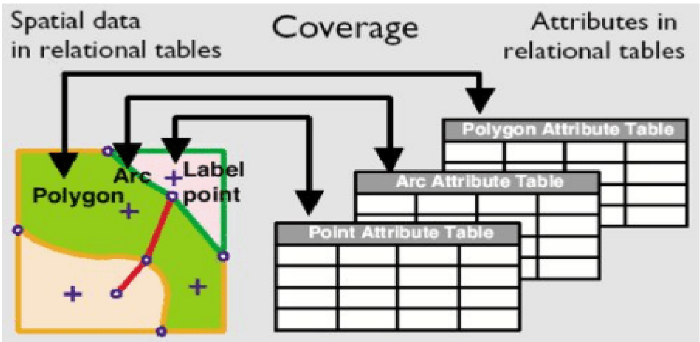


Fig.1.4: View of Spatial data storage in relational database

For example, a municipality will have property or asset information, illustrating individual land parcels or plots geographically. For each one of these parcels, the municipality will also store attribute information such as the contact information of the owner, street address of the home, etc. i.e. this various attributes describes different

Characteristics of that land parcel which can store in single or relational database.

2. Creation of Data and Knowledge

GIS have evolved by linking a number of discrete technologies into a whole. GIS have emerged as very powerful technologies because they allow geographers to integrate their data and methods in ways that support usual forms of geographical analysis, such as map analysis and modeling which are beyond the capability of manual methods. With GIS it is possible to map, query, and analyze large quantities of information, knowledge all held together within a single or relational database.

Knowledge is the most important capital for any organization. In GIS, Knowledge Integration and management is not a single technology, but rather a wide collection of techniques that need to be adopted and integrated which improves data capture, decision making, innovations, products and services. Integrating a geospatial data or related information for organizations about understands the contexts where knowledge is created for the organization, how it is transferred, utilized and applied through the organization and ultimately how it is reused and stored to support the organizations to achieve its objectives.

Here the transformation of data and information has been visualized within a hierarchy.

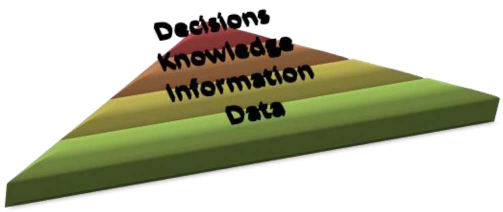
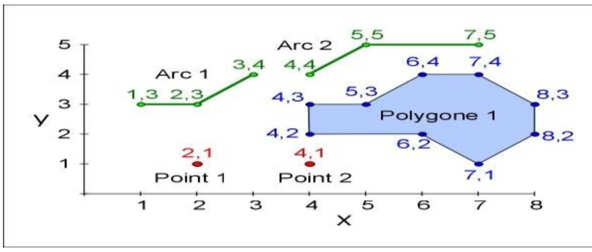


Fig 1.5: Representation of Data Transformation

3.1 Pre-processing Data in GIS:

When working on a GIS, the first issue that cartographers have to face is how to incorporate data into the system. This is the process called "data capture". Data capture is one of the most time consuming processes in GIS. It is very important that the GIS analyst has a clear idea of what the task intends to analyze, because depending on task, service affects. The effort to bring stable, accurate data is an enormous one for any GIS. But now there are different methodologies to capture data, depending on the fact and analyst use preexisting data as the origin of own data, or if they going to create data basically from scratch.

The below figure shows how data can be stored in a form of tabular structure



Point ID - Nr	x,y coordinates
1	2,1
2	4,1

Arc ID - Nr	x,y coordinates
1	1,3 2,3 3,4
2	4,4 5,5 7,5

Polygone ID - Nr	x,y coordinates
1	4,2 7,1 8,2 8,3 7,4 6,4 5,3 4,3

3.2 Integration of GIS Knowledge with diverse Techniques

The power of a GIS is a data analysis and data processing. Without data, GIS can't do anything. There are several ways to bring spatial data into GIS with different technologies.

- **Manual Digitizing**

Data: It is an unrecognized observation of any geospatial data.

Information: It is arrangement and processing of geospatial data into meaningful patterns.

Knowledge: It consists of truths and beliefs, facts, perspectives and concepts, judgments which can be put into productive use.

Decisions: It is a resolution reached after a consideration of all the geospatial knowledge.

This is a traditional common way to convert paper-based sources of spatial information (e.g. maps) to digital data. The paper map is attached by tape to a digitizing table (or tablet as the smaller digitizers). Here generally between 4 to 6 initial points of which the coordinates are known are as logged. Optimally these points are such locations as the intersections of graticule lines. In the absence of an overlying grid system, points are taken from identifiable locations such as street intersections or landmarks.

The data is then digitized by tracing the features of interest with a mouse like hand held device called a puck.

Once all the features (points, lines and polygons) are traced the newly acquired data is transformed from table units (the coordinates of the digitizing table) to real world units. Then it takes the known table coordinates of the initial points and wraps the data to match the real world coordinates assigned to those points.

Fig 1.6: A Puck used in manual digitizing.

- **Heads up digitizing**

With the explosion of low cost sources of digital imagery and large format scanners, heads up digitizing is becoming a popular method of digital conversion which is also called as on-screen digitizing. This method involves digitizing directly on top of an orthorectified image such as a satellite image or an aerial photograph. Orthorectified image is an aerial photograph geometrically corrected such that the scale is uniform. In this the features of interest are traced from the image. The benefit of this over manual digitizing is that no transformation is needed to convert the data into the needed projection. In addition, the level of accuracy of the derived dataset is taken from the initial accuracy of the digital image.

- **Coordinate Geometry (COGO)**

COGO, refers to a data conversion process in which a digital map is constructed from written descriptions, such as legal descriptions of land parcel boundaries. These descriptions often contain information about line, length, angles, direction, and point locations, all relative to the locations of certain key features such as geodetic control points, etc. Some basic types of elements of COGO are points, lines and horizontal curves (circular arcs).COGO also refers to automated mapping software used in land surveying that calculates locations using distances and bearings from known reference points.

Geocoding It is the process of elevating a description of a location, typically a postal address or place name, with **geographic coordinates** from spatial reference data such as building polygons, **land parcels**, **street addresses**, **ZIP codes** (**postal codes**).

A more accurate mean of geocoding is point-level geocoding. This incorporates locating a point at the centroid (center) of a land parcel or building, thus improves the geocoding accuracy. This level of detail may not be critical for all applications, but for applications like Flood Determination can make a very big difference. For example ***flood plain*** **is an area of land adjacent to a river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge so a**ccurate and current floodplain maps can be the most valuable tools for avoiding severe social and economic losses from floods. Geographic Information System (GIS) is a tool that can assist floodplain managers in identifying flood prone areas in their community. So with GIS, This kind of information can store in a database which can be queried and graphically displayed for different analysis.

- **Global Positioning Systems (GPS)**

GPS is a way to gather accurate linear and point location data, the current GPS consists of 28 satellites that orbit the earth, transmitting navigational signals. Through interpolation, these signals received by a data logger which can identify the holder's location. Depending on the unit, the location accuracy can reach to the millimeter and Combined with attribute data entered at the time of collection, it is a rapid and accurate method of data collection. The typical GPS-based data capture tool is a GPS receiver combined with a hand-held computer. These two components may be connected by a cable, or they may be combined as an integrated, hand- held unit. The hand-held computer is used for attribute entry and display data to the user. There are several variations on this theme, including the use of pen computers, laptop computers, and small hand-held units. The main design goal of this is, user can focus on observing and entering attribute data, since the position data 'just happens' automatically.

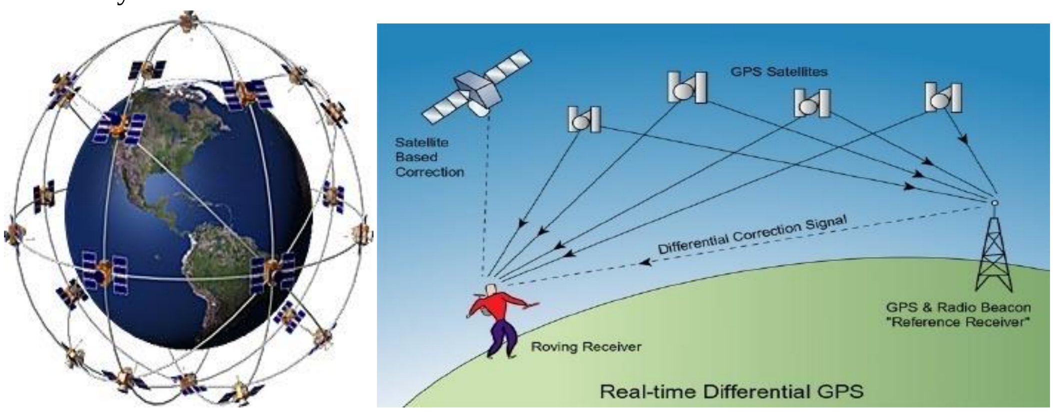


Fig.1.7: Visualization of Orbit and GPS

- ***Remote sensing:***

Remote sensing technology is used for gathering information and making measurements of the earth using sensors such as cameras carried on airplanes, satellites, GPS receivers, or other devices. In order for an observing sensor to acquire knowledge about remote object, there must be a flow of information between the object and the observer. There has to be a carrier of that information and carrier is the electromagnetic radiation (EMR). Through this sensors collect data as reflected electromagnetic radiation, which processed into a digital image and stored it in the form of digitize images along with provide specialized capabilities for manipulating, analyzing, and visualizing those images. Each part of the spectrum has different characteristics and gives different information about earth's surface. This technique also helps in various applications like *Forest management*, *Natural resource management, Land management*, *Street networks*, *Hydrology etc.*

For example, Water pollution monitoring is one of the important applications of remote sensing. This can be a serious problem in big cities and in offshore areas along industrial zones.

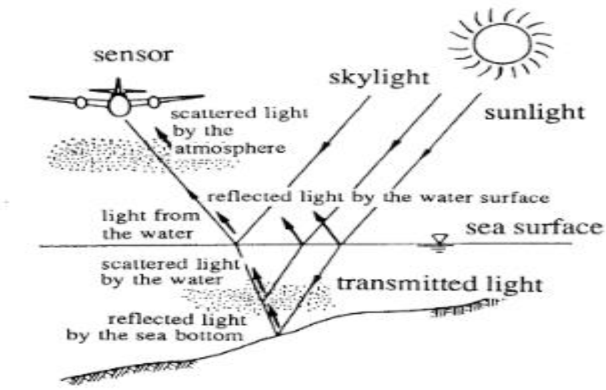


Fig:1.8 Incident light into a sensor on the Sea

The figure shows how the sensors are used to integrate data about the characteristics of reflection, absorption and scattering on the water surface, under the surface water and from the bottom as well as the sea color which depends on the absorption and scattering due to water molecules and suspended particles.

Conclusion

GIS has capabilities to capture and examine large amount of spatial data through diverse resources and this capacious data become useless without the improvement of techniques which can be used as an integrative decision support tool. This work is intended to show that the growth or management of knowledge and knowledge based integration methodologies such as GPS, remote sensing, COGO which can be used with the incorporation of facts as supportive decision based GIS techniques.

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