# Chapter : 1 : Introduction of GIS

❖ History of GIS :

➢ In 1960 the Department of Forestry and Rural Department of Canada has decided to pursue a large-scale project to manage the resources.

➢ The initial task was the inventory and mapping of the available forest and mineral resources wildlife requirements and water availability and quantity.

➢ The mission was just to gathering the amount of data, compilation, analysis, evaluation and modeling. It becomes obvious that the map of resources permit viewing the extents.

➢ The meeting between the Director of the Department of Forestry and Rural Development and IBM executive has suggested an application of the newly emerging computer technology to the problem was known as **Canada Geographical Information System (CGIS)**.

➢ Today it is an ever increasing requirement of the following companies……
   - Fire departments
   - The Military departments
   - Cellular Phone Companies
   - Real Estate Companies
   - Police Departments
   - Transportation Companies etc…..

❖ What is GIS?

➢ *"GISs are the tools that allows for the processing of spatial data to make a decision about some portion of the earth."*

➢ *"GIS is a computer system for capturing, storing, querying, analyzing, evaluating and displaying the geospatial data."*
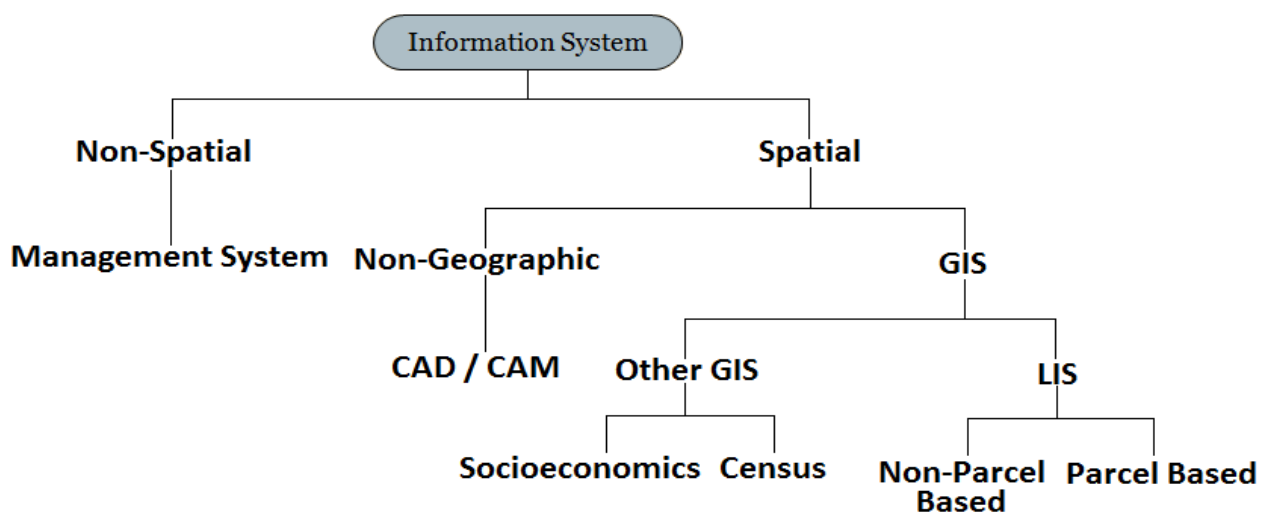
Taxonomy of Information System

❖ Applications of GIS :-

➢ Business

1. **Banking: -** Financial analysts employ GIS for targeting their markets by visualizing service needs. Companies including Metropolitan Life and Chase Manhattan Bank rely on GIS software to help them improve operational excellence and profitability.

2. **Insurance: -** Many insurance companies have made GIS a central component of their business, _using it to visualize, analyze, and distribute risk_. Companies such as CHUBB Insurance use GIS software for portfolio risk management.

3. **Media: -** GIS is used by media bureaus for everything from analyzing circulation and attracting advertisers to creating the maps used in the material itself. _The Associated Press_ (AP), USA TODAY, and National Geographic Society use GIS software to create accurate maps quickly for magazines, newspapers, and online news services.

4. **Real Estate: -** From map-based contact management to sophisticated investment analysis in large real estate investment trusts, real estate agencies rely heavily on electronic mapping. Companies such as SSR Realty Advisors, Inc. use GIS in commercial real estate, _while REALTOR.com uses GIS to bring maps online to 1.2 million people shopping for a new home_.

5. **Logistics: -** Logistics management requires planning the distribution fleet's activities, route locations, and schedules. Argentina's telephone company, _Grupo Telefónica, uses the GIS logistics routing solution shown to the right to increase the number of daily deliveries without increasing resources_.

6. **Retail: -** Businesses maintain information about sales, customers, inventory, demographic profiles, and mailing lists, all of which have geographic locations. Business managers, marketing strategists, financial analysts, and professional planners increasingly rely on GIS to organize, analyze, and present their business data.

➢ Government

1. **National Government: -** Government agencies trust GIS technology to establish and regulate policy and to strengthen the welfare of their citizens. GIS is also an intelligent means for agencies to provide public information. _The U.S. government relies heavily on GIS to evaluate the results of U.S. Census 2000_.

2. **Local Government: -** _Revenue collection, economic development, and public information_ are just a few opportunities that GIS affords municipalities. The cities of Madrid, Geneva, and Paris all use GIS for providing many city services.

3. **Homeland Security: -** GIS assets at local, regional, and national levels are used in emergency response in the areas of detection, _risk assessment, mitigation and prevention, preparedness, response, and recovery_. _Utilized in both natural and human-induced disasters_, GIS has merged into the common operating procedures for public safety and emergency response activities. City, county, state, and federal-level agencies use GIS as a common framework for organizing and sharing data in a digital world.

4. **Military Defense: -** Military defense uses GIS for _intelligence, terrain analysis, mission planning, and facilities management_. Geographic analysis is critical in military operations, tactical or logistical planning, and infrastructure management.

5. **Emergency Medical services: -** _GIS allows public safety personnel to effectively plan for emergency response_, determine mitigation priorities, analyze historical events, and predict future events.

6. **Transportation: -** GIS serves three distinct transportation needs: infrastructure management, fleet and logistics management, and transit management. GIS offers insight for network planning and analysis, **_vehicle tracking_** and routing, inventory tracking, and **_route planning analysis_**.

➤ **Education and Science**

1. **Research: -** GIS is an ideal tool to help researchers model the real world, classify and observe phenomena, and predict changes over time. Ready-made data models make it easy to work with layers of data to observe relationships and explore new methods to represent the world around us.

2. **Library and Museum: -** _GIS creates interactive maps for museum exhibits that help visitors explore people, places, and events_. GIS is also a valuable research tool used by museum scientists and researchers to increase people's understanding of natural systems and human cultures from anthropology to zoology.

➤ **Environment and Conservation**

1. **Water: -** Environmental management and stewardship programs integrate a broad spectrum of data with the analysis tools of GIS to provide a better understanding of how elements of natural communities interact across a landscape. _GIS is used worldwide in ecology labs, planning departments, parks, agencies, and nonprofit organizations to promote sustainable growth_.

2. **Ocean: -** _Marine GIS uses data from oceans and seas to represent near shore and deepwater phenomena_ such as current, salinity, temperature, biological and ecological mass, and density.

3. **Land: -** Accurate information about the local landscape is critical to making decisions about what to protect and how to protect it. _Digital maps of sites can be linked to a relational database that stores topography, baseline data, site documentation, and aerial digital photography_.

4. **Wildlife: -** GIS is an important tool in habitat and species management and protection. _GIS enables the study of animal populations_ at a variety of scales as well as analysis tools to study habitat corridors; migration patterns; and the influence of parks, reserves, and sanctuaries for wildlife conservation.

5. **Vegetation :-** GIS is ideal for mapping and inventorying vegetation across landscapes and to better understand threatened and endangered species inventories for scientific and managerial applications

➢ **Natural Resources**

1. **Agriculture :-** GIS provides the analytical capabilities that form the hub of a successful precision agriculture system. _GIS lets farmers perform site-specific spatial analyses of agronomic data_.

2. **Forestry :-** Ireland's forestry service, Coillte Teoranta, uses GIS as a key component in managing its timber resources and maintaining sustainable forest management. Coillte Teoranta leverages GIS functionality for applications as diverse as land valuation, timber market analysis, harvest route planning, and landscape visualization.

3. **Oil and Gas** :- _Where to drill, route a pipeline, or build a refinery_ are all questions that rely heavily on an understanding of geography

❖ **Components of GIS**

Like any other Information Technology, GIS requires the following five components to work with geospatial data.

1. **Computer System :-**

    ▪ Computer system includes the computer and Operating System to run the GIS.

2. **GIS Software :-**

    ▪ GIS Software includes the program and the user interface for driving the hardware. Common interfaces in GIS are Menus, Graphical Icons, Command lines and Scripts.

    ▪ e.g. Arc Map, Arc Catalog, Arc GIS Server etc…

3. **People :-**
   - Peoples refer to the GIS Professionals and users who define the purpose and objectives and provide the reasons and justification for using GIS.

4. **Data :-**
   - Data consists of the various kinds of inputs that system takes.

5. **Infrastructure :-**
   - The infrastructure refers to the necessary physical, organizational, administrative and cultural environment that supports GIS operations.

❖ What is Geospatial Data?

Geospatial Data are the data which describe the Location and Characteristics of Spatial Features such as Roads, Vegetations Stands and Land Parcels on the Earth's Surface.

Geospatial Data separate GIS from other Information Systems. Therefore before discussing the Operations of GIS we must understand the nature of Geospatial Data.

For Example to describe the road, we refer to its **location** (where it is) and it **characteristics** (Length, Name, Speed Limit and Direction). **The Location** also called a **geometry or shape**, represent *Geospatial Data*, where as the **characteristics** are *Attribute Data*.

Basically any Geospatial Data has a two components like : **Spatial Data Attribute Data**

1. **Spatial Data :-**
   - Spatial data describe the location of spatial features, which may be discrete or continuous.
   - **Discrete Features** are individually distinguishable features that do not exist between observation. It includes Point, Line and Areas (Polygon).
   - **Continuous Features** are features that exist spatially between observations. Examples of continuous are elevation and precipitation.
   - GIS represent these spatial features on the Earth's surface as Map features on a plane surface. This transformation involves two main issues:
     1. **Spatial reference system**
     2. **Data model**
   - Location of the spatial features on the Earth's surface are based on a geographic coordinate system with latitude and longitude values, where as the location of map features are based on the plain coordinate system with X, Y coordinates.

- ▪ **Projection** is the process the can transform the Earth's spherical surface to a plane surface and bridge the two spatial reference system.
- ▪ The Data Model defines how spatial features are represented in a GIS.
- ▪ The *Vector Data Model* uses Points and their X and Y coordinates to constructs spatial features of Point, Line and Area (Polygon).
- ▪ The *Raster Data Model* uses the grid and grid cells to represent the spatial variation of features.
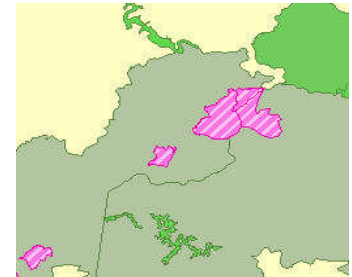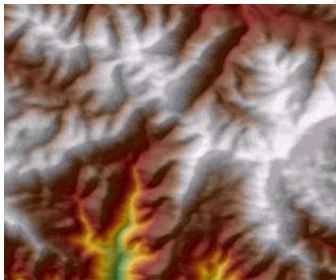
Vector data
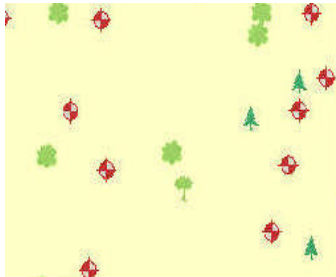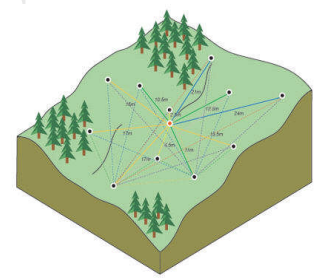

GIS Poins
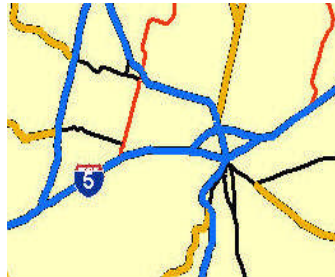
GIS Lines

GIS Polygons

Raster Data

Cell Based

Image Based

Grid Based

Vector Data	Raster Data
Vector Data are ideal for representing discrete features	Raster data are better suited for representing continuous Features
Vector formats map data by storing the spatial coordinates that define individual entities	Raster formats map data by dividing space up into equal sized grids and then code each cell with the appropriate value
Vector data model may be georelational or object based.	Raster data model uses simple data structure with rows and columns and fixed cell location.

2. **Attribute Data :-**

- ▪ The Attribute Data describe the characteristics of spatial features. For raster data each cell has a value that corresponds to the attribute to the spatial feature at that location.

- A cell is tightly bound to its cell value.

- For vector data amount of attribute data to be associated with a spatial feature can vary significantly. A road may only have the attributes of length and speed limit, where as the soil polygon may have dozens of properties, interpretation and performance data.

❖ Operations of GIS:-

Spatial Data Input	Data Entry : Use existing data, create new data Data Editing, Geometric Transformation Projection and Re-projection
Attribute Data Management	Data Entry and verification, Database Management Attribute Data Manipulation
Data Display	Cartographic Symbolization, Map Design
Data Exploration	Attribute Data Query, Spatial Data Query
Data Analysis	Vector Data Analysis Raster Data Analysis Terrain Mapping and Analysis Path analysis and network applications
GIS Modeling	Binary models, Index models Regression models, Process model

❖ Comparison of Traditional cartography and GIS :-

	Trad. Cart.	**GIS**
Data Collection	Arial Photography, Surveys	Arial Photography, Surveys
Data Processing	Aggregation, Classing Liner Process	Aggregation, Classing circular Process
Map Production	Final step	Not always a final step

❖ Comparison of Input Subsystem for Analog V/s Digital GIS :-

	Map	**GIS**
Input	Recorder on a paper from a collected source **Points, line, Area**	Encoded in to a computer from a collected source **Points, line, Area**
Sources	Arial Photography, Digital remote sensing, Surveying, Visual description, Census data, Statistical data	Same as Map data, Digital Line Graph (DLG) Digital Elevation Models, Digital Orthophotoquads, Other Digital Databases.

❖ Comparison of Storage and Retrieval Subsystem for Analog V/s Digital GIS

Map	**GIS**
Points, Line and Areas are drawn on paper with symbols.	Points, Line and Areas are stored as a grid cells or coordinate pairs and pointers in computer.
Retrieval is simply a matter of map reading	Retrieval requires efficient computer search techniques.

❖ Comparison of Comparison and Analysis Subsystem for Analog V/s Digital GIS :-

Map	**GIS**
Requires rulers, plan meters, compasses and other tools all used by a human analyst.	Uses the power of the computer to measure, compare and describe the content of the database.
Restricted to the data as they are aggregated and represented on the paper map.	Always ready access to the raw data and allows aggregation and reclassification for further analysis.

❖ Comparison of Reporting and Output Subsystem for Analog V/s Digital GIS :-

MAP Output	**GIS Output**
Graphic device only	The map is only one type of GIS output
Many forms of map	With minor exceptions, GIS offers some options as traditional hand drawn maps.
Modification can include cartogram	Also include tables, charts, diagrams, photographs etc…