Experiment No-3: Demonstration on Various GIS Software's and their salient features.

Aim: To explore and understand the functionalities and capabilities of various GIS software for spatial data analysis, visualization, and management.

Introduction

GIS and Remote Sensing software is designed *to store, retrieve, manage, display and analyse* all types of geographic and spatial data obtained from satellite and air borne sensor data. It produces maps and graphic display of geographic information for analysis and presentation.

GIS data are of two primary kinds: locational and attribute.

Locational data specify the spatial position of entities or phenomena, while **attribute data** describe their characteristics.

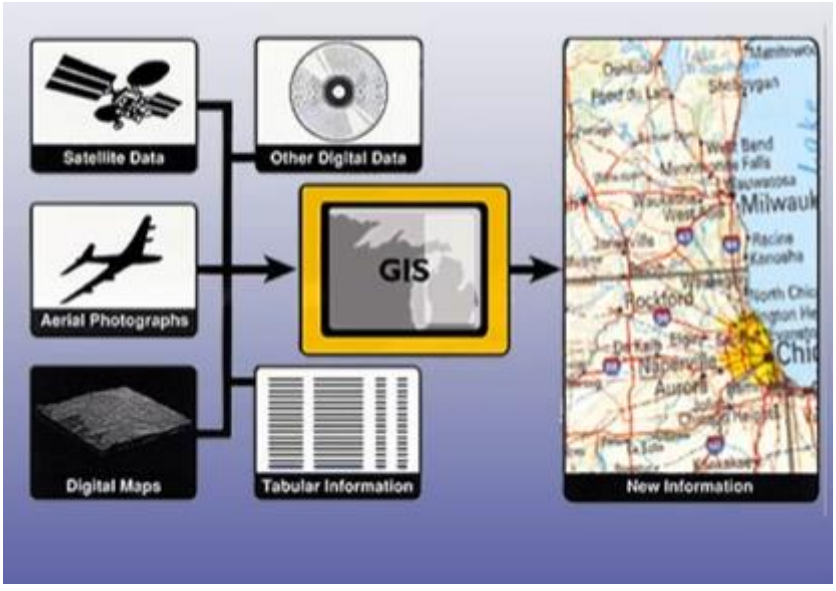
The **location** of a building, for example, can be specified in a spatial coordinate system such as longitude and latitude, while **attributes** describe characteristics such as storeys or roofing style. Both components – location and attributes

Data Models in GIS

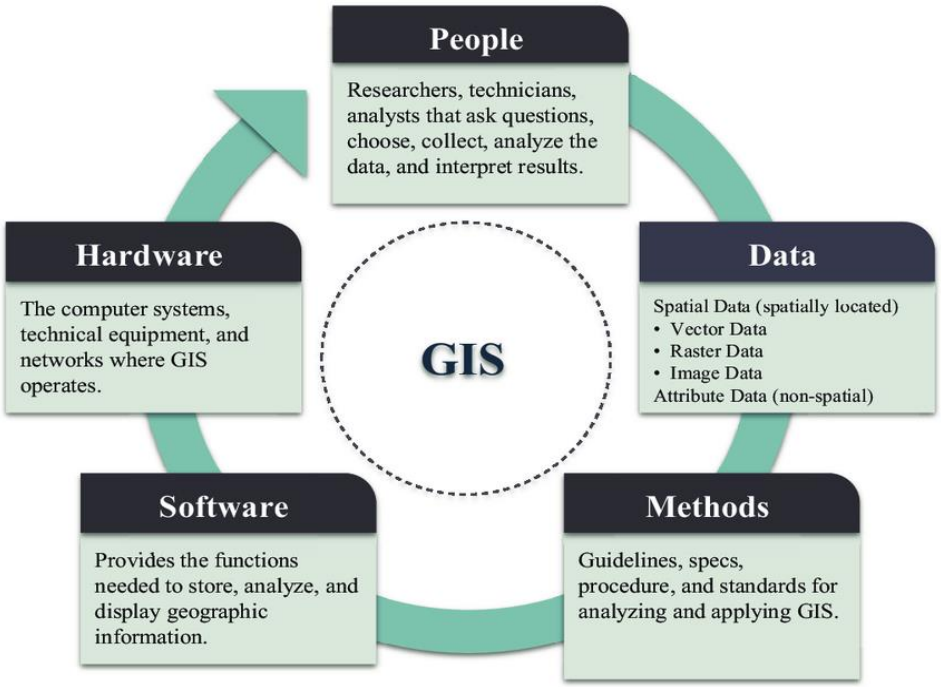
Raster and vector.

The **Raster model** has its origin in remote sensing images and their square pixels or cells, where a layer of these cells represents a discrete variable such as elevation or land-cover classes.

The **vector model** instead encodes the world as points, lines, and areas and stores a series of variables associated with these geometric entities.



Components



Importance of GIS Software

- Enables visualization, analysis, and interpretation of spatial data.
- Supports decision-making in various industries.
- Offers tools for mapping, modeling, and data integration.

These softwares can be categorized into open source and commercial softwares.

Here is list of GIS software:

Software	Description	Latest Version
ArcGIS	A proprietary GIS software for maps and geographic information by ESRI.	ArcGIS 10.5 (Dec 2016)
QGIS (Quantum GIS)	A free, **open-source** GIS software for geospatial data analysis.	QGIS 2.18.10 (June 2017)
GRASS GIS	**Open-source** GIS software for spatial modeling and visualization.	GRASS GIS 7.2
AutoCAD Map	A 3D GIS mapping software by Autodesk.	22.0 (March 2017)
MapInfo	GIS software for mapping and location analysis by Pitney Bowes Software.	15.2

Software	Description	Latest Version
Global Mapper	GIS software by Blue Marble Geographics for Microsoft Windows.	18.2
Geo Time	Geospatial analysis software for visualizing events over time.	5.7 (May 2016)
Manifold System	GIS software with vector and raster data support, spatial SQL, and more.	8.0.30 (March 2017)
Geomajas	Open-source GIS software with server-side geospatial data integration.	1.14
GeoDa	Open-source GIS software for spatial data analysis and modeling.	GeoDa 1.10
DIVA-GIS	Open-source software for mapping and analyzing biodiversity data.	Windows-compatible
gvSIG	GIS desktop application with a user-friendly interface.	gvSIG 2.3.1 (Oct 2016)
AGIS	Simple GIS shareware software for mapping geographic data.	-
IDRISI GIS (TerrSet)	Integrated GIS and remote sensing software for analyzing earth system dynamics.	TerrSet 18.07 (April 2015)
ILWIS	GIS and remote sensing software for digitizing, editing, and data analysis.	3.8.5
Capaware	Open-source 3D GIS software developed in Spain.	-
Falcon View	Open-source mapping system software for aeronautical charts and maps.	-
MicroDem	Application for maps and satellite imagery analysis.	12.1
SAGA GIS	Open-source GIS software for spatial data editing and analysis.	-
uDig	Open-source GIS software with layered mapping functionality.	2.0.0.RC1
JUMP GIS	Open-source GIS software in Java for spatial data processing.	1.11 (April 2017)

Software	Description	Latest Version
Whitebox GAT	Open-source GIS for advanced geospatial analysis and visualization.	3.2.1
Map Business Online	Web-based business mapping software for geographic data visualization.	-
eSpatial	Cloud-based mapping software for geographic data analysis.	-
Maptitude	Commercial GIS software with advanced features for mapping and analysis.	5.0
Orbis GIS	Open-source GIS for research purposes, licensed under GPLv3.	4.0.2
SPRING	GIS and remote sensing system integrating raster and vector data.	4.3.9 (June 2017)
GeoMedia	GIS software for geographic analysis and mapping.	-
Quorum GIS	Software for visualizing data in a spatial map view.	-

This table includes only GIS software from the original content. Let me know if you'd like further refinements!

Overview of Popular GIS Software

List of softwares

1. ArcGIS
2. QGIS
3. Google Earth Pro
4. GRASS GIS
5. MapInfo

ArcGIS by Esri

Salient Features:

1. Advanced spatial analysis tools.
2. Cloud integration (ArcGIS Online).
3. 3D mapping and visualization.

4. Extensive data compatibility.

Use Cases: Urban planning, disaster response, hydrological mapping, forest fire detection map, Land surface temperature etc.

QGIS (Quantum GIS)

Salient Features:

1. Open-source and free to use.
2. Supports plugins for extended functionality.
3. Cross-platform (Windows, macOS, Linux).
4. Strong community support.

Use Cases: Academic research, small-scale projects.

Google Earth Pro

Salient Features:

1. High-resolution satellite imagery.
2. Historical imagery for time-based analysis.
3. Easy-to-use interface for non-experts.
4. Free for basic use.

Use Cases: Education, tourism, environmental monitoring.

GRASS GIS

Salient Features:

1. Open-source and modular design.
2. Advanced raster and vector analysis.
3. Geospatial modeling and simulation.
4. Integration with other GIS tools.

Use Cases: Environmental modeling, research.

MapInfo

Salient Features:

1. User-friendly interface.
2. Strong data visualization capabilities.
3. Integration with business intelligence tools.
4. Customizable mapping solutions.

Use Cases: Business analytics, market research.

Applications of GIS Software

(i.) Cartography:

GIS is widely used to create, update, and analyze maps. For example, topographic maps, weather maps, and city planning maps are created using GIS tools.

(ii.) Geographic Intelligence:

GIS helps in analyzing spatial data for security and strategic purposes. For instance, tracking border movements or monitoring conflict zones using satellite imagery.

(iii.) Geospatial History:

GIS is used to study historical events by mapping changes over time. For example, reconstructing ancient trade routes or analyzing the spread of historical empires.

(iv.) Geographic Data Development:

GIS is used to collect, store, and manage spatial data. For example, creating databases for land use, population density, or natural resources.

(v.) Logistics:

GIS optimizes transportation and delivery routes. For example, companies like FedEx use GIS to plan efficient delivery paths and reduce fuel costs.

(vi.) Geo-marketing:

GIS helps businesses target customers based on location. For example, analyzing consumer behaviour in specific regions to plan marketing campaigns.

(vii.) Demographic Studies:

GIS is used to analyze population data. For example, mapping population growth, migration patterns, or age distribution for urban planning.

(viii.) Statistical Study:

GIS integrates spatial data with statistical analysis. For example, correlating crime rates with socioeconomic factors in different neighbourhoods.

(ix.) Military Planning:

GIS aids in strategic planning and operations. For example, mapping terrain for troop movements or identifying potential threats using satellite imagery.

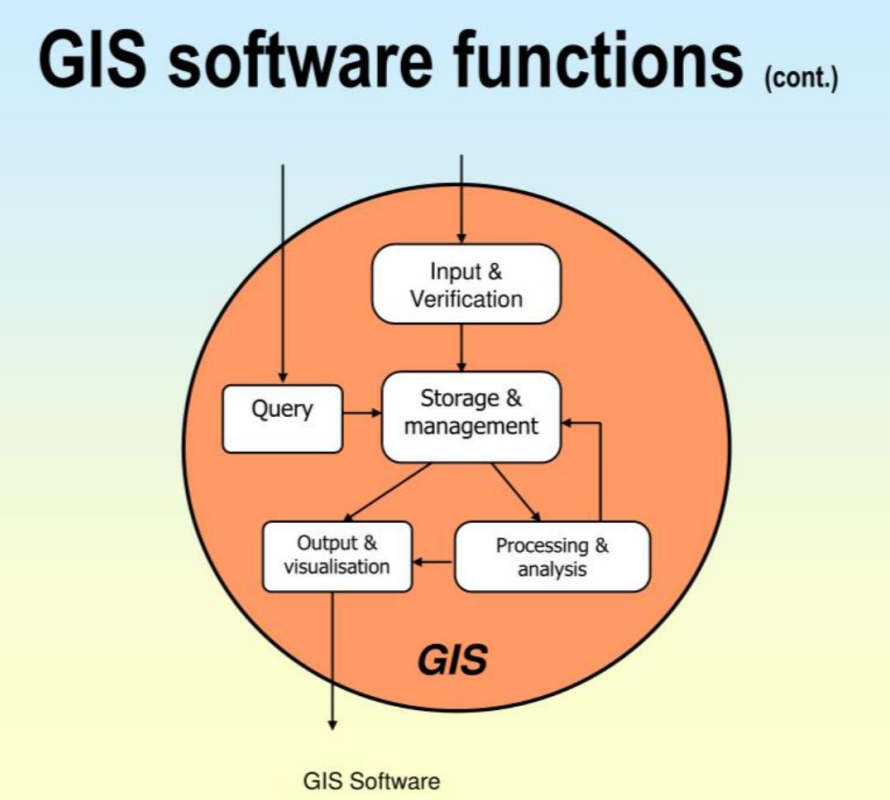
(x.) Disease Observation:

GIS tracks the spread of diseases. For example, mapping COVID-19 hotspots to allocate medical resources effectively.

(xi.) Environmental Contamination:

GIS monitors pollution and its impact. For example, tracking oil spills or mapping areas affected by industrial waste.

GIS Software functions



Input

- **Data Capture:** Collecting spatial data through methods like GPS, remote sensing, digitization, or surveying.
- **Editing and Error Correction:** Cleaning and correcting data to ensure accuracy (e.g., removing duplicates, fixing topology errors).
- **Geocoding:** Converting addresses or place names into geographic coordinates (latitude/longitude).

Storage and Management

- **Data Conversion and Access:** Converting data formats (e.g., shapefiles to geodatabases) and ensuring accessibility across platforms.
- **Data Integration:** Combining data from multiple sources into a unified system.
- **Database Management:** Organizing and maintaining spatial databases (e.g., using SQL or NoSQL systems).

- **Data Retrieval and Query:** Extracting specific data using queries (e.g., SQL queries or spatial queries like "find all points within a polygon").
- **Data Updating:** Regularly updating datasets to reflect changes (e.g., new roads, land use changes).
- **Metadata Management:** Documenting data details (e.g., source, accuracy, date) for better understanding and usability.

Processing and Analysis

- **Reclassification:** Grouping or categorizing data into new classes (e.g., land use categories).
- **Transformation:** Converting data between coordinate systems or projections.
- **Map Overlay:** Combining multiple layers to analyze relationships (e.g., overlaying soil and vegetation maps).
- **Spatial Analysis:** Performing operations like buffering, proximity analysis, or network analysis.
- **Modelling:** Creating spatial models to predict outcomes (e.g., flood risk models).
- **Simulation:** Simulating real-world scenarios (e.g., urban growth or traffic patterns).

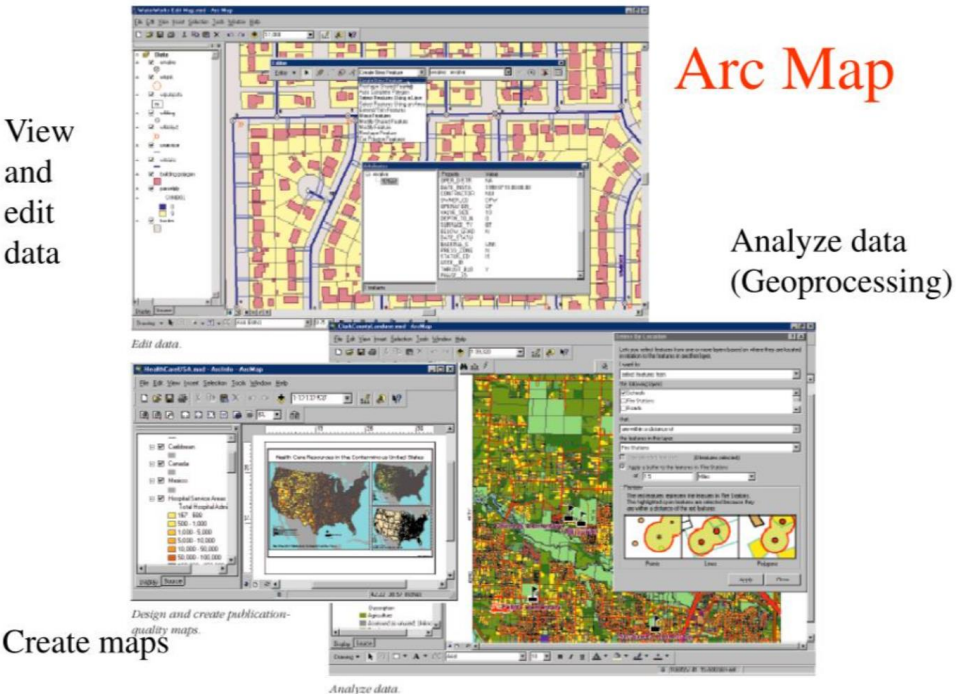
Output and Visualization

- **Interactive Graphical Display (Softcopy):** Displaying maps and data on screens for interactive exploration (e.g., web maps, GIS software interfaces).
- **Cartographic Output and Production (Hardcopy):** Creating printed maps with proper design elements (e.g., legends, scale bars).
- **Data Exchange Output:** Exporting data in standard formats (e.g., KML, GeoJSON) for sharing.
- **Publication and Online Services:** Publishing maps and data online for public or professional use (e.g., through web portals or APIs).

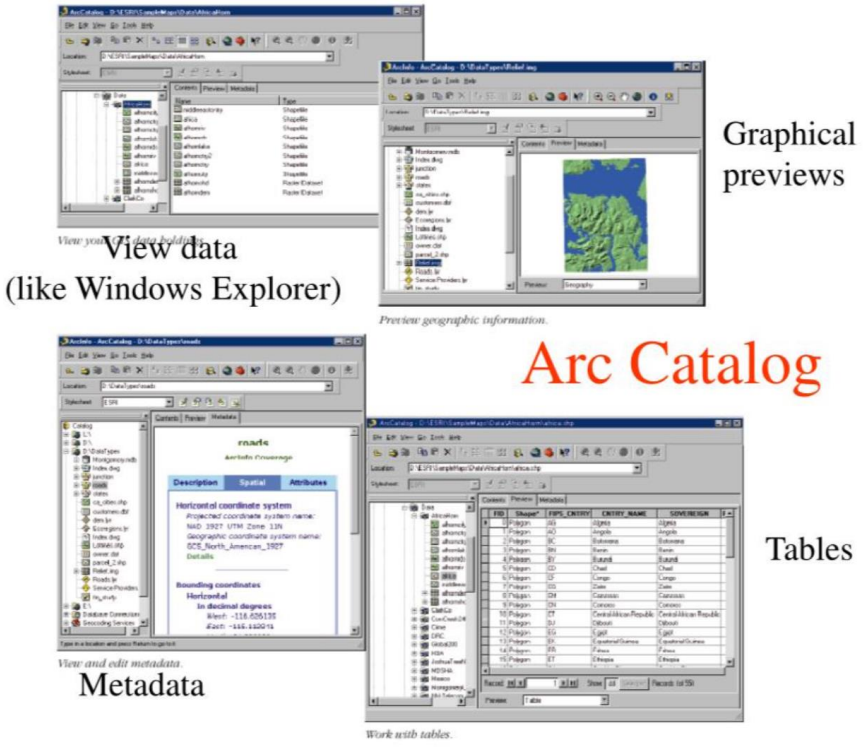
ArcMap Demonstration

Component of ArcGIS - ArcMap, ArcCatalog and ArcToolbox.

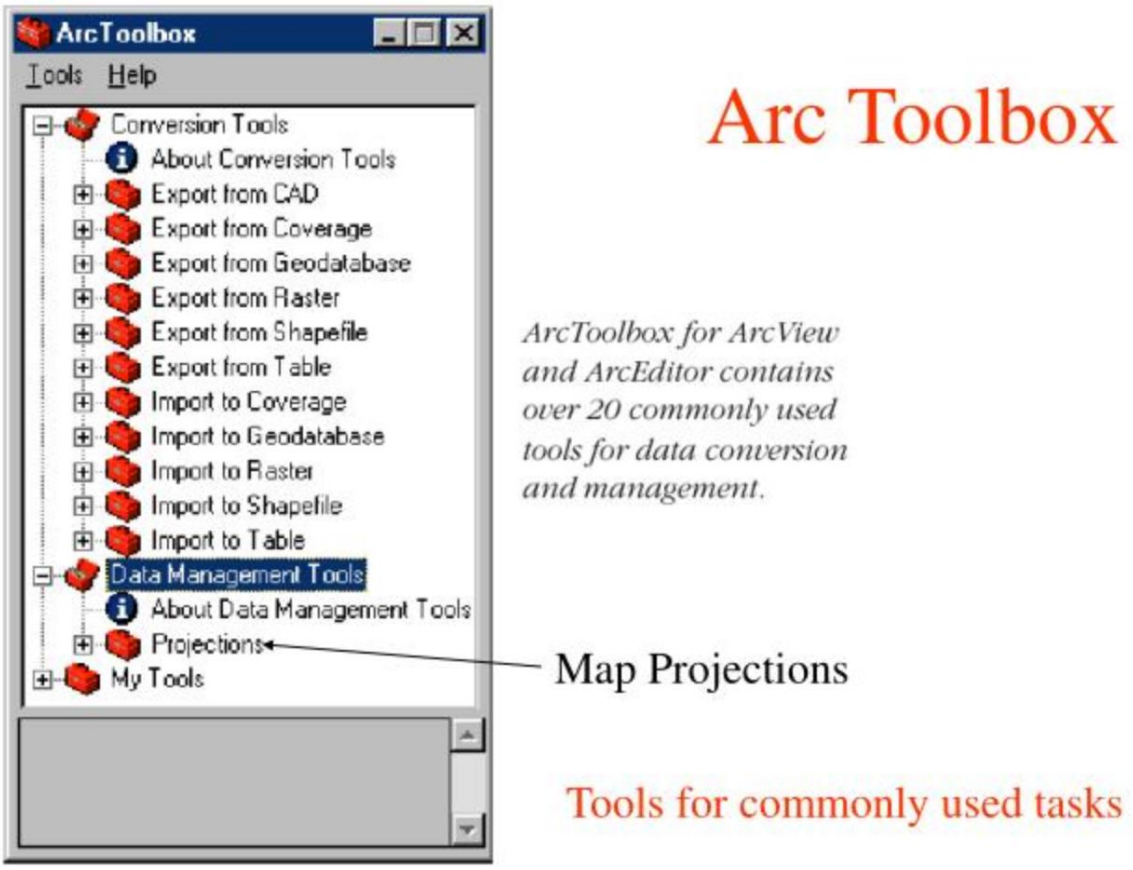
ArcMap



ArcCatalog



ArcToolbox



ArcMap Basics

1. Adding Map Layers

- Layers are **spatial datasets** (shapefiles, Rasters, databases, etc.).
- Add layers via **File → Add Data** or by dragging files into the **Table of Contents (TOC)**.

2. Data Frame(s)

- A **Data Frame** contains layers and controls the display.
- Multiple Data Frames can be used to organize different map views.

3. Frame Properties & Layer Properties

- **Frame Properties**: Controls projection, extent, and background.
- **Layer Properties**: Manages symbology, labels, and display settings.

4. Features & Attributes

- **Features**: Points, lines, and polygons representing real-world objects.
- **Attributes**: Tabular data associated with each feature (e.g., population for cities).

5. Handling Layers

- Layers can be re-ordered in the **TOC**.
- Toggle visibility using the checkbox next to a layer name.
- Use **Group Layers** to organize multiple layers.

6. Symbology

- Controls how layers appear (colors, patterns, classifications).
- Access via **Layer Properties → Symbology Tab**.

7. Transparency

- Adjust layer transparency via **Layer Properties → Display Tab**.
- Helps visualize overlapping layers.

8. View at Map Scale

- Controls layer visibility based on zoom level.
- Set under **Layer Properties → General Tab**.

9. Selecting Features

- **Interactive Selection**: Use the **Select Features** tool to click on map elements.
- **Attribute-Based Selection**: Use **Select by Attributes** to filter data.
- **Spatial Selection**: Use **Select by Location** for proximity-based selection.

Controlling Selection Layers

- Limit selections to a specific layer in **Selection → Selection Options**.
- Use **Selectable Layers** in the TOC to refine selections.

Creating a New Layer from Selection

- Right-click a selected feature → **Data → Export Data** to save as a new layer.

10. Queries

Basic Information

- Queries help extract and analyze specific data subsets.

Attribute Queries

- Use **Select by Attributes** to filter data based on conditions (e.g., "Population" > 1000000).

Spatial Queries

- Use **Select by Location** to find features based on spatial relationships (e.g., within a buffer zone).

11. Calculating New Attributes

- Open the **Attribute Table** → Use **Field Calculator** to compute new values (e.g., area, density).

12. Exporting Data

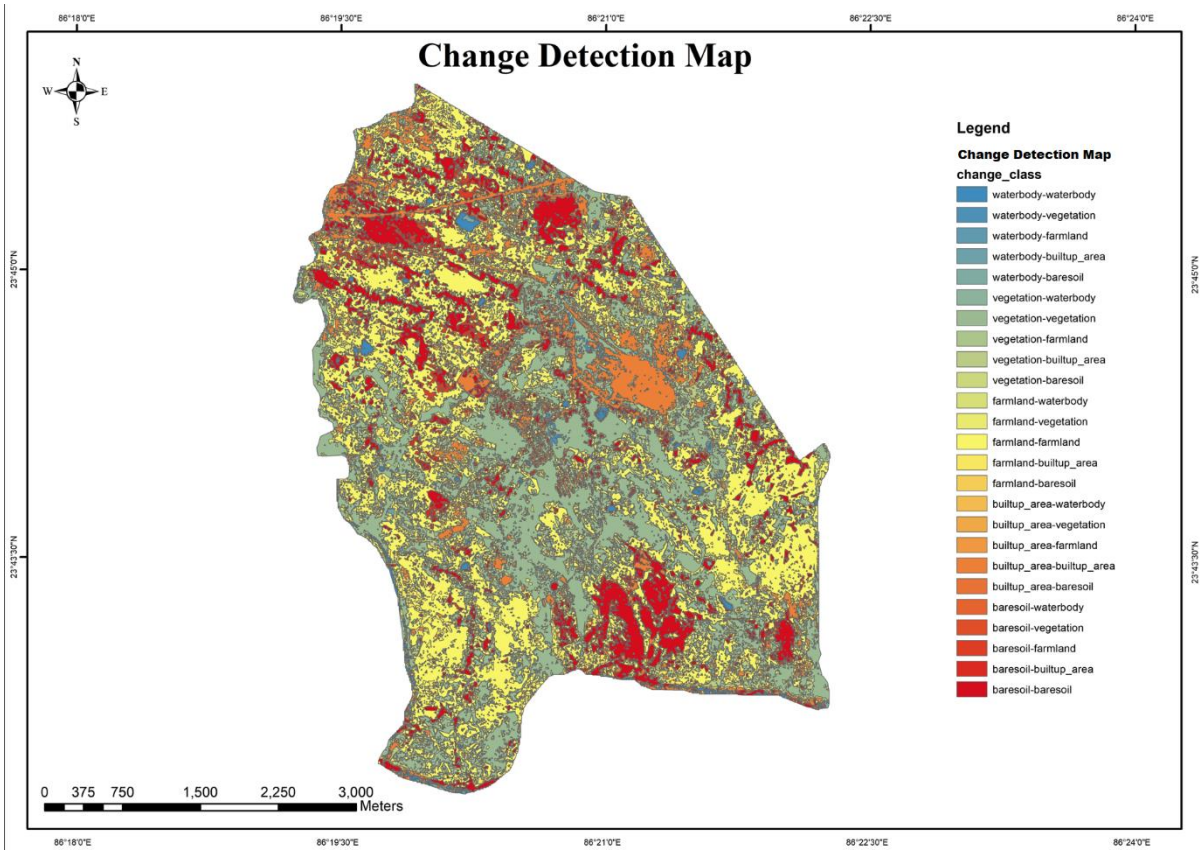
- Export selected features or entire layers by **Right-clicking → Data → Export Data**.
- Choose **Shapefile (.shp)** or **Geodatabase (.gdb)** formats for spatial data.

Identify case applications and their outputs using ArcMap.

Urban Planning & Land Use Analysis

Objective: Analyze land-use changes over the years using satellite imagery and zoning data.

Output:

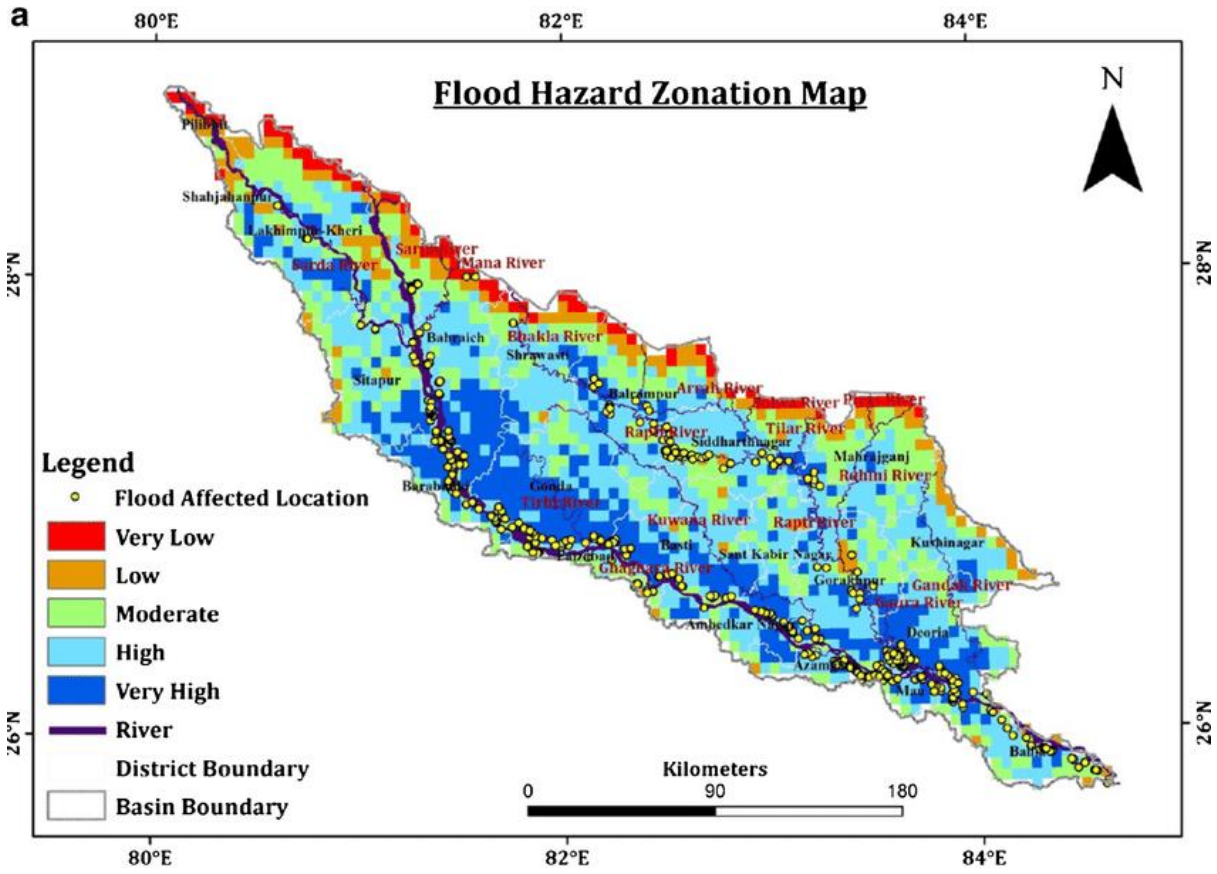


Disaster Management & Risk Assessment

Flood Hazard Mapping

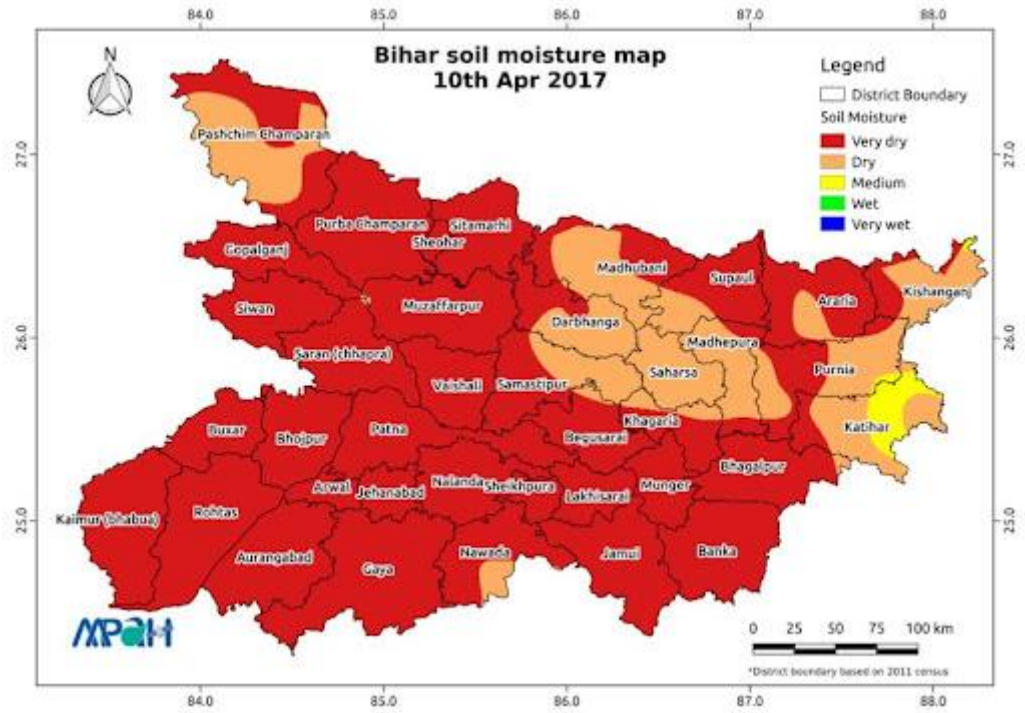
Objective: Identify flood-prone areas using historical flood data and digital elevation models (DEMs).

Output



Agriculture & Precision Farming

Objective: Assess the impact of soil properties and climate on agricultural productivity.



Future Trends:

1. **AI and machine learning integration.**
2. **Increased use of cloud-based GIS.**
3. **Real-time GIS applications.**