UNIT EIGHT: GEOSPATIAL INFORMATION AND DATA PROCESSING

Introduction to Geospatial Information and Data Processing

In this unit, you will explore how geographic data is gathered, processed, and used. Understanding these processes is crucial for analyzing and representing geographic information effectively.

Basic Concepts of Geospatial Information

1. Data vs. Information

- **Data** refers to raw observations, such as numbers, characters, or images. It represents various aspects of features, ideas, or statuses. Data needs processing to become meaningful. It follows a lifecycle:
    1. **Collection**: Gathering new (primary) or existing (secondary) data.
    2. **Processing**: Ensuring data quality and merging information.
    3. **Analysis**: Identifying relationships and visualizing results.
    4. **Dissemination**: Sharing results through reports, conferences, or publications.
- **Information** is the processed data that adds context and knowledge. It is derived from data and helps in understanding specific aspects or patterns.

Comparison Table

Data	Information
Raw and unprocessed	Processed and contextualized
Input for computer systems	Output derived from data
Examples: numbers, images	Examples: insights, conclusions

2. Basic Concepts of Geospatial Data

- **Geospatial Data**: Refers to information about objects, events, or phenomena with location data on Earth's surface. It combines:
    - **Location**: Coordinates or place.
    - **Time**: When the data was relevant.
    - **Attributes**: Characteristics of the object or event.

Components of Geospatial Data

- **Place**: Essential for mapping and measuring distances.
- **Time**: Important for dynamic aspects like temperature changes.
- **Attributes**: Descriptive details, such as temperature or population density.

3. Visualizing Geographic Data

Geographic data can be visualized as:

- **Discrete Objects**: Well-defined areas with clear boundaries (e.g., lakes).
- **Continuous Data**: Varies across surfaces without clear boundaries (e.g., elevation).

Sources and Tools of Geographic Data

1. Sources

- **Directly Collected Data**: Measured directly at the source (e.g., temperature readings, surveys).
- **Remotely Sensed Data**: Collected from a distance using satellites or aerial photography.

2. Tools for Data Collection

- **Global Positioning System (GPS)**: Uses satellites to determine precise locations. GPS receivers provide coordinates and elevation.
- **Digitizers**: Convert analog images into digital formats. Includes:
    - **Table Digitizer**: Converts physical maps into digital data.
    - **Scanner**: Digitizes paper maps.
    - **Smartphones**: Capture and convert geographic data.

Geographic Data Representations

1. Hardcopy vs. Digital Formats

- **Hardcopy (Analogue)**: Paper maps that are less flexible but can be used for various physical tasks.
- **Digital Format**: Easier to store, transmit, and analyze. Used in PCs and internet applications.

2. Geographic Data Structures

- **Point Data**: Represents single locations (e.g., weather stations).
- **Line Data**: Represents linear features (e.g., roads).

- **Area Data (Polygon)**: Represents enclosed regions (e.g., administrative boundaries).

3. Data Models

- **Vector Data Models**: Use points, lines, and polygons. Each feature is defined by coordinates.
- **Raster Data Models**: Use a grid of cells to represent geographic data. Each cell has a specific value representing attributes.

Illustrations of Data Models

- **Vector Representation**: Defines features with coordinates.
- **Raster Representation**: Uses a grid to show features like elevation or land cover.

Understanding these concepts and tools will help you effectively collect, process, and represent geographic data, enabling better analysis and decision-making in various applications.

Advances in Mapmaking and the Birth of Geographic Information Systems (GIS)

Historical Development of Mapmaking

Mapmaking has been crucial throughout human history, with evidence dating back thousands of years. The practice began with basic representations, such as cave paintings, and evolved through ancient maps from Babylon, Greece, and Asia. These early maps were rudimentary, often distorted and inaccurate.

Over time, mapmaking improved significantly. Advances in mathematics, astronomy, and the use of latitude and longitude lines allowed for more precise and detailed maps. The development of printing, photography, and, more recently, satellites, revolutionized mapmaking. Satellites now provide up-to-date, detailed images of nearly the entire Earth, enhancing the accuracy and reliability of maps.

Geographic Information System (GIS)

Components of GIS

1. **Hardware**:
    - Includes computers and peripheral devices (printers, plotters, scanners) necessary for GIS operations.
2. **Methods**:
    - Refers to well-designed procedures and rules for using GIS technology. This includes guidelines, specifications, standards, and procedures.
3. **Software**:
    - GIS software provides tools to store, analyze, and display geographic data. Key components include GIS software, database software, operating system software, and network software.
4. **People**:
    - Effective GIS requires various users, from administrators and managers to technicians and end users, each with specific roles in managing and applying GIS technology.
5. **Data**:
    - Geographic or spatial data indicates the location of features on Earth. Accurate data is crucial for GIS effectiveness. Data types include vector data (defined by points, lines, and polygons), raster data (grid-cell based), image data, and attribute data (descriptive information).

Creating a Local Administrative Map with ArcMap

1. **Starting ArcMap**:
    - Open ArcMap by navigating through Start > All Programs > ArcGIS > ArcMap 10.x.
2. **Adding Data Layers**:
    - For instance, to create a map of Oromia National Regional State, add shapefiles and adjust their appearance by removing any background shading.
3. **Selecting and Exporting Data**:
    - Choose the desired area (e.g., Oromia) from the attribute table, export the data, and save it in your project folder.
4. **Finalizing the Map**:
    - Add necessary elements such as a legend, scale bar, north arrow, coordinate information, gridlines, and the date of compilation.

Visual Presentation of Data

Graphs, charts, and diagrams are essential for presenting data effectively. They help in illustrating trends, comparisons, and relationships. Common types include:

1. **Bar Graph**:
    - Used to show relationships between different data series. Example: Rainfall data.
2. **Line Graph**:
    - Represents how data changes over time. Example: Temperature variation over a year.
3. **Pie Chart**:
    - Visualizes how a whole is divided into parts. Example: Percentage distribution of data categories.
4. **Diagram**:
    - Illustrates how separate parts work together. Example: Components of sustainable development.

Glossary of Basic Terms

- **Variable**: A data item that can have multiple values.
- **Field Survey**: Gathering information through observation and measurement.
- **Data**: Facts and statistics collected for analysis.
- **Information**: Data in context with meaning.
- **Base Map**: Fundamental map information used as a framework.
- **Area of Interest**: Geographic extent of a study or map.
- **Primary Source**: First-hand evidence of an object of study.
- **Secondary Source**: Information about an object of study, not direct evidence.
- **End User**: Person who uses the final output of a map or research.
- **Hard Copy Map**: A physical printed map.
- **Digital Map**: Virtual image of a map created through digital technology.

Unit Summary

This unit explores the development of mapmaking and GIS. Maps have evolved from simple, distorted representations to highly accurate tools thanks to advancements in technology. GIS, a computer-based system, allows us to store, analyze, and interpret geographic data. Understanding GIS components and the importance of data accuracy is crucial for effective geographic analysis. Additionally, presenting data through graphs, charts, and diagrams enhances communication and understanding of complex information.