UNIT EIGHT
GEO-SPATIAL INFORMATION AND DATA PROCESSING

Introduction

Geography education plays a crucial role in helping students develop real-world skills, including spatial thinking. Geographic Information Systems (GIS) are powerful tools used to handle and analyze spatial data. This unit focuses on how different landforms are represented on contour maps and the basics of GIS, helping students visualize and understand geographical features.

8.1.1 Basic Concepts of Relief and Topographic Maps

Relief refers to the variation in elevation between the highest and lowest points on the Earth's surface. It describes the physical shape of the land, including features such as plateaus, mountains, hills, valleys, and more. These features are formed through processes like erosion and deposition.

Topographic Maps are detailed representations of natural and man-made features on the Earth's surface. They include elements like rivers, forests, urban areas, and contours that show elevation changes. Maps are scaled-down versions of the real world, with the scale indicating the relationship between map distance and ground distance.

8.1.2 Methods of Representing Relief Features

Hachures:

- **Definition**: Short lines drawn in the direction of the slope or water flow.
- **Purpose**: To represent the steepness of slopes.
- **Limitations**: Hachures only provide qualitative information and do not show exact heights or gradients.

Contours or Isohypses:

- **Definition**: Imaginary lines connecting points of equal elevation.
- **Properties**:
    - Contours do not cross each other except at vertical cliffs or waterfalls.
    - They are always numbered to indicate increasing elevation.

    - Contours show slope steepness: closely spaced lines indicate steep slopes, while widely spaced lines indicate gentle slopes.
- **Types**:
    - **Index Contours**: Every fifth contour line, starting from zero elevation.
    - **Intermediate Contours**: Lines between index contours, usually four per index contour.

8.1.3 Major Relief Features and Their Contour Representations

- **Hill**: Rounded elevation with contours forming concentric circles. The smallest closed contour represents the hilltop.
- **Mountain**: Higher than hills with elongated closed contours increasing in value towards the center. Mountains have more prominent contours compared to hills.
- **Ridge**: A long, narrow elevated area with contours forming U or V shapes. The contours point away from the high ground.
- **Valley**: A long depression between two higher areas, with contours forming V shapes pointing upstream or towards high ground.
- **Saddle**: A dip or low point between two higher areas. Represented by a dip in the contours between higher ground.
- **Depression**: An area surrounded by higher ground, shown with closed contours having tick marks pointing towards the low ground.
- **Plateau**: Elevated flat area with roughly rectangular closed contours, with increasing values towards the center.
- **Gorge**: A steep, narrow valley with closely converging contours along the river course.
- **Spur**: A projection of land from higher to lower ground, shown by U or V-shaped contours pointing away from high ground.
- **Cliff**: A steep or vertical slope, represented by contours very close together or merging into a single contour.
- **Fill**: A man-made feature created by filling a low area, shown with contours along the fill line.

8.1.4. Catchment Representation on Contour Maps

Catchment Area (Drainage Basin): A catchment area or drainage basin is the entire geographic region that drains into a major river and its tributaries. The major river is the primary watercourse in the basin, while smaller streams that feed into it are called tributaries. The point where tributaries meet the major river is known as the confluence, and the river's starting point is its source. The river's end point, where it flows into a sea, ocean, or lake, is called the mouth.

Identifying Drainage Basins on Contour Maps:

1. **Locate the Major River and Outlet:** Find the major river and its outlet on the contour map. Mark the outlet point of the watershed.
2. **Trace Tributaries:** Highlight the paths of the tributaries and their flow directions on the map.
3. **Identify High Points and Ridges:** Find high points and ridges near the tributaries' origins. Mark these high points with an "X."
4. **Visualize Flow Direction:** Draw arrows to indicate the direction of surface water flow from the high points.
5. **Outline the Watershed:** Connect the high points with lines starting from the outlet to trace the boundary of the watershed.

Rules for Using Contour Lines:

- **Contour Lines and Slope:** Contour lines never go uphill or downhill; they only represent changes in elevation. Steeper slopes have closely spaced contours, while gentle slopes have widely spaced contours.
- **Flow Direction:** Water flows downhill and away from high points. On a ridge, water flows from the top downwards on both sides.

8.1.5. Drainage Pattern Representation on Contour Maps

Identifying Drainage Patterns:

1. **Dendritic Pattern:** Found in areas with uniform rock types, creating a tree-like structure with branching streams.
2. **Trellis Pattern:** Forms in regions with alternating hard and soft rock layers. This pattern is influenced by tectonic forces such as folding and faulting.
3. **Radial Pattern:** Occurs around elevated features like volcanoes, with rivers flowing outward in all directions.
4. **Centripetal Pattern:** Found where rivers flow from higher areas towards a central basin.

Activities:

- **Feature Identification:** Use contour maps to identify different landforms and their corresponding drainage patterns. Analyze slope types, landforms, and features represented by letters on the map.

8.2. Basic Concepts of Geographic Information Systems (GIS)

8.2.1. Definition and Importance of GIS

Geographic Information System (GIS): GIS is a computer-based tool used to capture, store, analyze, and display geographically referenced data. It integrates hardware, software, and data to create maps and analyze spatial relationships.

Importance of GIS:

- **Decision Support:** Helps in planning and managing land use, natural resources, transportation, and urban facilities.
- **Data Integration:** Combines diverse data sources for comprehensive analysis and visualization.
- **Problem Solving:** Addresses issues like climate change, resource management, and disaster planning.
- **Teaching Tool:** Enhances geography education by providing practical applications and visualizations.

8.2.2. Components of GIS

1. **Hardware:** Includes computers, GPS devices, scanners, and printers used for input and output of GIS data.
2. **Software:** Tools like ArcGIS and QGIS are used for managing, analyzing, and displaying geographic information.
3. **Data:** GIS uses spatial data (points, lines, polygons) and attribute data (non-spatial characteristics) to represent geographical features.
4. **People:** GIS users (who use the data) and GIS specialists (who manage and analyze the data) are essential for the system's success.
5. **Methods:** GIS operates based on well-defined plans and practices unique to each organization.

8.3. ArcMap and Main Tools

Objective: By the end of this unit, you'll be able to:

- Open, save, and close ArcMap documents.
- Describe the functions of the main tools in ArcMap.
- Use ArcMap menus to add and display data.
- Map different geographical issues and distributions.

Keywords: Adding, ArcMap, Closing, Displaying, Opening, Removing, Saving, Tools

8.3.1. Opening, Saving, and Closing ArcMap Documents

- **Opening ArcMap:**
  - Access ArcMap by clicking the ArcMap icon in your Start menu or double-clicking an existing .mxd file on your desktop. By default, ArcMap opens with a new, blank document.
- **Saving a Map:**
  - To save your work, click **File** > **Save**. ArcMap appends the .mxd extension to your document name. You can also save the map with its data as a map package for sharing.
- **Closing a Map:**
  - To close the current map, click **File** > **Close**. Opening a new map will automatically close the current one.

8.3.2. ArcMap Main Tools and Their Role

- **ArcMap Menus and Tools:**
  1. **New Project:** Opens a new blank ArcMap document (.mxd file).
  2. **Open Project:** Opens an existing .mxd document.
  3. **Save Project:** Saves the current document, linking to but not storing the actual data.
  4. **Print:** Prints the current map view.
  5. **Add Layers:** Adds GIS data to your document from local files, networks, or online services.
  6. **Edit Function:** Used to edit GIS data.
  7. **Arc Catalog:** Manages GIS data such as creating, copying, or deleting shape files.
  8. **Arc Toolbox:** Contains tools for geoprocessing tasks like analysis and conversion.
  9. **Zoom In/Out:** Adjusts the map view to show more or less detail.
  10. **Pan:** Moves the map view in any direction.
  11. **Full Extent:** Expands the view to show the full geographical extent of your data.
  12. **Select Element:** Chooses features on the map using various shapes.
  13. **Identify:** Queries information about features on the map.
  14. **Find Tool:** Performs text searches on data themes.
  15. **Add XY:** Drops a point and generates X, Y coordinates.
  16. **Measure Tool:** Measures distances between locations on the map.
- **Arc Toolbox:**
  - **Analysis Toolbox:** Tools for geoprocessing tasks like overlays and proximity analysis.
  - **Cartography Toolbox:** Tools for map production and cartographic standards.
  - **Conversion Toolbox:** Converts data between different formats.
  - **Coverage Toolbox:** Tools for operations specific to coverage data.

- **Data Management Toolbox:** Manages feature classes, datasets, and raster data.
- **Geocoding Toolbox:** Tools for address geocoding and locator management.
- **Linear Referencing Toolbox:** Tools for linear referencing tasks.
- **Spatial Analyst Toolbox:** Tools for analyzing raster data and integrating raster/vector data.

8.3.3. Adding, Removing, and Displaying Data

- **Adding Data:**
  - Use the **Add Data** button or drag and drop from Arc Catalog to include data in your map. Data layers appear in the Table of Contents (TOC) organized by type (points, lines, polygons).
- **Removing Data:**
  - To remove data, right-click the layer in the TOC and select **Remove**.
- **Displaying Data:**
  - **Data View:** For exploring and querying data in real-world coordinates.
  - **Layout View:** For arranging map elements like titles and scale bars on a page. Switch views via **View** > **Data View** or **Layout View**.