Water and Development
Part 3b: Models, Maps and GIS

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2D objects

- 0-d: points with \((x, y)\), location. 1-D: lines and curves. notion of length. 2-D: closed curves and polygons. notion of area.
- Operations: centroid: \(2D \rightarrow 0D\), computes the centroid of an area. intersect: \(2D \times 2D \rightarrow 2D\): computes the intersection of two areas.
- Attributes. 0D: location of schools, number of pupils. 1D: streams, roads. width. 2D: plots of lands, wards, village boundaries. census data.
3D

- Basic 3d: functions on 2D, i.e., \( f(x, y) \). Operations: Compute mimimum. Restrict domain.
- Various uses: Elevation, Rainfall, distance to school.
- Discretization: Representation as DEM. Generalization: Making function out of point data.
GIS-Geographical Information System

- A universal \((x, y, z)\) frame:
  - (latitude, longitude, elevation).
  - Usually, only a lat-long \((X-Y)\) plane, with \(z\) as a function.

- Layers and Functions
  - **Layers**: Diagrams in the X-Y plane, such as features, polygons etc, e.g., a farm-plot, or a stream.
  - **Functions**: Storing functions \(f(x, y)\), e.g., \(rainfall(x, y)\).

- Layers will have names:
  - drainage, land-use

- Each layer:
  - points, lines, curves, polygons—wells, streams, farm-plots
  - functions—elevations

- Operations
  - Intrpolation, Extrapolation, Subdomains
  - Use-specific: watershed delineations, run-off models etc.

- Display tools—converting layers and functions into images.
Papagni Watershed

The Papagni river water shed is about 2500 sq. km, in a border district of Andhra Pradesh. It is one of the study areas of the Foundation for Ecological Security (www.fes.org.in). The following maps are from FES.

- The physical map - The toposheet.
- The Drainage - outlines all streams and rivers in the water shed.
- The sub-water shed map - outline all sub-domains down to micro-watersheds, which are about 3-10 sq. km.
- The next two are the geological data sheets.
- Next, we have the land use data.
- Finally we have the development-potential. This is a basic input for any development plan.

Question - Static Data

What goes into the collection of such data and its representation?
The Papagni maps

- 1:250,000 maps of a particular district/valley in A.P.
- These cover various attributes related to ground and surface water.

**Water related:** Drainage, Digital terrain Map (DTM), Micro-watershed, Geology, Landscape, Land-Use/Cover, Groundwater potential, **Sub-watershed priority**.

**Ancillary:** Soil erosion, Risk of Fire.

**Development related:** Composite Land Development Unit.

**Scales:**

<table>
<thead>
<tr>
<th>Scale</th>
<th>1m</th>
<th>1 Hectare (in mm.)</th>
<th>Typical use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:250,000</td>
<td>250 km</td>
<td>&lt; 1sq. mm</td>
<td>District</td>
</tr>
<tr>
<td>1:50,000</td>
<td>50 km</td>
<td>2 × 2</td>
<td>Taluka</td>
</tr>
<tr>
<td>1:5,000</td>
<td>5 km</td>
<td>20 × 20</td>
<td>Gram-Panchayat</td>
</tr>
</tbody>
</table>
Legends

- Drainage, DTM obvious and so is the micro-water shed map.
- What is the data required and how is it obtained?
  - DTM is the base map which is remote-sensed (How?).
  - Watersheds are outlined through an automatic delineation.
  - Drainage:
    - Towns, villages, roads, political boundaries: a GIS layer.

- Geological: This is about the origins of soil/rock of the area. It is also typically, what lies below the regolith, i.e., unconsolidated overlying material.
  - Crystalline: substrate rock, typically crystalline, in this case, gneiss and granite.
  - Intrusive: that which intrudes from beneath the crystalline base rock. Usually a dike (planar fault) or pipes (tubular fault), or because of a different rock-type, in this case quartz.
  - Residual: The parent rock.
More Legends

Geomorphological/Landscape: The shape rather than the origin.
- **Structural hill:** Largely uneroded outcrops.
- **Denudational hill:** Weathered hills.
- **Pediment:** Roughly planar rock, with or without a thin layer of soil. Typically between hills.
- **Pediplain:** A tapestry of pediments.
- **Pediment-Inselberg:** A hill outcrop from a pediment.
- **Piedmont:** Plains at the base of hills formed by stream deposits.
- **Papagni:** Largely structural hills and pediplains.

Land Use/Cover: Agricultural (season,fallow), Forest, Waste.
- **Papagni:** Largely kharif, fallow. Forests on the hill-slopes.
- Also note the correlation with the geo-morphology.

**Groundwater Potential:** seems correlated with dikes and drainages. Generally poor.

**Erosion:** seems correlated with the *slope-map*.

Finally, Land Dev. Unit: Prescriptions, largely water interventions.
## Typography of data

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Means of gathering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>Scientific</td>
<td>Satellite, Surveying</td>
</tr>
<tr>
<td>Geology</td>
<td>Scientific</td>
<td>Surveys, bore-logs</td>
</tr>
<tr>
<td>Rainfall etc.</td>
<td>Climatological</td>
<td>weather stations</td>
</tr>
<tr>
<td>Drainage</td>
<td>Intermediate</td>
<td>Surveys, Mathematics</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Intermediate</td>
<td>mathematical</td>
</tr>
<tr>
<td>Land Use</td>
<td>Socio-economic</td>
<td>talathi, satellite</td>
</tr>
<tr>
<td>Cropping pattern</td>
<td>Socio-economic</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Census, roads</td>
<td>administrative</td>
<td>various departments</td>
</tr>
<tr>
<td>Household compensation</td>
<td>policy planning</td>
<td>composite</td>
</tr>
<tr>
<td>Development Priority</td>
<td>planning</td>
<td>composite</td>
</tr>
</tbody>
</table>
Maps

The main national source of maps are:

- **Survey of India, Geological Survey of India** for 1:250,000 standard data and geology.
- **National Remote Sensing Center**
Thanks