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Geographers’ Tools: Automated Mapping

8

Prof. Anthony Grande
Hunter College Geography

Digitizing a Map

- A digitizer turns a printed map into electronic format by assigning X,Y coordinates to every point on the map like a mesh. The closer the points the sharper the image (similar to use of pixels and HD concept).
- Attributes (details) are added to each X,Y coordinate point: these may include latitude, longitude, time of day, elevation, land use, photographs, crime statistics, colors, symbols or shading, etc.
- This is called “geocoding”: The adding of attributes (or details) to point locations.

Revising a Digitized Map

- We can now revise a map without redrawing it by just updating the attributes at a particular X,Y coordinate.
  1. We go to the geocoded list and make needed changes.
  2. The mapping program will reconfigure the data as soon as “enter” is hit.
  3. A new, revised map will be produced and is ready to be viewed and/or printed.

The Digitized Map

A printed map is turned into electronic format by covering it with an electronic mesh of reference points. This can be done in two different ways by using the vector format or the raster format.
**Vector and Raster Formats**

**Vector:** Assigns data to X,Y coordinates. Thousands of points with different attributes can be placed very close to each other. This creates a relatively smooth image and can be enlarged without distortion.

**Raster:** Uses equal-sized coded cells (pixels) to show data. The entire cell has the same value (information). This gives a boxy appearance, especially when zooming in on an area, because the individual pixels can be seen. When densely packed (HD), this creates a clear, sharp image.

**SUMMARY: Vector vs. Raster**

- **Vector:** Assigns data to X,Y coordinates. Creates a smooth image; can be enlarged without distortion.
- **Raster:** Uses equal-sized coded cells (pixels) to show data. Creates a boxy appearance when enlarged; when densely packed (HD), creates a clear, sharp image.

**Automated Map Making**

An electronic mesh of X,Y coordinates covers the map. THEN attributes are added to each coordinate. To each coordinate, symbols and colors may be assigned. Maps can be redrawn using any of the variables programmed into the system ➔ Automated Cartography.

**Automated Cartography**

- Automated or computer cartography employs a digital database and software programs to **COMPILE, DESIGN, DRAW** and **REVISE** maps.
  - It includes a Digital Elevation Model (DEM) which is a set of equally surfaced surface elevations keyed to latitude and longitude.
  - DEM is compiled using **global position system (GPS)** (latitude/longitude/elevation/time).
  - For example, flood zone maps are drawn based on a predetermined volume of water reaching a preset elevation. (This can be animated if time sequencing is included.)

- **Georeferencing:**
  1. In order to match old paper maps, aerial photographs and satellite imagery with each other, objects (control points) need to be identified, geocoded (lat,long coordinates along with specific information to create data points).
  2. Control points (minimum of four, the more the better) are selected for their permanency over time so as to avoid any argument as to their location past or present.
  3. The paper map, photograph or image is scanned (digitized) to convert it to electronic format. In this way they can be manipulated, moved and saved for future retrieval.
  4. The digitized images are moved electronically to place them over each other, making sure the control points match up.
  5. Transformation georeferencing maintains straight lines and reduces distortion by just rotating, scaling or skewing the object.
  6. Rubber sheeting is a georef. process by which a data layer is distorted (pulled/bent/shrunk/rotated) to make it fit with other geographic layers of the same area.
    - It preserves the interconnectivity between points.
    - It does not preserve straight lines and may have to be re-adjusted to avoid major distortions.
    - This is used to rectify historic maps with present-day landscapes by matching objects found in both.

- [Video](https://www.youtube.com/watch?v=xVVdZOQiBuQ) 5 min georeferencing video
- [Video](https://www.youtube.com/watch?v=PIxLsVBFdLo) 7 min georeferencing old map of Montana (no sound)
- [Video](https://www.youtube.com/watch?v=ZXiLcYBlq9Y) 2 min georeferencing old map of Montana (no sound)
Crime Data
San Francisco crime statistics represented in an elevation model.
Shows concentration by neighborhood. Crime reports are located using X,Y coordinates. Studying individual crime maps can lead to selective policing.

3-D Maps and Animations
Many attributes can be assigned to each coordinate: elevation, land use, crime stats, temperature, etc.
✓ Now we can add information as to how that point will appear under a set of circumstances: time of day, angle of the sun, approaching a site from a certain direction.
We can also add time sequencing (movement).
✓ The result is an animated 3-D map that can be manipulated by changing variables in a time sequence that gives the illusion of movement.

3-D Animated Maps
2 minute ARCGisce 3-D landscape animation
https://youtu.be/9CyGqguOhso
3 minute Big Bend National Park, TX animation
https://www.youtube.com/watch?v=4VEh8gQheo
5 minute Portland, OR 3-D city animation
https://www.youtube.com/watch?v=PCy9logoSEo

Draping a Map over an Image
Visualization of multiple LIDAR returns in a forest canopy, showing:
1. Returns from the top of forest canopy,
2. Returns from forest understory
3. Returns near or on the ground.
4. The bare earth surface produced from post-processing is also shown.

LIDAR Mapping
LIDAR - Light Detection and Ranging - is a remote sensing method used to examine the surface of the Earth. It can be calibrated to detect layers.

Using LIDAR to Map a Forest-hidden Archeological Site
SOURCE: ASPRS
2 minute ARCGIS modeling animation with LIDAR
https://www.youtube.com/watch?v=QApMk7b52Eg
Using LIDAR to Map a Forested Area

LIDAR sees through the tree cover to locate non-vegetated objects when vegetated “echoes” are removed in processing.

LIDAR use in GEOLOGIC SURVEYS

- “Bare Earth” LIDAR technique enables researchers to remove overlying land cover, both man-made and natural, to see bedrock formations.

Computer Cartography

There are many steps required to prepare images for mapping. Electronic images must be processed and corrected to make them useful.

Satellite image of Great Smoky Mts. National Park draped over a DEM.

GIS: Geographic Information Systems

- A GIS is a spatial information system that is designed for data management, mapping and analysis. It goes beyond automated cartography!

GIS: Layering

Layered data allows a GIS to work.

Each data set layer is anchored by coordinates of latitude and longitude:
- Layers can be added and removed from the data base.
- Layers can be shown in any combination.

Variables within any layer can be altered to create a new map based on new data relationships.
GIS: Geographic Information Systems

A GIS is a spatial information system that is designed for data management, mapping and analysis.

I. It allows data to be manipulated.

There is a database of location information plus instructions.
✓ can produce special purpose maps
✓ can help answer the question: WHAT IF .... ?
✓ can analyze situations and come up with a final map

II. It is interactive.

When one or more variable is changed, all other data will change accordingly based on the pre-programmed instructions.

III. It helps us to create standardized models.

- **Capability Models**: Are the physical attributes of the area able to support activity "X"?
- **Suitability Models**: Do the socio-economic attributes make this area a good location for activity "X"?

IV. It helps us to create geographic simulations or "Smart GIS".

The map of the future is an intelligent image.

a) **Recognize** a situation (based on a model).
b) **React** to it (based on another model).
c) **Send out instructions** (based on a third model).

- Your car GPS talking to you (insisting you to make a U-turn).
- Locating and isolating a water main break.
- Turning traffic lights in favor of emergency vehicles.
- Creating a detour route for traffic in congested areas.

Examples of GIS

- [https://www.youtube.com/watch?v=6AlH5TvFolw](https://www.youtube.com/watch?v=6AlH5TvFolw): Intro to GIS featuring Shasta College (CA) GIS Program (10 min)
- [www.google.com/maps](http://www.google.com/maps)
- [http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30&extent=-74.023087936646,40.59437834730017,-73.9865240635401,40.60513235247505](http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30&extent=-74.023087936646,40.59437834730017,-73.9865240635401,40.60513235247505)

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