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Geographers' Tools: Automated Mapping

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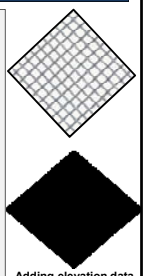
Digitizing an Existing Map

- 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, photographs, land use, crime data, colors, or symbols, etc.*
  - This is called "**geocoding**": **The *adding of attributes (or details) to point locations.***
- ✓ Older, printed maps are useful to geographic research and may be brought into the modern era through **"digitization."**



Adding elevation data can create the illusion of 3-D when added to instructions within a software program.

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IMPORTANT

The electronic mesh created by the "X,Y coordinates" is NOT the same as the grid created by latitude and longitude.

Latitude and longitude information may be added to digitized X,Y coordinates as attributes, along with any other attribute the mapper/data entry person wishes to include in the data base.

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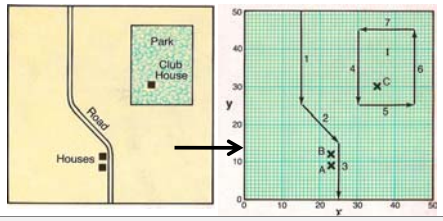
The Digitized Map



A printed map is turned into electronic format **by covering it with an electronic mesh of reference points.**

This can be done in two ways by using either the **vector format** or the **raster format**.

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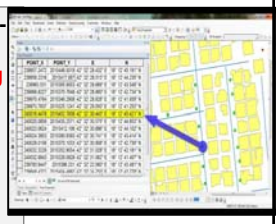
Revising a Digitized Map



- **Once a map has been digitized, we can revise it 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.

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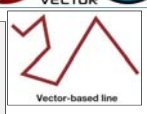
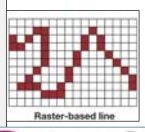
Vector and Raster Formats

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.**



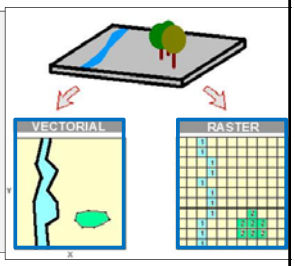
SUMMARY: Vector vs. Raster

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.



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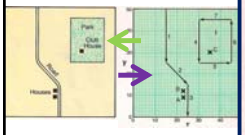
Automated Map Making



1. An electronic mesh of X,Y coordinates covers the map.

2. THEN attributes are added to each coordinate.

3 Symbol	2 Attribute (What's there)	1 x,y Coordinates
Point Letter		
A	House	23,9
B	House	23,12
C	Club House	35,30
Line Number		
1	Road	15,50–15,25
2	Road	15,25–25,15
3	Road	25,15–25,0
4	Park Boundary	30,45–30,25
5	Park Boundary	30,25–45,25
6	Park Boundary	45,25–45,45
7	Park Boundary	45,45–30,45
Area Numeral		Boundary Lines
1	Park	4,5,6,7
	Map Symbol	Attribute / Geocoded entries

3. To each coordinate, symbols, colors and words may be assigned. Maps can be redrawn using any of the variables programmed into the system = Automated Cartography.

BENEFIT: *In the file, information is cross-referenced by both X,Y coordinates and attributes. When one thing is changed, all linked items are changed, too.*

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.)

https://coast.noaa.gov/floodexposure/#/map

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Georeferencing: Control Points

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.

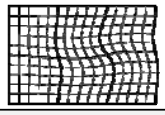
3.The paper map, photograph or image is scanned (digitized) **to convert it to electronic format.** In this way they can be manipulated, moved and saved for future retrieval.

https://www.youtube.com/watch?v=xVVdZOQiBuQ 5 min georeferencing video

https://www.youtube.com/watch?v=PXiLcYBlq9Y 2 min georeferencing old map of Montana (no sound).

http://nls.georeferencer.com/map/1ArXmBwCXwFtySLq0Jbk7m/201705240629-vvCN21/visualize# example of opaqacy tool

Georeferencing: matching control points



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.***

http://maps.nypl.org/warper/maps/8245#Preview_tab

http://maps.nls.uk/geo/explore/#zoom=5&lat=60.7087&lon=-17.7409&layers=101943491&b=1

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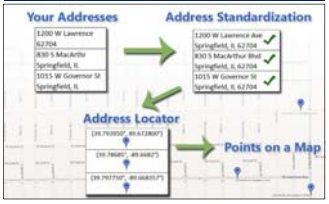
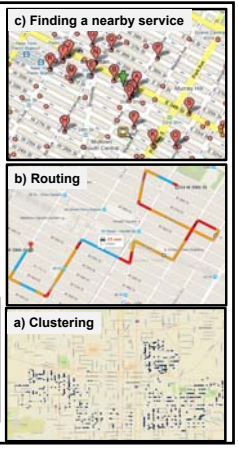
Geocoding Address Lists



Placing address points on a map lets you see connections not apparent from address lists, as clustering, places outside of a service zone, optimum routing or the searching for specific services -- as pizza near the Empire State Building.



Portraying Crime Data

San Francisco crime statistics re-presented in DEM format showing crime numbers visually as "elevation": high and low crime areas.

- ✓ Shows crime concentration by neighborhood. Crime reports are located using X,Y coordinates.
- ✓ Studying individual crime maps can lead to selective policing.

Here the "hills" created by the digital elevation model (DEM) are the number of crimes recorded, not altitude.

Source: SFPD

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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.

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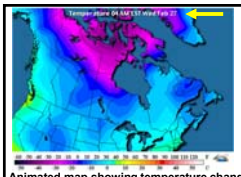
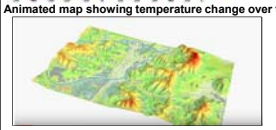
3-D Animated Maps



Animated map showing temperature change over time



2 min.ARCscene 3-D landscape animation
https://youtu.be/tGOTmgthQxE (no sound)

3 min. Big Bend Nat'l Park, TX fly over animation
https://www.youtube.com/watch?v=q4VEIja7Noc

Coronavirus 3D interactive, rotatable map
https://icao.maps.arcgis.com/apps/webappviewer3d/index.html?id=d9d3f8fa9a23425c8f0889baab626186

4 min Newark-Liberty flight simulator (take-off)
https://www.youtube.com/watch?v=QApMk7b52Eg

6 min. Virtual city 3-D animation (shadows/wind/congestion)
https://www.youtube.com/watch?v=1ake22nfomg

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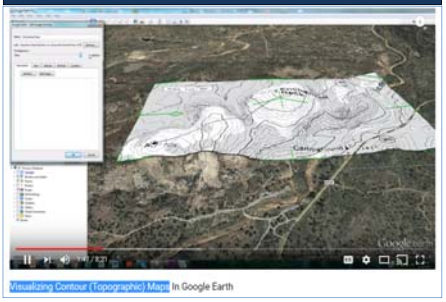
Draping a Map over an Image



https://www.youtube.com/watch?v=55BNufFfXdc 8 min
Visualizing Topographic Maps: turning 2D map into 3D map
(isolines connect points of equal elevation)

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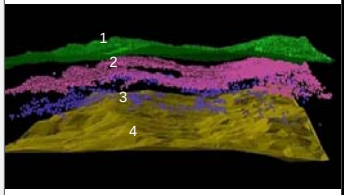
LIDAR Mapping

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.

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.

SOURCE: ASPRS



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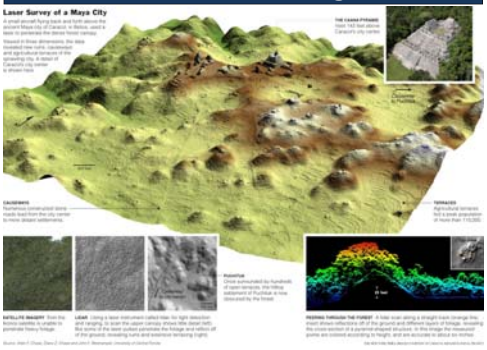
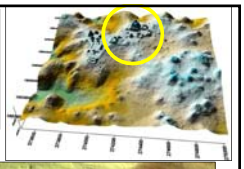
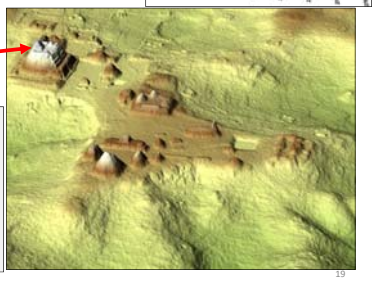
Using LIDAR to Map a Forest-hidden Archeological Site



LIDAR "Sees" Through the Tree Tops to Map the Forest Floor





LIDAR can locate non-vegetated objects when vegetated "echoes" are removed in processing.
As of summer 2018, 60,000+ Mayan structures have been located in densely vegetated areas of Guatemala and mapped.

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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.

http://lidarportal.dnr.wa.gov/#47.08509:-122.10754:9

https://wadnr.maps.arcgis.com/apps/Cascade/index.html?appid=36b4887370d141fcbb35392f996c82d9

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Mapping Biodiversity from Airplanes

https://www.nytimes.com/2019/06/10/science/coral-reefs-mapping-biodiversity.html?searchResultPosition=1

Global Airborne Observatory: airplane equipped with sensors, including LIDAR, that can perform detailed analysis of the underlying terrain. It was first used to map rainforests beneath the treetops.

Most airborne and satellite instruments have difficulty penetrating seawater and therefore, cannot "see" nor map coral reefs.

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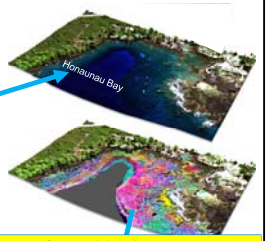
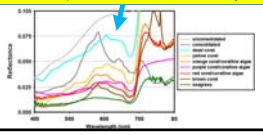
Mapping Biodiversity from Airplanes

Top image: *3-D map of Honaunau Bay, Hawaii in natural color.*



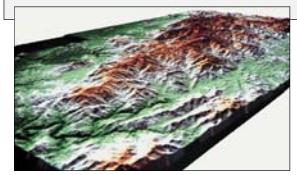
Bottom image: Sensors are now able to pierce sea-water to a depth of 50 ft. to create 3-D reef maps (using LIDAR), detect coral bleach-ing and identify different species of coral, including dead coral, by using electro-magnetic technology to match spectral signatures stored in a data dictionary.

CORAL BIODIVERSITY: Bright colors represent com-munities of coral in a 3-D map with the seawater removed.. Colors are assigned to the spectral signatures of live coral, dead coral, underwater plants, sand, rock and other objects.



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.

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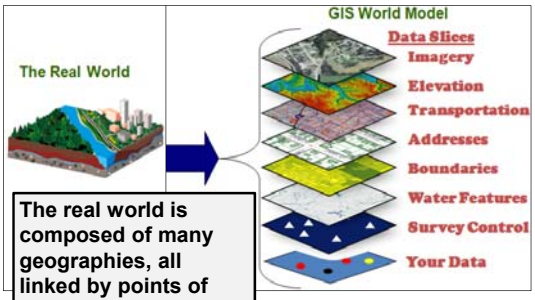
Geographic Components of Reality



The real world is composed of many geographies, all linked by points of latitude and longitude.

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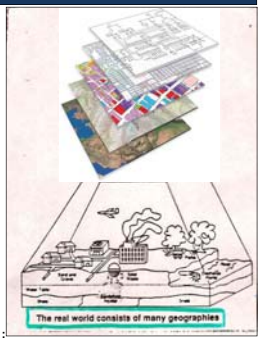
GIS: Geographic Information Systems

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

It goes beyond automated cartography!



https://www.youtube.com/watch?v=oMUGp0rGf7I : **What is GIS (2 min)**

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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.

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GIS: Geographic Information Systems

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

❖ **Four features of a GIS make it a useful tool:**

1. It allows data to be **manipulated**.
2. It is **interactive**.
3. It helps us to create **standardized models**.
4. It allows us to create **geographic simulations:** the "Smart GIS".

Layered data tied to latitude and longitude coordinates allows a GIS to work.

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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 data base 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

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GIS: Geographic Information Systems

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

II. It is interactive.

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

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GIS: Geographic Information Systems

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

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"?

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GIS: Geographic Information Systems

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

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.

https://www.youtube.com/watch?v=DV4QqJNIju0 flood model, see minute 3 animation (total 6 min long)

FIRST EXAM

❖ **Friday, Feb. 27 – Monday, Mar. 1, 2021**

- Combination of multiple choice questions and map interpretation.
- Based on class lectures supplementing Chapter 1. Review lectures 1-8 on home page.
- Review the STUDY GUIDE for Exam 1. If you miss this exam, a written-response make up test (with the place name maps) will be given.

http://www.geo.hunter.cuny.edu/courses/geog101_grande/handouts.html

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