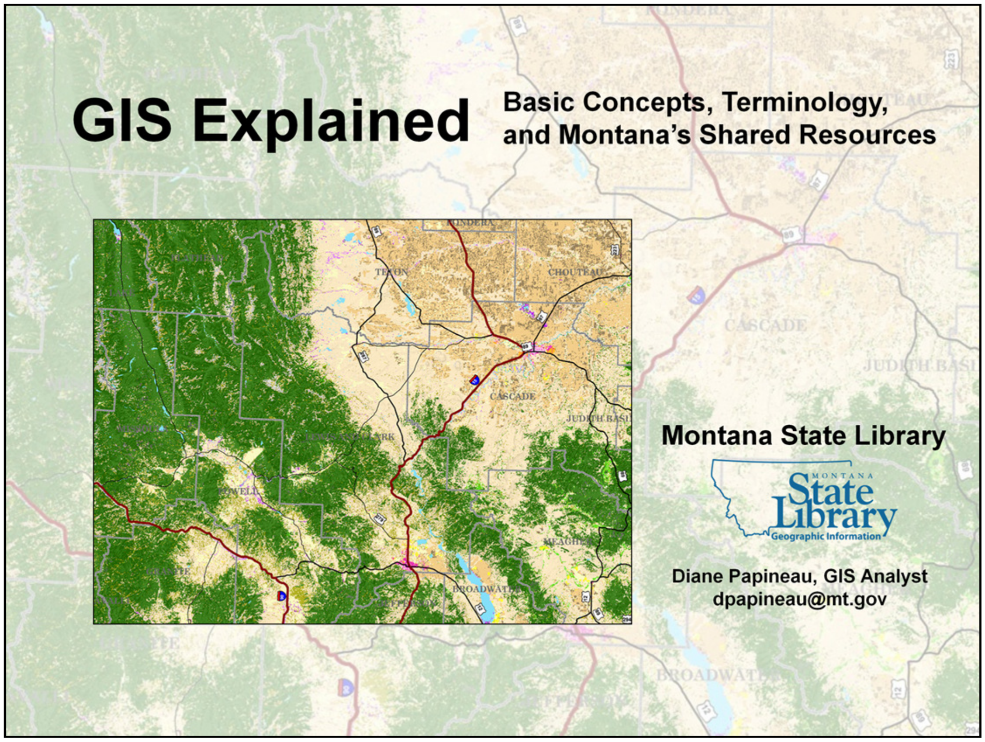
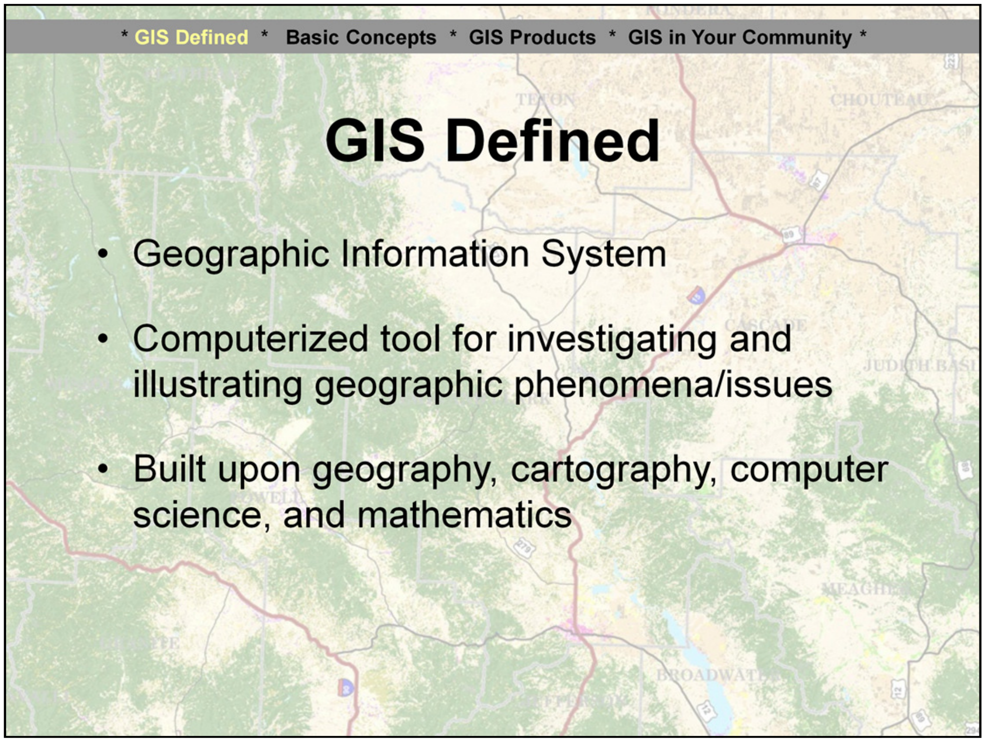


-I'll be spending a bit of time with you introducing the basics of GIS

Goal: vocabulary and basic concepts

-This presentation will cover these 4 topics

-I’ve included our outline at the top of the screen so we’ll know where we are as we progress

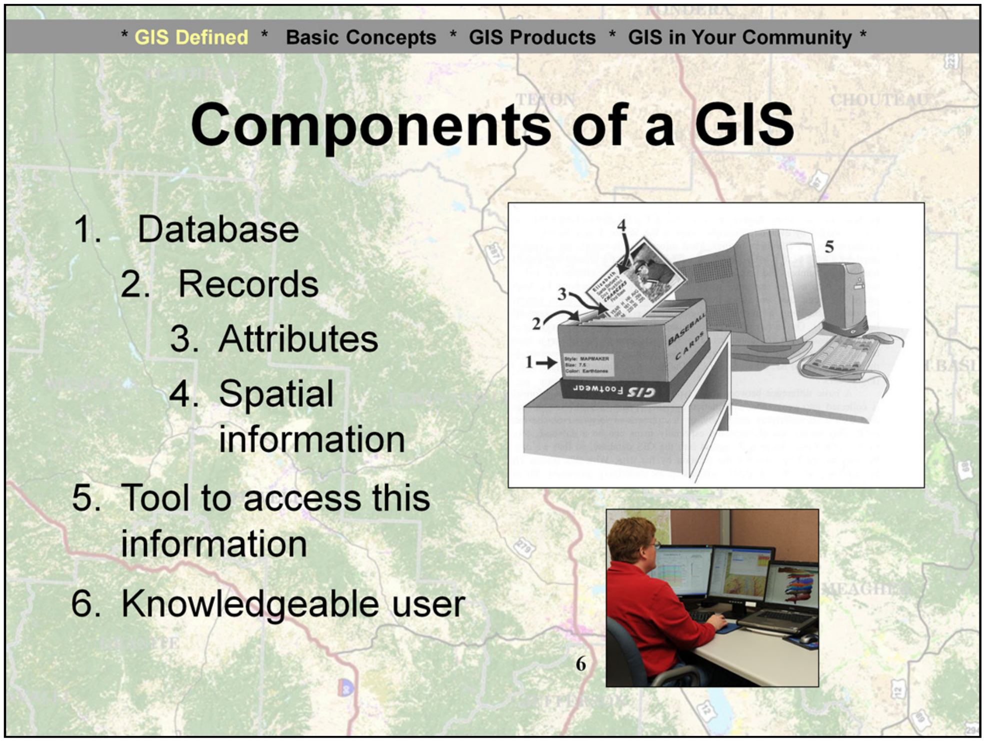


-It stands for both GI System and GI Science

-GIS is a computerized tool…

-GIS allows us to easily do in the computer environment what we often try to do manually or in our minds

-GIS is built upon the fields of…

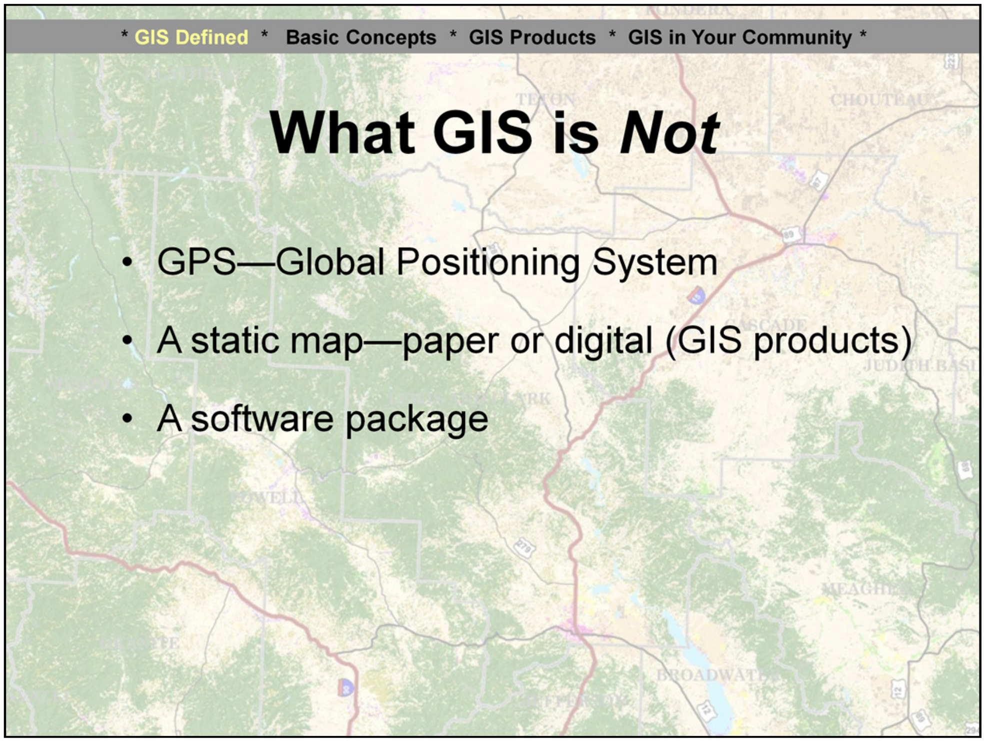


-The components of the GIS begin with the database of information

-The database is made up of records, each of which has attribute and spatial information.

-We then add the computer hardware and the software as the tool to access this information

-We also need a knowledgeable user

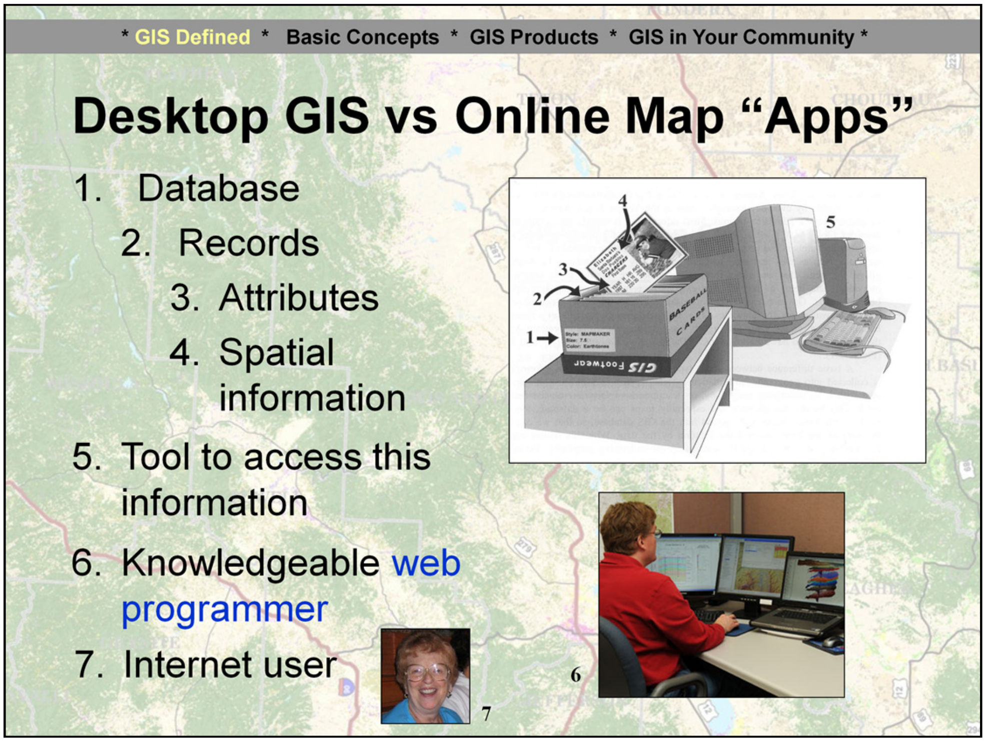


-It's important to clarify what GIS is not:

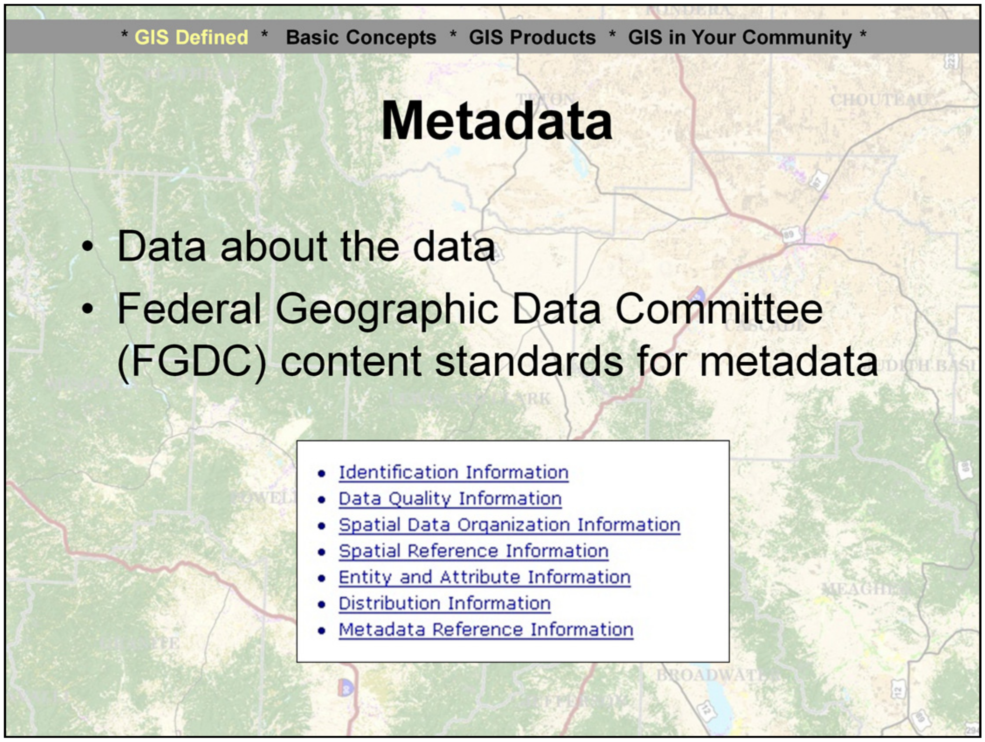
-It is not GPS—Global Positioning System is a tool to obtain data for use in a GIS

-It is not a map—this is a product of a GIS

-and it's a common mistake to think of GIS as merely a software package



- Web programmer needed
- Internet map user
- The amount and type of GIS functions offered through an online map application is usually very limited when compared to what a desktop GIS can accomplish



-Documentation of data is critical. GIS documentation is called metadata— "data about data"

-In the form of web pages, text files, Word files, XML files, etc.

-Read it for the data you obtain,

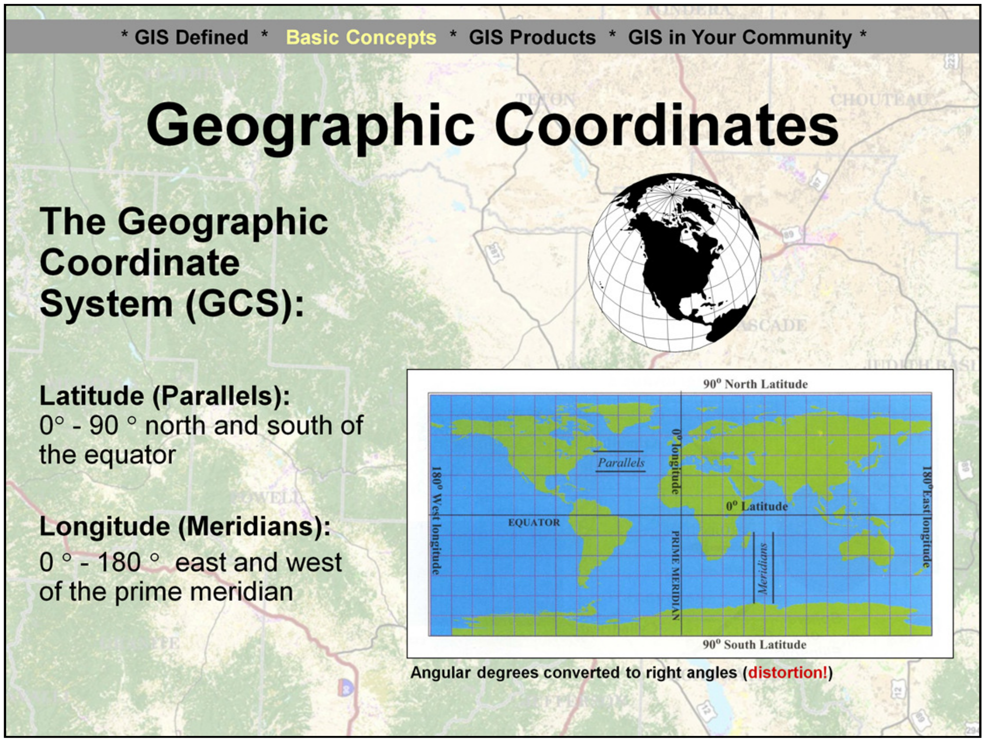
-Write it for the data or products you create

-Metadata enables us to share data resources

-Metadata standards were established and mandated in the US in 1993. All federal metadata must address the seven categories shown. Montana has a metadata standard for all state data created.

Basic GIS Concepts

- Geographic Coordinates
- Map Projection
- Map Scale
- Data Types
- Spatial Analysis
- Resource Sharing: Spatial Data
- GIS Products



-To represent the Earth in a computer or on a map, we have to flatten it from 3D to 2D.

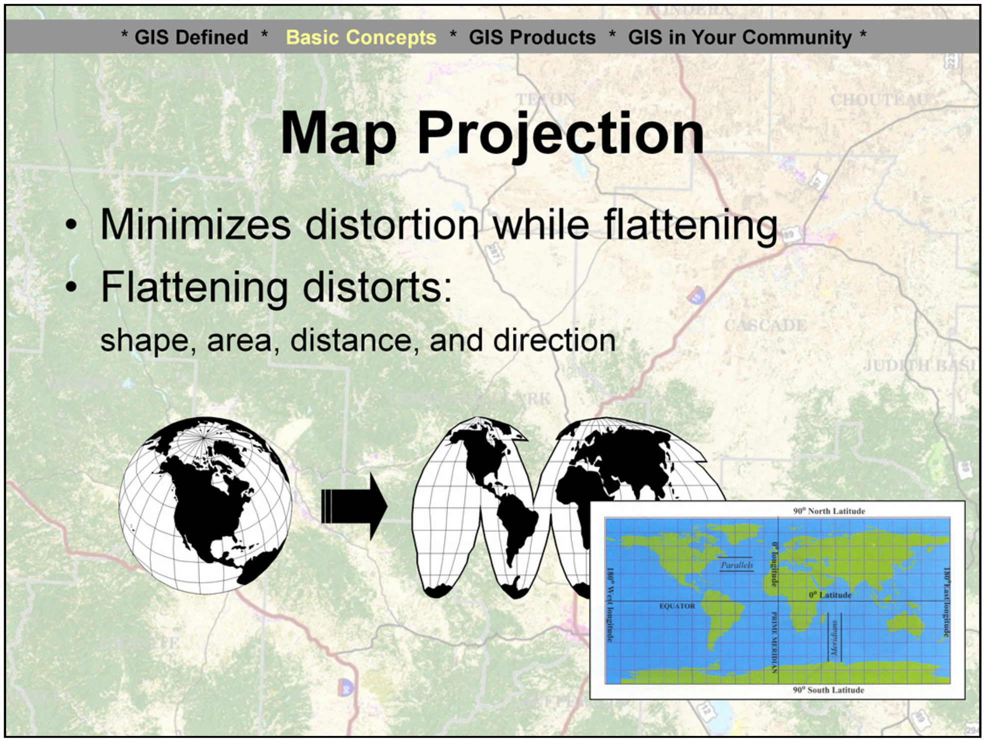
-Before we think about flattening the world, we need to refresh our memory about how the round earth is spatially divided.

-When we refer to places on the round earth we use the terminology of a geographic coordinate system (abbreviated GCS). This system divides the earth into angular measurements of degrees, minutes, seconds both horizontally and vertically. Note that we've not flattened or projected the earth yet:

---Latitude (represented by parallels): the horizontal lines north and south of the equator. The equator is a latitude.

---Longitude (represented by meridians): the vertical lines that are east and west of the prime meridian in Great Britain and West Africa.

-Dividing the earth this way was a major early achievement in geographic thought. It enabled a clearer understanding and communication of climate regimes and the management of global time and ship navigation.



-However, flattening the earth from 3D to 2D introduces distortion in shape, area, distance and/or direction

-Map projections are designed to minimize distortion in one of more of these four geographic qualities. The projection shown is one method that flattens the earth as if the surface were peeled like an orange.

-The map on the previous slide, although flattened, was not "projected." If all the parallels and meridians look straight and neatly spaced, it's really just a simple representation of a GCS flattened out (like a typical x and y graph).

-Notice the shape of North America on each of these representations of the earth.

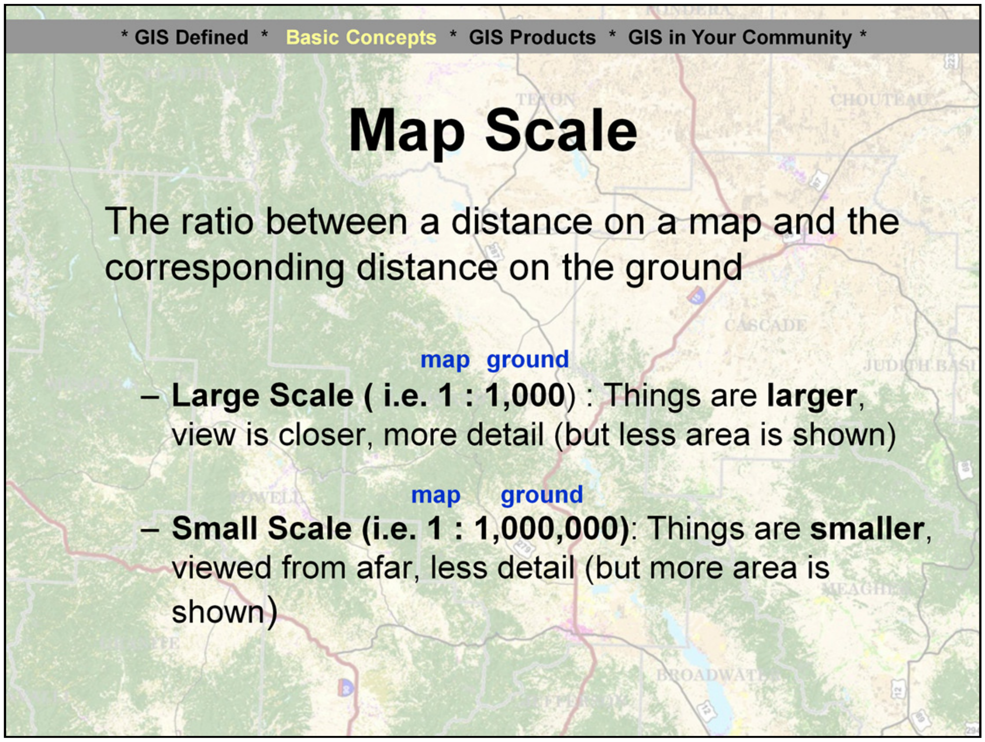
-There are many, many types of projections. It's a fascinating process that we won't cover in detail. Knowing them all by name is not that important.

-It's quite likely that particular states or regions have chosen a type of projection that minimizes the amount of distortion introduced for that part of the world. Inquire locally to learn which is used.

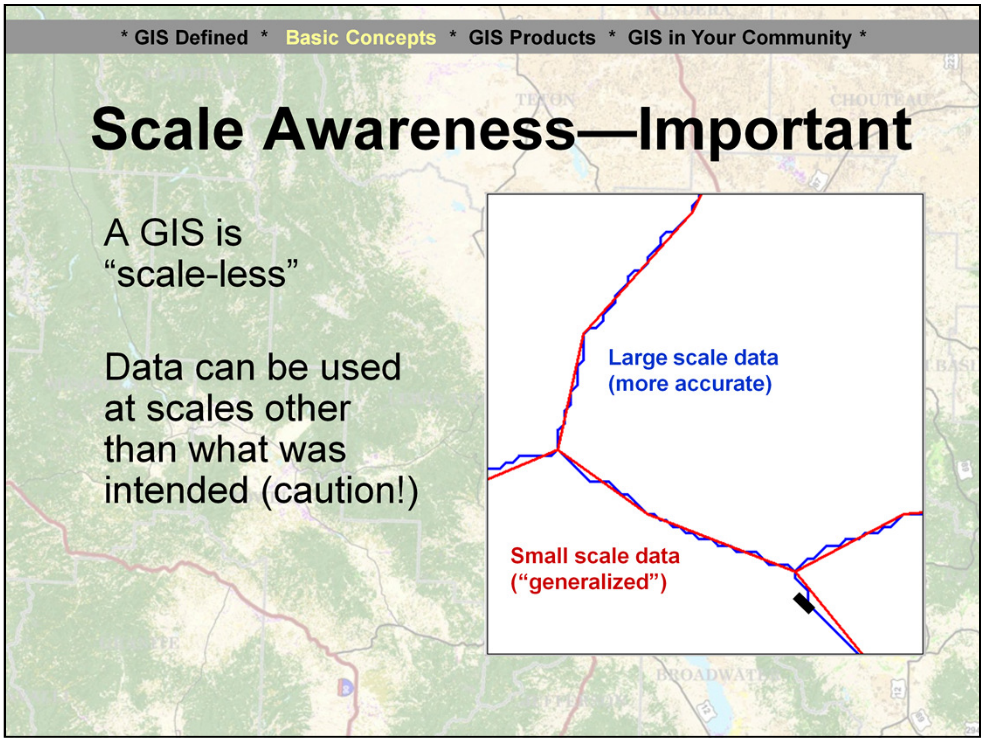
GIS and Projections

A GIS can integrate and align data in many forms:

- Land ownership data in
  State Plane Coordinates, South Zone (NAD 1927)
- Engineering data in
  State Plane Coordinates (NAD 1983)
- U.S. Census data in
  Latitude/longitude coordinates (unprojected!)
- Field work data from a GPS unit in
  UTM coordinates



We need to talk a bit about map scale as well:

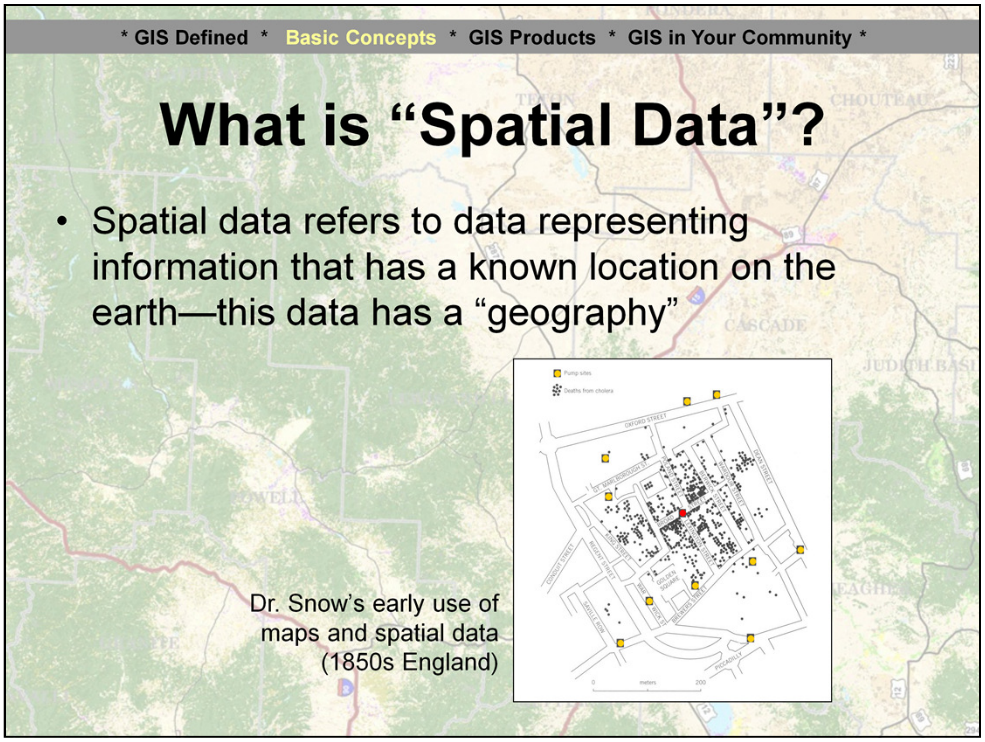


-It may seem strange to say that GIS is "scale less" after our discussion on scale. What we mean here is that you can use data at scales other than the scale it was intended. This can lead to misrepresentation of the data implying accuracy that just isn't there.

*(Blue lines): Department of Fish Wildlife and Parks has river route data created from a low-flying aircraft image, which is large scale with good detail

*(Red Lines): Lewis and Clark Trail Historical Society river route data, which is small scale. They mapped at a small scale because they're interested in a large area (multiple states) and mapped the route using a satellite image that shows the general river route through the western part of the U.S. as if viewed from way up in the sky.

The Historical society's data is "generalized" and not appropriate to use at larger scales.

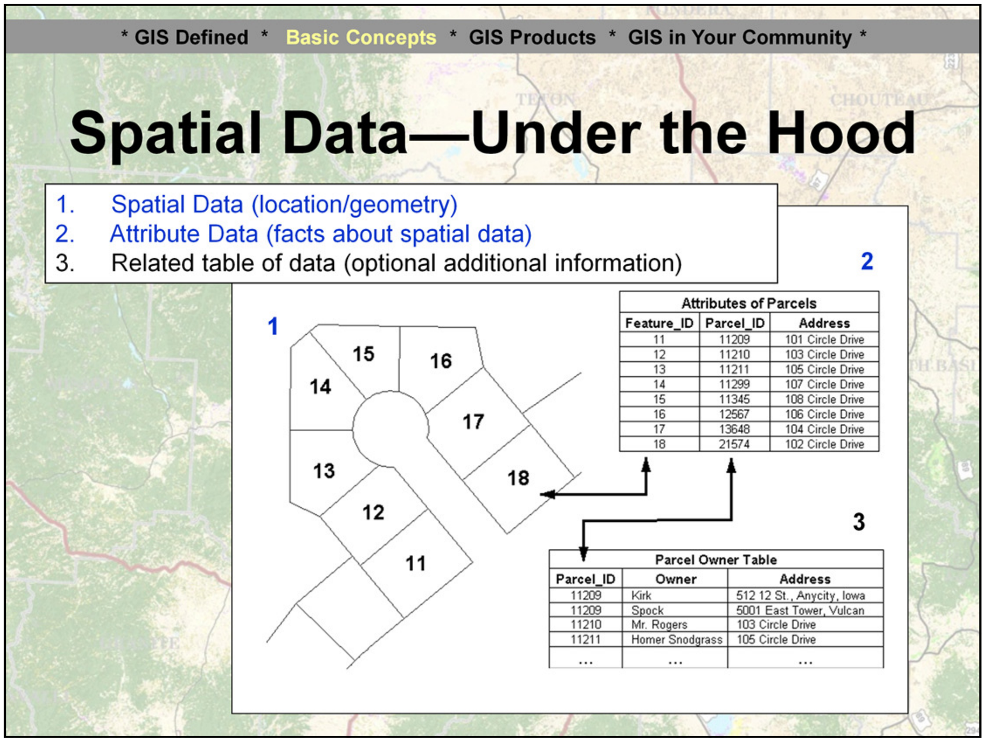


-"Spatial data" refers to data that can be linked to locations in geographic space.

-80 percent of all data has a spatial component

-Many of you may know of Dr. Snow and his famous map of the cholera epidemic in the 19th century England. Dr. Snow was a pioneer in the field of epidemiology. The cholera epidemic broke out many times between 1831 and 1854 in England. In 1853 alone, cholera claimed 10,675 lives. During a three day period in late summer 1854, the largest outbreak occurred. 127 people living around the Broad Street pump in Soho died.

-Dr. Snow formed a hypothesis pointing to a contaminated well and used cartography to visualize his hypothesis. It's one of the earliest examples of visualized (though manual) spatial analysis.



--Each spatial object, in this case land parcels in a cul-de-sac, is connected to the attribute table at the top right and can be additionally related to other tables like the parcel owner table at the bottom.

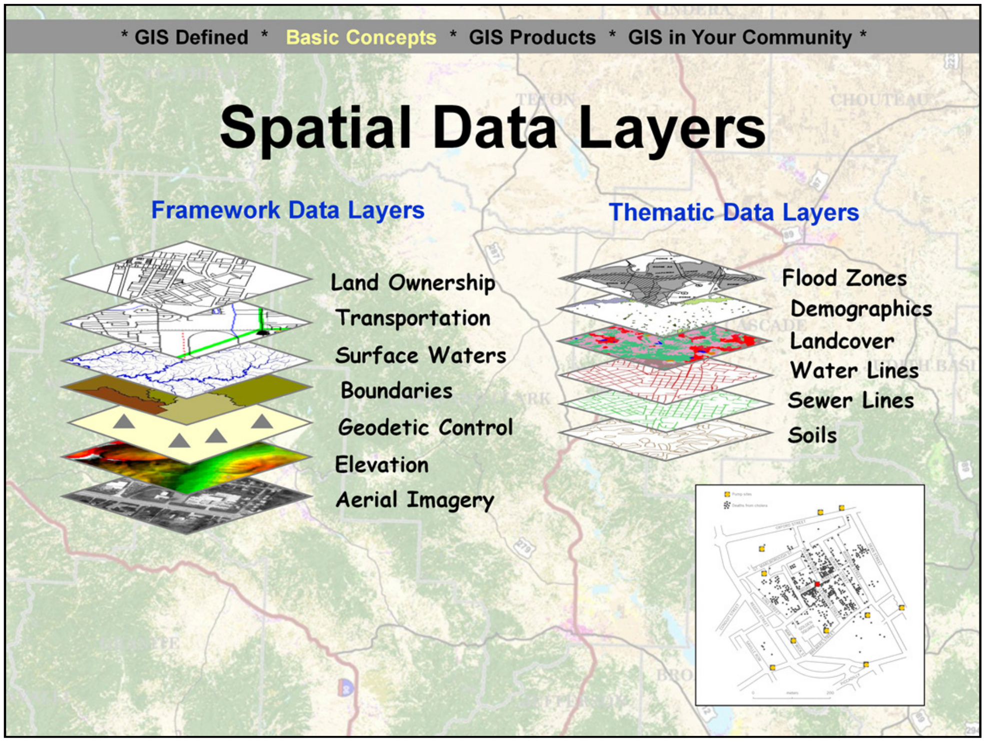
The bottom table could easily have come from local government public records. -You can create tables of data that will relate to a vector layer as needed (for instance, data gathered from field work).

In a broad sense, spatial data sets incorporate two types of data that work together:

-Spatial

-Attribute

Optionally: Related tables



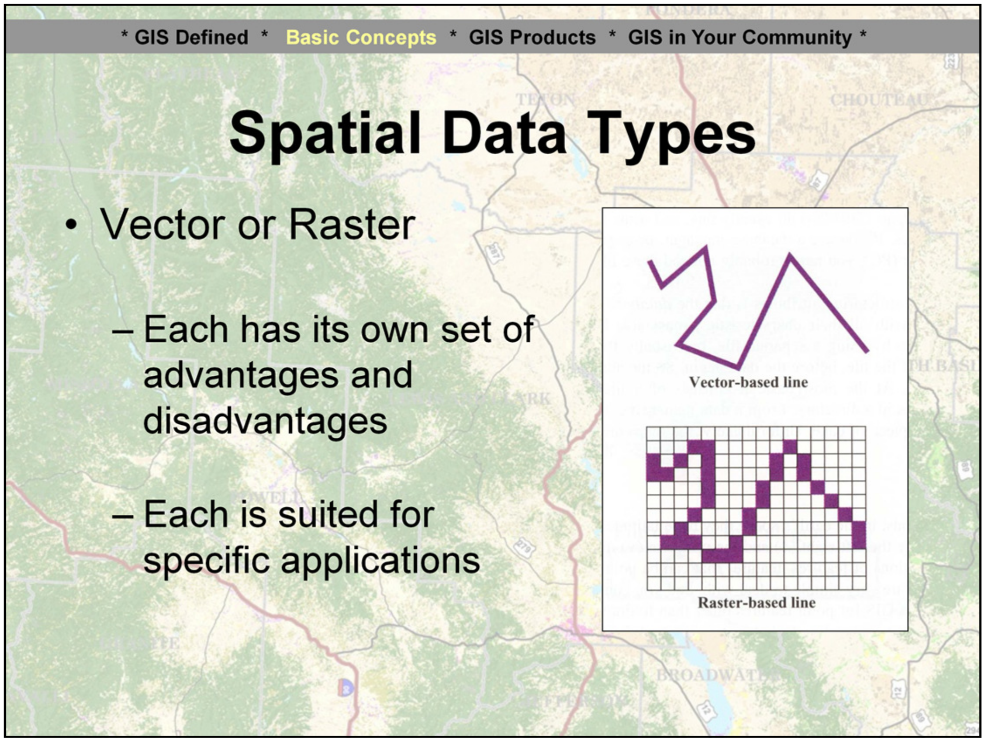
-Users have a recurring need for a few common themes of data. These 7 themes of data form a foundation for many applications of geographic data and provide a framework of reference for most other applications.

-The "thematic data layers" represent other data that can be referenced, or overlaid, on the Framework data.

-Once these data sets are created to standards and documented, they can be shared across user organizations and used many times to support different decisions or mapping needs. This results in cost savings, organizational efficiencies, and better decision-making.

What data layers do you think Dr. Snow would use today?

Reference data:	Transportation
Thematic data:	Water lines and pumps
Possibly supplied as a table:	Locations of deaths



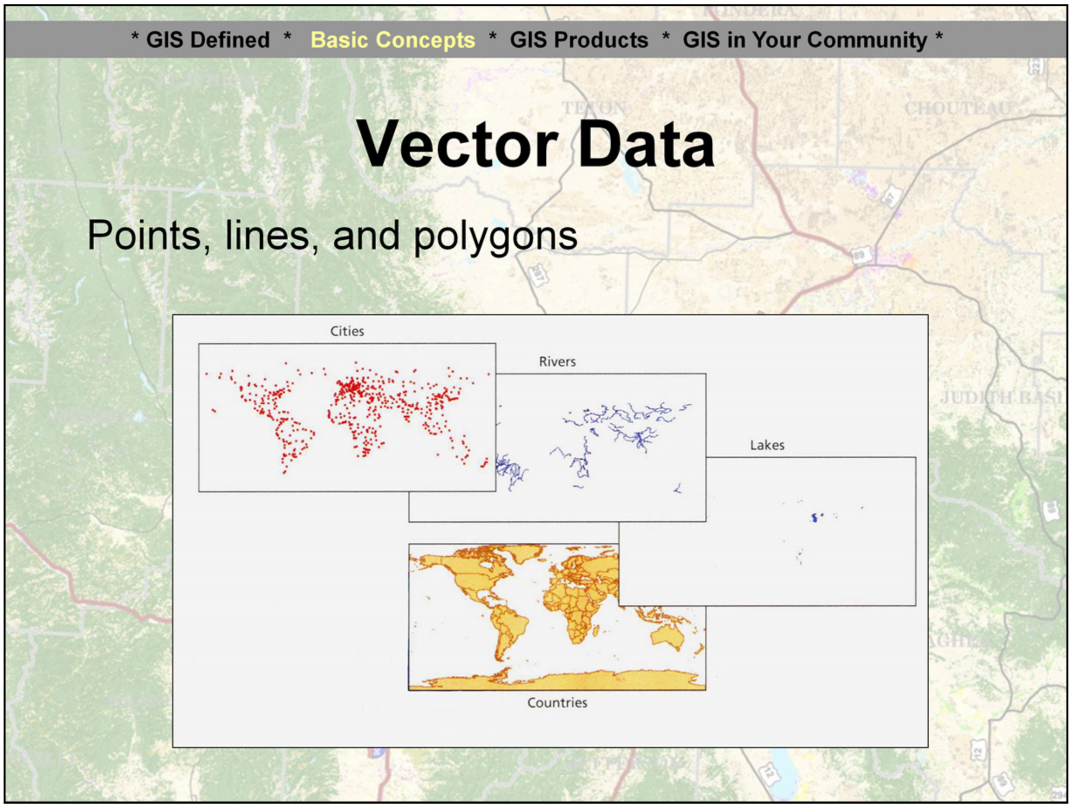
-There are two types of spatial data: either Vector or Raster.

-Vector data is defined/drawn in the computer mathematically (i.e. “plot the start of this line here, go this angle for this distance, turn this direction at this angle, go this distance, etc.).

-Raster data is constructed and drawn differently. It’s not mathematically defined like vector data, but is based on an underlying grid.

-Each has it’s own set of advantages and disadvantages.

-Each is suited for specific applications as well



The Vector data are most often used to represent discrete data—data with defined edges—as points, lines, and polygons. For instance:

Points can represent:

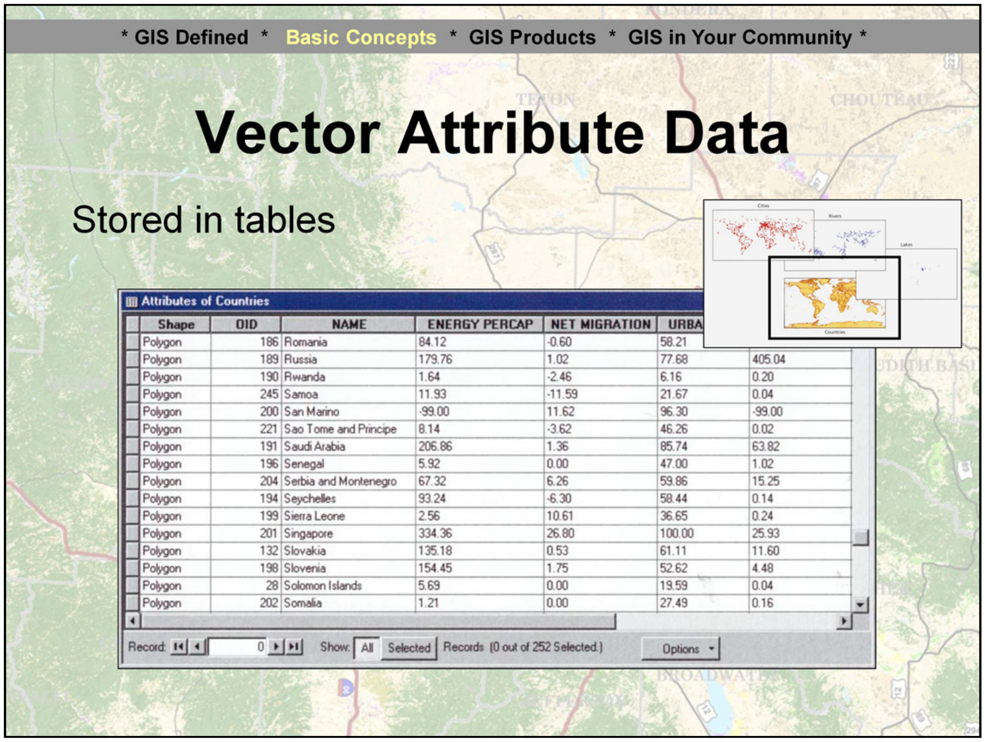
Cities, wells, addresses, schools, etc.

Lines can represent:

Rivers, streams, roads, etc.

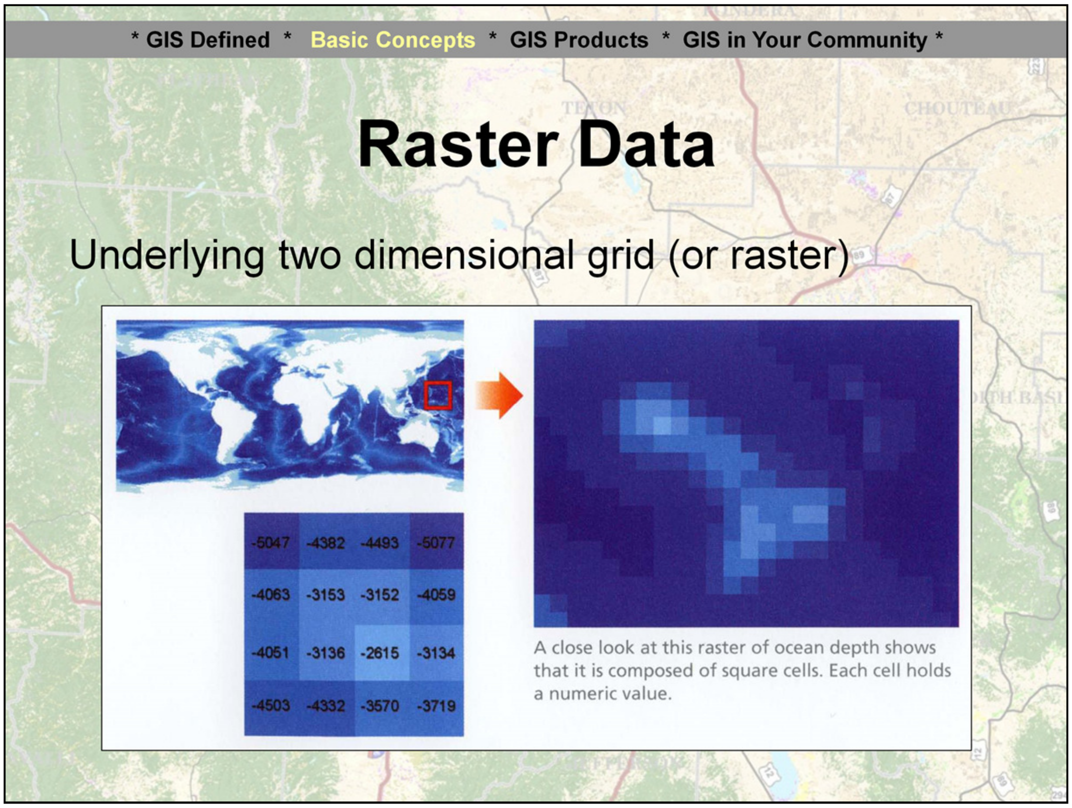
Polygons can represent:

Countries, lakes, county boundaries, ownership parcels, census units, etc.



Shape	OID	NAME	ENERGY PERCAP	NET MIGRATION	URBA	
Polygon	186	Romania	84.12	-0.60	58.21	
Polygon	189	Russia	179.76	1.02	77.68	405.04
Polygon	190	Rwanda	1.64	-2.46	6.16	0.20
Polygon	245	Samoa	11.93	-11.59	21.67	0.04
Polygon	200	San Marino	-99.00	11.62	96.30	-99.00
Polygon	221	Sao Tome and Principe	8.14	-3.62	46.26	0.02
Polygon	191	Saudi Arabia	206.86	1.36	85.74	63.82
Polygon	196	Senegal	5.92	0.00	47.00	1.02
Polygon	204	Serbia and Montenegro	67.32	6.26	59.86	15.25
Polygon	194	Seychelles	93.24	-6.30	58.44	0.14
Polygon	199	Sierra Leone	2.56	10.61	36.65	0.24
Polygon	201	Singapore	334.36	26.80	100.00	25.93
Polygon	132	Slovakia	135.18	0.53	61.11	11.60
Polygon	198	Slovenia	154.45	1.75	52.62	4.48
Polygon	28	Solomon Islands	5.69	0.00	19.59	0.04
Polygon	202	Somalia	1.21	0.00	27.49	0.16

-With each vector data layer is an attribute table (in this case the countries data layer). There are some required columns of information like Shape, OID (object ID), but the rest is defined and filled in by the data creator. These can be as useful and information rich as the data creator would like.



-Now lets switch gears and talk about raster data:

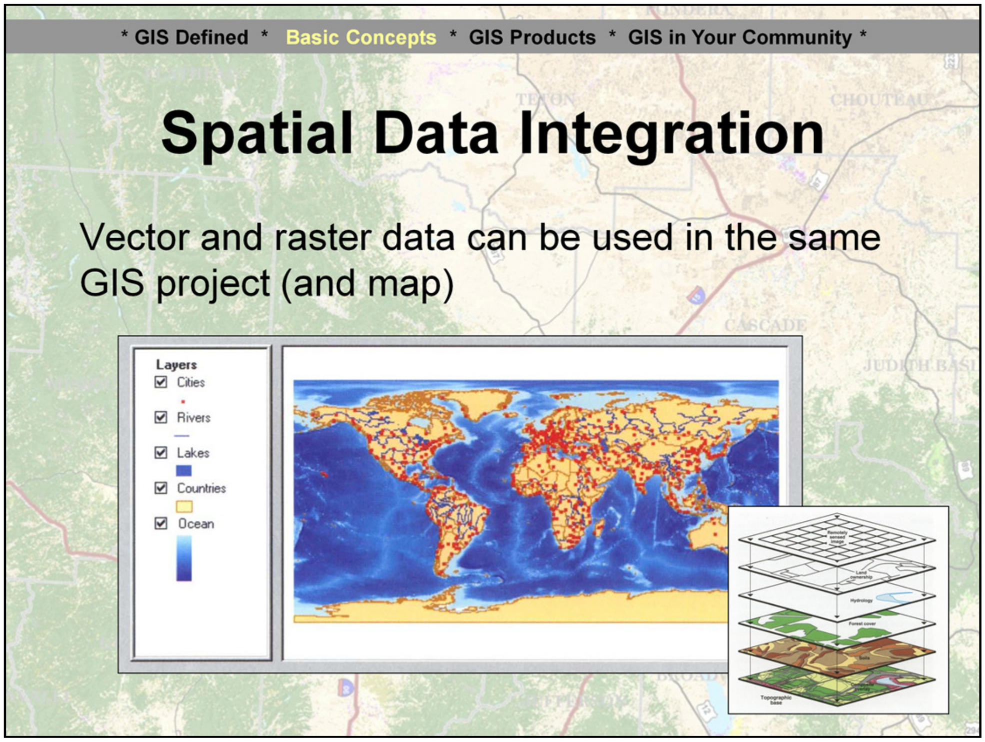
-Raster GIS is based on an underlying two dimensional grid or raster. This raster represents the worlds oceans.

-Each cell or pixel in the raster has data associated with it-- in this case it's ocean depth.

-Data stored in a two dimensional grid or raster has many advantages for spatial analysis and modeling applications. Given different cell values this allows us to easily depict the variability of phenomena over a surface.

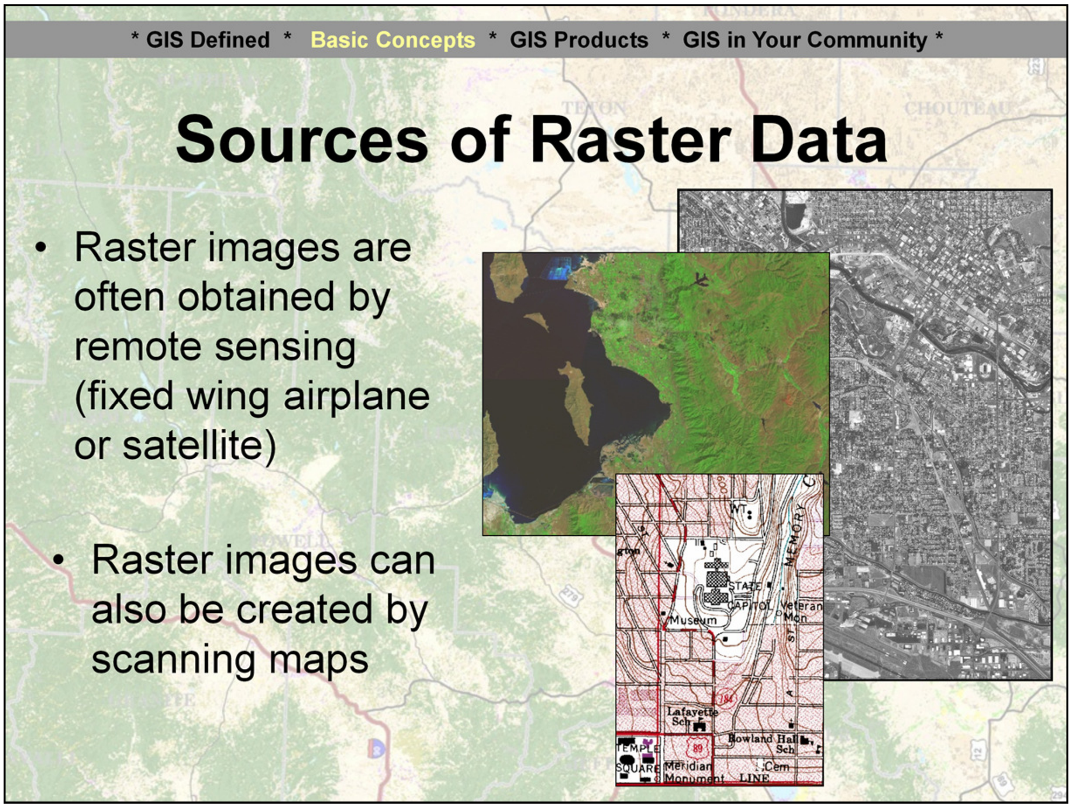
-We can perform analysis operations using more than one raster at the same time. It's a very powerful type of GIS data.

-Disadvantages of raster GIS are that it is often not as user friendly as vector data, and it can be taxing on computer resources depending upon the cell size or resolution of the raster.



Here we see both vector data and raster data combined in the same GIS project. The raster data is simply used as a background to make a map.

-This view shows how the data is represented in the computer as a series of layers.



-I'm going to return to raster data for a bit since a lot of GIS data is gathered in raster.

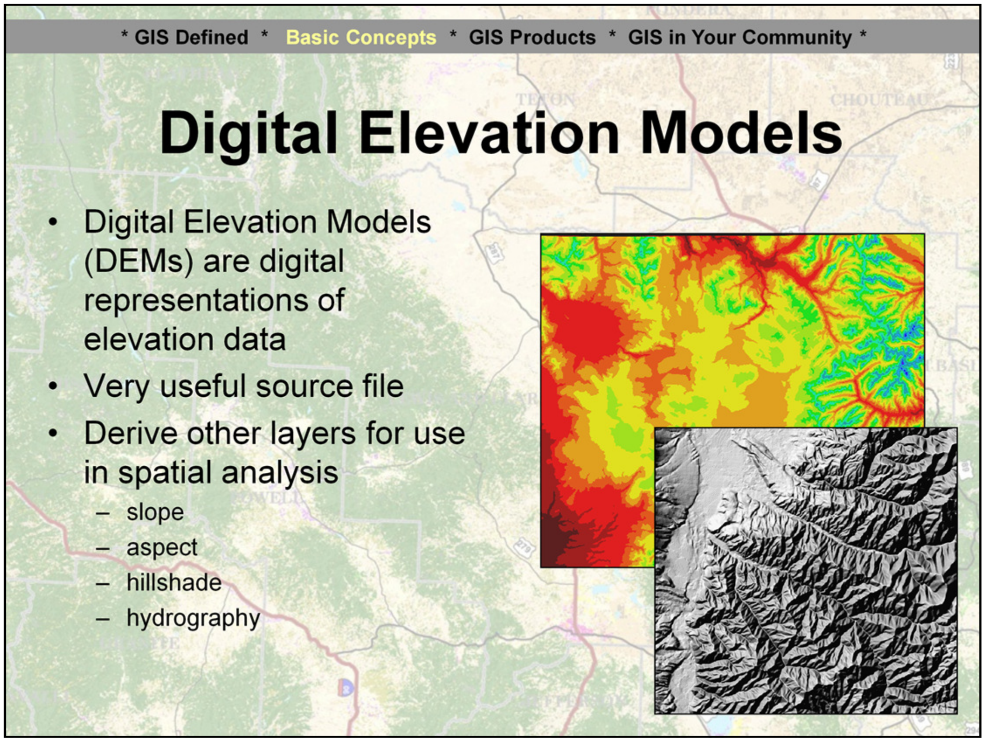
-Remotely-sensed data can provide valuable imagery for use in a GIS.

-The black and white image here is a Digital Orthophoto Quad (DOQ). This is high altitude photographic imagery shot from an airplane. The resolution is 1 meter (one raster cell is 1 square meter) and it has been rectified (adjusted) to fit a 1:24,000 map base.

-The higher resolution makes the DOQ a nice backdrop for local mapping, as well as a source dataset used to produce other vector data layers such as roads (lines) or building footprints (polygons). Such vector data can be digitized, or traced, on the screen right on top of the imagery.

-The color image of Northern Utah was captured by a satellite housing the Landsat Thematic Mapper (TM). The image consists of data sensed in multiple spectral bands (red/green/blue/infrared/thermal). This data can be manipulated to generate new data. For example, it can be classified to produce a vegetation data layer.

-Printed maps can also be scanned and stored as images and then "georeferenced" to be located in real space. The bottom map was scanned from a USGS 7 ½ minute quadrangle map.



-Another type of raster data is a digital elevation model--abbreviated DEM.

-DEMs can be used to generate many other data layers for use in a GIS project: layers such as slope, aspect, shaded relief images, and topographic contour data;

Used (beyond simple elevation knowledge):

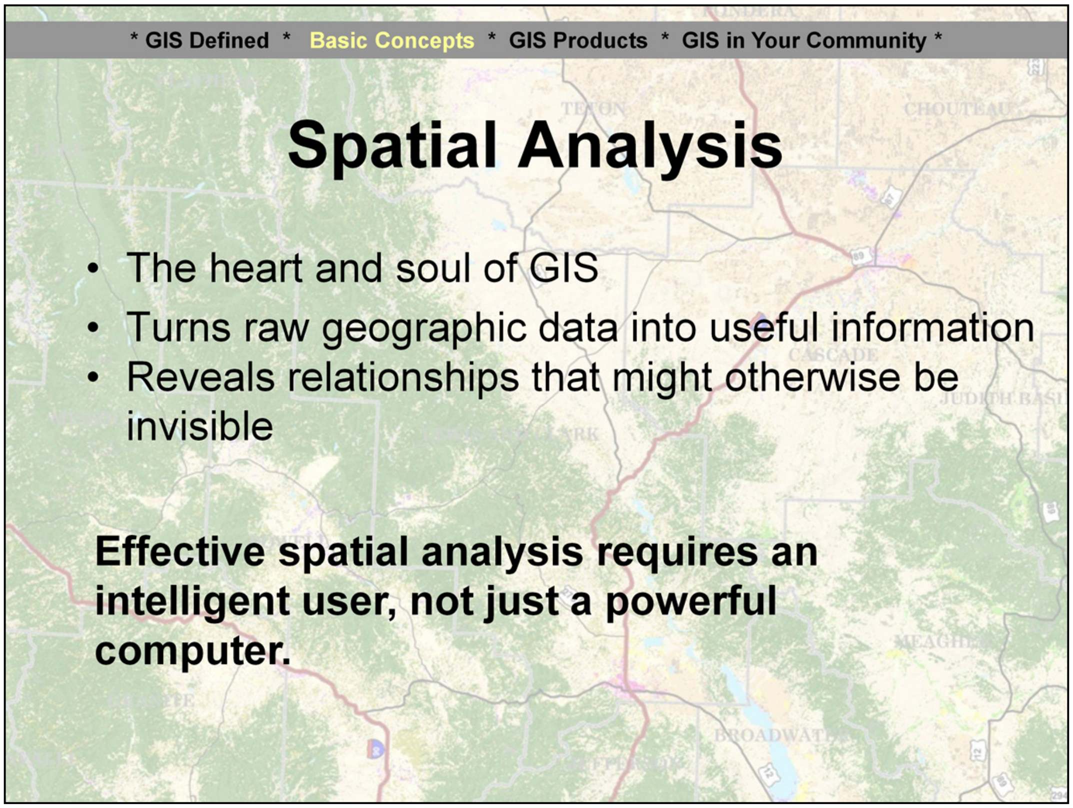
-for analysis of hydrography and runoff;

-for analysis of solar radiation received on the land;

-for determination of what part of the landscape is visible from various locations;

-for estimation of volumes of proposed earthworks or reservoirs; and for analysis of difficulty of traversing the terrain.

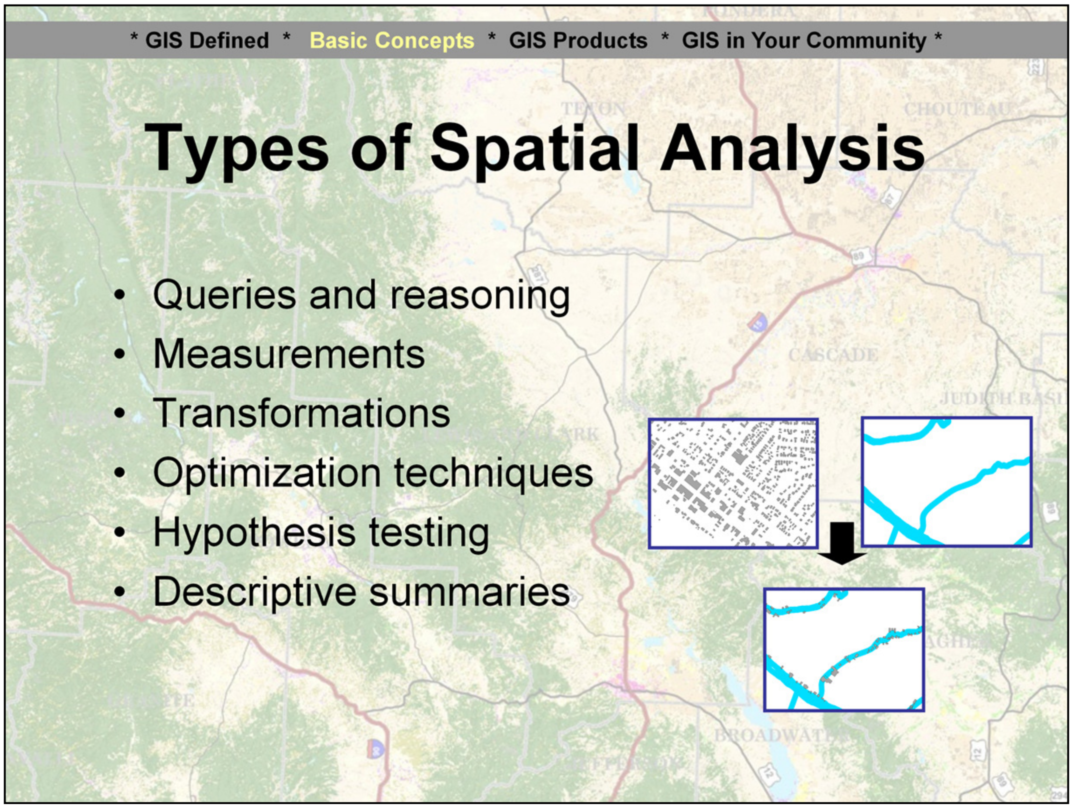
The color image is classified and symbolized inside a desktop GIS software to visually show the elevation values stored inside the DEM. The grayscale image is a hillshade data layer (different landscape, derived from a different DEM).



-Spatial analysis is the really the heart and soul of GIS—the heavy lifting. Spatial Analysis is comprised of a collection of tasks and tools or combinations of these tasks and tools that let GIS users add value to raw data, making it even more useful, or to reveal relationships that are often invisible.

-Like Dr. Snow’s manual form of spatial analysis, we can plot data in space and use GIS to derive meaning and understanding. The GIS reveals spatial associations and relationships that are not always readily apparent.

-But the computer is not the critical operator in spatial analysis. We need knowledgeable, trained GIS professionals to design and perform the analysis.



-Queries and reasoning: How many hospitals are in Gallatin County? What is the quickest route to the nearest hospital?

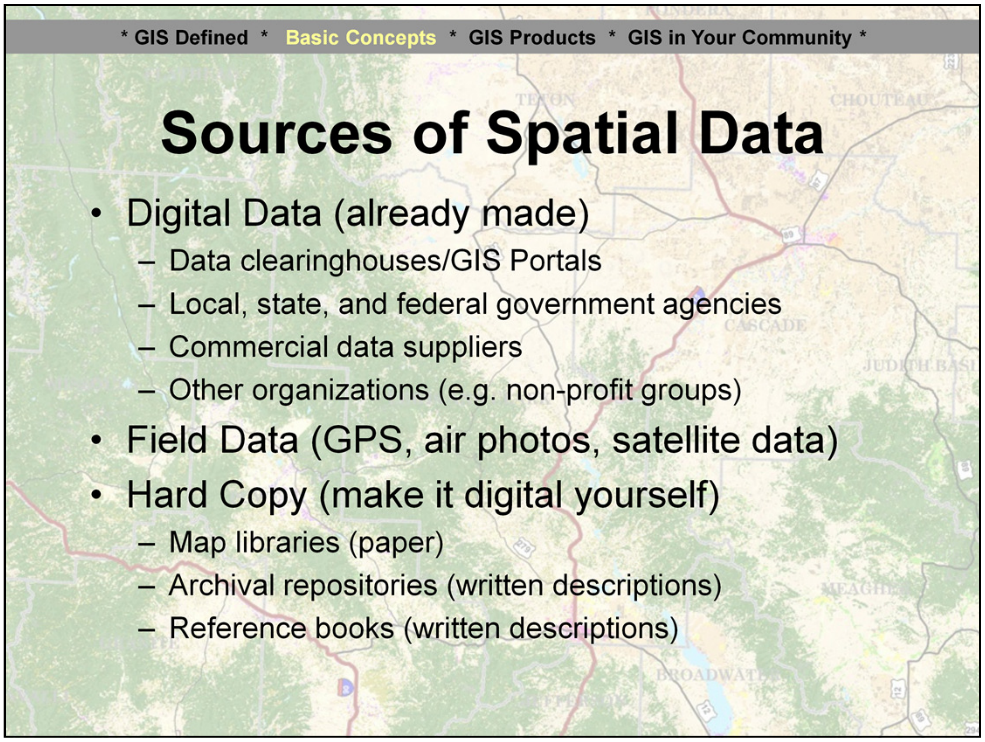
-Measurements: What is the area of Yellowstone Lake?

-Transformations: Creating new data layers by, for instance, combining the attributes of one layer based on the spatial extent of another using overlay functions such as intersect.

-Optimization techniques: Finding the least costly path from one point to another considering one or more variables of impedance like elevation stored in a DEM. Highway designers would use this

-With a well-designed analysis we can test hypotheses.

-Descriptive summaries fall in the realm of statistics, which can play a significant role in spatial analysis



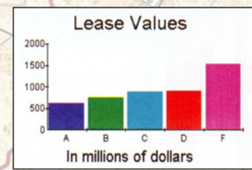
-Choosing data is a very important task. We need to understand the way the data was created to get a sense of its accuracy, its intended use, and its limitations.

Resource Sharing: Spatial Data

- Montana State Library
  - Montana Geographic Information Clearinghouse (since late 1980s)
  - Montana Framework Data Management (since 2010)
    - Assists MT cities/counties with data creation
    - Aggregates local data into statewide framework datasets
- Data creator websites

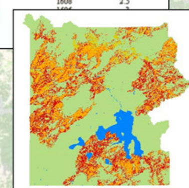
GIS Products

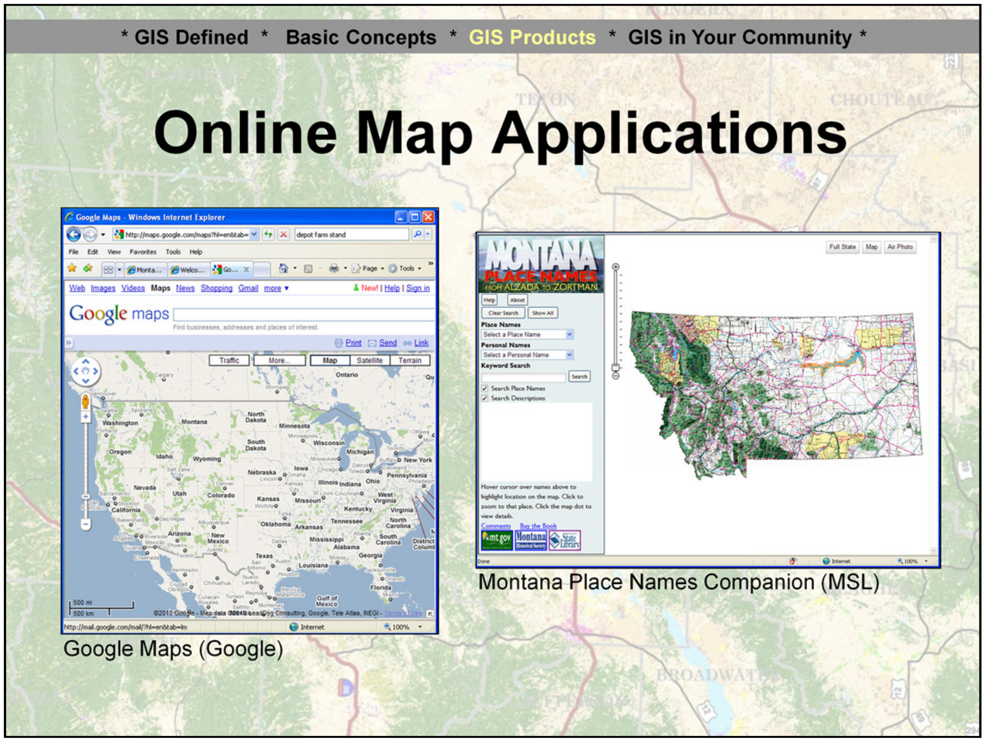
- Data
- Charts and Graphs
- Reports
- Presentations
- Maps
- Cartographic models
- Online GIS applications



Available Three Bedroom Houses

ADDRESS	SALE_PRICE	SQ_FT	BTH_RMS
1148 LAWTON ST	110500	1498	2
1029 CALHOUN ST	115500	1116	2
1136 COLUMBIA	120000	1236	1.5
1144 WASHINGTON ST	128500	1380	2
936 CLAY ST	142000	1272	2
1016 N LAWTON ST	145000	1887	2.5
1149 CLAY ST	158900	1808	2.5
831 WASHINGTON ST	159900	1832	2.5
1020 CALHOUN ST	162000	1608	2.5
1018 TEXAS ST	164000		
901 WASHINGTON ST	166500		





-GIS products can be made public and interactive and this is where the online map applications come in.

For instance, when you use a web site like Google maps, you are interacting with their internet mapping application. –

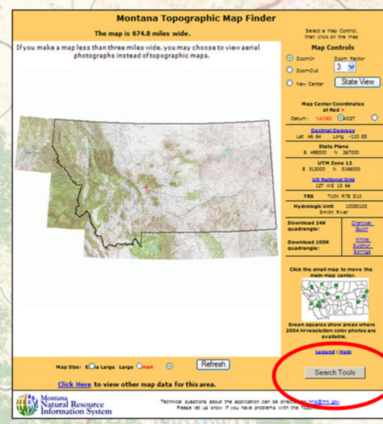
Another example of an internet mapping service is the State Library's Montana Place Names map application. You can look up place names in Montana, see where those places are and learn name histories.

Some more sophisticated online map applications permit you to execute some basic GIS functions used by GIS professionals.

* GIS Defined * Basic Concepts * GIS Products * GIS in Your Community *

Online Map Applications

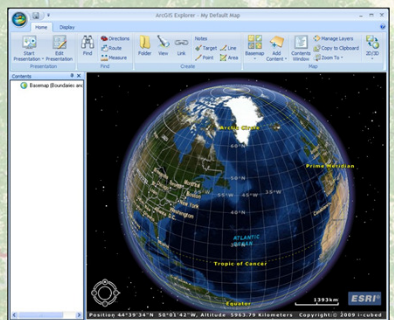
Montana Cadastral (MSL)



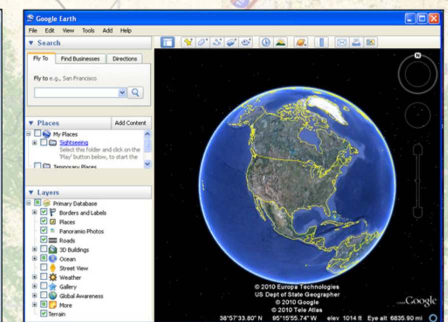
Montana Topofinder (MSL)

Hybrid Online Map Applications

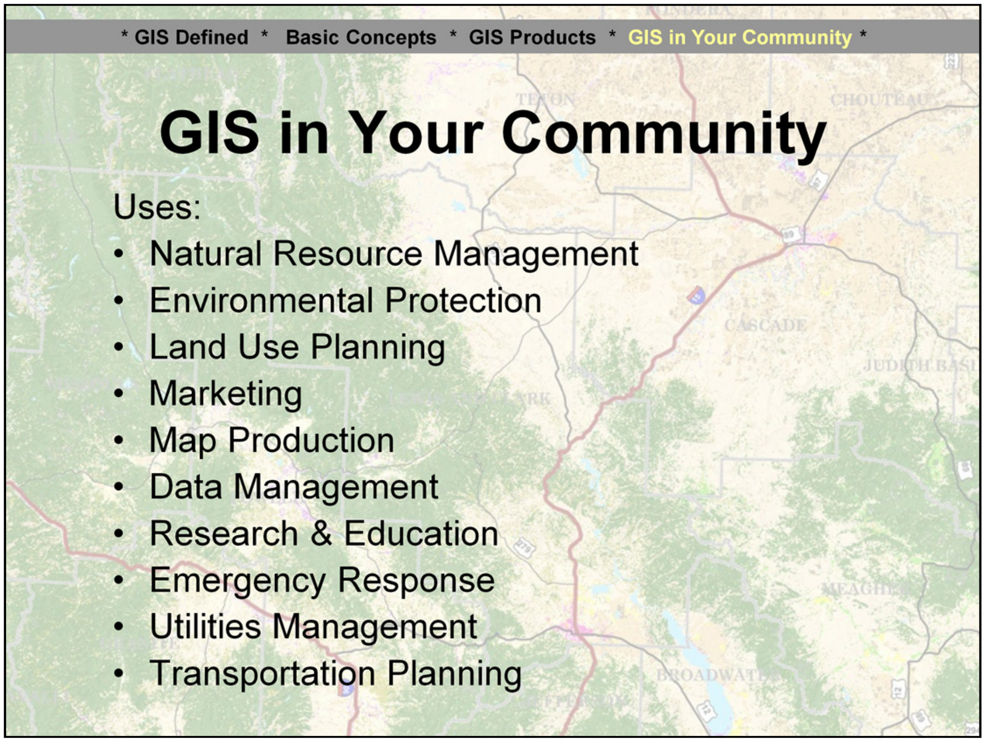
Online data, your data, and limited desktop GIS functions



ArcGIS Explorer (ESRI)



Google Earth (Google)



-There are many, many disciplines where GIS is used

-Land management applications come to mind readily, but it’s also used in fields like marketing.

GIS in Your Community

- City/county GIS departments (land planning too)
- State government (many, many departments)
- University researchers and students

- Montana Association of Geographic Information Professionals (MAGIP) www.magip.org

- GIS in elementary and secondary school curriculum
- Annual Geography Awareness Week Mid-November each year
- GIS Day Wednesday of Geography Awareness Week

More Shared Resources

- MAGIP services: MAGIP listserv, Discussion Forums, User Groups, Conferences
- GIS Best Practices in Montana
- MAGIP GIS Mentoring program
- GIS Training Resources and Opportunities
- Montana Spatial Data Infrastructure (MSDI) Framework Data
- Montana Land Information Advisory Council (MLIAC)
- Montana State Library's role in Montana's GIS community, including data discovery and access, online map applications/tools, and more from the Montana Geographic Information Clearinghouse at Montana State Library
- Montana GIS Data List
- Metadata Standard for the Montana GIS Data List
- Montana State Plane Coordinates to Lat/Long Conversion tool (and vice versa)
- Latitude/Longitude Format Conversion tool (D.ddd; D/M.mm; D/M/S)
- Montana Public Land Survey Subsection Finder
- Montana Topofinder and its topographic map Search Tools


Montana State Library
MONTANA
State
Library
Geographic Information
Diane Papineau, GIS Analyst
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