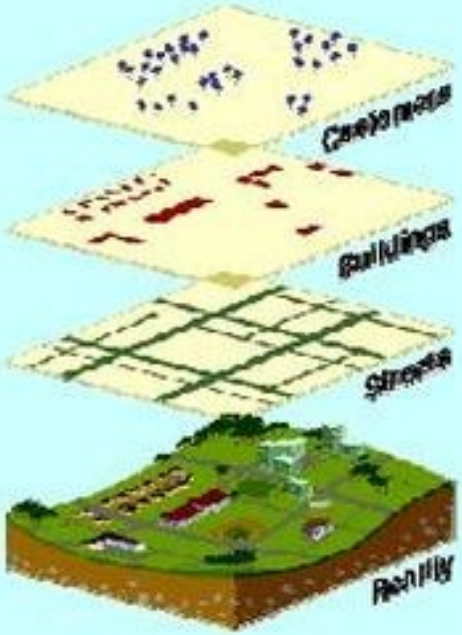
Introduction to GIS

By John Middendorf
Degree in Geographic Information Systems, Penn State, 2005

What is GIS?

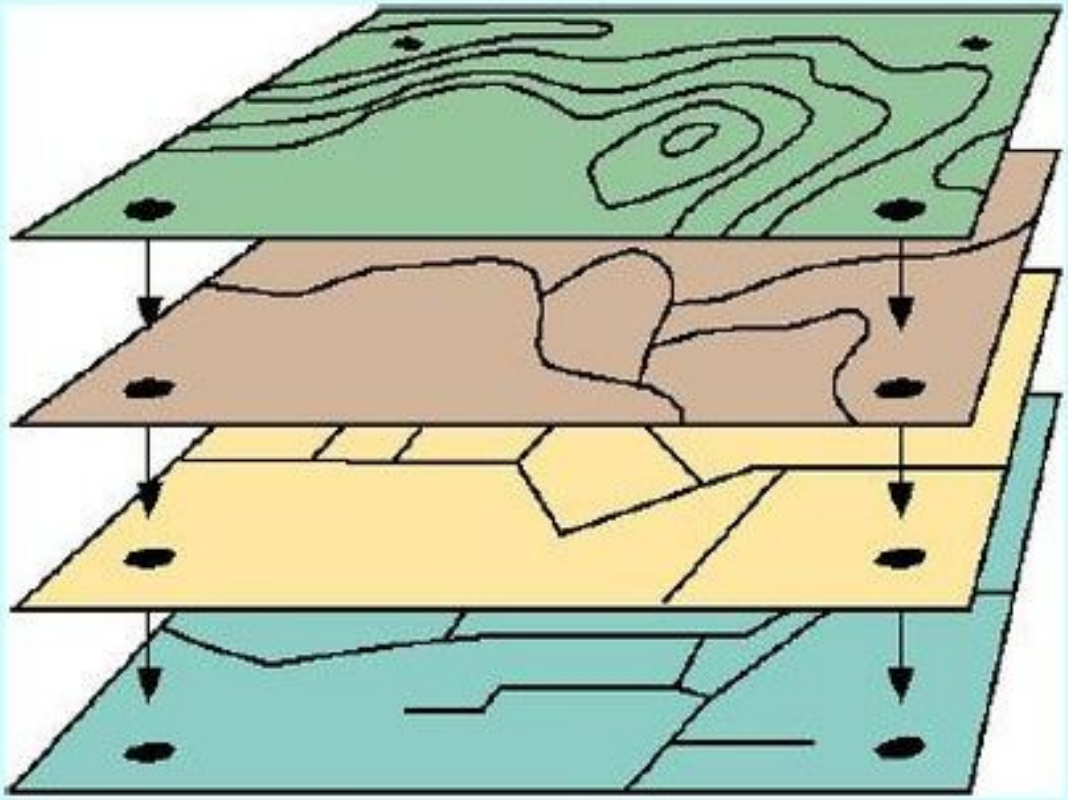


- Geographic Information Systems (GIS) a collection of computer hardware, software, data, personnel and methods that enable you to better understand and evaluate your data by using cartographic tools to display the information stored in your database.

- Spatial analysis of data which shares a common location reveals hidden patterns and relationships that aren't readily apparent in spreadsheets or statistical packages.

GIS Data Structure

STACKED MAP LAYERS: Each layer represents unique phenomena, and the layers can be superimposed.



Average Temperature

Parasite Drug Resistance

Average Age Per Census Tract

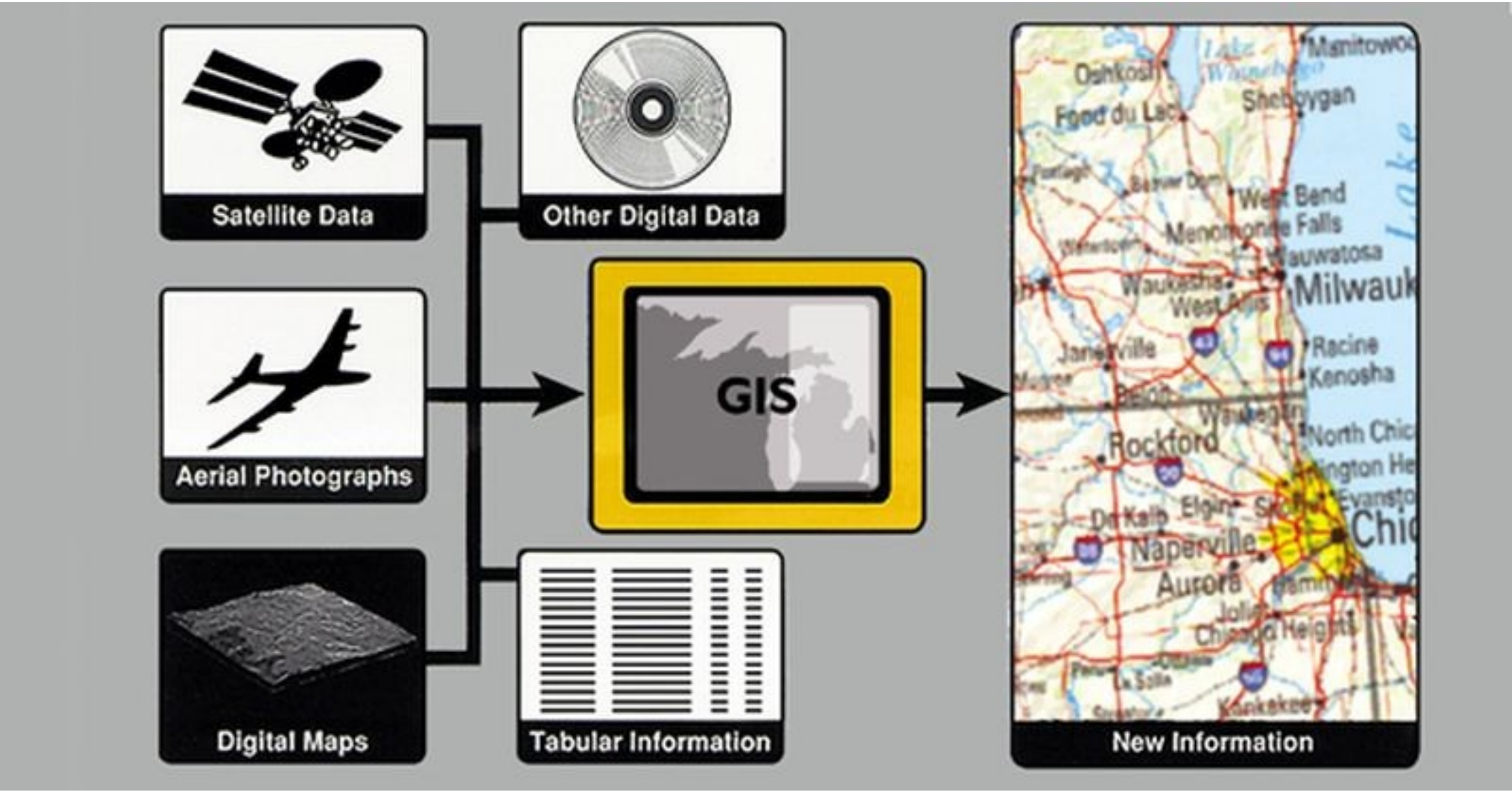
Water Distribution

and Industrial activities

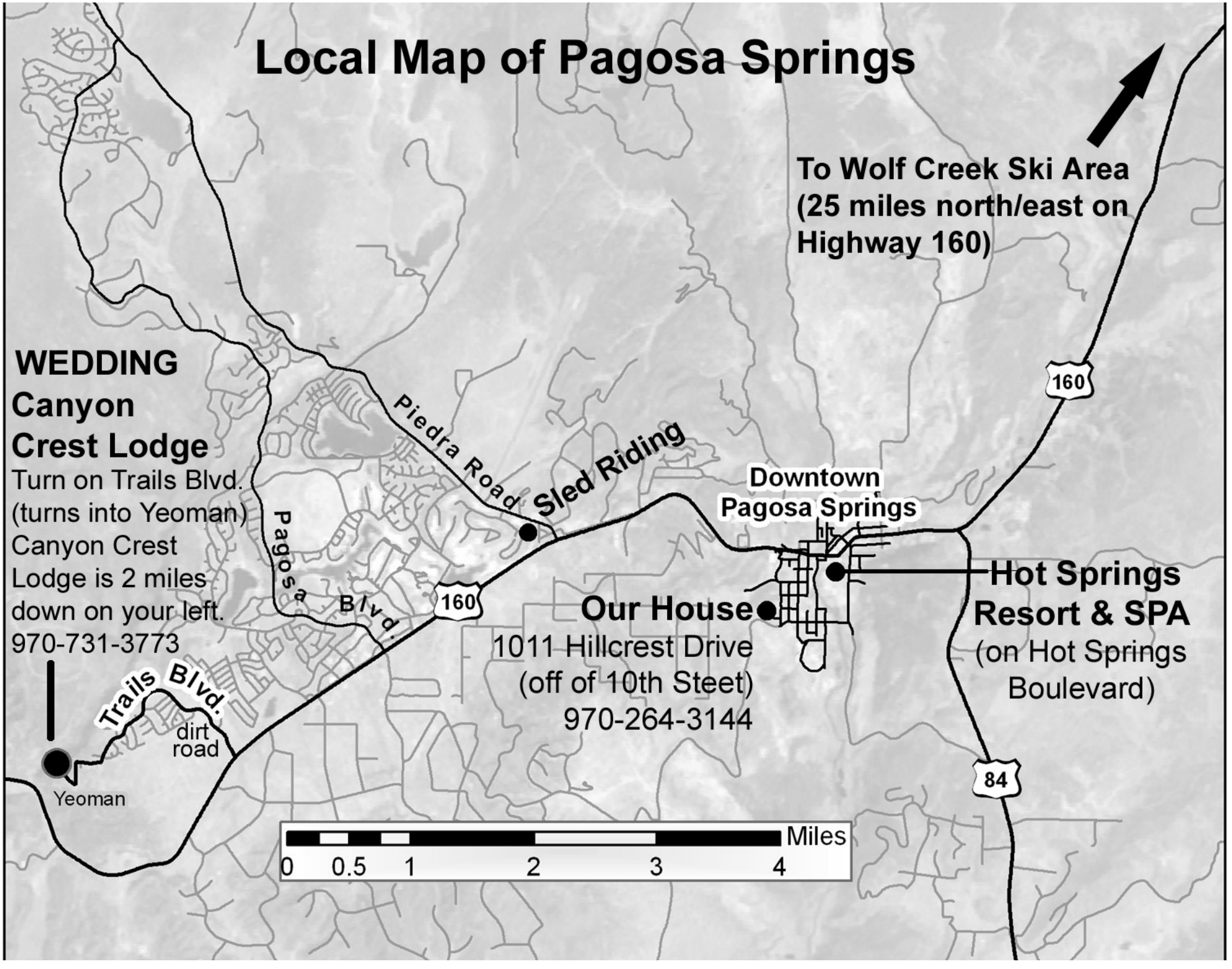
Hospital and Health Stations

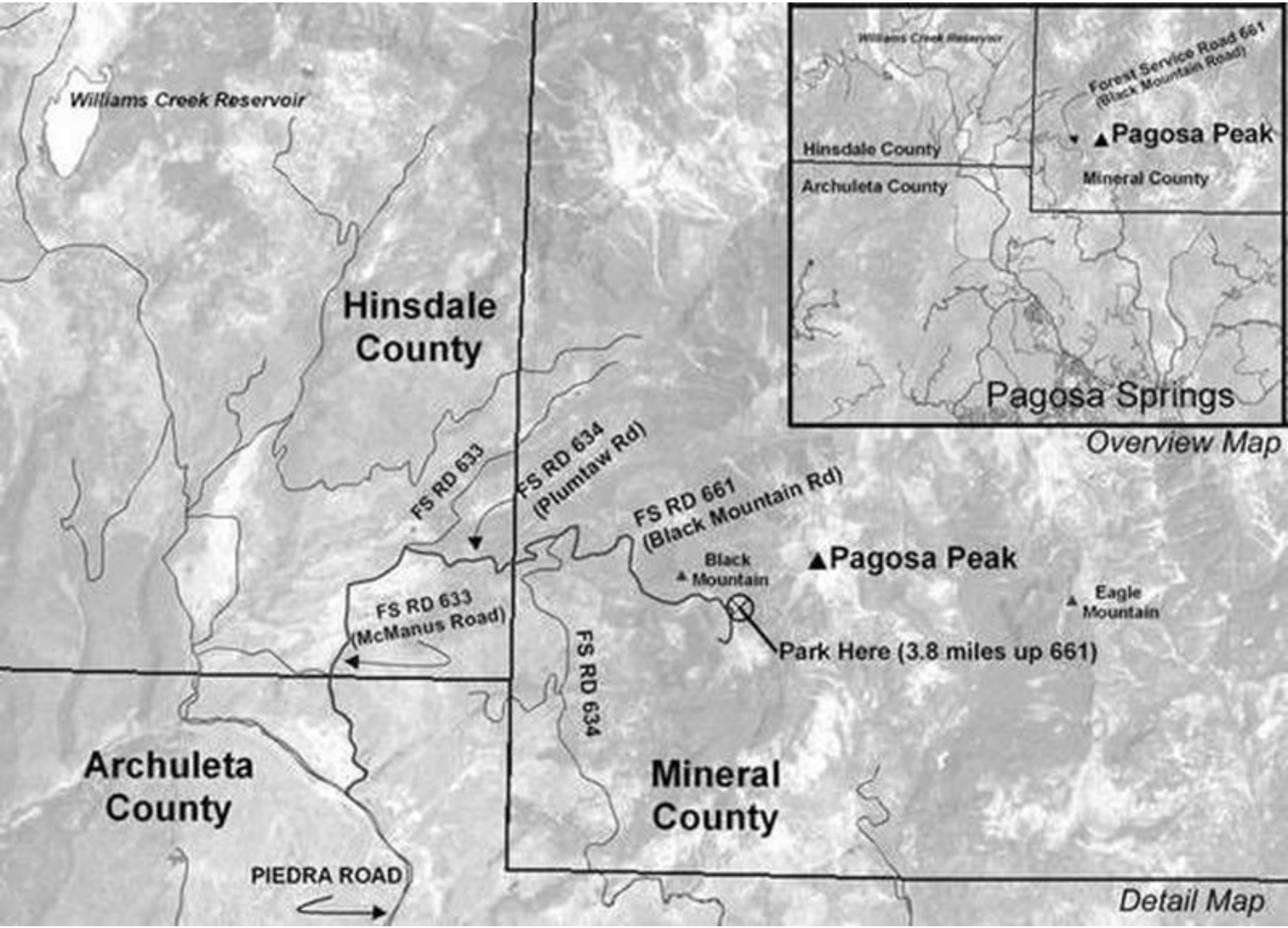
others ...

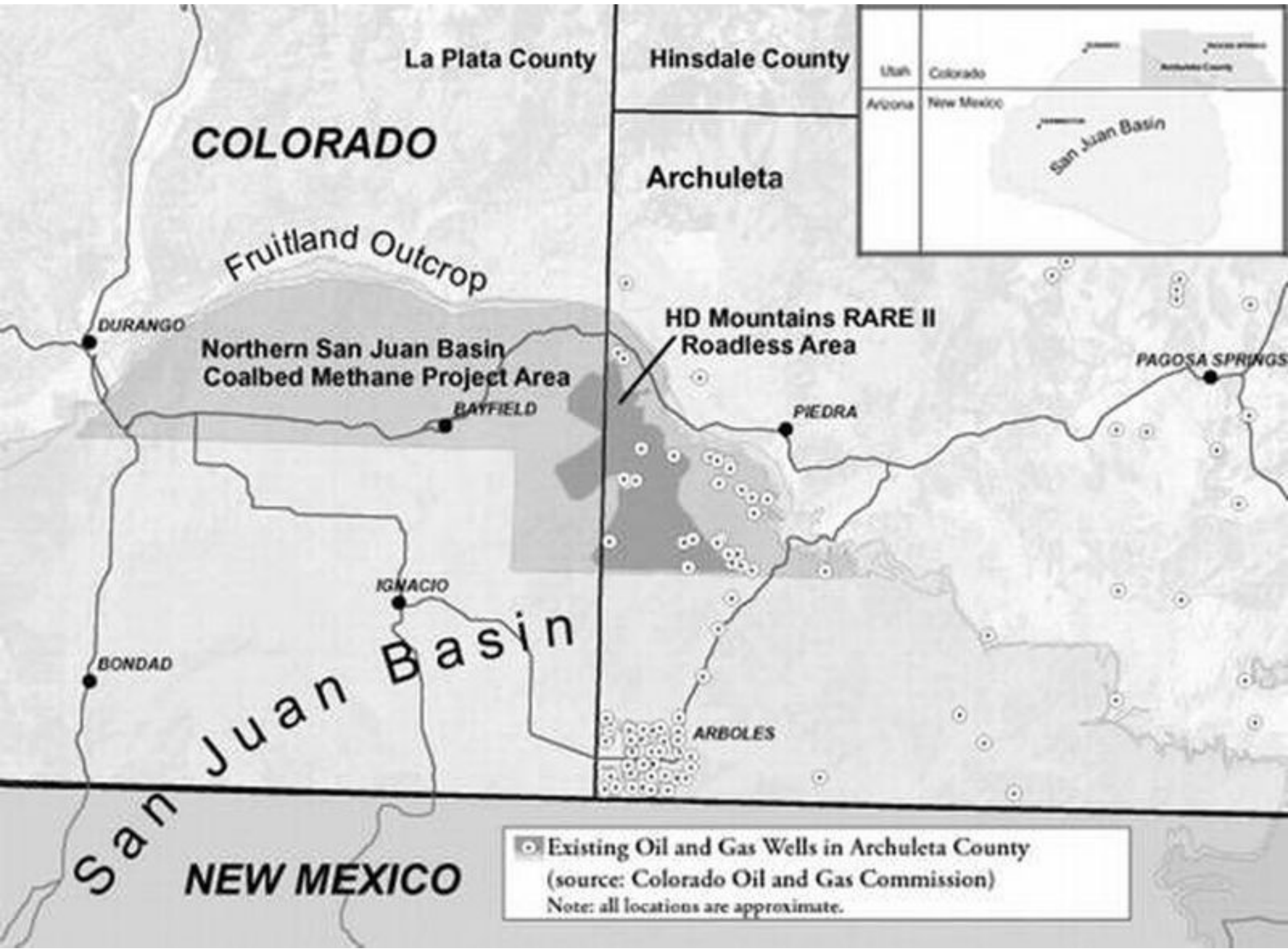
Data can come from a variety of different sources....



You can use GIS to create many different kinds of maps

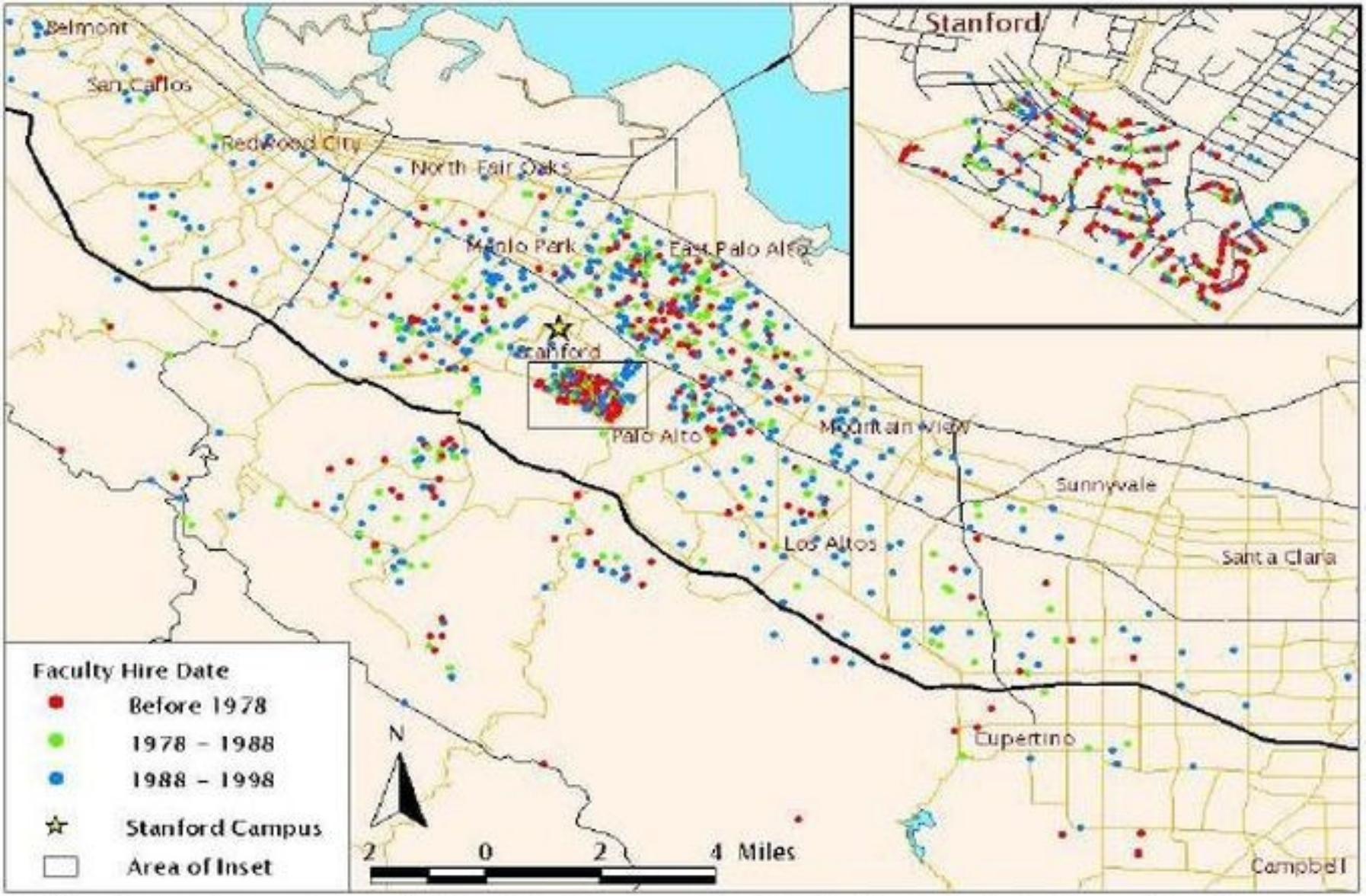

Local Map of Pagosa Springs
To Wolf Creek Ski Area
(25 miles north/east on
Highway 160)
WEDDING
Canyon
Crest Lodge
Turn on Trails Blvd.
(turns into Yeoman)
Canyon Crest
Lodge is 2 miles
down on your left.
970-731-3773
Piedra Road
Sled Riding
Pagosa Blvd.
160
Downtown
Pagosa Springs
Hot Springs
Resort & SPA
(on Hot Springs
Boulevard)
Our House
1011 Hillcrest Drive
(off of 10th Steet)
970-264-3144
Trails Blvd.
dirt
road
Yeoman
84
Miles
0 0.5 1 2 3 4


Williams Creek Reservoir
Hinsdale County
FS RD 633
FS RD 634
(Plumtaw Rd)
FS RD 661
(Black Mountain Rd)
Black
Mountain
Pagosa Peak
Eagle
Mountain
Park Here (3.8 miles up 661)
FS RD 633
(McManus Road)
FS RD 634
Archuleta
County
Mineral
County
PIEDRA ROAD
Detail Map
Williams Creek Reservoir
Forest Service Road 661
(Black Mountain Road)
Hinsdale County
Pagosa Peak
Mineral County
Archuleta County
Pagosa Springs
Overview Map


La Plata County
Hinsdale County
COLORADO
Archuleta
Utah
Colorado
Arizona
New Mexico
San Juan Basin
Fruitland Outcrop
DURANGO
Northern San Juan Basin
Coalbed Methane Project Area
BAYFIELD
HD Mountains RARE II
Roadless Area
PIEDRA
PAGOSA SPRINGS
IGNACIO
BONDAD
San Juan Basin
ARBOLES
NEW MEXICO
Existing Oil and Gas Wells in Archuleta County
(source: Colorado Oil and Gas Commission)
Note: all locations are approximate.

Questions Answered with GIS...

Where Stanford Faculty Members Live: All Faculty, South Bay

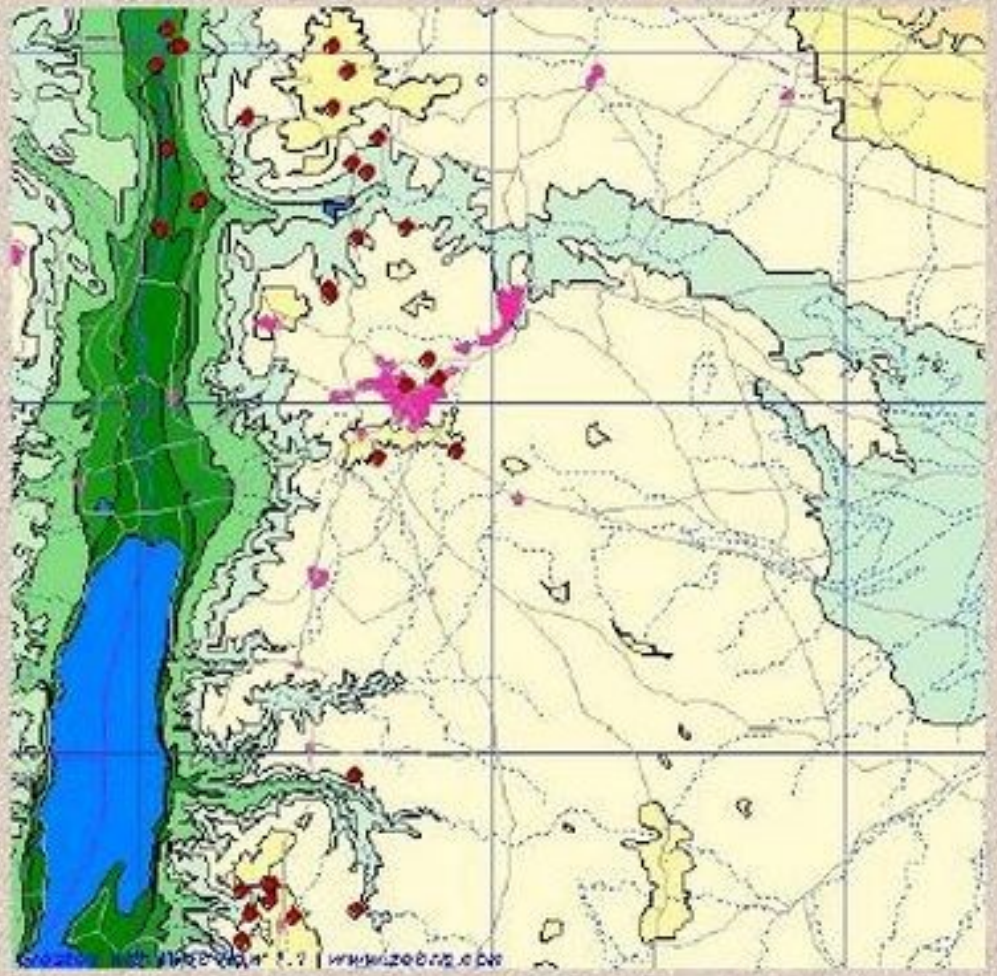


* Of the 1595 total data points available, 117 points were not included in this study due to incomplete address data and/or address location outside of Bay Area. This map was prepared using ArcView GIS at the Branner Earth Sciences Library.

E. Roman
L. Roman
Unsp. Byz.
E. Byzantine
L. Byzantine
E Islamic
Umayyad
Abassid
Abassid-Fatimid
Fatimid
Crusader
Ayubid
Ayubid-Mameluk
Mameluk
L Islamic
Unsp. Ottoman
E. Ottoman
L. Ottoman
Unsp. Islamic
Modern
Home

The map pages are hosted at the Archaeological Research Institute, at ACU.

Late Bronze II Sites in Jordan



Legend

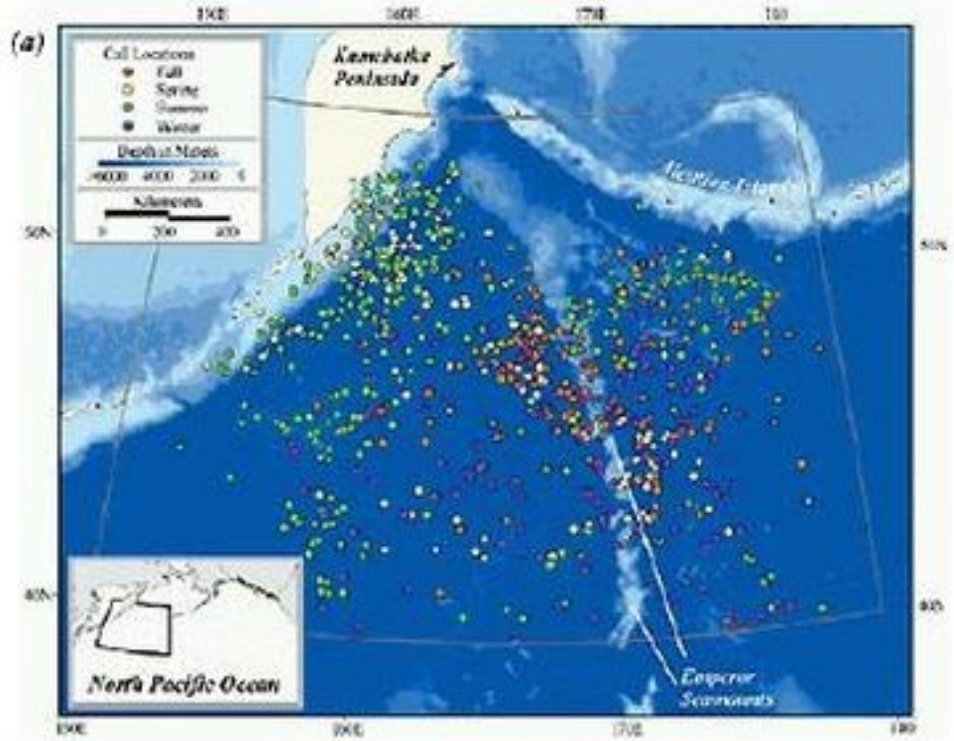
- Sites
- Modern Roads
- Modern Cities
- Wadis
- 50 km Palestine Grid
- Rivers
- Borders
- Lakes/Seas

Topography (m)

-400 to -100

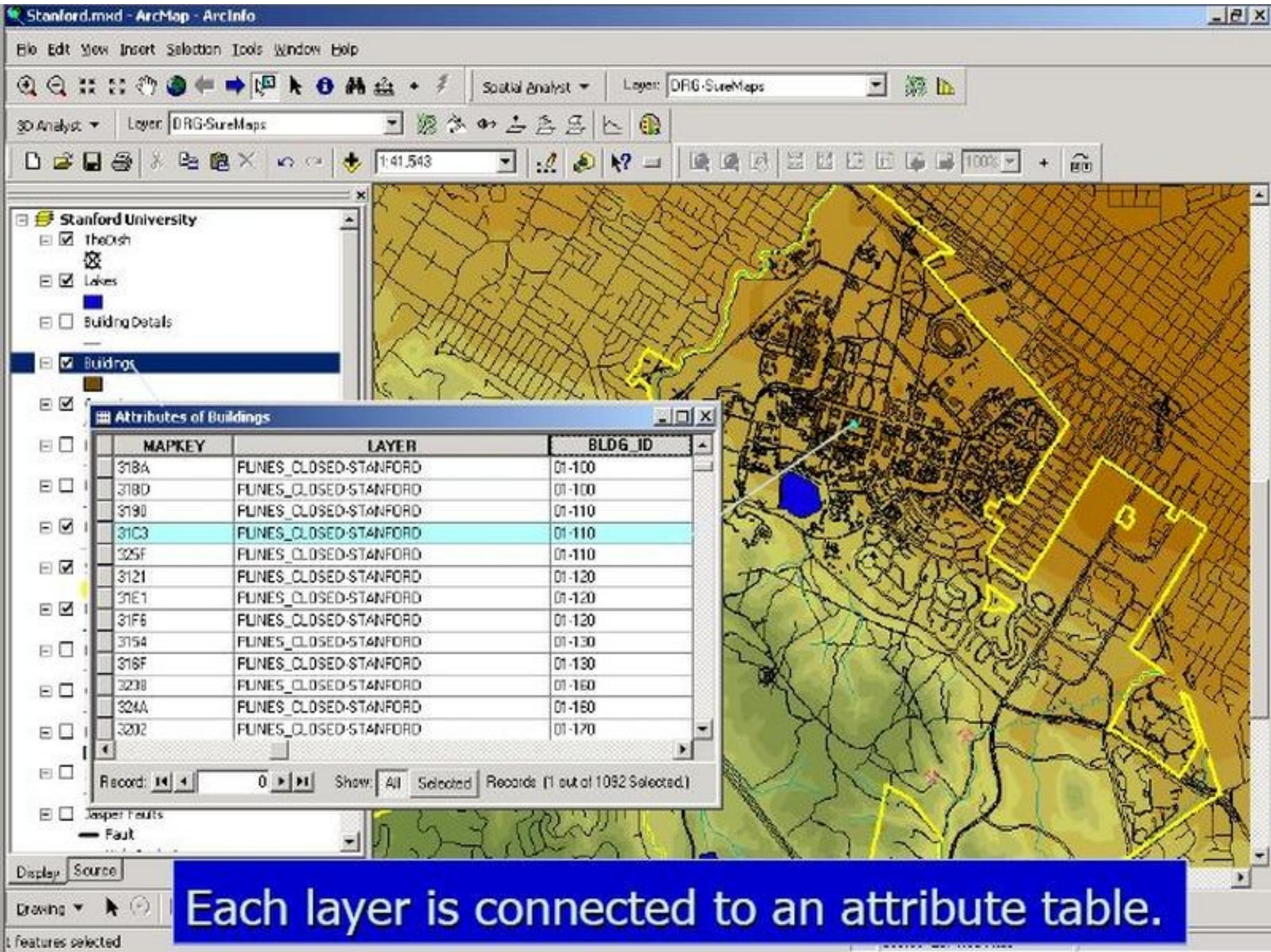
Introduction - Directions

Blue Whale Habitat Associations in the Northwest Pacific



http://nmml.afsc.noaa.gov/CetaceanAssessment/bluewhale/bluhabitat.htm

Figure 1. Locations of calling blue whales in the NW Pacific region in relation to bathymetry in planar projection (a); and in 3-D projection (b). Whale call locations are associated with the Emperor Seamounts and the steep slopes off Kamchatka Peninsula.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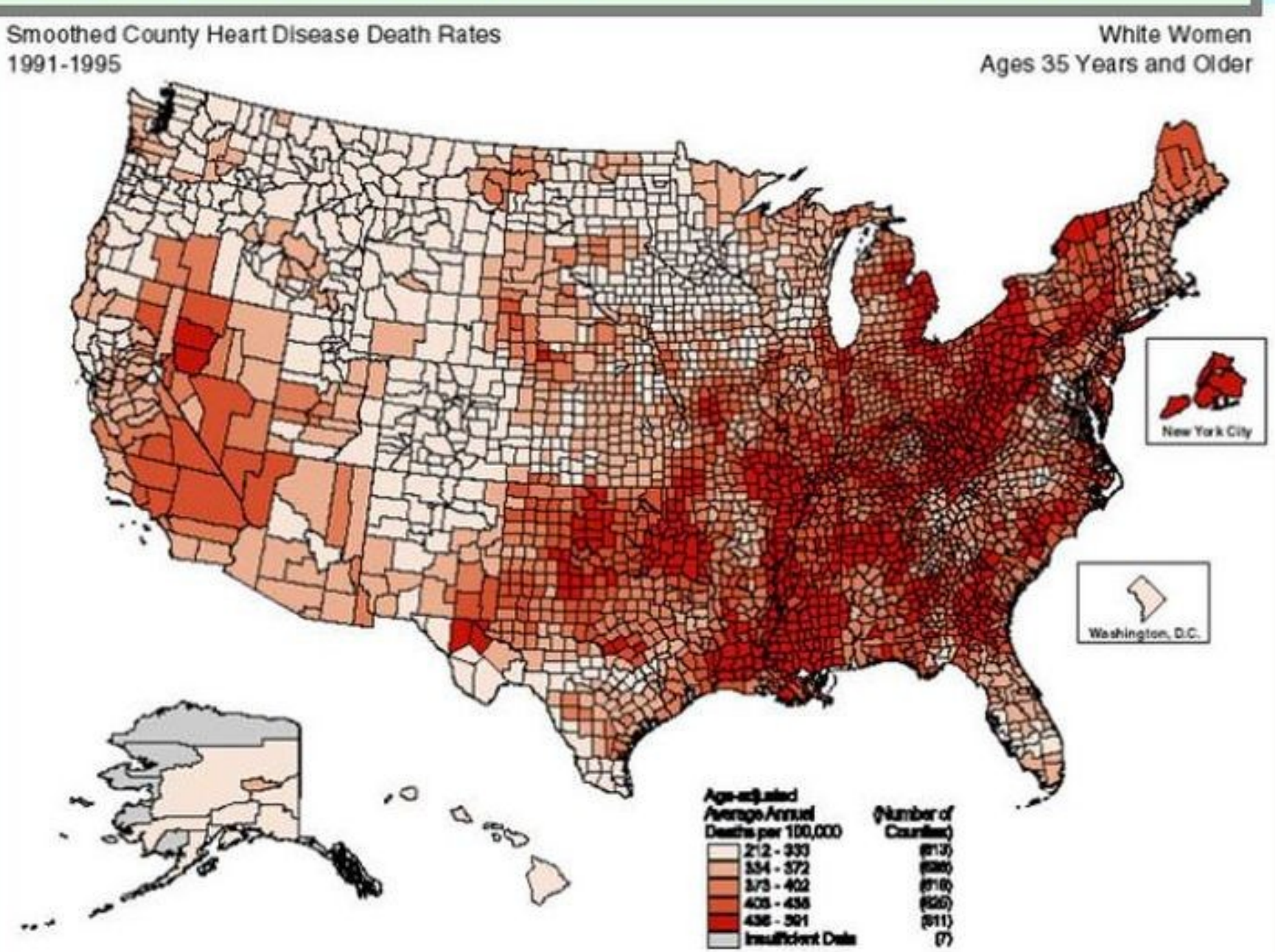
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer: ORG-SureMaps
3D Analyst
Layer: ORG-SureMaps
1:41,543
Stanford University
TheDish
Lakes
Building Details
Buildings
Attributes of Buildings
MAPKEY
LAYER
BLDG_ID
318A FUNES_CLOSED-STANFORD 01-100
318D FUNES_CLOSED-STANFORD 01-100
3190 FUNES_CLOSED-STANFORD 01-110
31C3 FUNES_CLOSED-STANFORD 01-110
325F FUNES_CLOSED-STANFORD 01-110
3121 FUNES_CLOSED-STANFORD 01-120
31E1 FUNES_CLOSED-STANFORD 01-120
31F6 FUNES_CLOSED-STANFORD 01-120
3154 FUNES_CLOSED-STANFORD 01-130
316F FUNES_CLOSED-STANFORD 01-130
3238 FUNES_CLOSED-STANFORD 01-160
324A FUNES_CLOSED-STANFORD 01-160
3202 FUNES_CLOSED-STANFORD 01-170
Record: 0
Show: All Selected
Records (1 out of 1092 Selected)
Jasper Faults
Fault
Display Source
Drawing
features selected
Each layer is connected to an attribute table.

Geographic Variation for Heart Disease Death Rate



Austronesian Languages in Taiwan

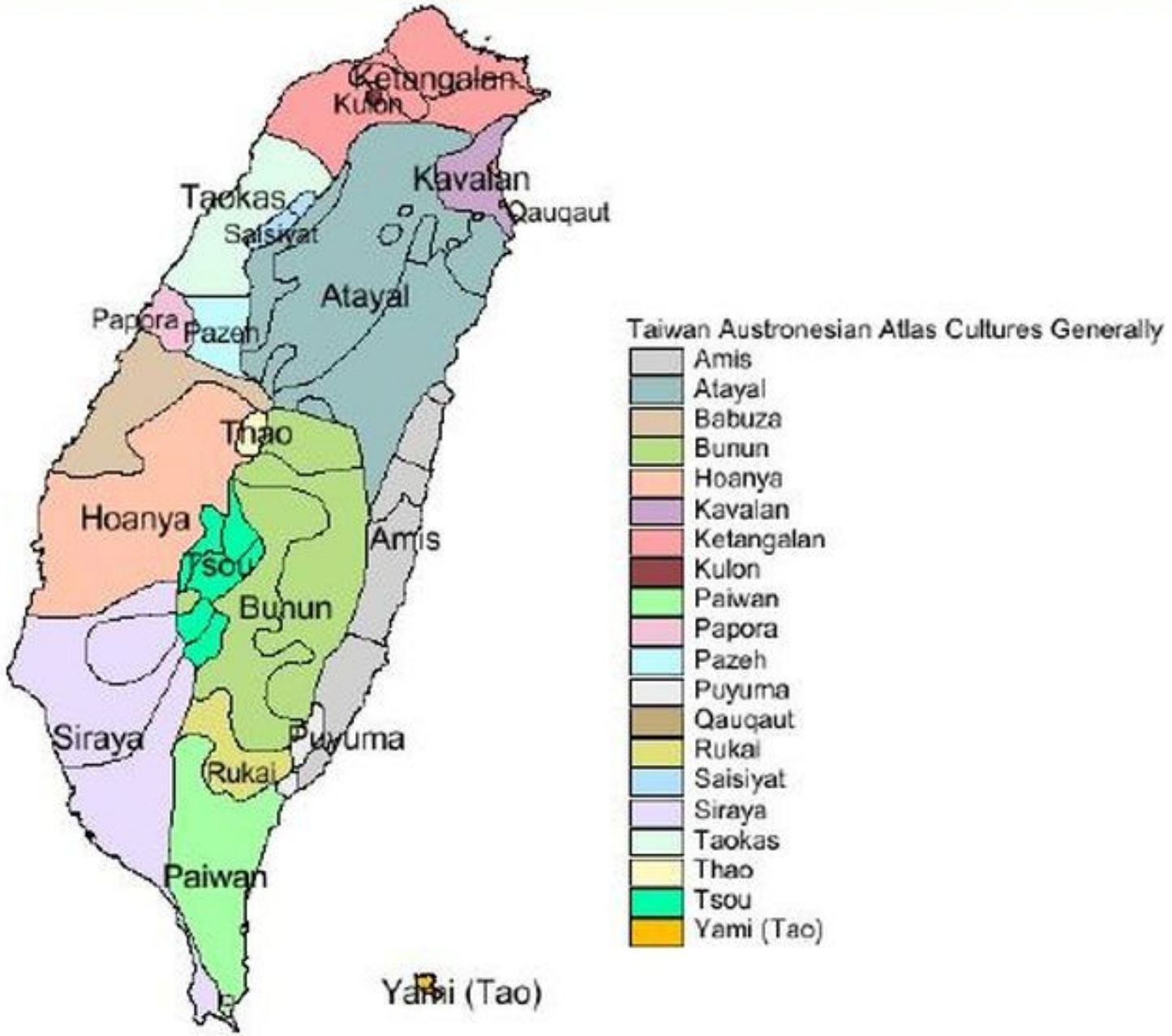
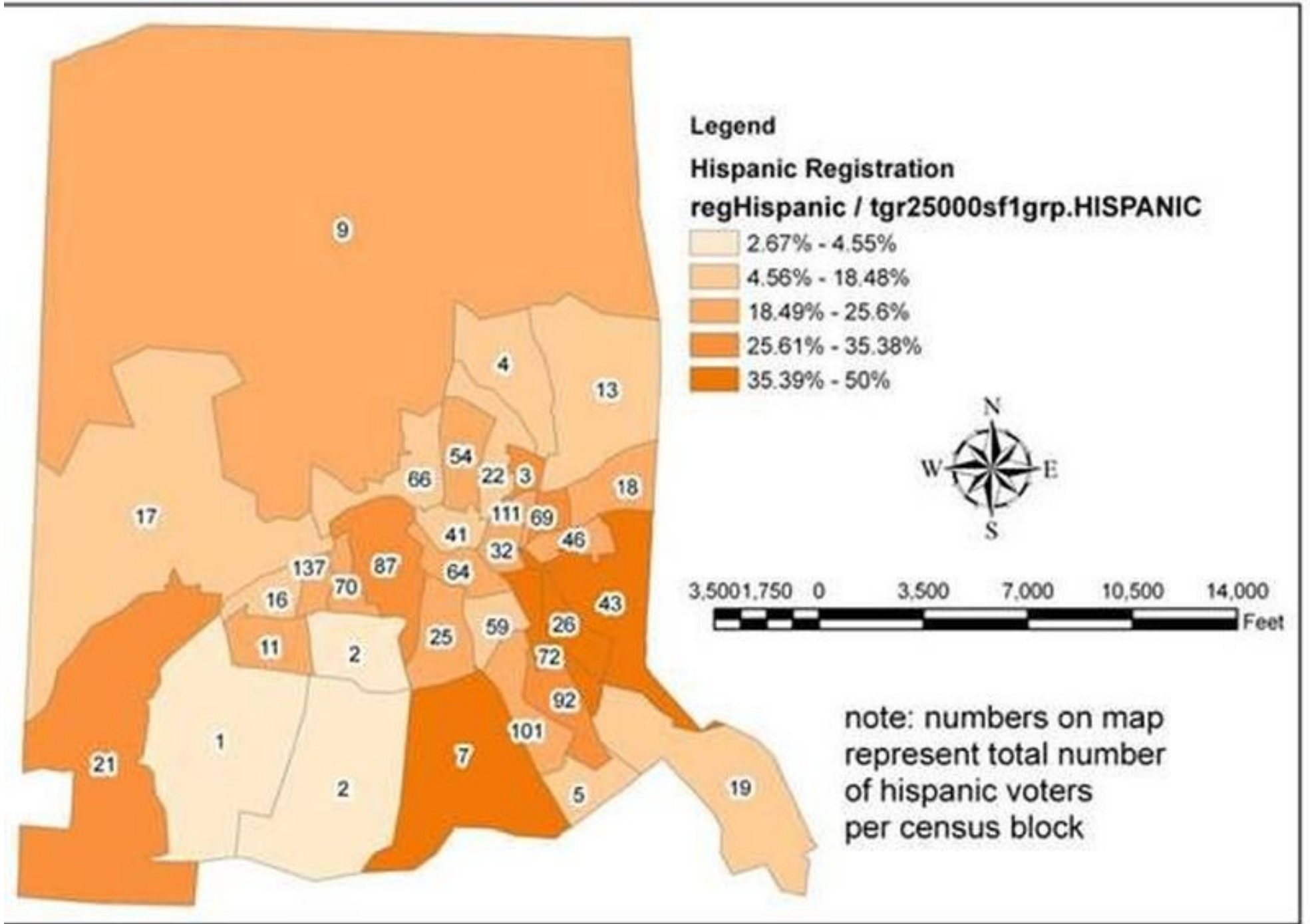
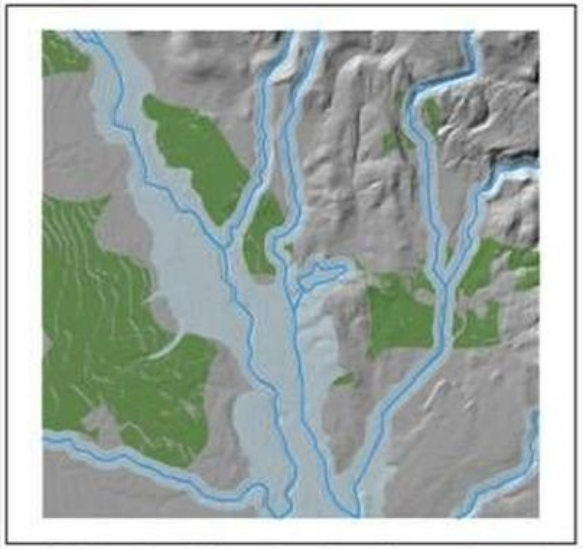


Figure.4 Taiwan Austronesian Atlas Cultures Generally

Registered Hispanic Voters



Suitable Winery Sites



Legend

- Suitable
- hydro
- Flood Plain

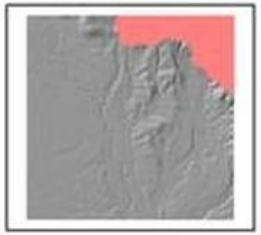
N
W E
S

0 255510 1,020 1,530 2,040
Meters

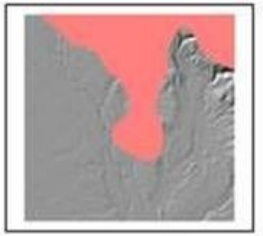
Criteria for Selection

= Unsuitable sites

SOIL DRAINAGE

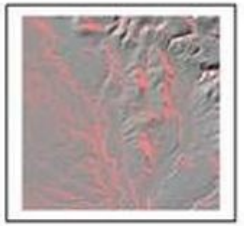


SOIL DEPTH

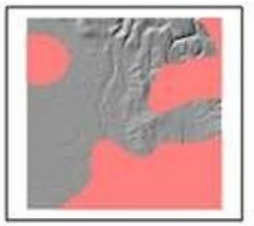


MIN TEMPERATURE

LAND USES

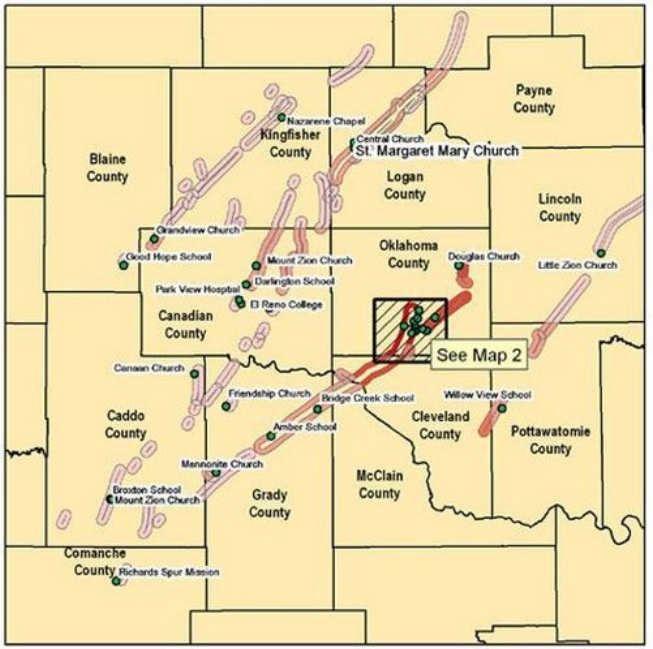


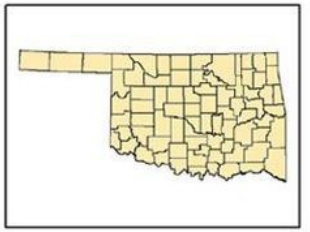
ASPECT ANGLE



MAX WIND

Tornado Relief Sites
Oklahoma May, 1999 Tornadoes





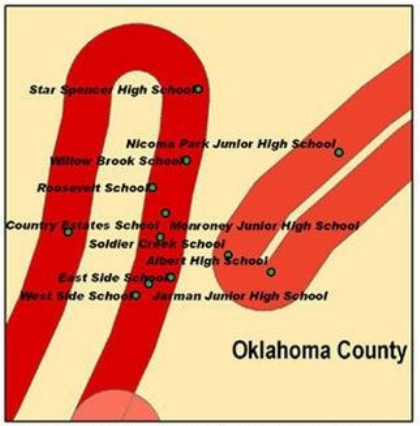
Legend

ReliefPriorityZones
ReliefPrio

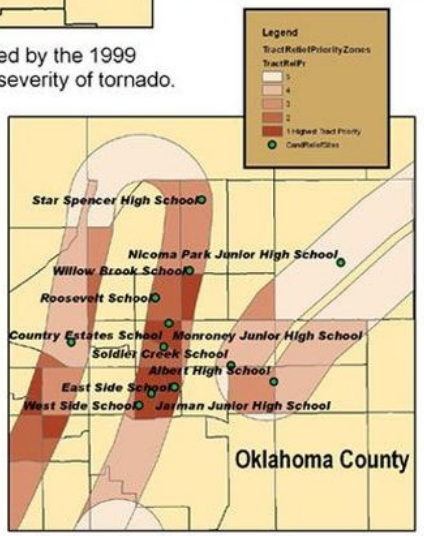
- 5 Lowest Priority
- 4
- 3
- 2
- 1 Highest Priority

0 15 30
Miles

Map 1: Potential Relief Zones in the counties affected by the 1999 Tornadoes. Relief Priority also noted by county and severity of tornado.



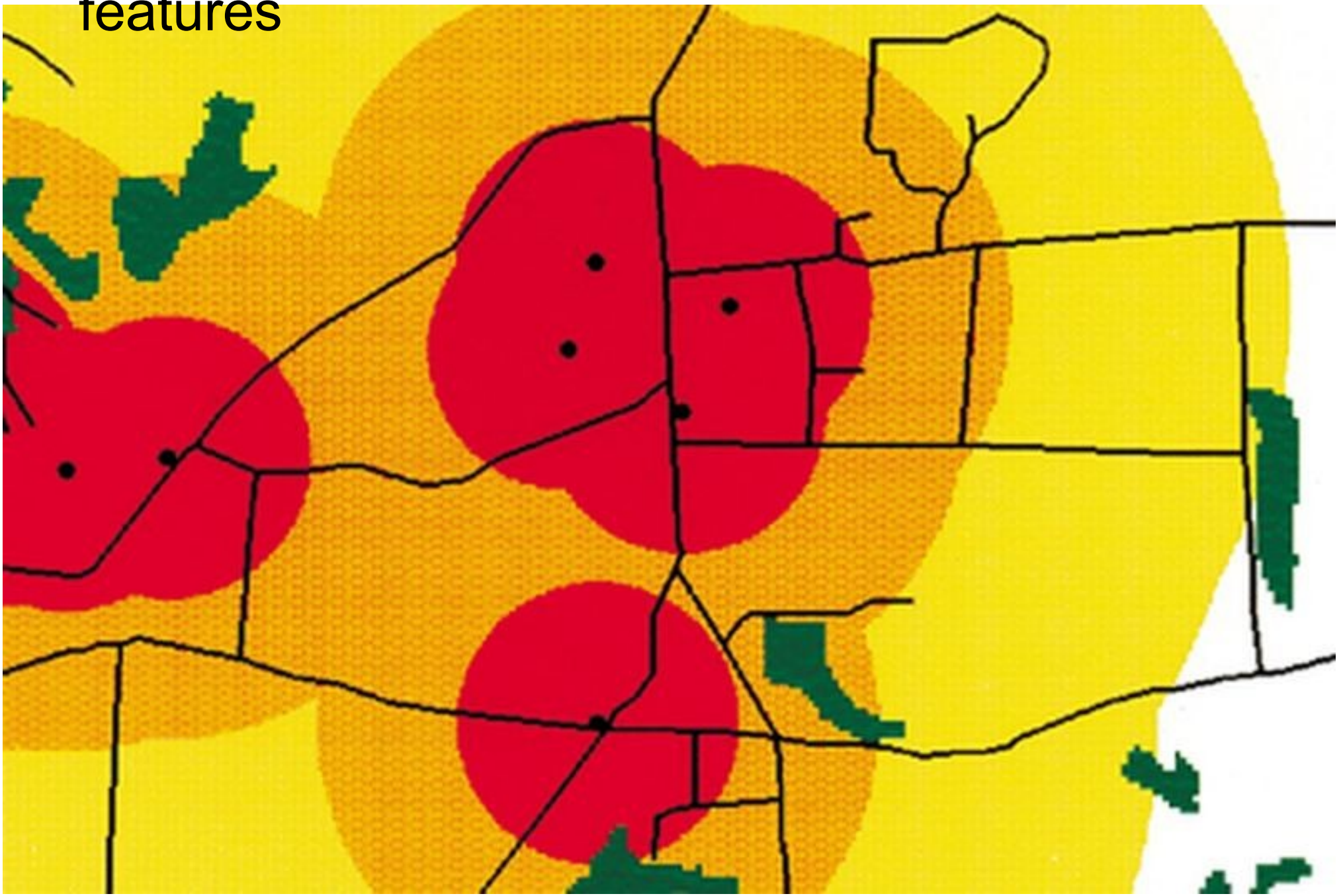
Map 2: Detail of potential relief sites for counties affected by 1999 tornadoes.



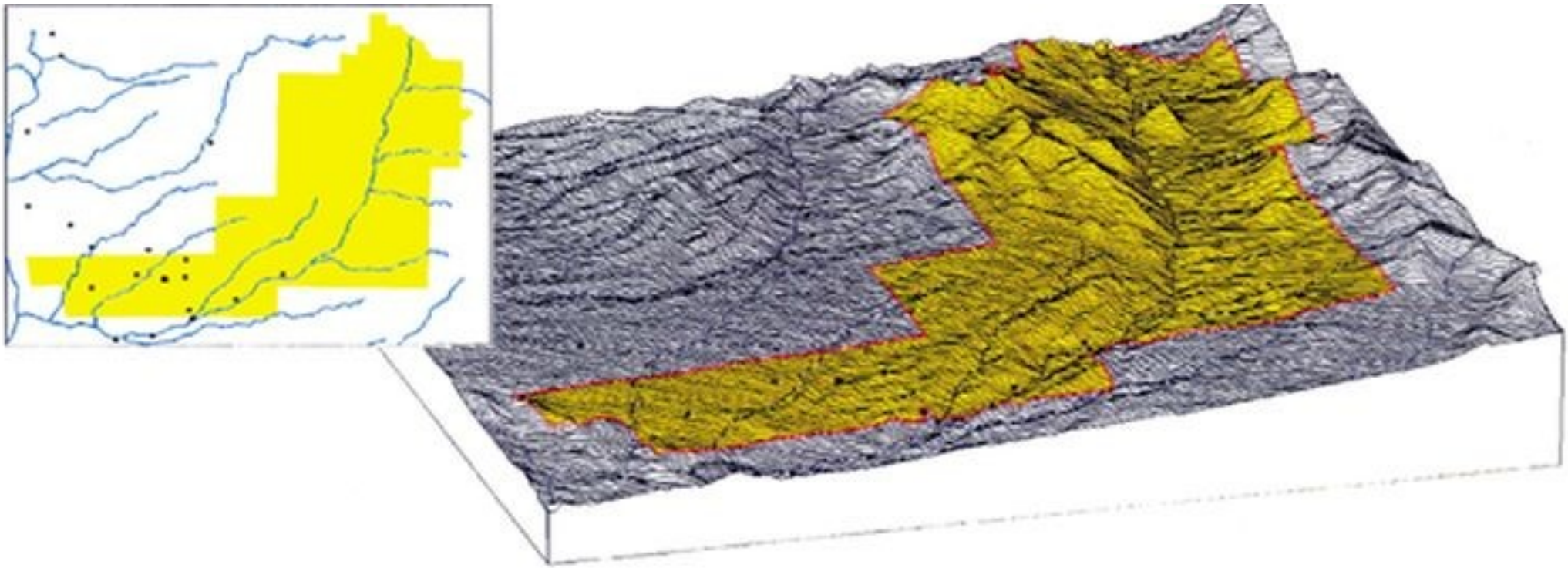
Map 3: Relief priority zones and potential relief sites for census tracts affected by 1999 tornadoes.

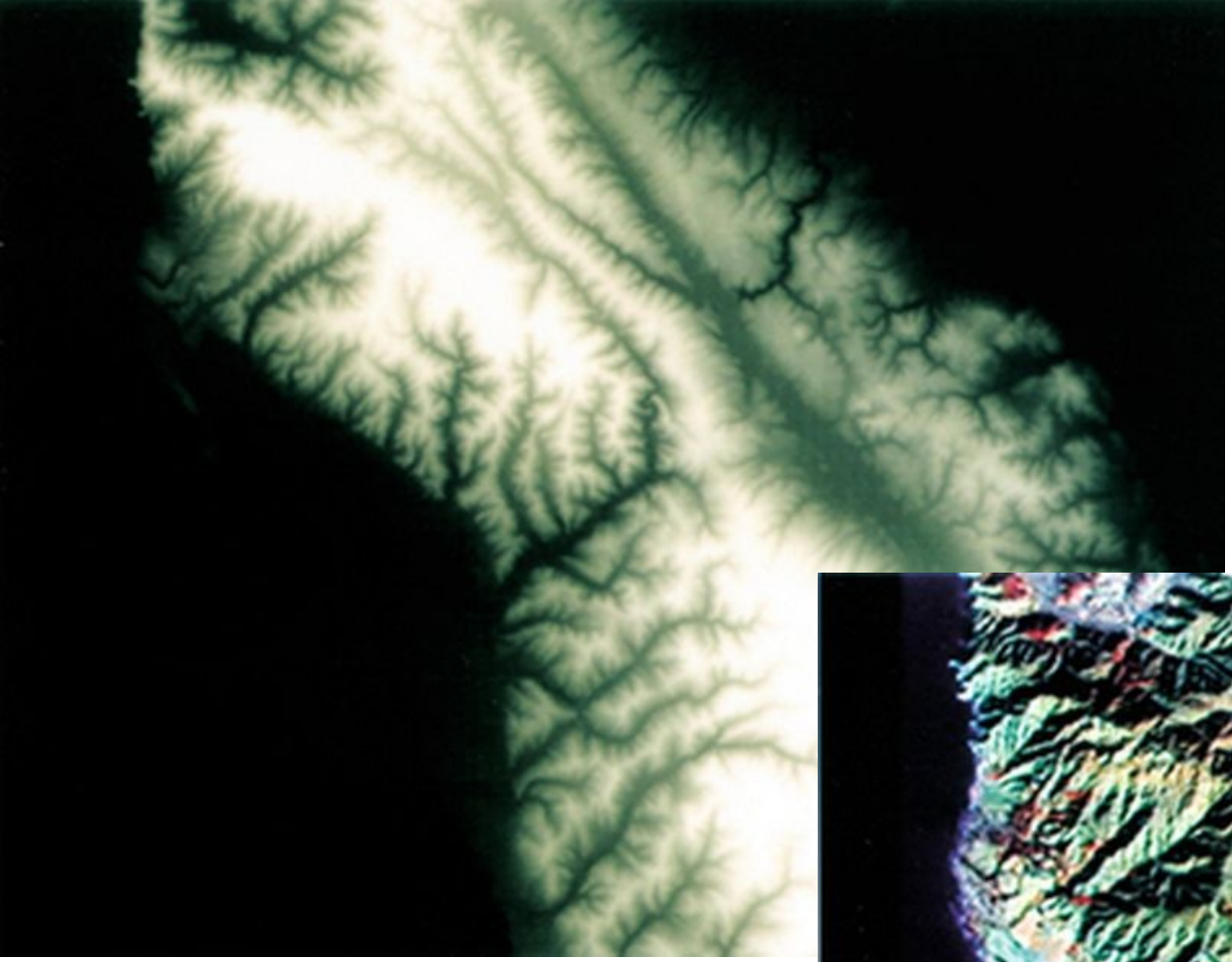
Map sources: Penn State Geog483 course data Winter 2006, accessed 1/30/05

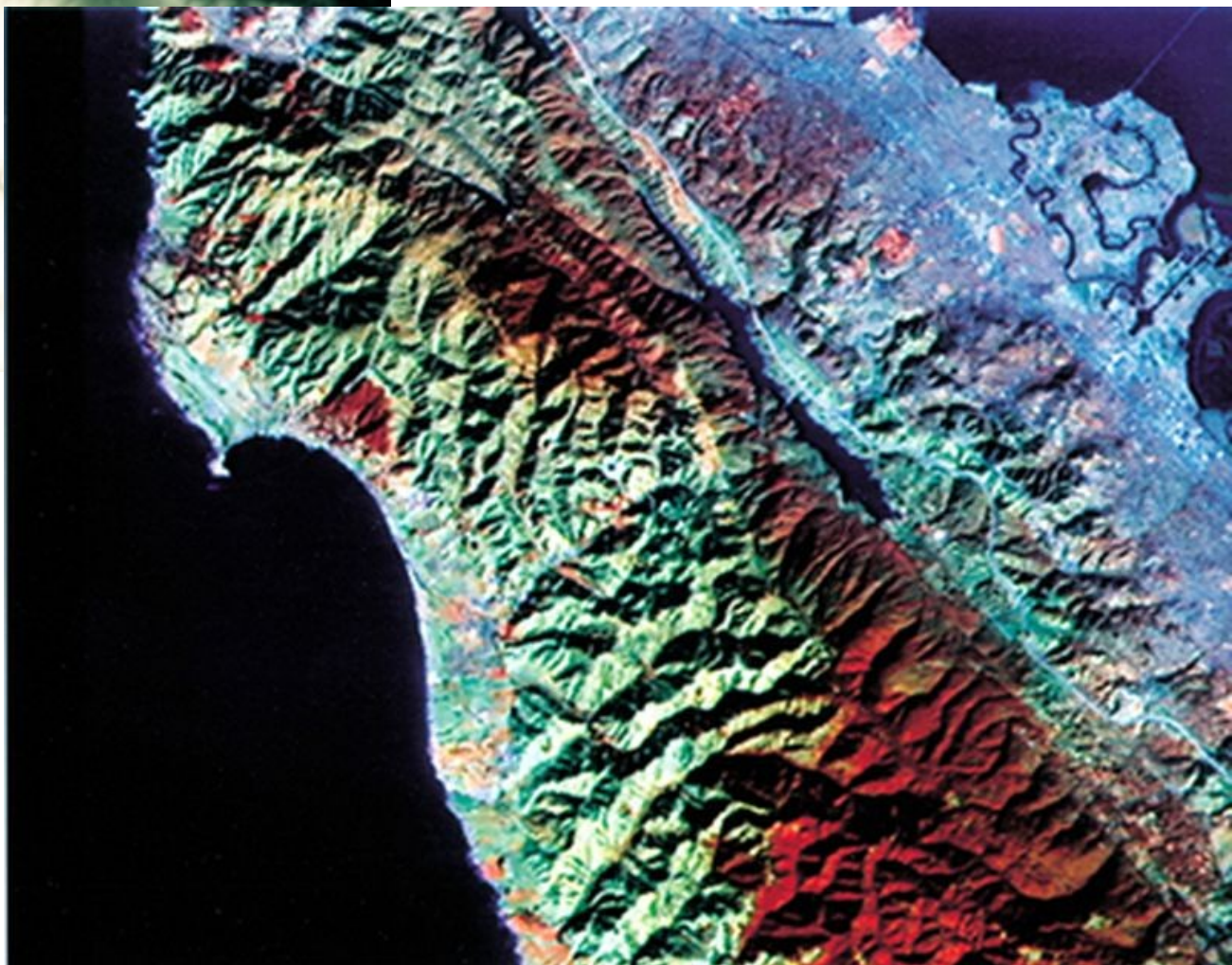
Create Buffers around features

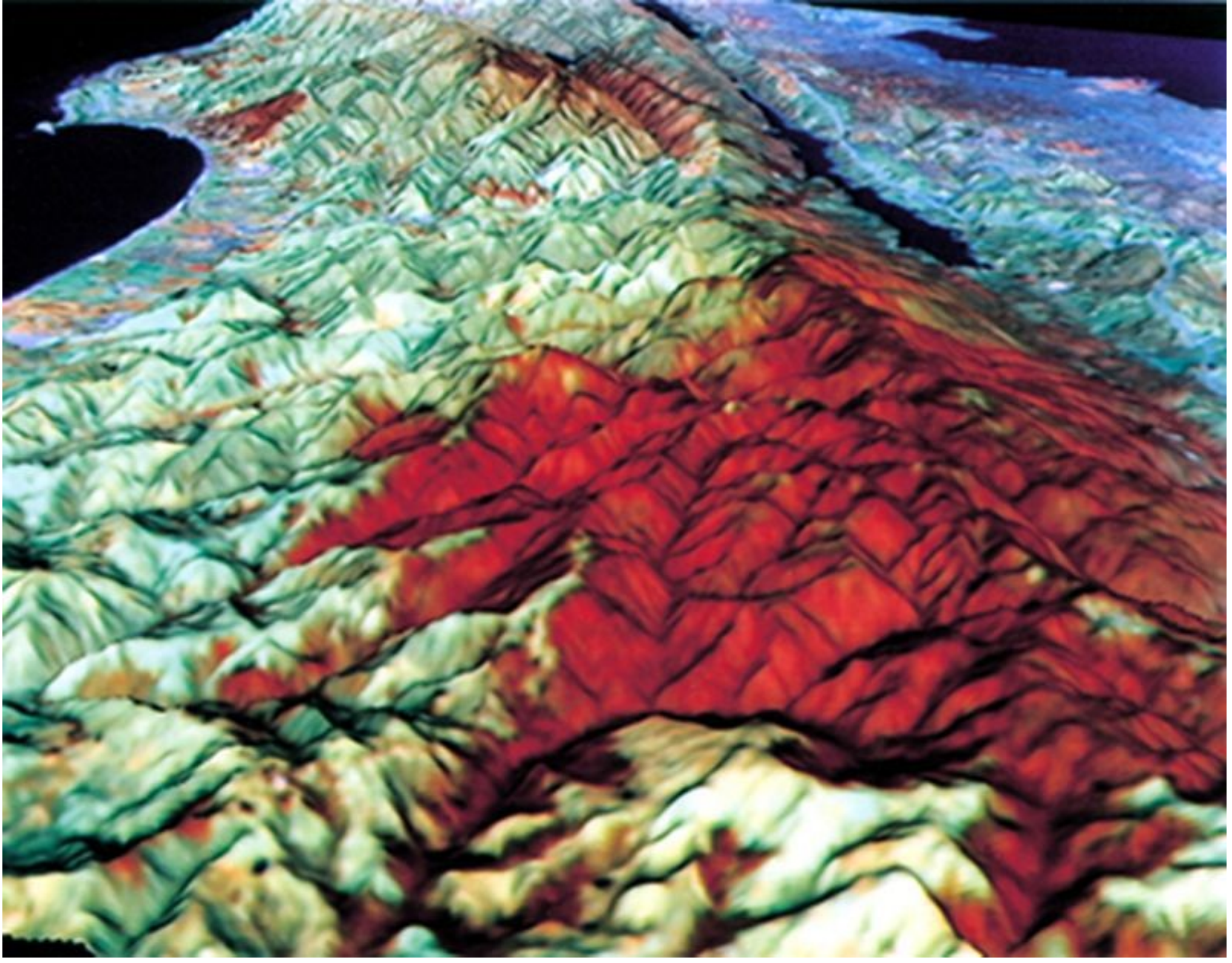


Combining 2D and 3D information

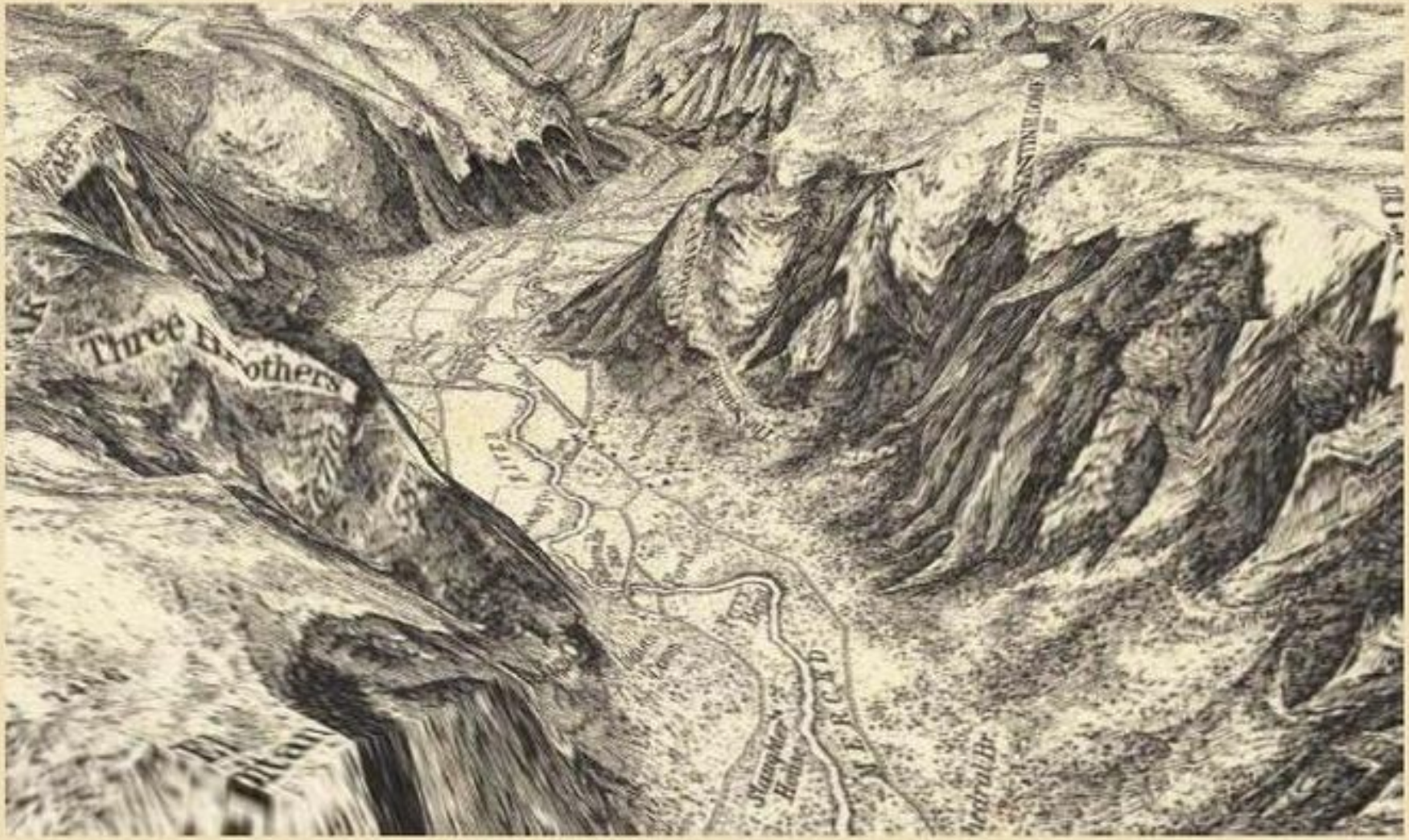








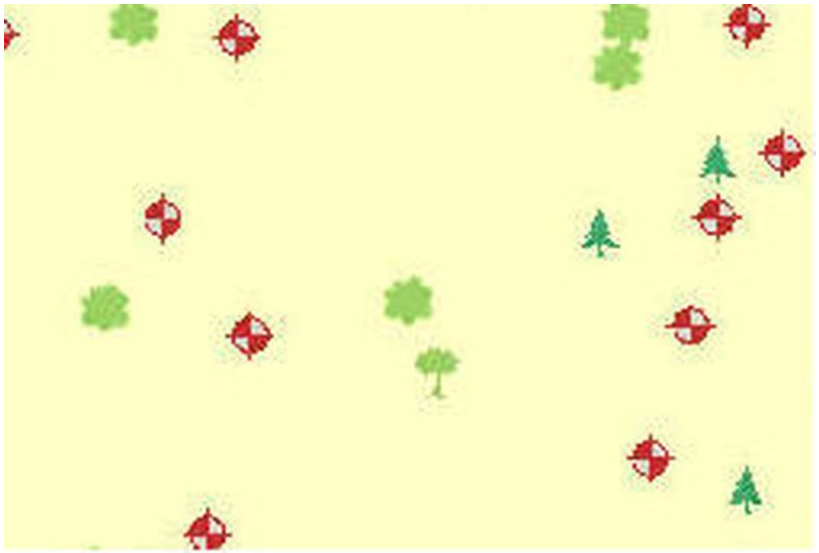
Incorporating Historical maps with modern spatial data

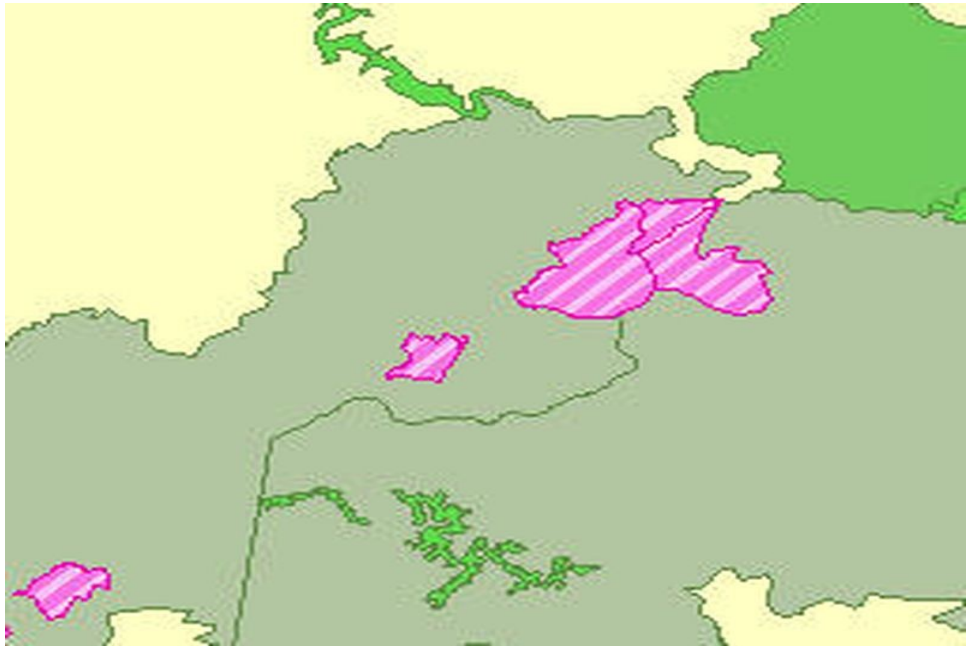


Wheeler's 1883 map of Yosemite Valley in 3-D

Types of Data-VECTOR

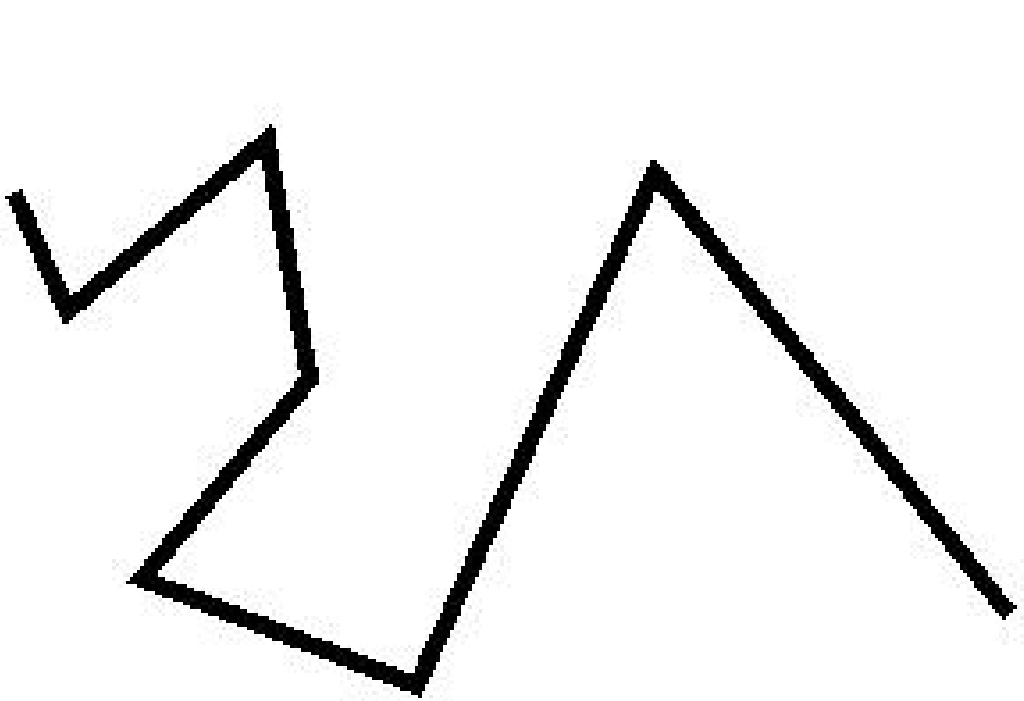
Shapefiles
--points
--lines
--polygons



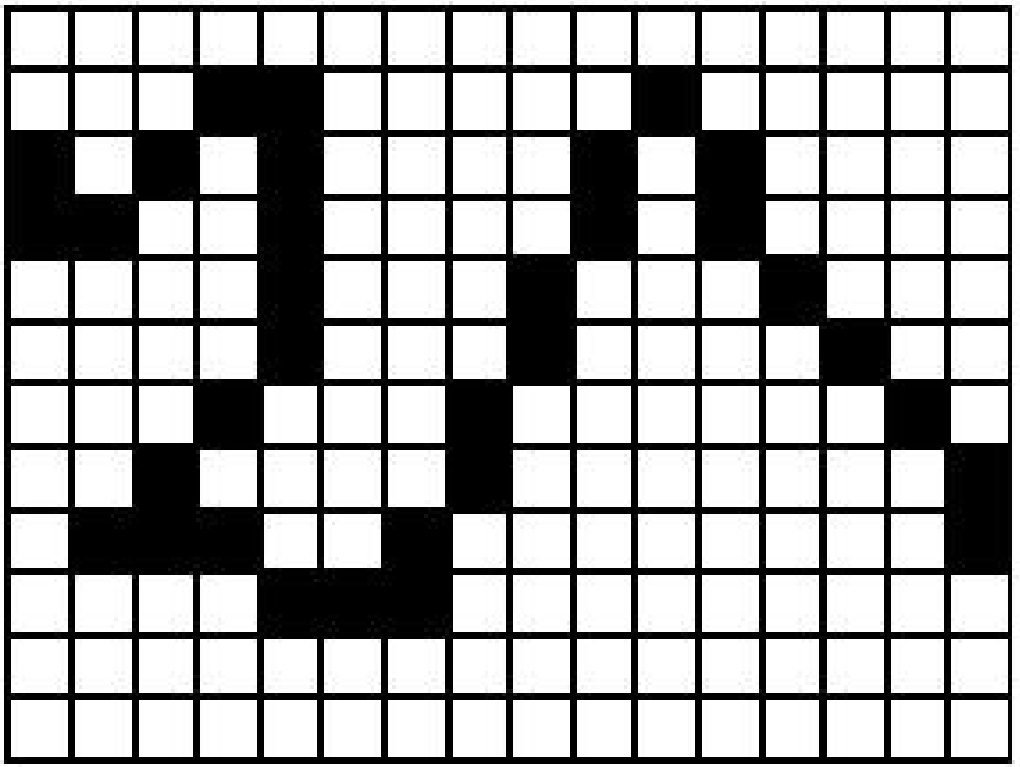


Types of Data-RASTER

Images
-USGS DRGs
-USGS DOQQ
-Satellite Imagery
Grid Data
-DEM (Digital Elevation Models)

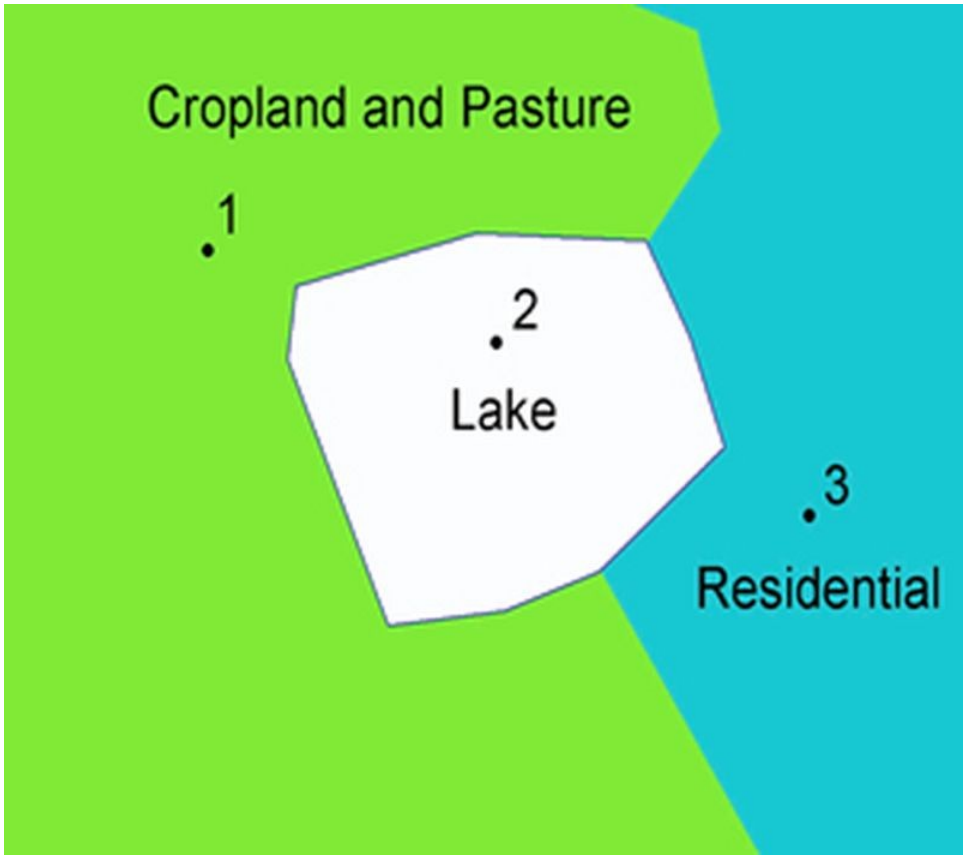


Vector-based line

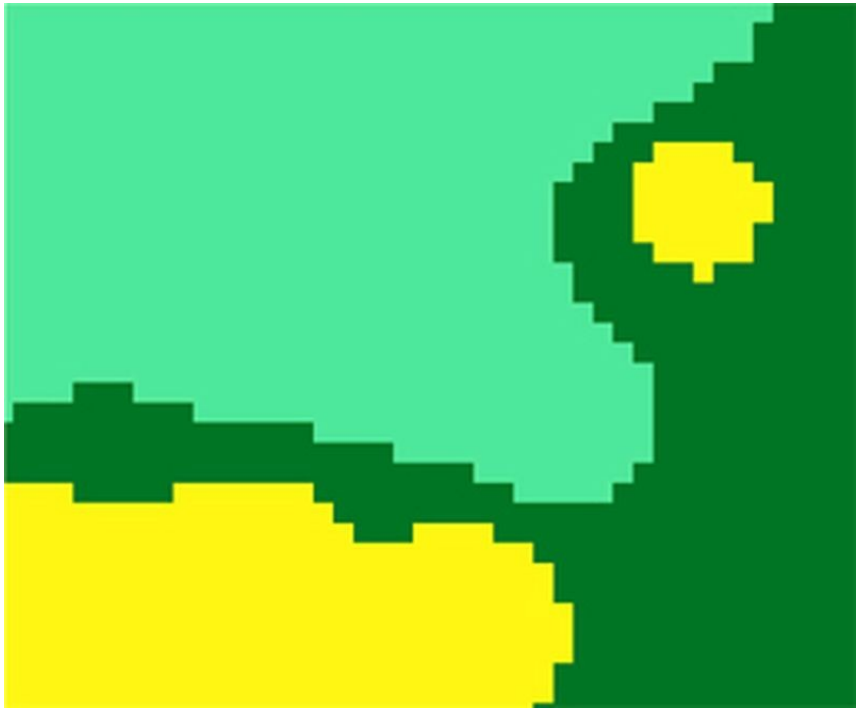


Raster-based line

Vector



Raster



1	1	1	1	1	1	1	3	3	3
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1	1	1	2	2	2	2	3	3	3
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1	1	1	1	2	2	2	3	3	3
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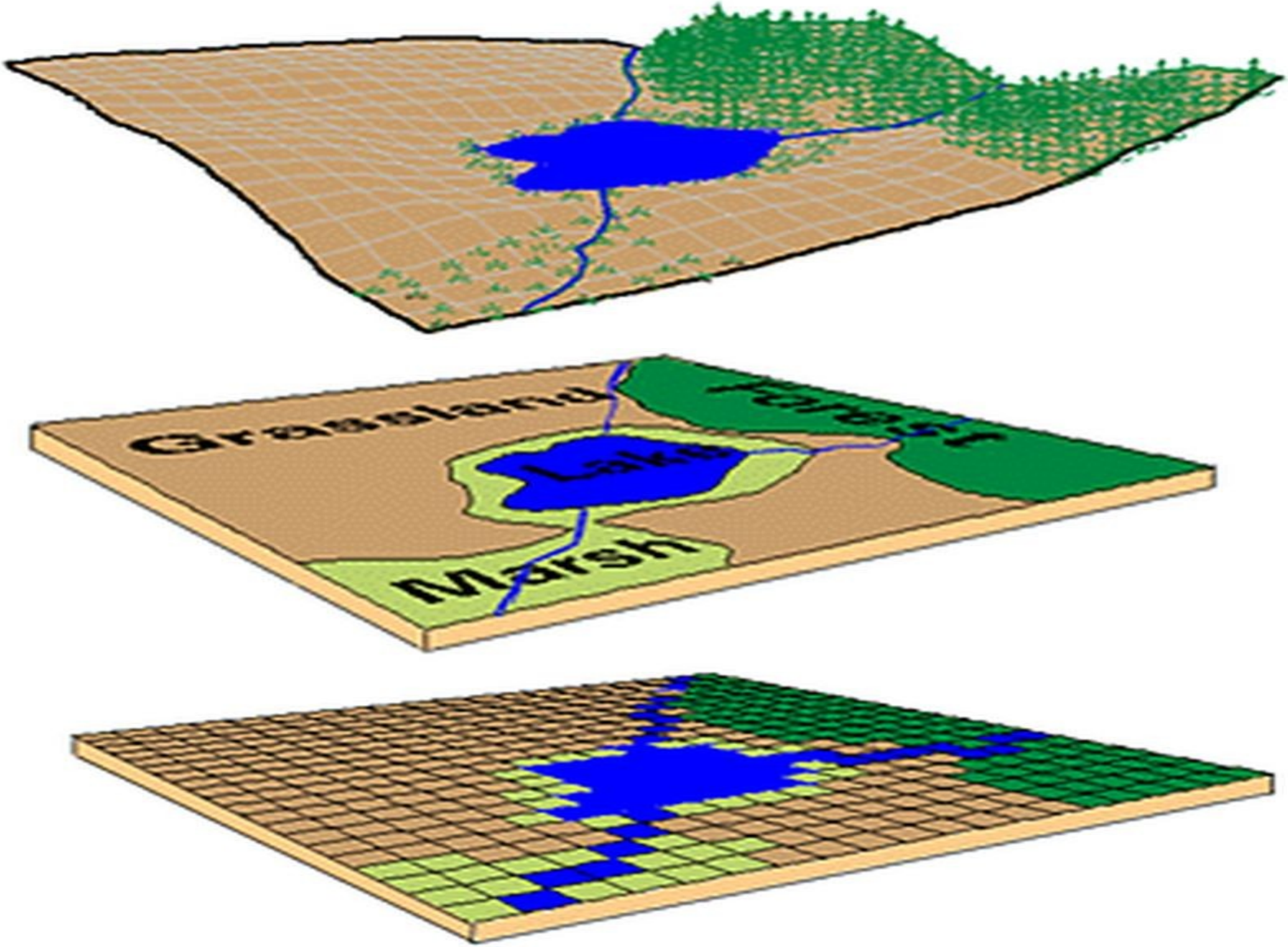
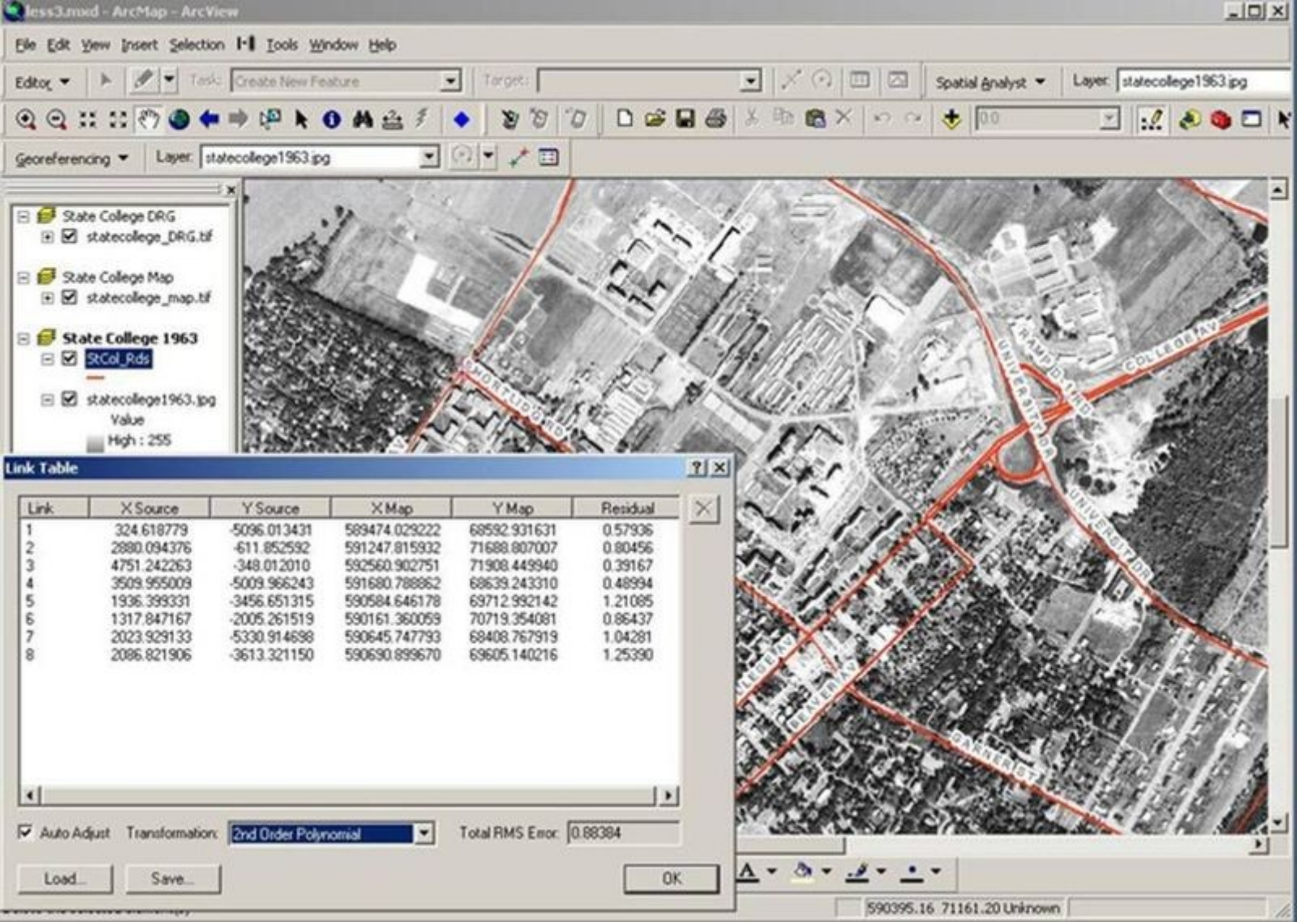

Grassland
Forest
Lake
Marsh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Georeferencing
Layer: statecollege1963.jpg
State College DRG
statecollege_DRG.tif
State College Map
statecollege_map.tif
State College 1963
StCol_Rds
statecollege1963.jpg
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3 | 4751.242263 | -348.012010 | 592560.902751 | 71908.449940 | 0.39167
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5 | 1936.399331 | -3456.651315 | 590584.646178 | 69712.992142 | 1.21085
6 | 1317.847167 | -2005.261519 | 590161.360059 | 70719.354081 | 0.86437
7 | 2023.929133 | -5330.914698 | 590645.747793 | 68408.767919 | 1.04281
8 | 2086.821906 | -3613.321150 | 590690.899670 | 69605.140216 | 1.25390
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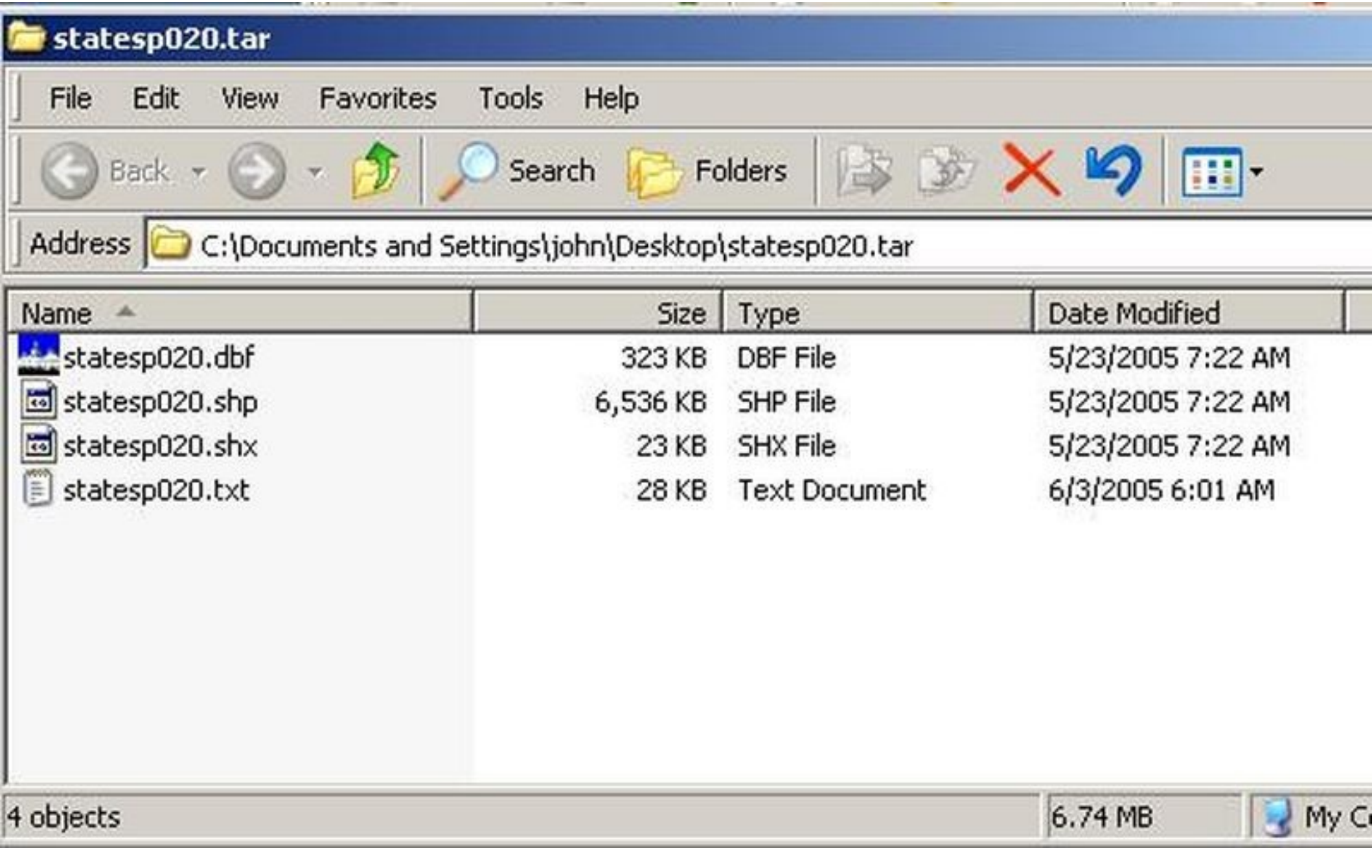
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File Edit View Favorites Tools Help
Back
Search
Folders
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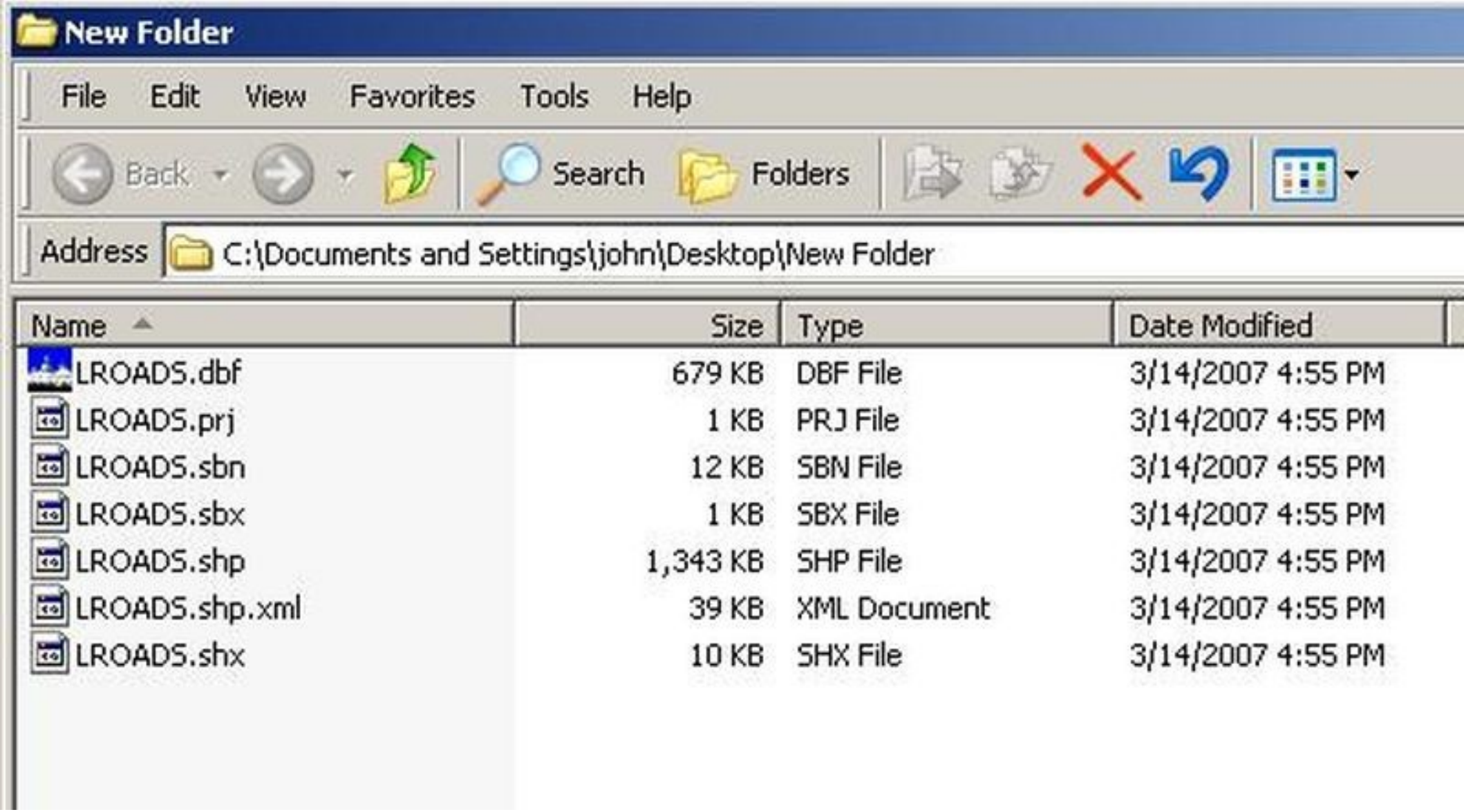
statesp020.shp 6,536 KB SHP File 5/23/2005 7:22 AM
statesp020.shx 23 KB SHX File 5/23/2005 7:22 AM
statesp020.txt 28 KB Text Document 6/3/2005 6:01 AM
4 objects
6.74 MB


New Folder
File Edit View Favorites Tools Help
Back
Search
Folders
Address
C:\Documents and Settings\john\Desktop\New Folder
Name
Size
Type
Date Modified
LROADS.dbf 679 KB DBF File 3/14/2007 4:55 PM
LROADS.prj 1 KB PRJ File 3/14/2007 4:55 PM
LROADS.sbn 12 KB SBN File 3/14/2007 4:55 PM
LROADS.sbx 1 KB SBX File 3/14/2007 4:55 PM
LROADS.shp 1,343 KB SHP File 3/14/2007 4:55 PM
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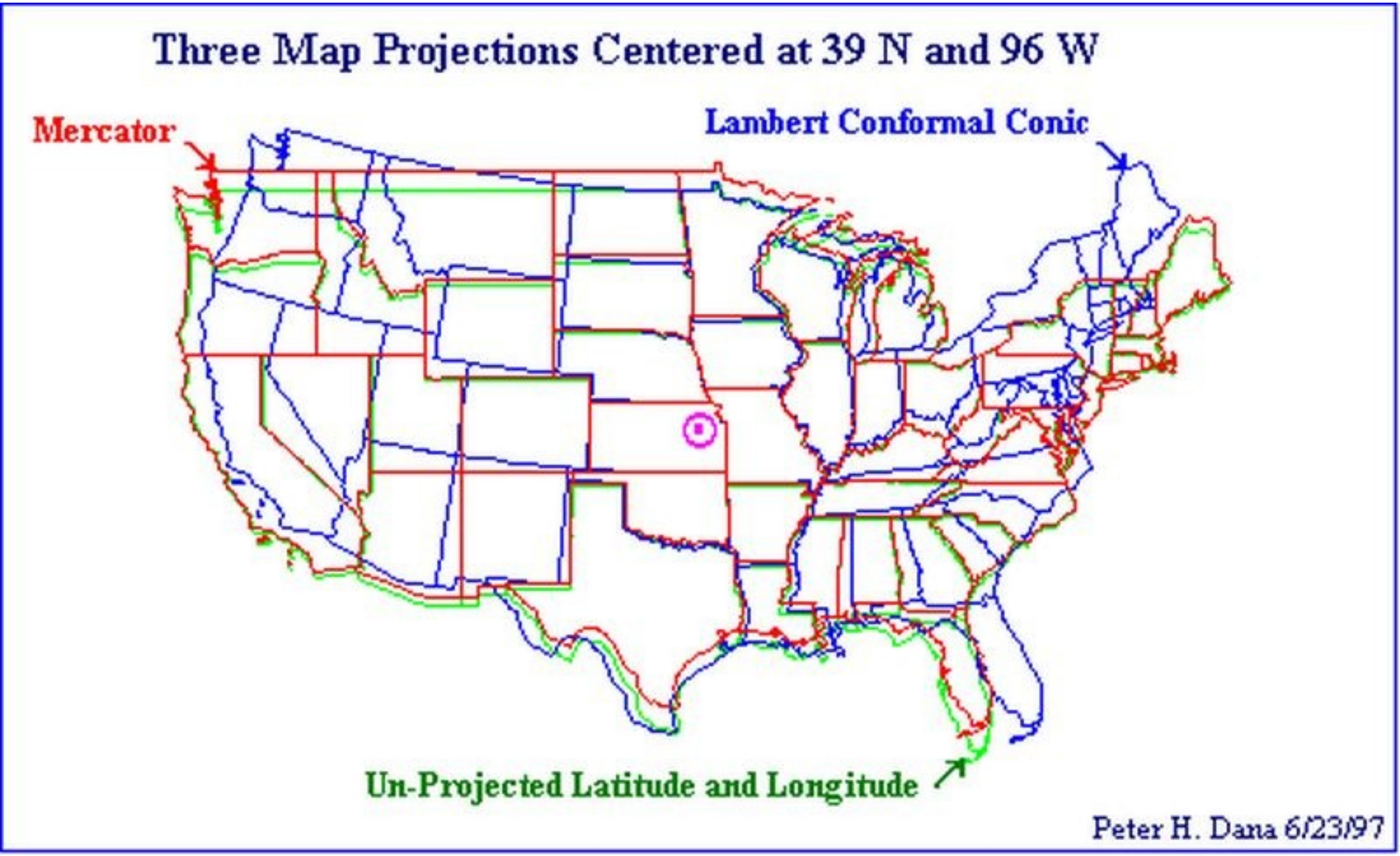
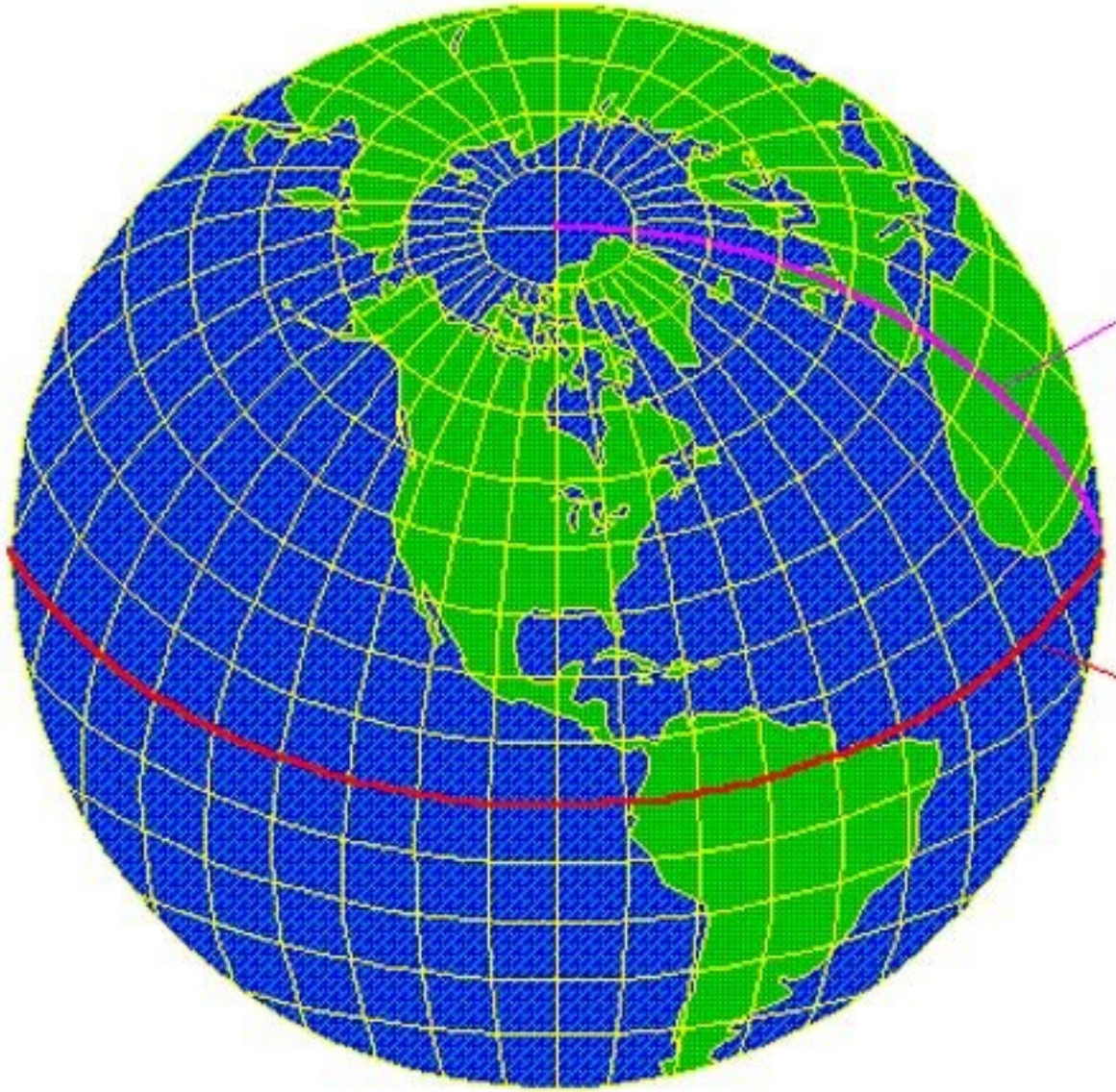
PROJECTIONS AND DATUMS



Unprojected--Latitude/Longitude



Prime Meridian

0 Degrees Longitude

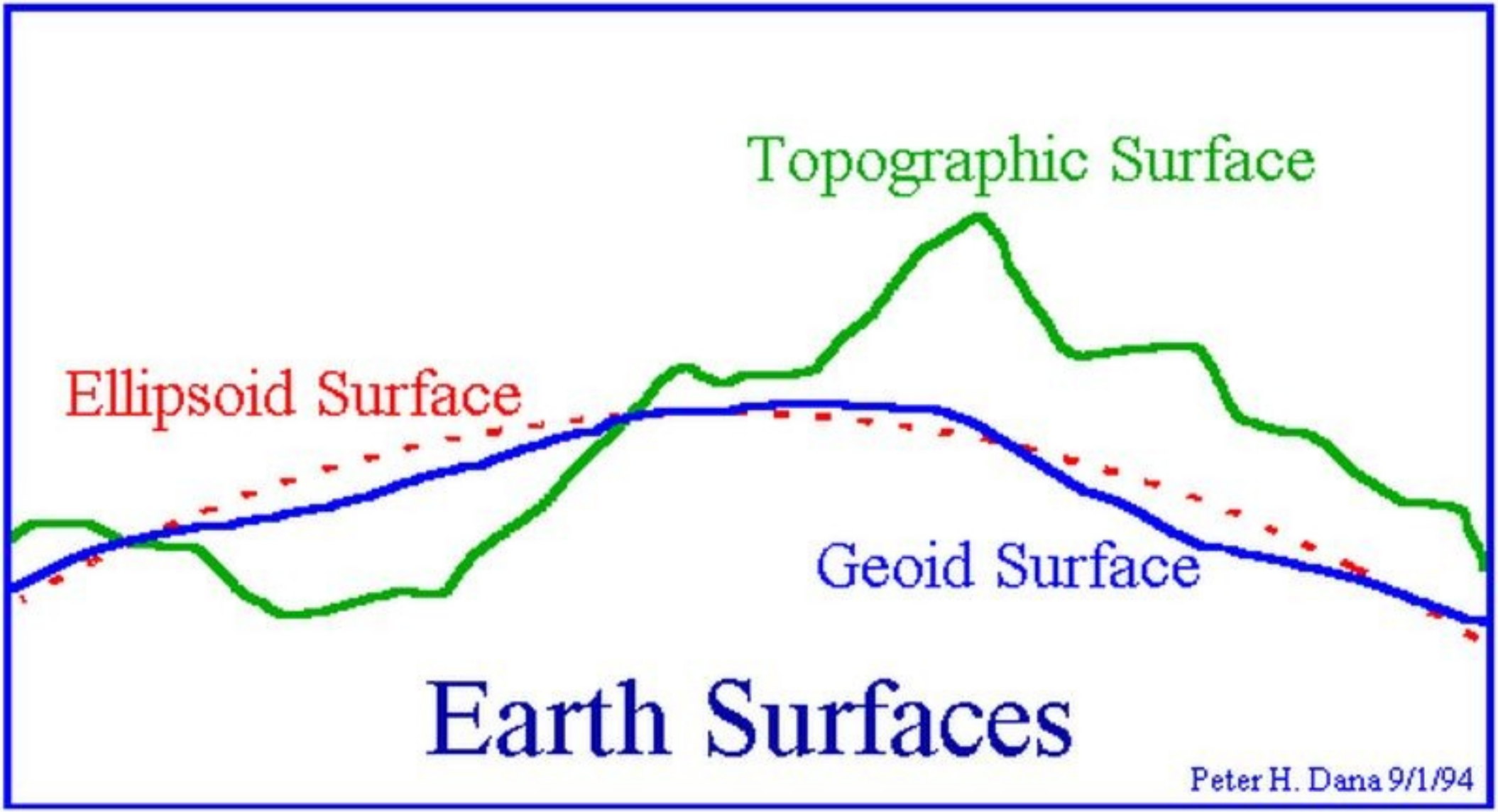
Equator

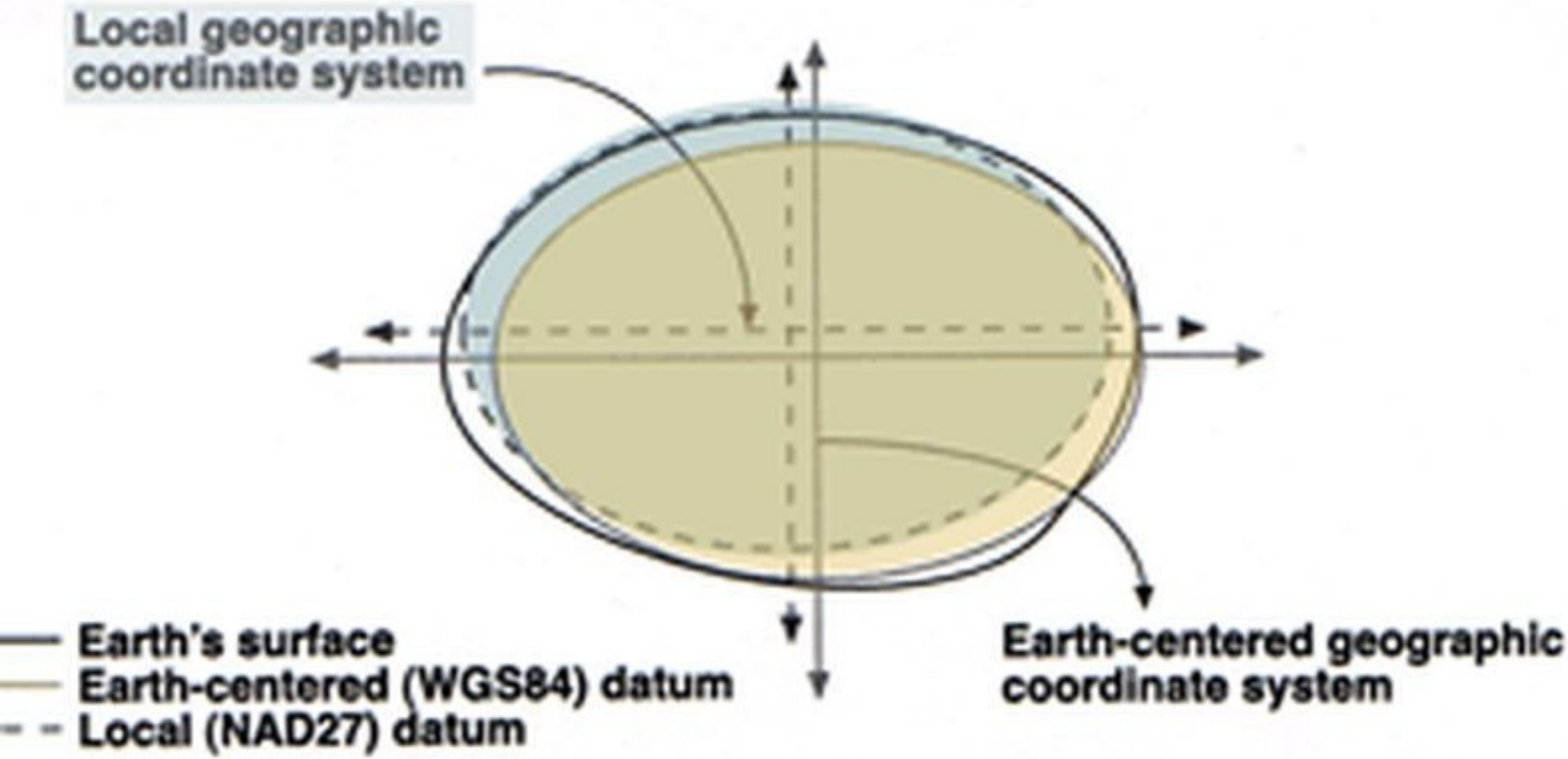
0 Degrees Latitude

Peter H. Dana 9/1/94

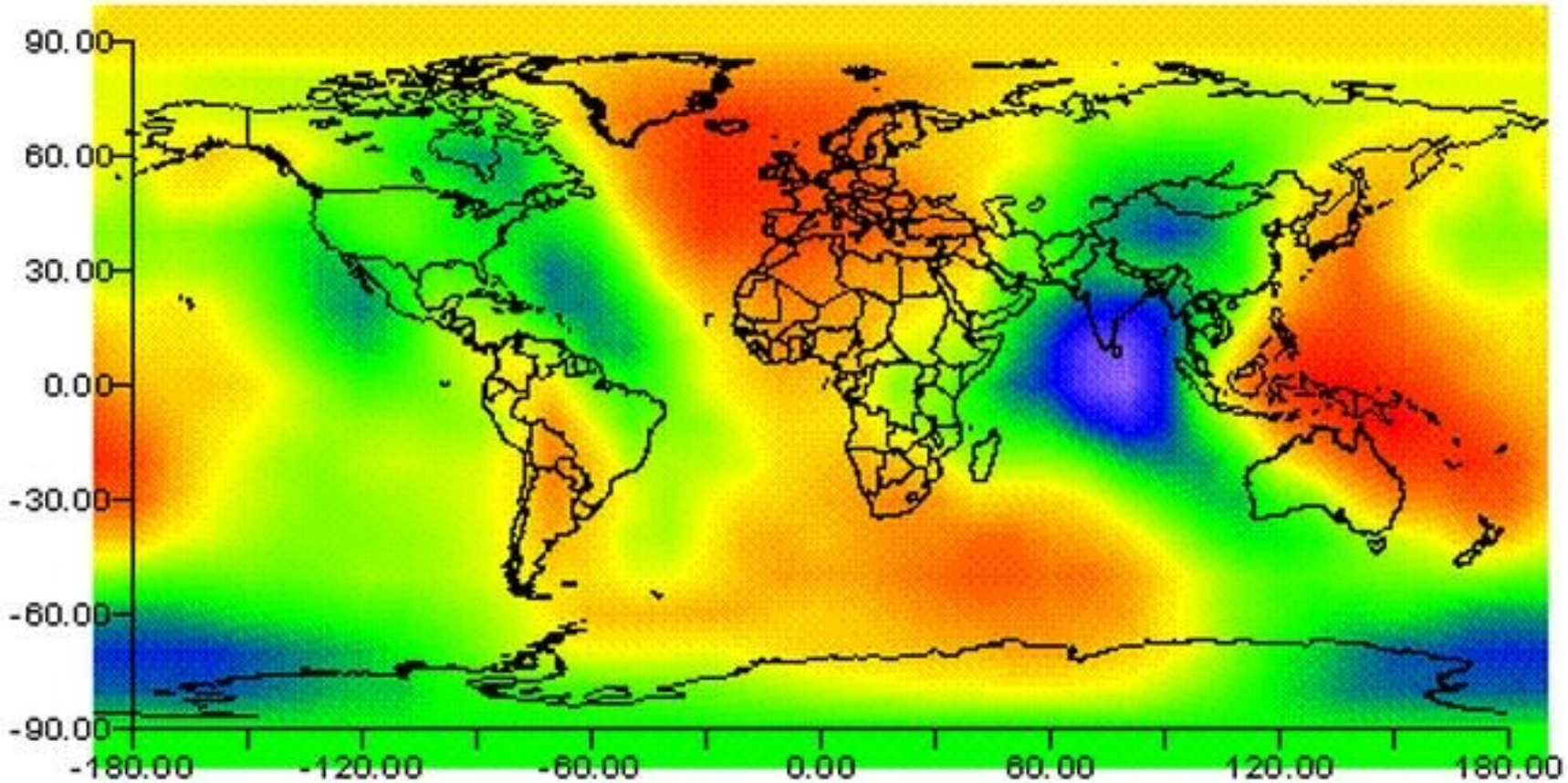

C:\Documents and Settings\deuce4\Desktop\Project 1\utms.exe
ENTER LATITUDE:
DD MM SS.SSSSS
37 15 30.96200
DIRECTION OF LATITUDE - N OR S
TYPE N OR S NOW
n
ENTER LONGITUDE:
NOTE IF THE DEGREES ARE LESS THAN 100
YOU MUST ENTER A ZERO FIRST
94 DEGREES WILL BE 094
DDD MM SS.SSSSS
107 01 12.57900
DIRECTION OF LONGITUDE - E OR W
TYPE E OR W NOW
w
UTMS FOR THE GRS80/WGS84 ELLIP (NAD83 DATUM)
NORTH(Y) EAST(X) ZONE CONVERGENCE SCALE
4125472.865 320854.585 13 -1 13 24.09 0.99999535
ANY MORE COMPUTATIONS (Y/N)?

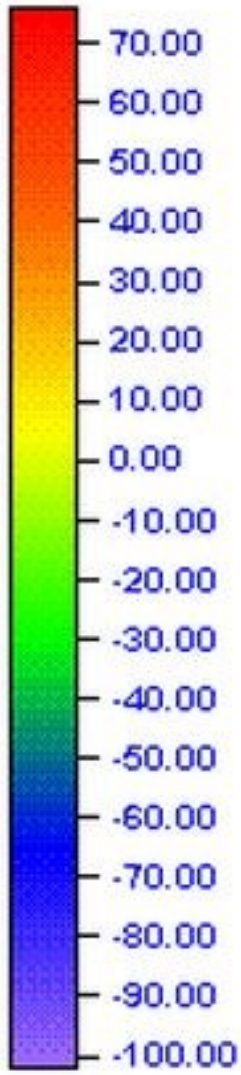
DATUM—An approximation of the earth's actual surface




Local geographic coordinate system
Earth's surface
Earth-centered (WGS84) datum
Local (NAD27) datum
Earth-centered geographic coordinate system

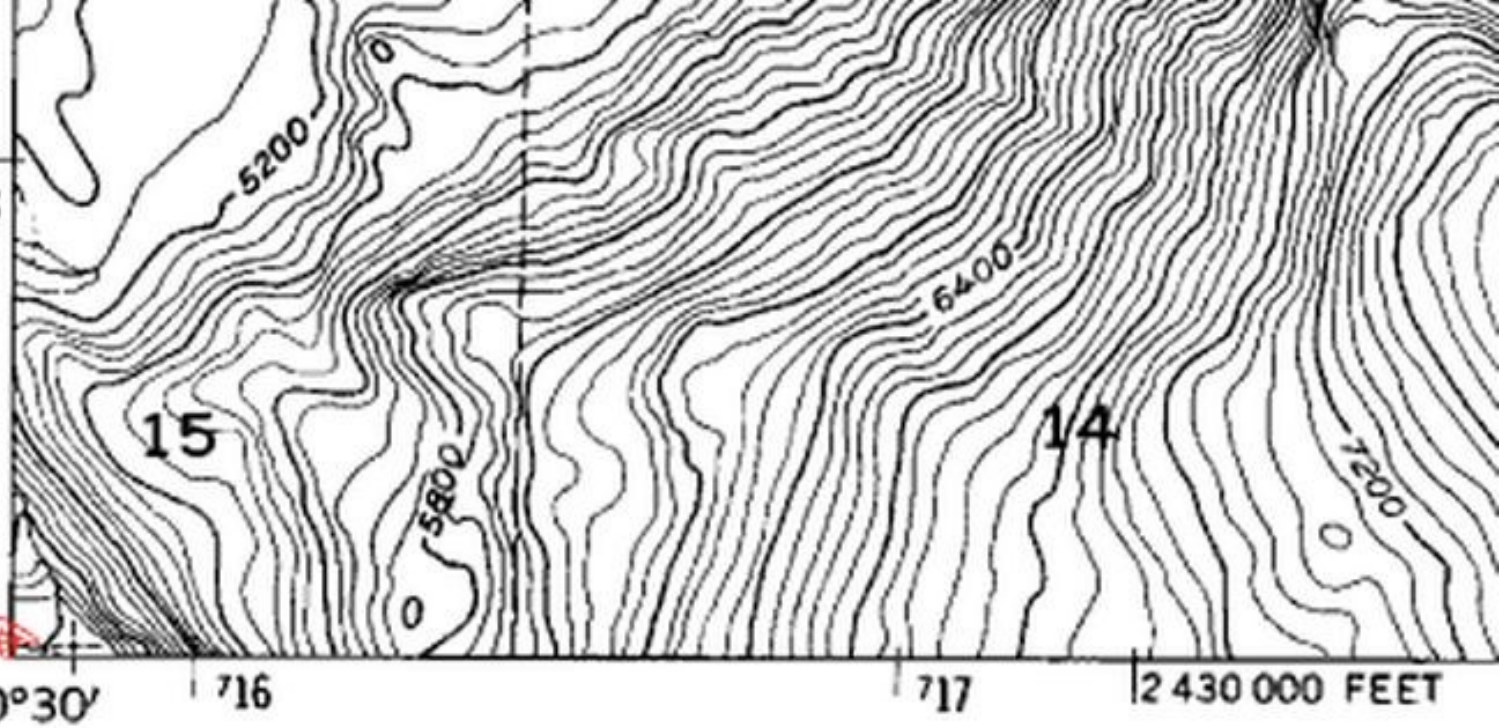
WGS-84 Geoid Height





From DMA 10 by 10 Degree Geoid Height Grid

Peter H. Dana 11/05/95



Dashed corner ticks

Mapped, edited, and published by the Geological Survey

Control by USGS and NOS/NOAA

Topography from aerial photographs by multiplex methods
Aerial photographs taken 1953. Field check 1955

Map datum

Polyconic projection. 1927 North American datum
10,000-foot grid based on California coordinate system, zone 2
1000-meter Universal Transverse Mercator grid ticks,
zone 10, shown in blue
To place on the predicted North American Datum 1983
move the projection lines 15 meters north and
89 meters east as shown by the dashed corner ticks

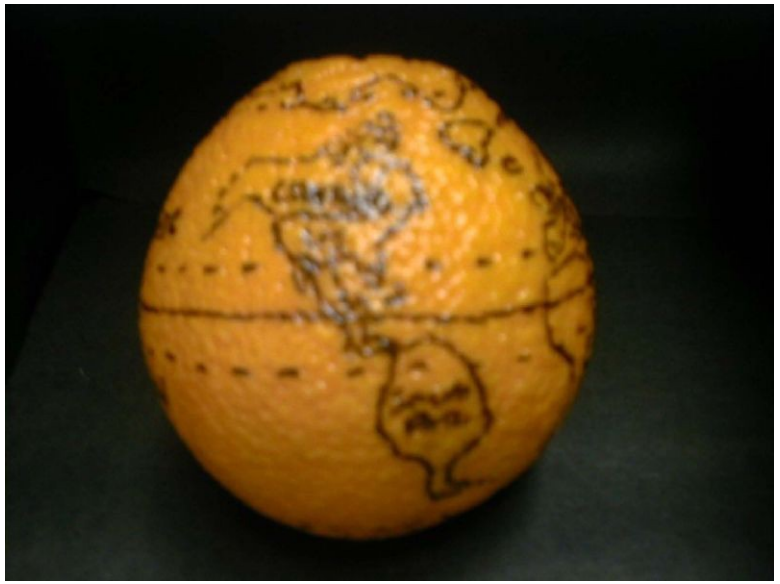
Datum offset

Projections—turning a 3D surface into a "deployable" 2D representation.

Map projection characteristics

Different map projections retain or distort the following quantities. It is not possible for any one projection to retain more than one of them over a large area of the earth.

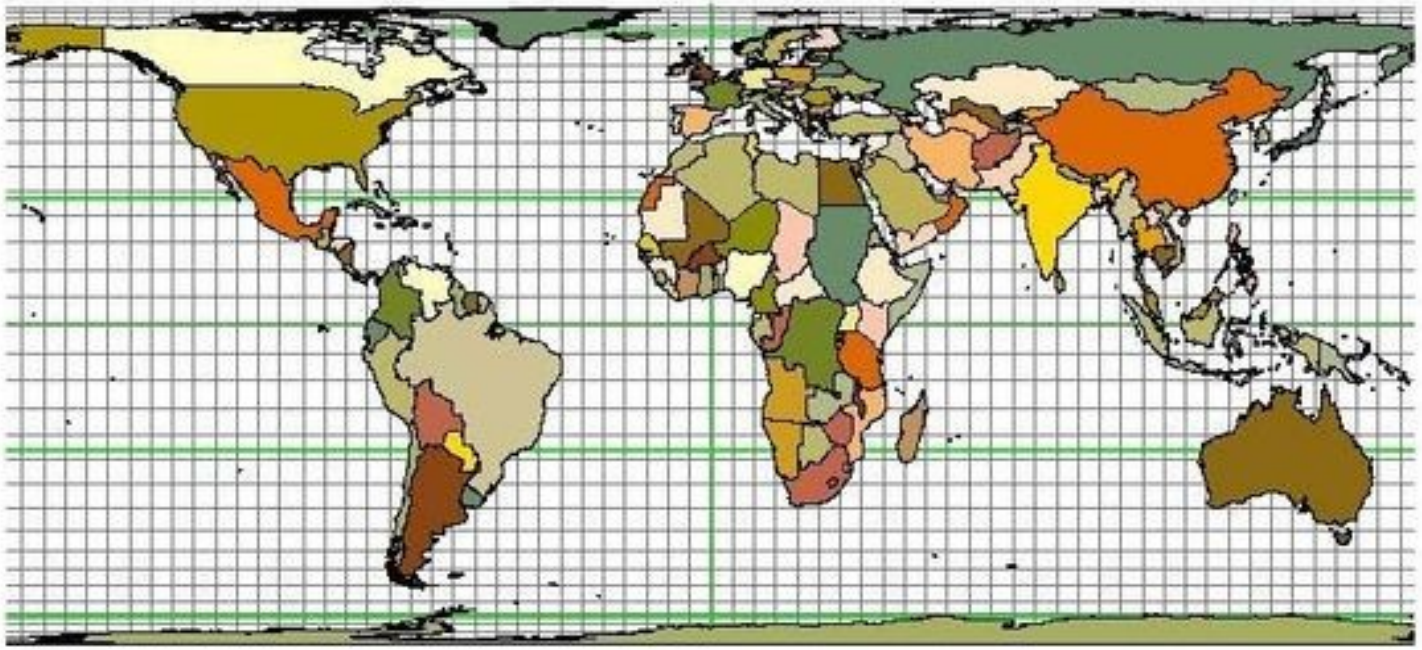
- area: **equal-area** means that a spatial unit on one part of the map covers exactly an equal area of the actual Earth as a spatial unit of the same size in any other part of the map
- shape: **conformal** projections preserve the relative local angles about every point on the map, so that meridians intersect parallels at 90 degrees; no map can be both equal-area and conformal
- scale: no map projection shows scale correctly throughout the entire map; **equidistant** projections show true scale between one or two points and every other point on the map, or along every meridian
- direction: **azimuthal** projections show correctly the directions from all points on the map to the centre



MAP AND INSET

Leeann Bland
Jessica Jones

BEHRMANN



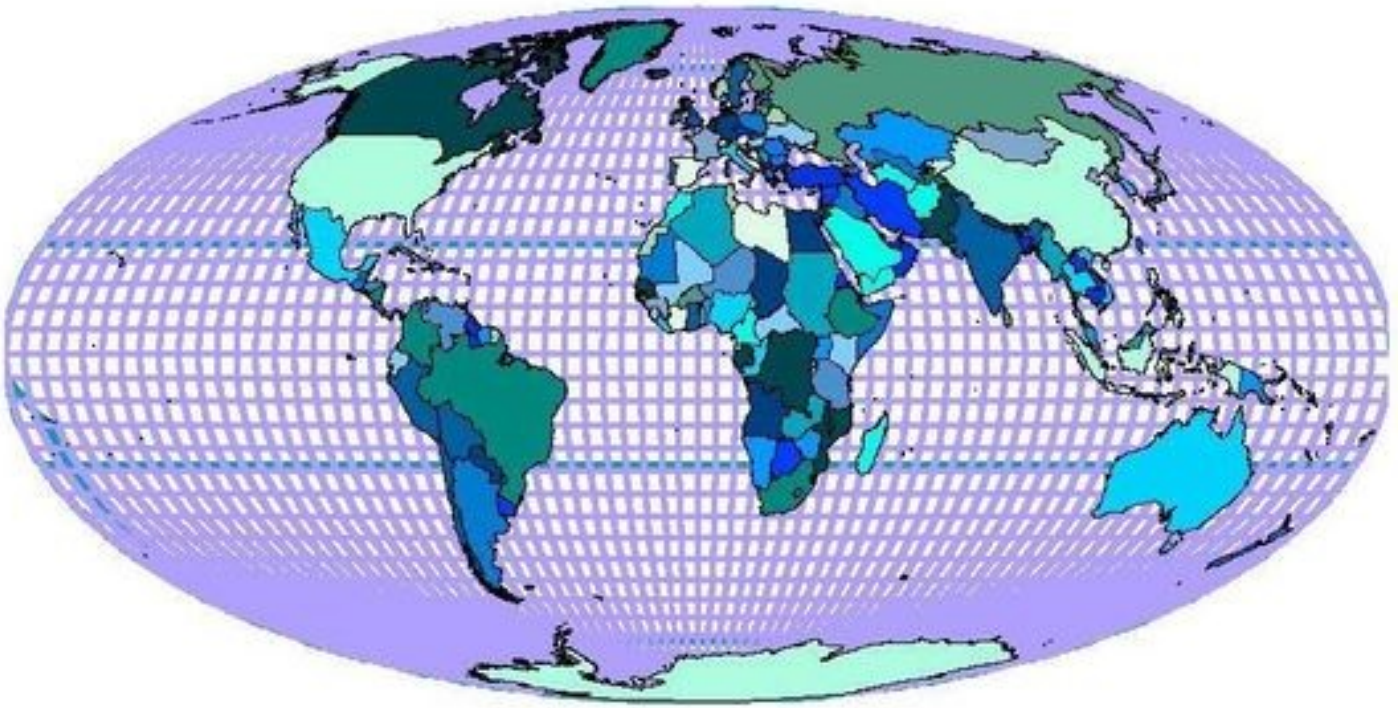
World Map

Cartographer: Judy, Sarah, Karlee

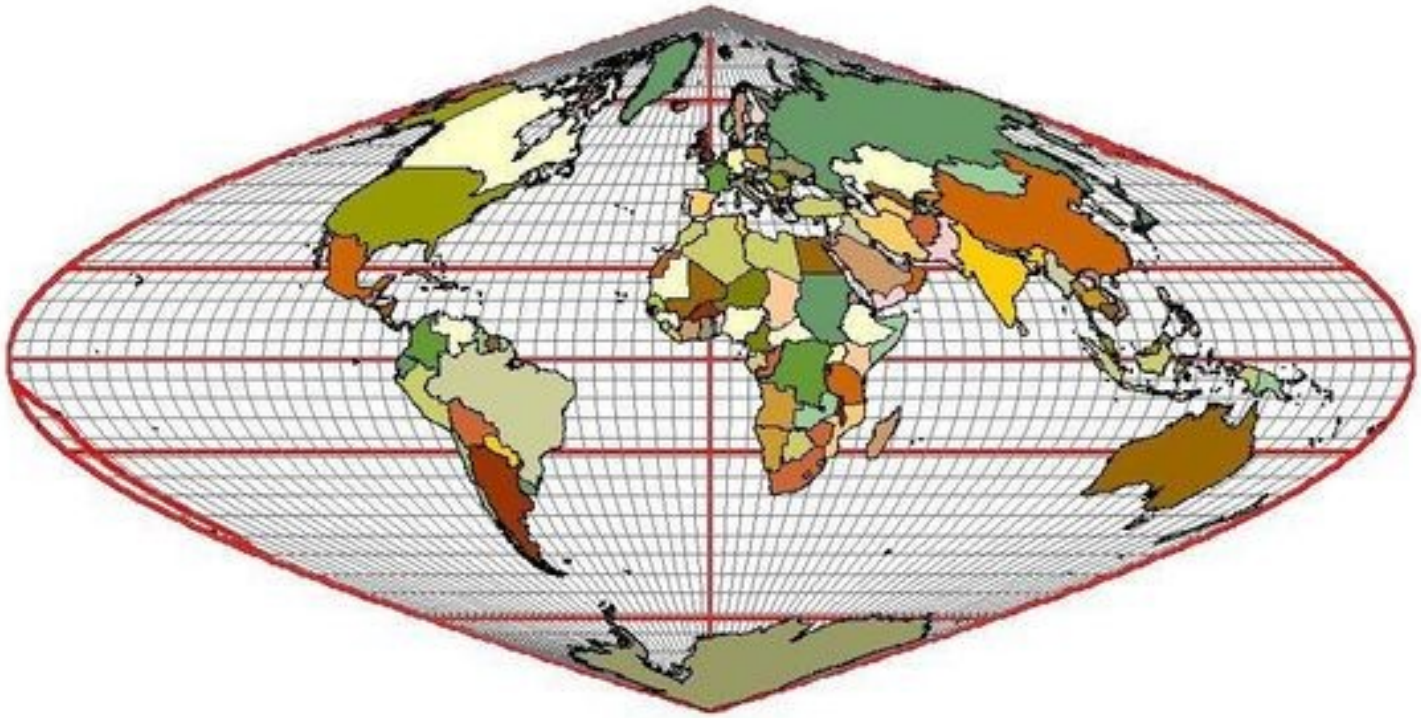
Date:Feb. 5, 1999

Scource:Arc View

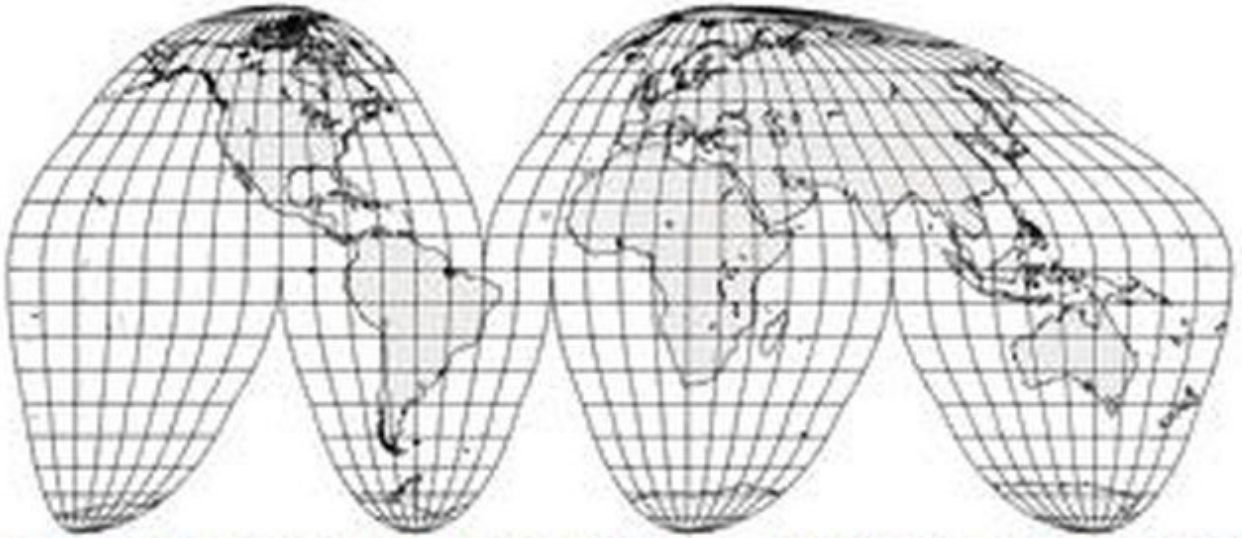
Projection:Molliwide



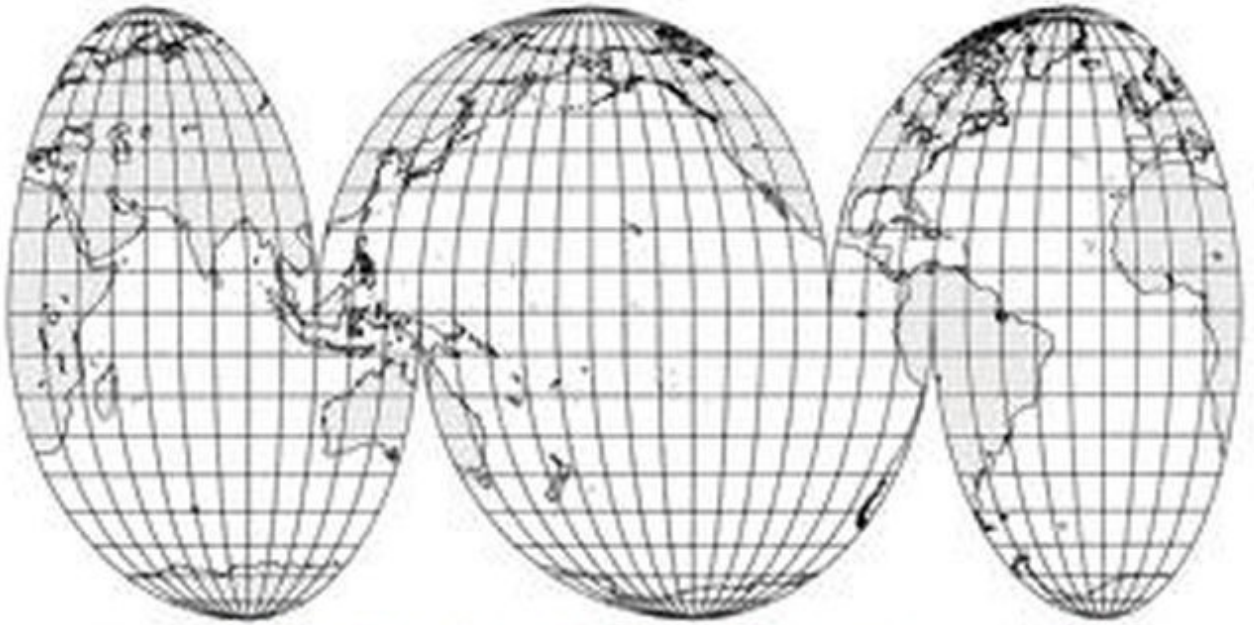
World map



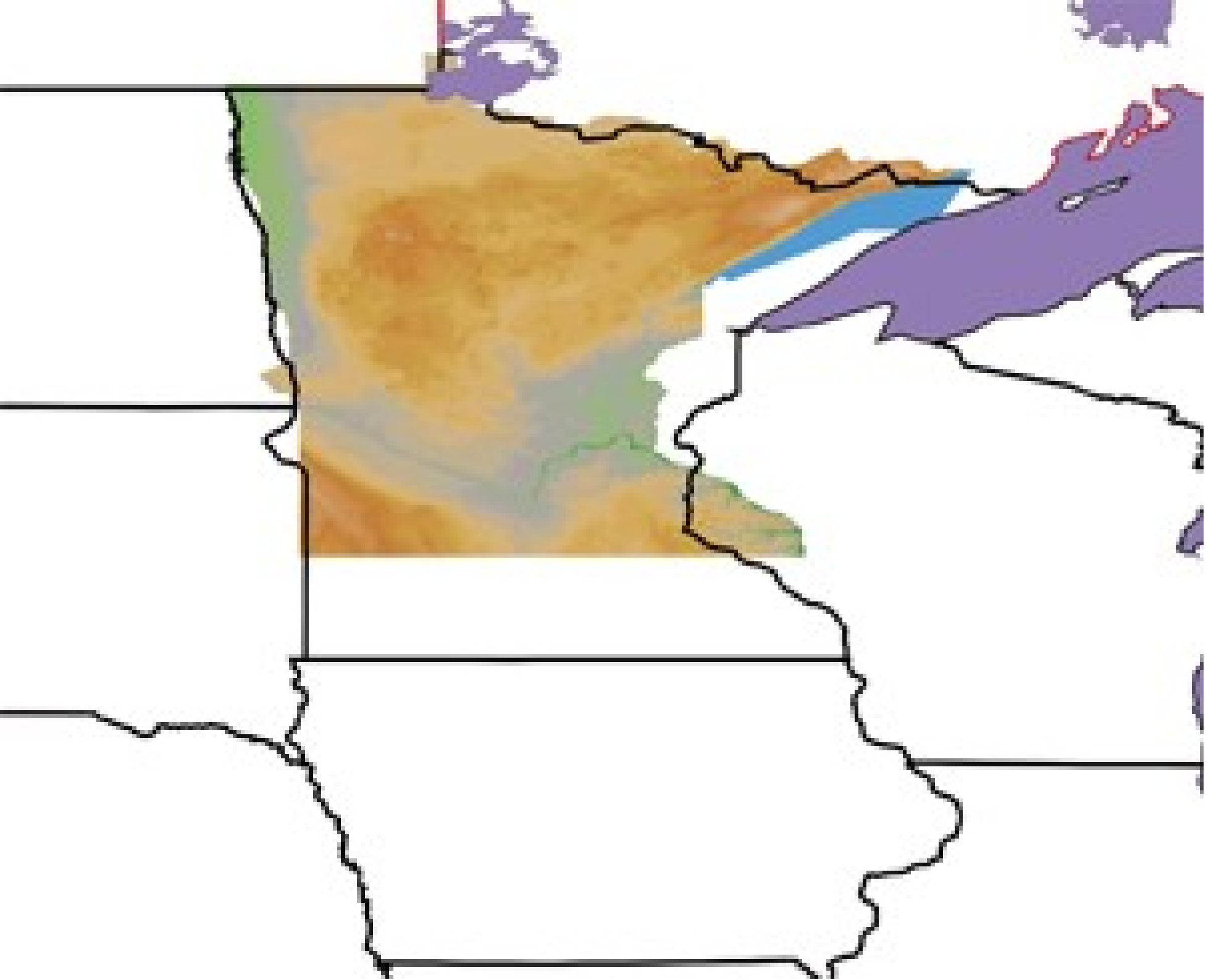
Lydia Castillo, Jack Molinaro,
Crystal Lowrie
2-5-99
Sinusidal

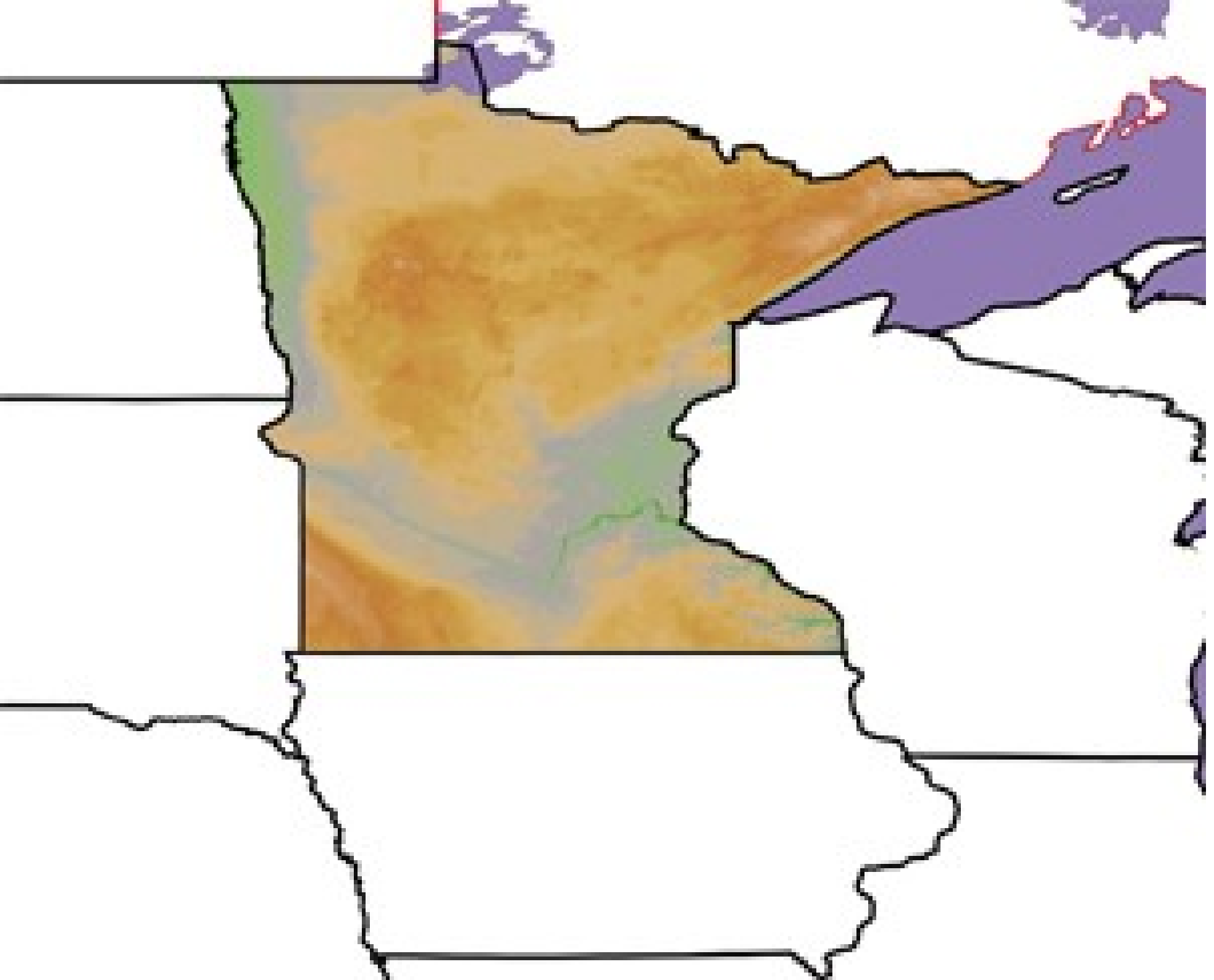


Interrupted Goode Homolosine equal-area projection
with 10° graticule, to show land masses.



Interrupted Mollweide equal-area projection
with 10° graticule, to show oceans.





Common projections

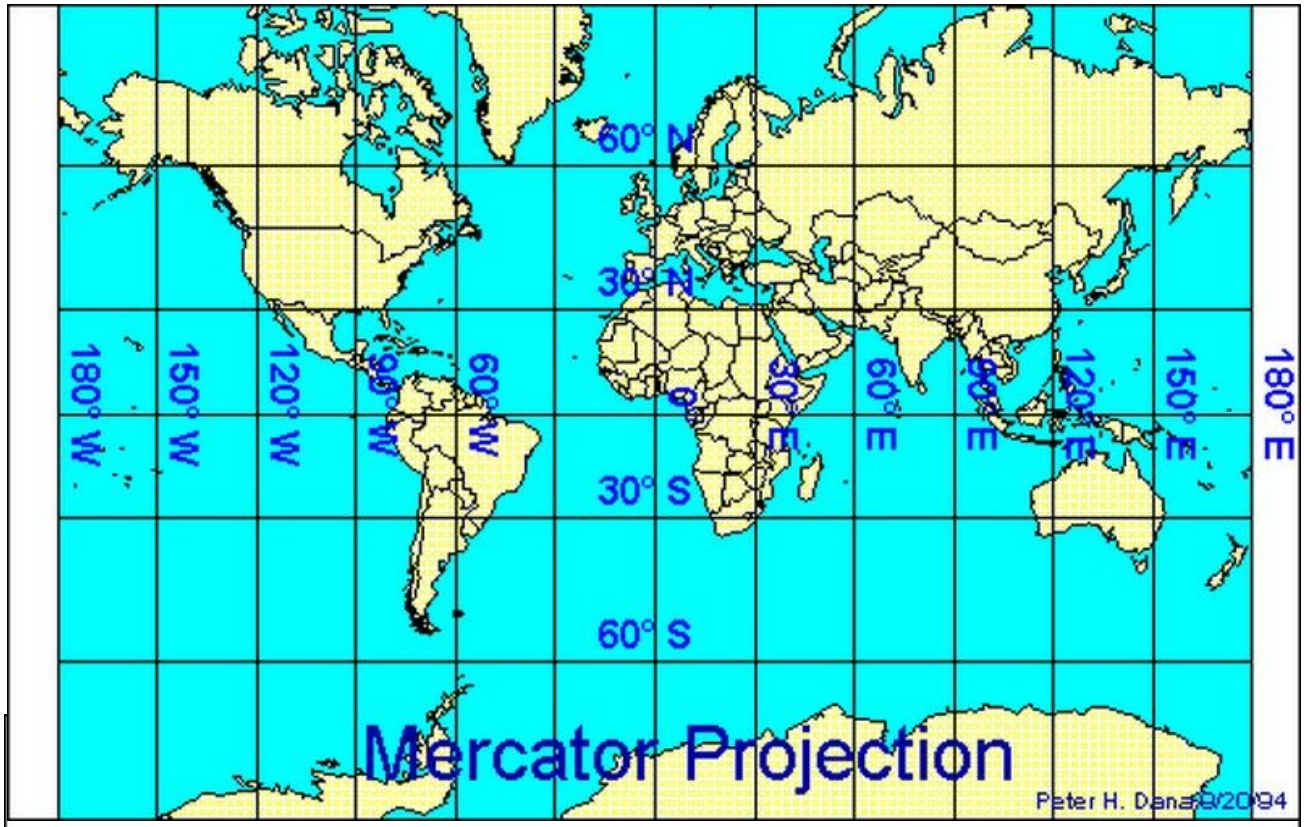
Some of the common projections in use are:

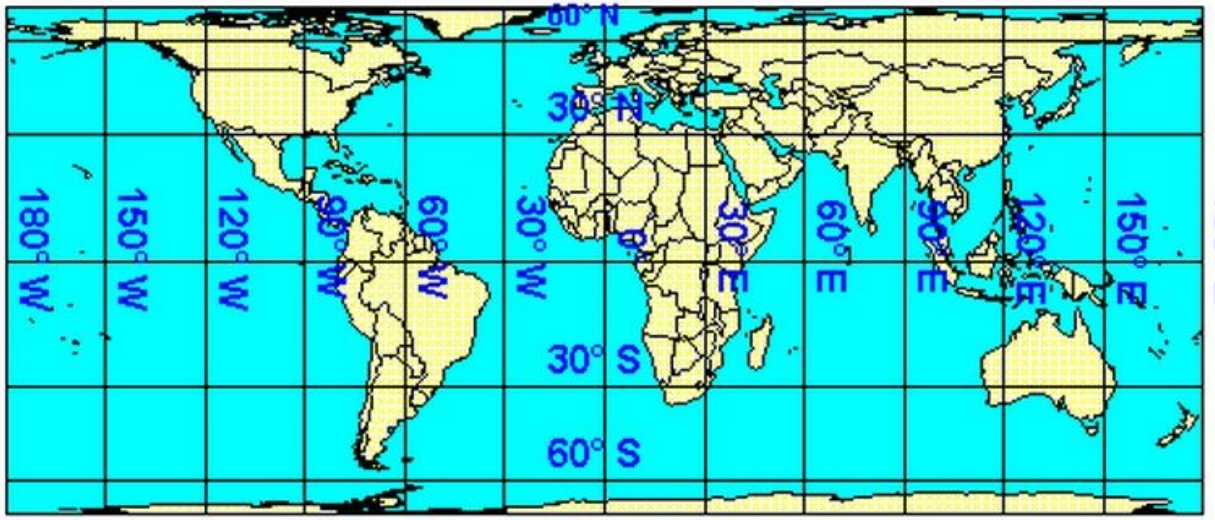
- **Universal Transverse Mercator (UTM)**: conformal, best for north south extents; scale is true along the two meridians halfway between the Central Meridian and the edge of the zone (too small between these lines and too large outside of these lines); standard projection for basemapping and thematic mapping in BC; BCE regions extend across more than one UTM zone preventing the construction of a seamless GIS database

- **Polyconic**: preserves area, shape, distance and azimuth for small area s; best for north-south extents; scale increases away from the central meridian; used for the 1:2 Million map of BC (CM of 129:00:00 W used for source paper map so that province would sit straight up and down on sheet); generally considered that the scale distortion is acceptable only up to 9 degrees away from the Central Meridian; BC spans 115:00:00 W to 140:00:00 W which is 12 1/2 degrees on either side of the Central Meridian; former projection for US topographic maps of 1 degree extent, but not recommended for larger areas because of distortion

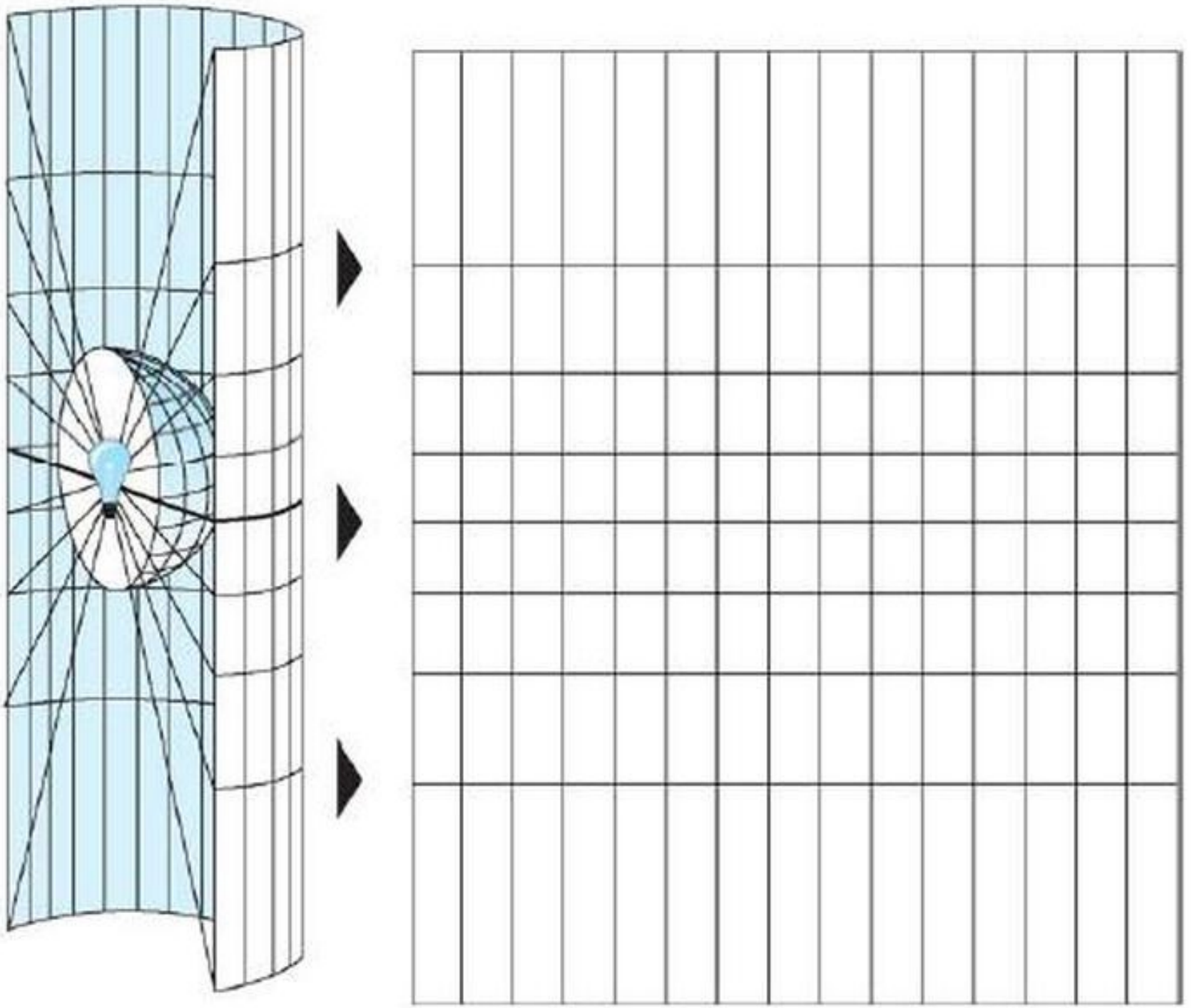
- **Lambert Conformal Conic**: conformal, best for east-west extents away from the equator; used in National Atlas of Canada and for Agriculture Canada 1:1 Million soil maps; US state basemaps; scale is too small between standard parallels and too large beyond them

- **Albers Equal-Area Conic**: equal-area, best for east-west extents away from the equator; scale is too small between standard parallels and too large beyond them; one of most commonly used projections for maps of conterminous USA

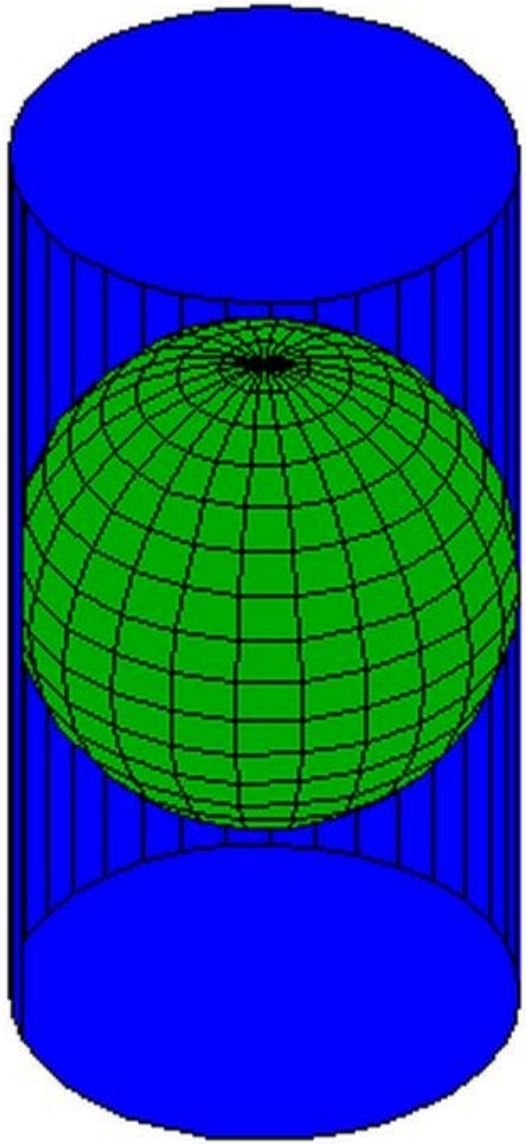




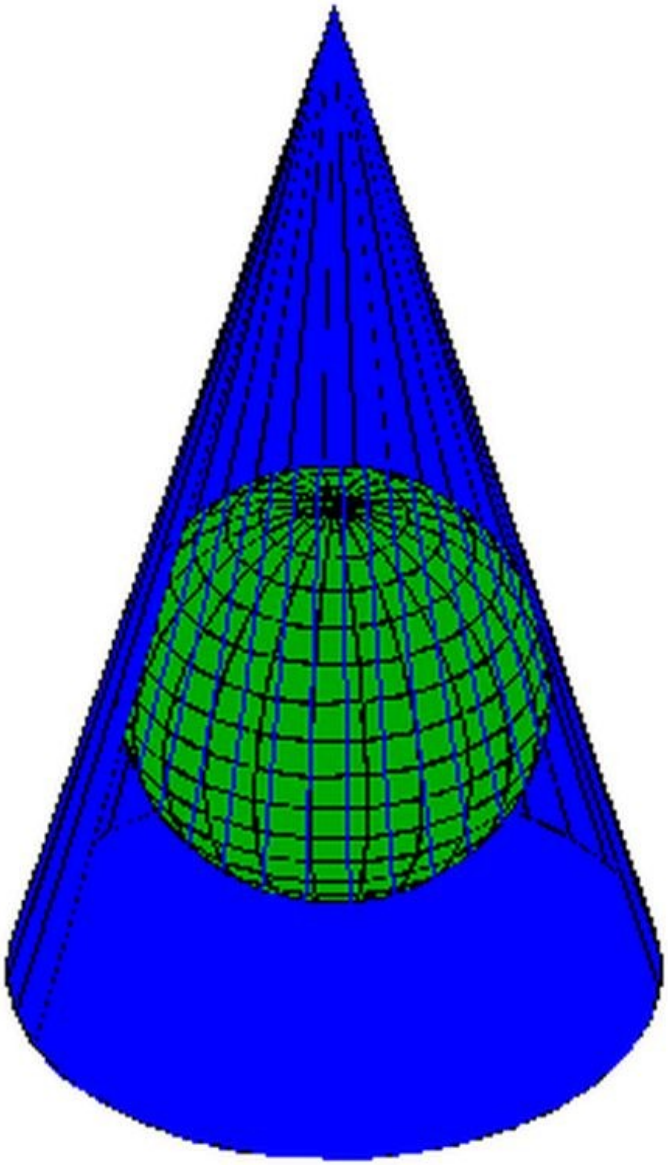
Behrmann Cylindrical Equal-Area



The graticule of a geographic coordinate system is projected onto a cylindrical projection surface.

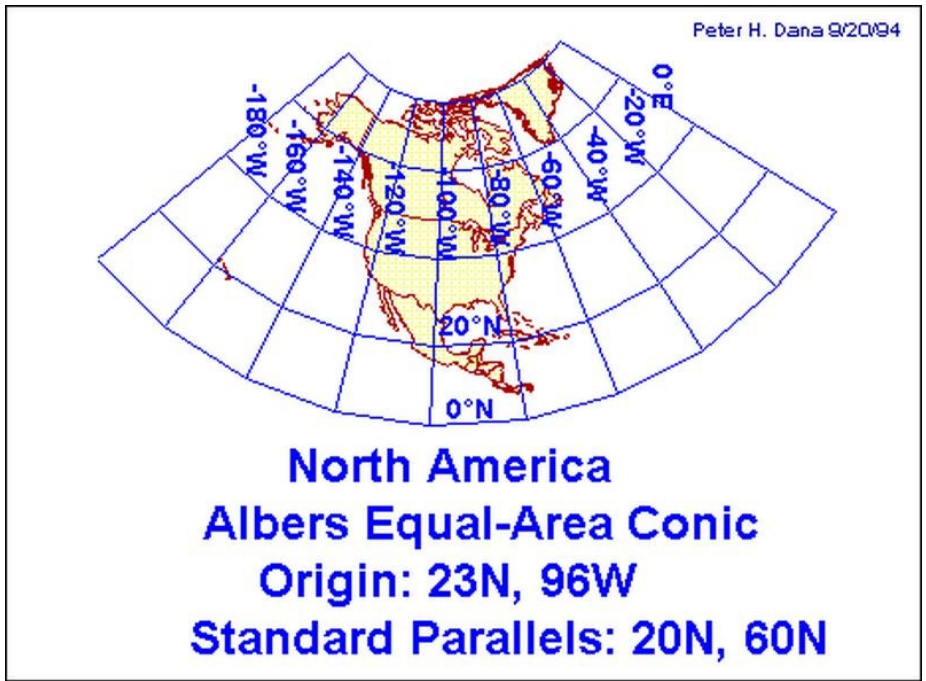


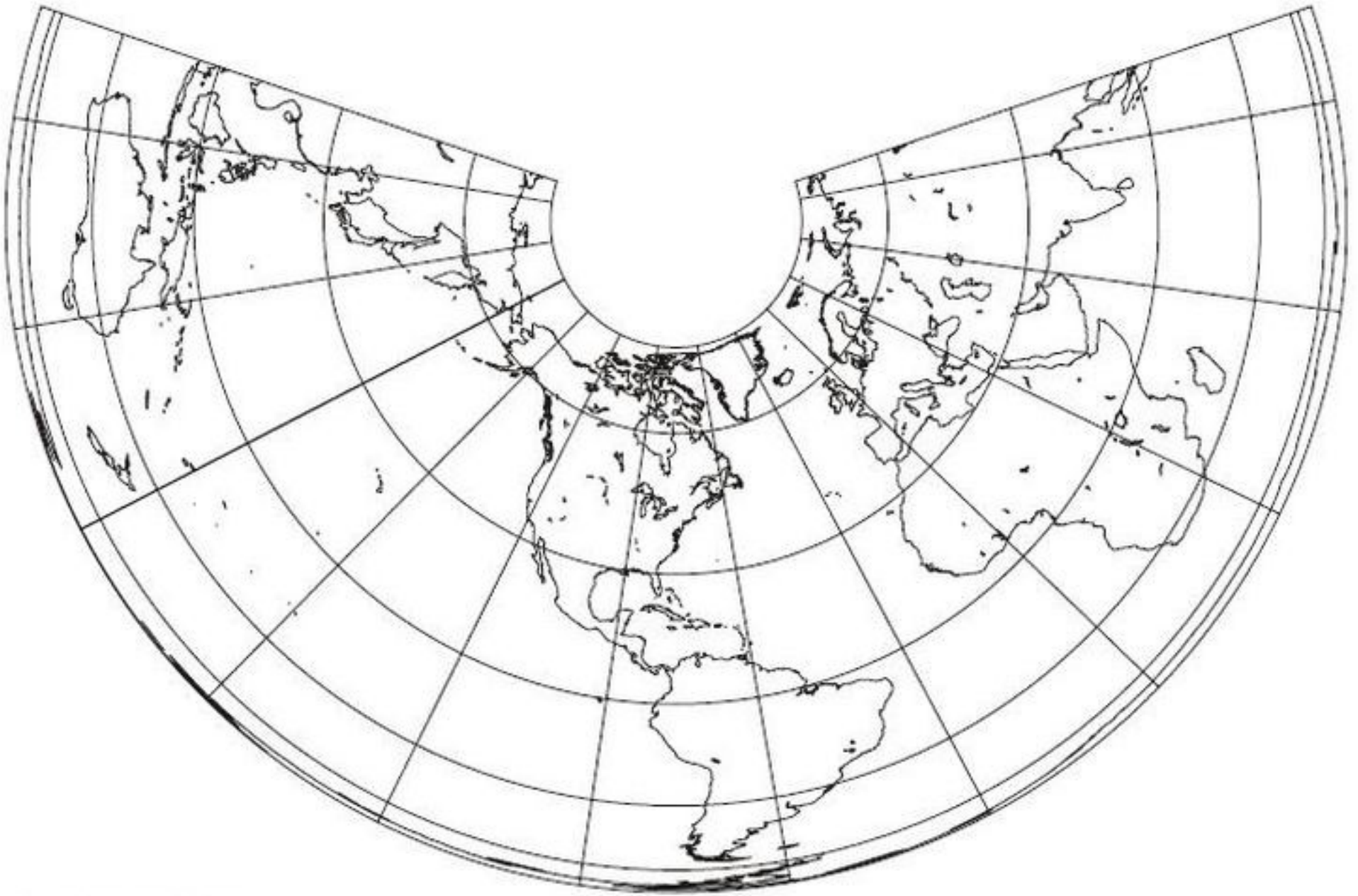
Cylindrical Projection



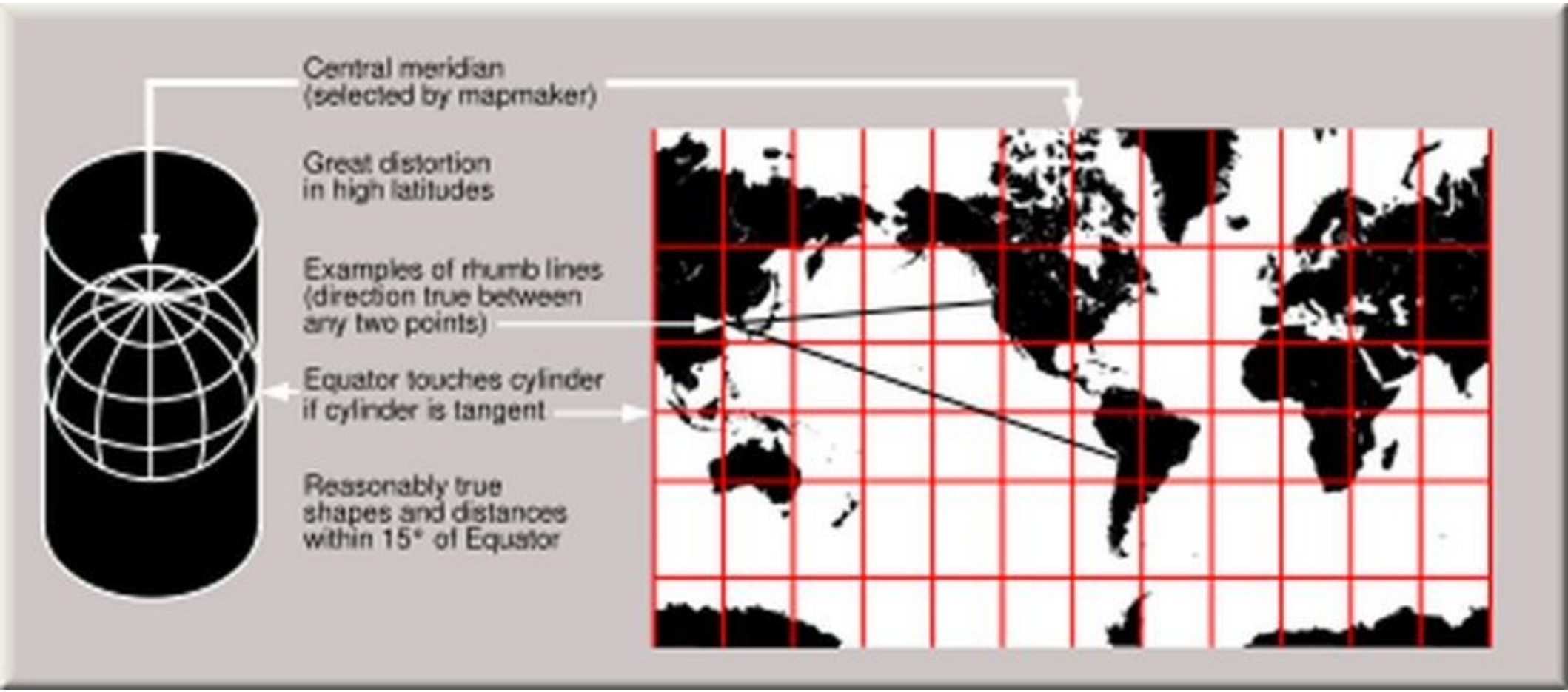
Conical Projection Surface


Two standard parallels
(selected by mapmaker)
Equal areas. Deformation of shapes
increases away from standard parallels.


Peter H. Dana 9/20/94
-180°W
-160°W
-140°W
-120°W
-100°W
-80°W
-60°W
-40°W
-20°W
0°E
20°N
0°N
North America
Albers Equal-Area Conic
Origin: 23N, 96W
Standard Parallels: 20N, 60N



Albers Equal-area Conic;
H. C. Albers; 1805

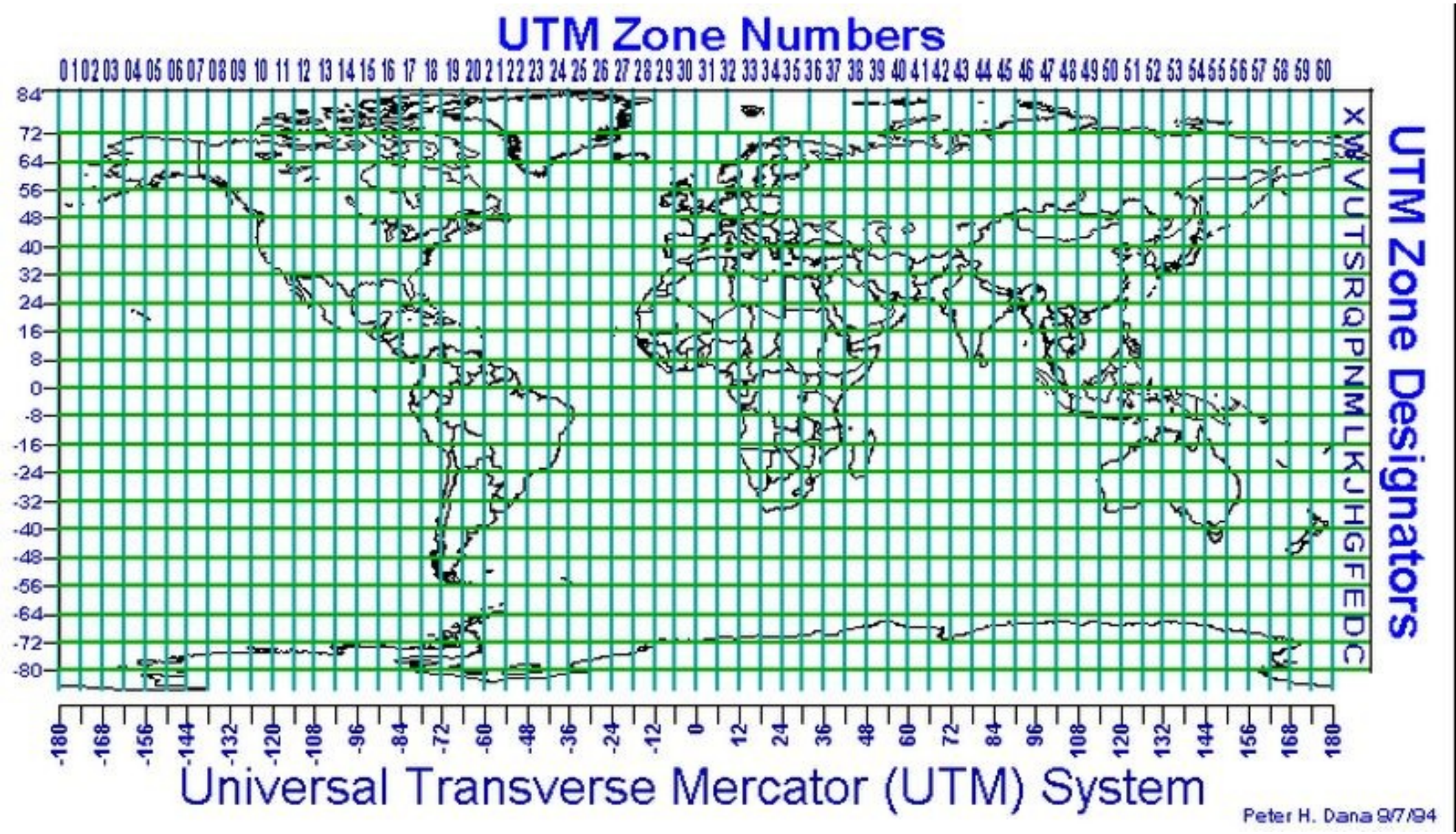

Central meridian
(selected by mapmaker)
Great distortion
in high latitudes
Examples of rhumb lines
(direction true between
any two points)
Equator touches cylinder
if cylinder is tangent
Reasonably true
shapes and distances
within 15° of Equator

Central meridian selected by mapmaker touches cylinder if the cylinder is tangent.

Equator

Can show whole Earth, but the directions, distances, and areas are reasonable accurate only within 15 degrees of the central meridian.

No stright rhumb lines.


UTM Zone Numbers
0 1 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 2 1 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 4 1 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
84
72
64
56
48
40
32
24
16
8
0
-8
-16
-24
-32
-40
-48
-56
-64
-72
-80
X W V U T S R Q P N M L K J H G F E D C
UTM Zone Designators
-180 -168 -156 -144 -132 -120 -108 -96 -84 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

The Universal Transverse Mercator Grid

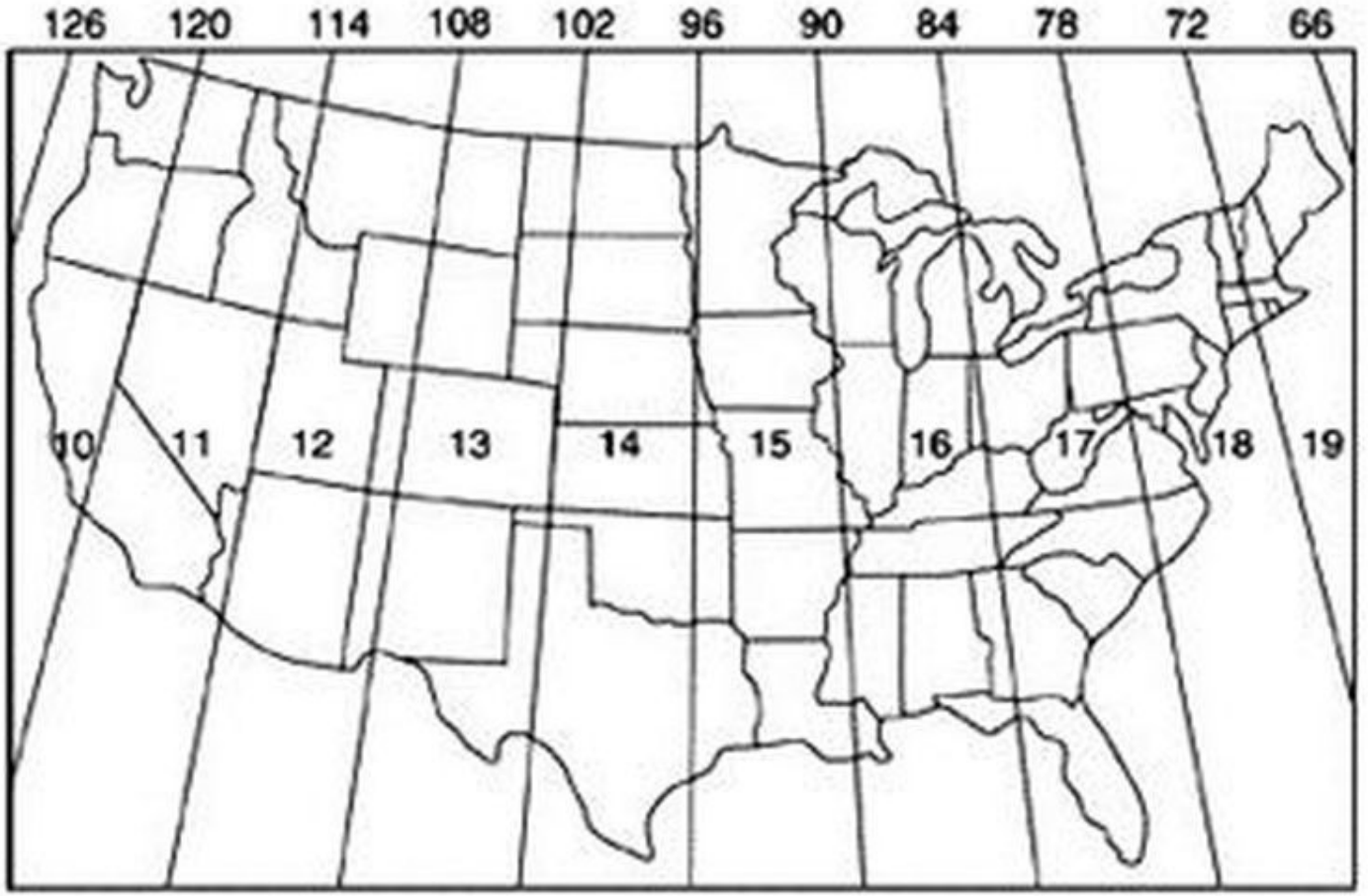
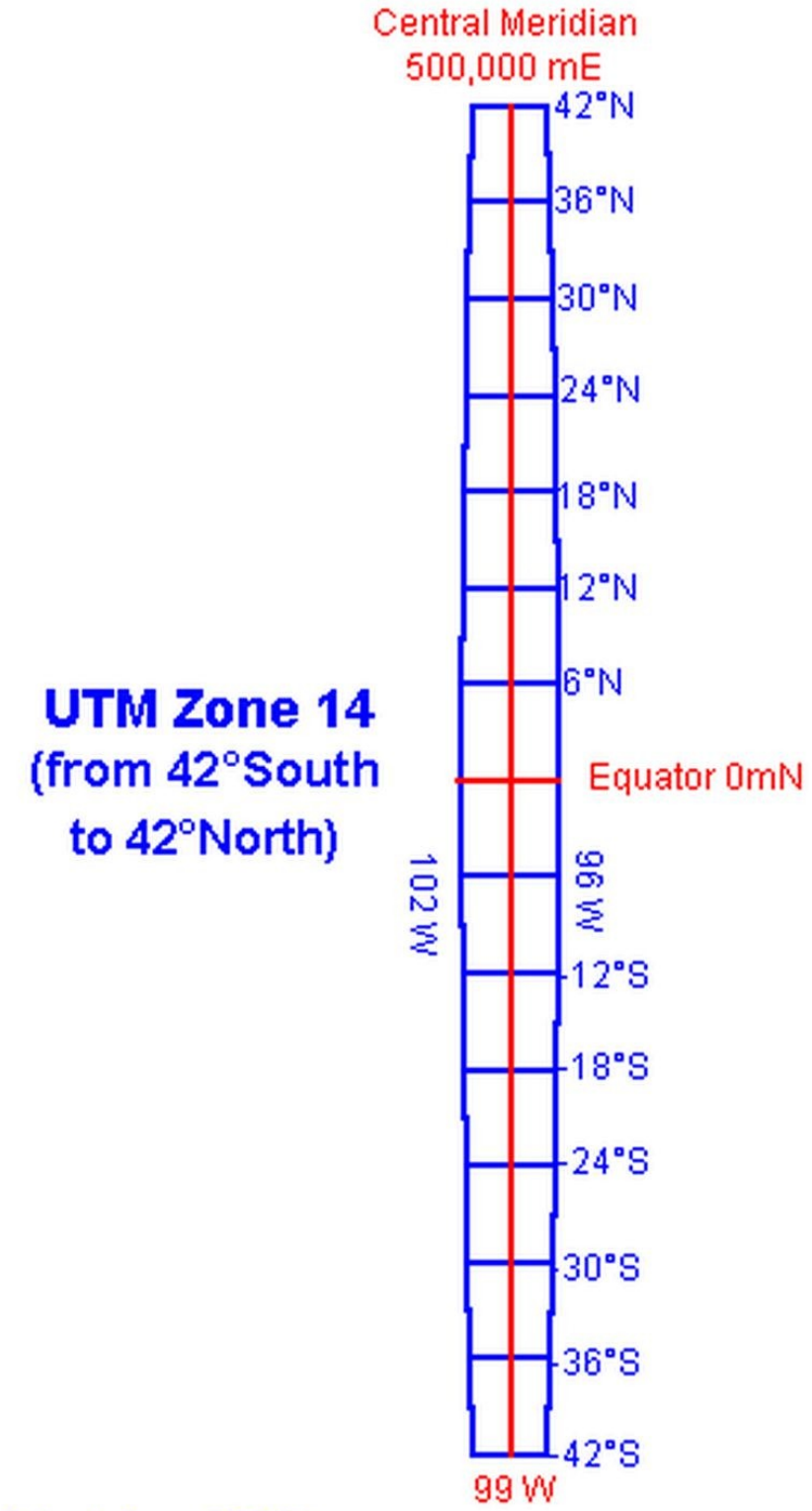
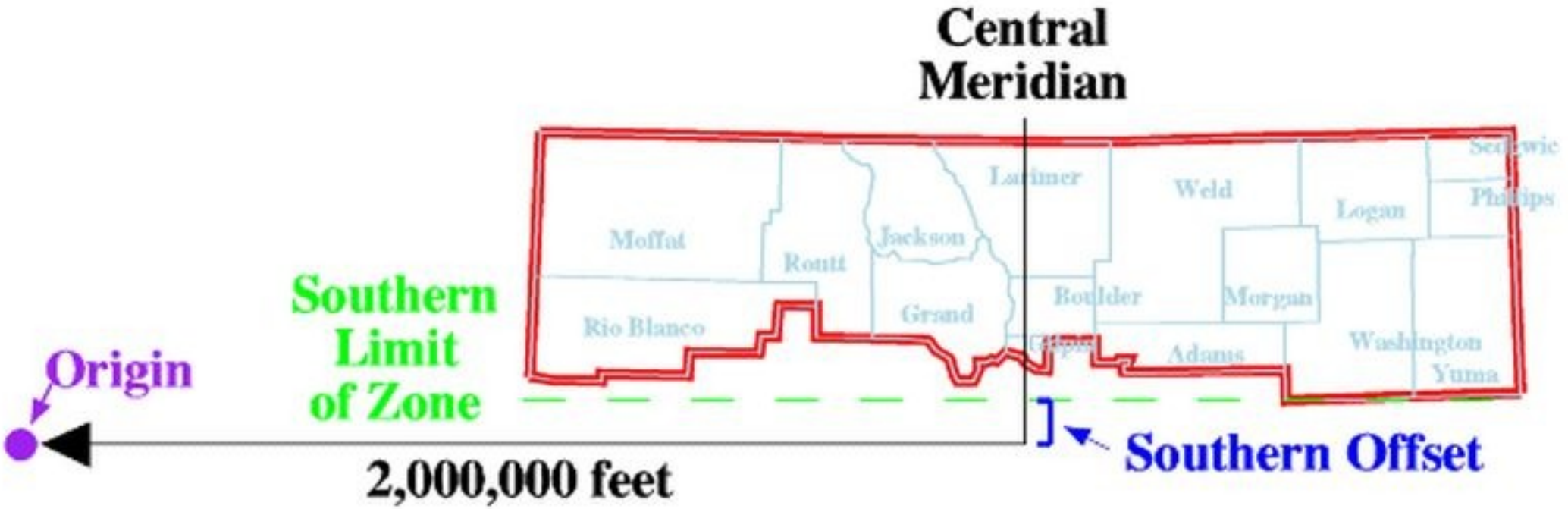


Figure 1. The Universal Transverse Mercator grid that covers the conterminous 48 United States comprises 10 zones—from Zone 10 on the west coast through Zone 19 in New England.



UTM Zone 14
(from 42°South to 42°North)

Peter H. Dana 9/20/94


Central
Meridian
Moffat
Routt
Jackson
Larimer
Weld
Logan
Sedgwic
Phillips
Rio Blanco
Grand
Boulder
Morgan
Adams
Washington
Yuma
Southern
Limit
of Zone
Origin
2,000,000 feet
Southern Offset

USGS

Geographic Names Information System (GNIS)

Click here to view & print all. (Use browser print function.)

Query | Result

Geographic Names Information System Feature Query Results

Click any column name to sort the list ascending ▲ or descending ▼. Click the feature name for details.
Note: If data is returned and the column headings display but no data appears, click on any column heading.

Feature Name	ID	Class	County	State ▲	Latitude	Longitude	Elev(ft)	Map	BGN	Entry Date
Pagosa Springs	184338	Populated Place	Archuleta	CO	371610N	1070035W	7113	Pagosa Springs	-	13-OCT-1978
Pagosa Springs Job Corps	184347	Locale	Archuleta	CO	371814N	1070558W	7841	Pagosa Springs	-	13-OCT-1978
Pagosa Springs District Ranger Office	197193	Locale	Archuleta	CO	371610N	1070014W	7100	Pagosa Springs	-	01-DEC-1991
KPAG-AM (Pagosa Springs)	204047	Tower	Archuleta	CO	371524N	1070108W	7129	Pagosa Springs	-	01-SEP-1994
KRQS-FM (Pagosa Springs)	204172	Tower	Archuleta	CO	371132N	1070557W	8619	Oakbrush Hill	-	01-SEP-1994
Pagosa Springs	1794694	Spring	Archuleta	CO	371547N	1070042W	7057	Pagosa Springs	-	18-MAY-1998
Pagosa Springs Division	1935541	Census	Archuleta	CO	371040N	1065326W	8350	Serviceberry Mountain	-	26-SEP-2001

Transverse Mercator

Choose a map projection

Transverse Mercator

redraw the map

View projection documentation

Define projection parameters

Central Meridian: -100

Define map extent (decimal degrees)

40 North

-120 West -80 East

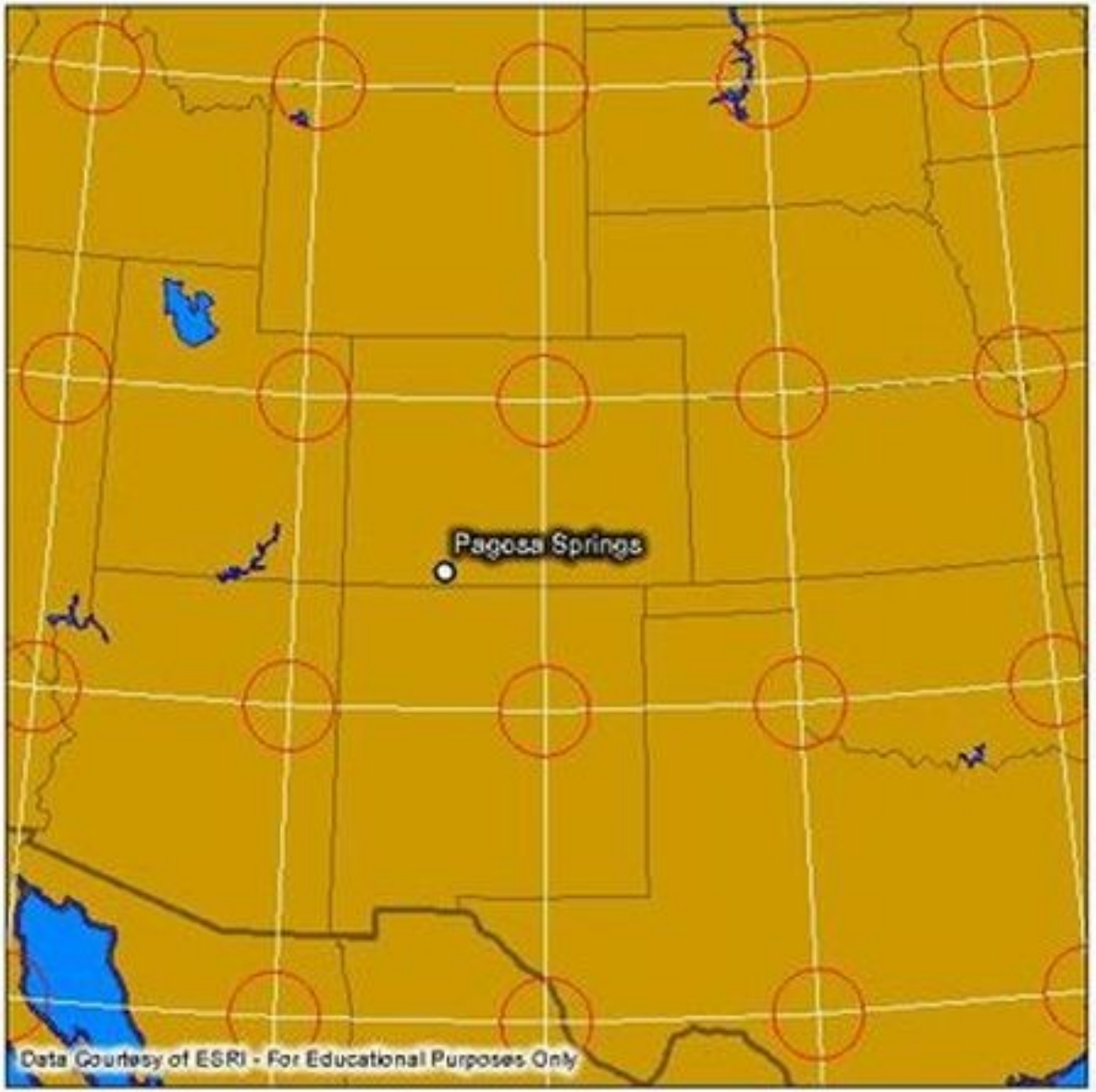
30 South

Plot a Location (decimal degrees)

Latitude: 37.2536

Longitude: -107.0202

Place Name: Pagosa Springs



Lambert Conformal Conic

Choose a map projection

Lambert Conformal Conic

redraw the map

View projection documentation

Define projection parameters

Standard Parallel 1: 37.233

Standard Parallel 2: 38.4333

Central Meridian: -105.5

Latitude of Origin: 36.667

Define map extent (decimal degrees)

46 North

-89 West -121 East

29 South

Plot a Location (decimal degrees)

Latitude: 37.2536

Longitude: -107.0202

Place Name: Pagosa Springs