

GIS Workshop

Map Projections & Georeferencing

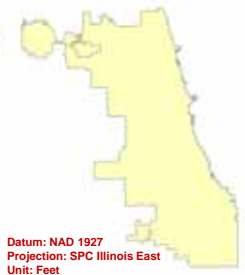
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 Government and Geographic Information and Data Services
 University Library (Evanston)
 Northwestern University

Spatial Reference System and Map Projections

GIS Data and Location

Each of the following maps was created/drawn in a different spatial reference system ...

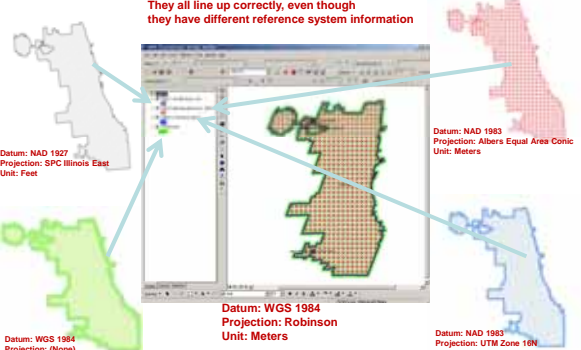
- All geographic/GIS data must refer to (or must be registered to) specific locations in the real world
- Meaning... when geographic/GIS data were created, all were registered in a specific spatial reference system



Datum: NAD 1927
 Projection: SPC Illinois East
 Unit: Feet

ArcMap can Mathematically Adjust!

They all line up correctly, even though they have different reference system information



Datum: NAD 1927
 Projection: SPC Illinois East
 Unit: Feet

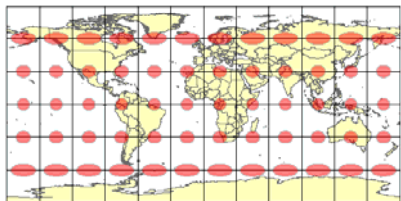
Datum: WGS 1984
 Projection: Robinson
 Unit: Meters

Datum: NAD 1983
 Projection: Albers Equal Area Conic
 Unit: Meters

Datum: NAD 1983
 Projection: UTM Zone 16N
 Unit: Meters

Exercise 9

- Applying different map projections to observe how the On-The-Fly system works in ArcMap
- Export data in a new projection



..So, What are Spatial Reference Systems ?

- They are devices to reference GI (Geog. Info) on the earth
 - The earth is round but maps are flat...
 - In an attempt to flatten the earth, mathematicians came up with complicated formulas (two kinds: datum & projections.)
 - Remember: no matter what the format types are, **all geographic features (or map layers) were created in a specific geographic environment.**
 - Meaning, all map layers are spatially referenced using specific datum and/or map projections

Why Does SRS Matter?

Stuff happens –

"I added data in ArcMap but I don't see the data in ArcMap!"

"I have two map layers but they appeared in different space, not overlaying on the other!"

- Remember: map layers won't be rendered correctly if your data files don't know what their spatial reference system (SRS) is (i.e. they don't know their location). You also need to define SRS of the Data Frame in ArcMap.

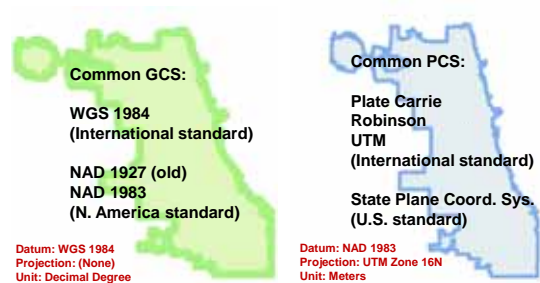
Dealing with a Projection Problem

- If your data don't overlay properly try the followings
 - Check to see if SRS was already defined
 - How do we know it? – (1) see if **.prj** (vector spatial reference file) or **world** file (imagery spatial reference file) comes the data, OR (2) check metadata in ArcCatalog (under "spatial")
 - If not defined, find what the original SRS of the data was
 - How do we know it? – Check data documentation
 - And then – Define a projection
 - How?
 - Use ArcCatalog (*Properties > XY coordinate system*)
 - Or, use *Define Projection* tool in ArcToolbox
- I cannot find out what the original SRS was!
 - http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Identifying_an_unknown_coordinate_system

Coordinate Systems

- Spatial reference systems (SRS) used to represent the locations of geographic features
- Two coordinate systems used in GIS
 - Geographic** coordinate system (GCS) = **Datum**
 - Global, 3D, spheroid – slightly squashed sphere – base system
 - A system that tells us exact geographic location
 - All GIS data should have assigned GCS/Datum
 - Often referred as **datum**
 - Projected** coordinate system (PCS) = **Projection**
 - Optional
 - Flat, a two-dimensional Cartesian coordinate plane base system (based on datum, or GCS)
 - Most maps use a **projected coordinate system** to represent the area better (or trying to represent as accurate as possible.)

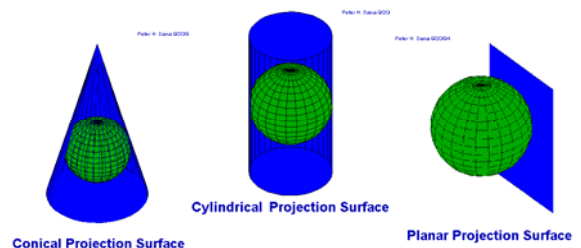
GCS/Datum and PCS/Map Projection



Map Projections

- So many projections – see the [USGS poster](#)
- None of the map projections is perfect
 - Four spatial properties that are subject to distortion: **Shape** – **Area** – **Distance** – **Direction**
 - However, if your study area is small, distortion will be minimum anyway, no matter which projection to use
- Select a map projection that suits your purpose & area
 - Rule of thumb:** Use the map projection used most often in your study area
 - If you are not sure:** pick one from ArcGIS's selected projections for each continent ("Projected Coord. Systems > Continent")

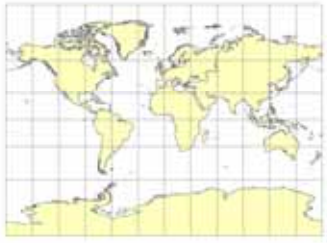
Main Projection Types



http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html


Selected Map Projections

- **Global**
 - Winkel Tripel (National Geographic Society)
 - Robinson
 - Miller Cylindrical



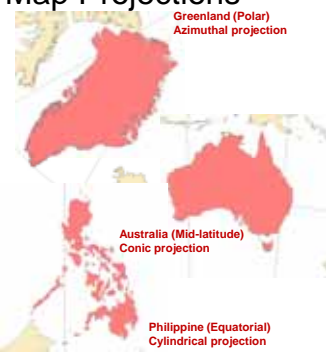
Selected Map Projections

- **Continents and Large Countries**
 - (Europe) Equidistant Conic
 - (Europe) Albers Equal Area Conic
 - (Africa) Plate Carree



Selected Map Projections

- **Country**
 - Depends on their location
 - Polar
 - Equatorial
 - Mid-latitude
 - The shape orientation (extends along)
 - North-South Transverse Mercator, etc.
 - East-West Mercator, Conic proj, in general



Great Online Tool!!

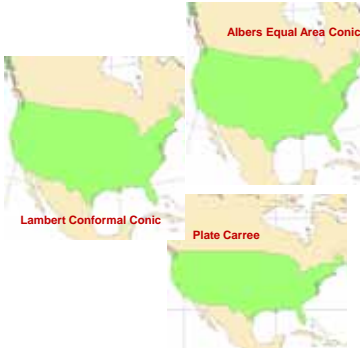
<http://mcmcweb.er.usgs.gov/DSS/>

- A cool interactive tool by USGS for selecting an optimum map projection considering various factors.



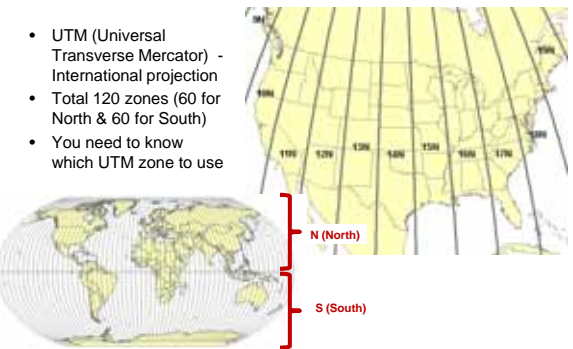
Selected Map Projections

- **USA**
 - **Continuous 48 States**
 - Albers Equal Area Conic
 - Lambert Conformal Conic
 - Plate Carree
 - **Individual state**
 - UTM
 - State Plane Coordinates



UTM Zones

- UTM (Universal Transverse Mercator) - International projection
- Total 120 zones (60 for North & 60 for South)
- You need to know which UTM zone to use



State Plane Zones

- U.S. only
- State Plane Coordinate System (US Only)
- You need to know which zone to use...

Exercise 10 : Map Projections

More about coordinate systems and map projections in ArcGIS:
http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An_overview_of_map_projections

Georeferencing

- Sometimes, your only source of geographic information is print resources, such as maps or airphotos
 - i.e. no GIS data is available
 - Or, you want to create GIS data based on maps or airphotos
- **Raster images**, such as JPEG, GIF, TIFF, **do NOT** normally come with **spatial reference (location) information** (unless they were specifically created for GIS use)
- And thus they won't be displayed in the right location in ArcMap unless you assign spatial reference information to the files.

Using Your Own Maps or Airphotos

“I want to use my paper map in ArcGIS”

1. Scan the paper map and save it in a common image format, such as TIF or JPEG.
2. Since it hasn't been georeferenced yet, you need to add spatial reference information to the image (a.k.a. "georeference")
3. Use ArcMap's **Georeferencing Tool** to add a spatial reference information file (called "world file" in ArcGIS)

How does it work?

- Two components to "georeference" files
 - Source file (i.e. images)
 - Reference file (optional, but generally needed)
 - Street data
 - Or, other physical feature files
- Two places to store the spatial reference information
 - **Header** : some image processing software can embed it in the header of the file (i.e. one file) Example: GeoTIFF, ERDAS img
 - **World file** : An ArcGIS way to store spatial reference information
 - JPEG world file : .jgw
 - TIFF world file : .tifw
 - MrSID world file: .sdw(x) (MrSID is a compressed image format)

World File

x-scale; dimension of a pixel in map units in x direction	→	20.17541308822119
rotation terms	→	0.000000000000000
negative of y-scale; dimension of a pixel in map units in y direction	→	0.000000000000000
	→	-20.17541308822119
translation terms; x,y map coordinates of the center of the upper left pixel	→	424178.11472601280548
	→	4313415.90726399607956

Exercise 11 : Georeferencing

- Georeferencing historic (circa 1938-41) aerial photograph



Exercise 11 (Cont.)

- For more information: ArcGIS 9.3 Help
 - http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?id=2710&pid=2701&topicname=Georeferencing_a_raster_dataset
 - (Tutorial video)
http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Georeferencing_video_sample