Coordinate systems and transformations in action

Melita Kennedy and Keera Morrish
Objectives

- Coordinate systems
  - Geographic versus projected
  - Project considerations
  - ‘Gotchas’
- Identifying an unknown coordinate system
- Picking a geographic/datum transformation

Session ID: 1585

Note: Presentation will be available on the Proceedings CD
Coordinate systems
Geographic coordinate system
Geographic coordinate system

(gcs, geogcs)

- Name
- Datum
  - Spheroid
- Prime Meridian
- Angular unit of measure
Geographic coordinate system

(gcs, geogcs)

- Name (European Datum 1950)
- Datum (European Datum 1950)
  - Spheroid (International 1924)
- Prime Meridian (Greenwich)
- Angular unit of measure (Degrees)
Projected coordinate system

- Linear units
- Lengths, angles, and areas are constant
- Shape, area, and distance may be distorted
Projected coordinate system

(PCS, ProjCS)

- Name
- Geographic coordinate system
- Map projection
- Projection parameters
- Linear unit of measure
Projected coordinate system

(PCS, ProjCS)

- Name: (NAD 1983 UTM Zone 11N)
- GCS: (NAD 1983)
- Map projection: (Transverse Mercator)
- Projection parameters: (central meridian, latitude of origin, scale factor, false easting, false northing)
- Linear unit of measure: (Meters)
Demonstration
Geographic versus Projected
Choosing the right coordinate system

- What does your boss think?
- What are other government agencies/partners using?
- For what purposes are the data going to be used?
- Minimize projecting data on the fly
  - Impacts performance
Coordinate system gotchas

- Defining a coordinate system updates the metadata ONLY
  - Doesn’t affect the coordinate values
  - Define data in its current coordinate system, then project
- Add XY Data tool uses the map’s coordinate system by default
- Exporting a layer in ArcMap using the data frame’s coordinate system
  - SAME as using the Project or Project Raster tools
- UTM “N” and “S”
  - North and South, not the “N” and “S” latitude band designations
UTM zones and latitude bands

Adapted from Wikimedia Commons and attributed to a NASA image
What happened to the prj files?

- Coordinate systems were stored as .prj files
  - ArcGIS home\Coordinate Systems
- At 10.1, virtual folder structure
- Search by area, name, WKID/code
- Favorites are usable everywhere
- Use Import to access your own prj files
Demonstration
Improved coordinate system dialogs
Unknown coordinate systems
Unknown coordinate systems

- ALWAYS define the coordinate system
- Good professional practice - help your successor
- Units are unknown
- Map scale is incorrect
- Geodatabase tools can’t use default values
What if I don’t know my data’s coordinate system?

- Check the data provider or source
- Check any existing metadata
- Similar data types
- What coordinate systems are used in the area?
  - http://www.epsg.org
  - http://www.epsg-registry.org
What if I don’t know my data’s coordinate system?

- Try using ArcMap to figure it out
  - See Knowledge Base article 24893
    
    *HowTo: Identify an unknown coordinate system using ArcMap*

- Live Training Seminar (free)
  
  *Working with Map Projections and Coordinate Systems in ArcGIS*
  
Familiarize yourself with common coordinate systems

- Know what ones are used in the area
- Learn what the layer extents should be

<table>
<thead>
<tr>
<th>San Diego, California</th>
<th>NAD 1983</th>
<th>X / longitude</th>
<th>Y / latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic</td>
<td></td>
<td>-116.67 °</td>
<td>33 °</td>
</tr>
<tr>
<td>UTM zone 11N</td>
<td></td>
<td>530,000 m</td>
<td>3,650,000 m</td>
</tr>
<tr>
<td>State Plane (California zone 6)</td>
<td></td>
<td>1,960,000 m</td>
<td>593,000 m</td>
</tr>
</tbody>
</table>
Real world example

- Longitude: -88.365934
  Latitude: 28.738369

Calculated NAD 27 XY Coords:
- Longitude: 10431702.916855
- Latitude: 1202802.892336
What do you know?

Decimal degrees:
Longitude: -88.365934  
Latitude: 28.738369

Calculated NAD 27 XY Coords:
Longitude: 10431702.916855  
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What do you know?

In the U.S.

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No units
What do you know?

decimal degrees

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In the U.S.

NAD27

Calculated NAD 27 XY Coords:
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X or Y?
No units

No units
Demonstration
Identifying Unknown Data
Geographic (datum) transformations
Geographic transformations

- Convert between two geographic coordinate systems
- Offsets can be significant

<table>
<thead>
<tr>
<th>Geographic</th>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAD 1927</td>
<td>-116.6691455°</td>
<td>32.9999533°</td>
</tr>
<tr>
<td>NAD 1983</td>
<td>-116.6700000°</td>
<td>33.0000000°</td>
</tr>
<tr>
<td>NAD 1983 HARN</td>
<td>-116.6700004°</td>
<td>33.0000000°</td>
</tr>
</tbody>
</table>
Datum transformations are important!

- Omit or choose the wrong one—up to 200 m
- Multiple ones exist
  - Have different areas of use or accuracies
  - Up to you to decide which one is best
- See Knowledge Base article #21327
Transformations in North America
Warning: different geographic coordinate system...

The following data sources use a geographic coordinate system that is different from the one used by the data frame you are adding the data into:

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Geographic Coordinate System</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHoodNameCentroidsProjected</td>
<td>GCS_WGS_1984</td>
</tr>
</tbody>
</table>

Alignment and accuracy problems may arise unless there is a correct transformation between geographic coordinate systems.

You can use this button to specify or modify the transformation(s) used by this data frame:

Transformations...

The Transformations dialog can also be accessed from the Data Frame Properties dialog's Coordinate Systems tab after you have added the data.

- Don't warn me again in this session
- Don't warn me again ever

About the geographic coordinate systems warning
Services and coordinate systems

• If publishing through ArcMap, set up transformations there
  1. Change the coordinate system of the data frame or add data in ‘other’ GCS
  2. Set the appropriate transformation
  3. Change back the data frame’s coordinate system or remove the data

• Server will use the transformation if data is requested in that coordinate system
Demonstration
Working with Geographic Transformations
Wrap-up
More information

• Don't forget the Knowledge Base!
  - http://support.esri.com
    - 23025, 29129, 24893, 29035, 17420
• Esri forums for user-to-user help
  - http://geonet.esri.com
• Virtual Campus
  - http://campus.esri.com
  - Live Training Seminar and Course
• http://www.epsg.org
  - Database of coordinate systems & datums
  - Guidance Note 7-2
Books, etc.

- **Maher.** Lining Up Data in ArcGIS
- **Meyer.** Introduction to Geometrical and Physical Geodesy
- **Snyder.** Map Projections: A Working Manual
- **Flacke & Kraus.** Coordinate systems in ArcGIS
- **Snyder & Voxland.** An Album of Map Projections. **USGS PP 1453**
- **Iliffe and Lott.** Datums and Map Projections
Thank you...

- Please fill out the session survey
- Online – search using the session name
- Paper – pick up and put in drop box