Where is my Data?

Problem
Horizontal Coordinate Systems
Geographic and Projected
What does a coordinate system tell us?

Distance

Location

Direction
Q: How far is it from San Francisco to Los Angeles?

- 352.34 miles
- 690.67 kilometers
- 567.03 kilometers
- 620111.549 yards
Q: How far is it from San Francisco to Los Angeles?
A: It depends on the coordinate system.

- 352.34 miles
- 690.67 kilometers
- 567.03 kilometers
- 620,111.549 yards
Location

Q: What are the coordinates for Los Angeles?

(-118.25, 34.05)

(1276.333, 2421.545)

(2054060.514, 3897101.109)

(-13163527.521, 4035514.817)
Q: What are the coordinates for Los Angeles?
A: It depends on the coordinate system.

(-118.25, 34.05)
(1276.333, 2421.545)
(2054060.514, 3897101.109)
(-13163527.521, 4035514.817)
Direction

Q: In which direction is the North Pole?

- Down
- To the right
- Up
- Can’t, not on the map
Direction

Q: In which direction is the North Pole?
A: It depends on the coordinate system.

Down
To the right
Up
Can’t, not on the map
Two Kinds of Horizontal Coordinate Systems

- Geographic coordinate system
- Projected coordinate system
Geographic Coordinate System (GCS)

- 3D spherical surface

- Point P has:
  - Longitude – 80° E
  - Latitude – 50° N
Geographic Coordinate System (GCS)
Projected Coordinate System (PCS)
Horizontal Coordinate System
Horizontal Coordinate System

Geographic Coordinate System

Prime Meridian

Datum

Angular Unit

Spheroid
Two Ways to Specify a Coordinate System

Well-known ID

Well-known text
Horizontal Coordinate Systems
Demo in ArcGIS Pro
Map projections
Projecting to a Different Coordinate System
Why are there so many map projections?

- Shape
- Area
- Direction
- Distance

Illustration by Charles Preppernau, geographer.xyz
Web Mercator Projection

Q: Which is bigger?

- Greenland
- South America
- Antarctica
Web Mercator Projection

Q: Which is bigger?

- Greenland ~ 2,166,000 km²
- South America ~ 17,840,000 km²
- Antarctica ~ 14,000,000 km²
Web Mercator Projection vs. Reality
Q: Which projection is the best?

- Albers equal-area
- Stereographic
- Azimuthal equidistant
- Transverse Mercator
Q: Which projection is the best?
A: It depends on what you are doing.

Selection

Albers equal-area
Stereographic
Azimuthal equidistant
Transverse Mercator
Preserve Area

- Albers equal-area conic
Preserve Angles

- Stereographic
  - Only at infinitesimal scale
Preserve Direction and Distance

- Azimuthal equidistant
  - Only from the center
Datum (Geographic) Transformations
Transforming Means Changing Datum

Earth-centered datum (WGS 84)
Transforming Means Changing Datum

- Earth-centered datum (WGS 84)
- Local datum (NAD 27)

Earth's surface

Data
Why do we need to transform our data?

WGS 1984

ED 1950
Why do we need to transform our data?

WGS 1984

ED 1950
Geographic (Datum) Transformation

NAD 1927 → NAD_1927_To_WGS_1984_1 → WGS 1984
Geographic (Datum) Transformation

NAD 1927 → NAD_1927_To_WGS_1984_1 → WGS 1984

NAD 1927 ← ~NAD_1927_To_WGS_1984_1 ← WGS 1984
Defined for Certain Area

- 33 transformations:

  NAD 27

  WGS 84
How do I find transformations?
Map Properties: Geographic Transformations

- Transformation

Map XY coordinate system

- GCS WGS 1984

Details

Choose the transformation to convert source coordinate systems to map coordinate system.

<table>
<thead>
<tr>
<th>XY Coordinate System</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS North American 1927</td>
<td>NAD 1927 To WGS 1984 79 CONUS</td>
</tr>
<tr>
<td>GCS WGS 1984</td>
<td>None</td>
</tr>
</tbody>
</table>

OK Cancel

Geographic Transformations
Demo in ArcGIS Pro
ArcGIS Coordinate Systems Data
ArcGIS Coordinate Systems Data

- 1.5 GB additional data install
- GEOCON v1.0
- NTv2 (CA, ES, CH, UK)
- VERTCON / GEOID12B
- Geoids (JP, NZ, CH)
- EGM2008 (1' x 1', 2.5' x 2.5')

Geographic Transformations

Vertical Transformations
Now you understand...

Coordinate Systems

Projecting your data

Transforming your data
Unknown Coordinate Systems
Unknown Coordinate Systems

- ALWAYS define the coordinate system
- Good professional practice (help your successor and user)
- Units are unknown
- Map scale is incorrect
- Geodatabase tools can’t use default values
What if the coordinate system is unknown?

- Check the data provider or source
- Check any existing metadata
- What coordinate systems are used in the area?
  - http://www.epsg-registry.org
- Try using ArcMap to figure it out
  - http://esriurl.com/11518
  - HowTo: Identify an unknown coordinate system using ArcMap
- Lining Up Data in ArcGIS, Margaret Maher
Familiarize Yourself with Common Systems

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

<table>
<thead>
<tr>
<th>System</th>
<th>X / longitude</th>
<th>Y / latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic</td>
<td>-116.67 °</td>
<td>33.0 °</td>
</tr>
<tr>
<td>UTM zone 11N</td>
<td>530,000 m</td>
<td>3,650,000 m</td>
</tr>
<tr>
<td>State Plane (Calif. zone 6)</td>
<td>1,960,000 m</td>
<td>593,000 m</td>
</tr>
</tbody>
</table>
Where is my Data?
Solution
Resources

• Don't forget the Knowledge Base / Technical Articles!
  - http://esriurl.com/11518

• Esri forums for user-to-user help
  - http://geonet.esri.com

• http://www.epsg.org
  - Database of coordinate systems & datums
  - Guidance Note 7-2

• Lining Up Data in ArcGIS, Margaret Maher
## More about Coord. Systems, Reference Frames, Transformations, Map Projections

<table>
<thead>
<tr>
<th>WORKSHOP</th>
<th>LOCATION</th>
<th>TIME FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Geographic (datum) and Vertical Transformations: A Deep Dive</td>
<td>• Room 17 B</td>
<td>• Today, 4:00 – 5:00 pm</td>
</tr>
<tr>
<td>• Coordinate Systems and Datum Transformations in ArcGIS</td>
<td>• Room 05 B</td>
<td>• Tomorrow, 10:00 – 11:00 am</td>
</tr>
<tr>
<td>• Coordinate System Standards</td>
<td>• Esri Showcase: Spotlight Theater</td>
<td>• Tomorrow, 12:15 – 12:35 pm</td>
</tr>
<tr>
<td>• What’s New in High Accuracy GNSS Data Collection, from Eos Positioning Systems</td>
<td>• Room 30 A</td>
<td>• Tomorrow, 11:30 – 12:30 pm</td>
</tr>
<tr>
<td>• Collector for ArcGIS: Working with High Accuracy Data</td>
<td>• Ballroom 06 D</td>
<td>• Tomorrow, 4:00 – 5:00 pm</td>
</tr>
</tbody>
</table>
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Complete answers and select “Submit”