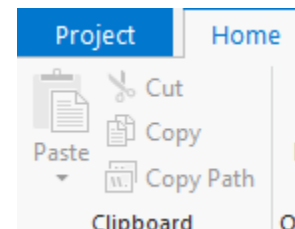
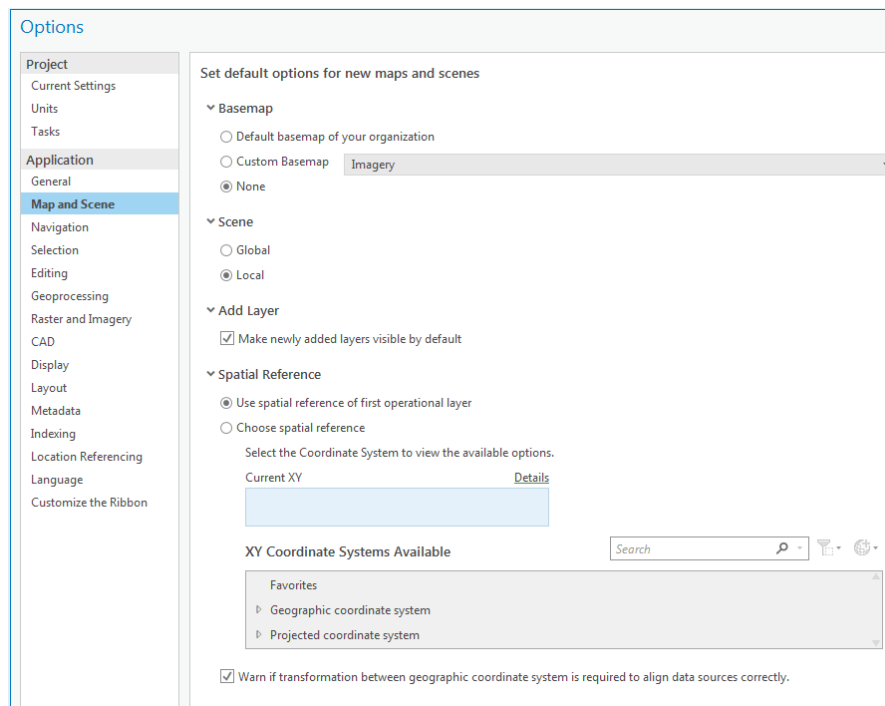


## BIOL 4460/5460 and GEOL 4460 Introduction to GIS

### LAB3 - MAP PROJECTIONS

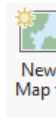
In this exercise we will inspect different projections and how ArcGIS Pro deals with these when displaying geographic data on the screen. We will inspect on the distortions that projections cause on features when trying to project geographic data on a flat surface, and how to properly fix issues to minimize errors.

- Download the Exercise\_3.zip file from [http://geo02.tamtu.edu/gis\\_2018](http://geo02.tamtu.edu/gis_2018).
- Unzip the file by right-clicking, choose 7-zip and then click on Extract Here
- Start ArcGIS Pro. Choose Blank as the project template on the right side of the screen.
- Type Lab3 as the name for the project, and browse to your GIS\_Exercises folder as the location for the project. Select the GIS\_Exercises folder and then click OK.
- Click on the Project tab on the upper left area of the window.
- Click on Options, and then click on the Map and Scene section.
- Change settings to match those of the following image.



- Click OK on the Options window, and then click on the Back arrow on the upper left.

This time the project does not have a map pre-built like the Lab1 project. We do not need a basemap for this exercise, and that is why we have changed the options above.

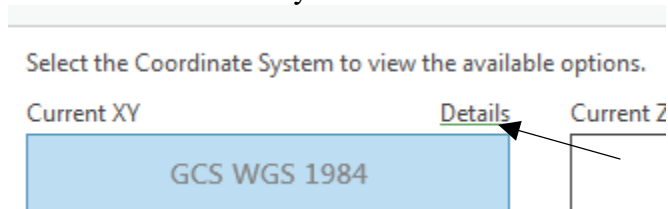


- Click on the Insert tab, and then click on the New Map button. If you click the down arrow, make sure you click New Map, not any of the other options.
- ArcGIS Pro creates a blank map.

- Under folder in the Catalog pane, create a connection to the Exercise\_3 folder you downloaded. (Right-click Folders > Add Folder Connection).
- Add the continent.shp file to the map by dragging it to the map area.
- Add the States3.shp file to the map
- Read the text on the warning window.

This warning will appear every time you add a layer that has a different coordinate system from the data frame. The data frame or current map obtains the coordinate system of the first layer that you added, which in this case is the continent layer. Click Cancel on the window.

- In the table of contents (left pane), right-click Map under the “Drawing Order” text and then click on Properties.
- Click the Coordinate Systems section. Click on Details.



1. Record the following:

Name \_\_\_\_\_ WKID \_\_\_\_\_ Datum \_\_\_\_\_

Semimajor Axis \_\_\_\_\_

Semiminor Axis \_\_\_\_\_

Inverse Flattening \_\_\_\_\_

- Click Cancel on the Map Properties window.
- Double-click on the States3 layer (shortcut: this is the same as right-clicking and selecting Properties).
- Click on the Source section and expand the Spatial Reference section.

2. Record the following:

Name \_\_\_\_\_ WKID \_\_\_\_\_ Datum \_\_\_\_\_

Semimajor Axis \_\_\_\_\_

Semiminor Axis \_\_\_\_\_

Inverse Flattening \_\_\_\_\_

These two datasets have coordinate systems based on different datums. The differences are

minimum and, as you can see, ArcGIS Pro was able to still overlay the two layers correctly. This is called “On the fly projection.” ArcGIS Pro will try to make necessary adjustments to the datasets to align them. This is not a permanent modification on the datasets. It is always recommended to change the coordinate system of datasets so that all of them match. This is done to minimize alignment issues but it is more critical when performing geoprocessing operations that require measurements of distances and areas. We will later explore how to make layers match one another.

So far we have used geographic coordinates, thus, all units are in degrees of latitude and longitude. We will create a 30-degree grid that covers the whole earth to inspect how shapes are modified to create a more realistic representation of the earth on a map using projected coordinate systems.

- Remove the States3 layer from the map.
- Click the Analysis tab, and then click Tools to open the Geoprocessing pane.
- In the Find Tools search box type “grid index features”.
- Click on the tool with this name (Cartography tools).
- Type grid for Output Feature Class.
- Choose 30 Decimal Degrees for Polygon Width and Polygon Height.

Polygon Grid Origin Coordinate refers to the lower left corner of the group of grids to be created. Remember that geographic coordinates are measured right and left of the Central Meridian (X) and above and below of the Equator (Y). Therefore, we want our origin to be -180(X) and -90(Y).

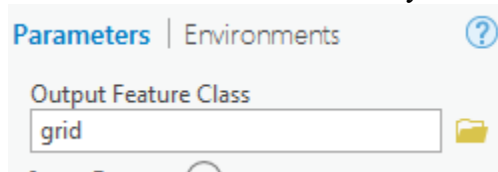
- Enter these values for X and Y

3. Why are these numbers negative?

- Enter 6 for number of row and 12 for number of columns.

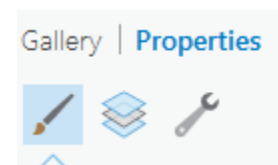
4. How wide and tall is each grid in decimal degrees? \_\_\_\_\_

- Since we are creating a new feature class from scratch, we must define a coordinate system. We want it to match the continent layer. Click on the Environments Section.



- Click on the down arrow for Output Coordinate System and select continent. Click Run.

- Change the symbology of the grid to black outline, click on Properties section and change the width to 1. Click Apply.



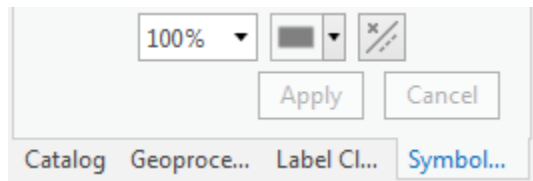
5. Use the Explore tool in the Map tab, click on the grid square where Laredo is located and identify the following:

PageName\_\_\_\_\_

PageNumber\_\_\_\_\_

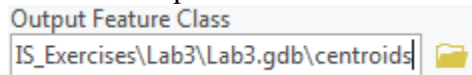
-Save your project and continue to save as often as you can remember!

-In the Geoprocessing pane (remember all panes remain open on the right side of the interface and you can switch using the tabs at the bottom), click the back arrow on the Grid Index Features tool, then search for “Feature to Point” and click on the tool (Data Management).



-Click the down arrow for Input Features and select the grid layer.

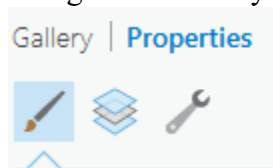
-In the Output Feature Class section, replace the automatically generated name with centroids. Do not erase the path of the database. Only replace the part after Lab3.gdb with “Centroids”



-When the tool finishes running, click the back arrow and search for the tool “buffer”.

-Open the tool (Analysis Tool). Select centroids as the Input features, and name the output circles (remember, only change the final name not the path). Under Distance, enter 15 and change Unknown to Decimal Degrees. Click Run.

-When the tool finishes running, change the circles symbology to black outline. Since you previously changed symbology for the grid, the symbology will be on the Properties section. Change Color to black, Outline Color to No Color, and Outline width to 1.0. If you wanted to change to another symbol, you need to click on the Gallery section. Click Apply.



-Deselect the centroids layer under the Contents pane.

This map in its current view shows a representation of the world as if it was flat. How would the grid and circles change if we wanted to make them fit into a more realistic representation of the earth?

-Double-click Map on the Contents pane.

-Click on the Coordinate Systems section.

-Under XY Coordinate Systems Available, expand the Projected Coordinate Systems folder, and then expand the World folder.

-Select the Azimuthal Equidistant (world) option and click OK.

-Right-click the circles layer and select Zoom To Layer.

6. Deselect the circles and grid layers as needed so you can see them independently. In what area of the map does the least distortion occur?

- Click on the Insert tab and select to add a new map
- If necessary, switch to the Catalog pane. Remember all panes are open in tabs on the right side.
- Add the States1, States2 and States3 layers. Click Cancel on the warning messages.

7. Identify the coordinate system of each of the layers.

States1 \_\_\_\_\_ States2 \_\_\_\_\_


States3 \_\_\_\_\_

You will notice that everything seems to line up perfectly at a small scale.



- On the Map tab, click on the Locate button. On the Locate pane on the right side, enter 26.111, -97.169. Click enter.
- These are coordinates in South Padre Island. You may need to zoom out to a scale of 1:5,000.

8. Turn on and off the three layers so you can analyze if they line up. Which of the layers line up?

- 
- On the Map tab click on the Full Extent  button next to the Explore button. This button is useful to return the map view to show a full view of the layers present in the map.
  - Click on the Explore button and click on the small set of islands present on the far-right side of the map. And no the correct answer is not Hawaii.

9. What state do these islands belong to? \_\_\_\_\_

10. Why are these islands on the right side of the map and not attached to the rest of the state on the left side of the map?

-Save you map

- Once again, create a new blank map.
- From the Exercise3 folder, add the Laredo layer, and then Campus1.tif.
- Click on Campus1 and drag it to make sure is on top of the Laredo layer. This may take a moment,

-Open the properties window of the Campus layer and click on the Source section. The campus layer does not appear in the map view. This is ok. We are about to learn why this happened.

11. What is the spatial reference of the Campus layer?

- 
- Click Cancel on the Campus1 layer properties window.
  - Right click on the Campus1 and click on Zoom To Layer.
  - Add the Campus 2, 3 and 4. Pan around the map area to see the whole image.

You will notice the 4 campus images do line up with one another.

- Click on the Full Extent button.

Nothing appears on the map because there are images with coordinate system associated with them, so ArcGIS Pro cannot line them up appropriately.

- Right click the Laredo layer and zoom the layer.



- On the map tab click on the Basemap button and select to add Imagery.
- Click OK on the transformation window warning.
- Locate the Lake Casa Blanca on the map, and use the mouse scroll button to zoom in to the TAMIU campus area (move the scroll button forward). Zoom in enough to see the entire campus.

We need to define the projection of the Campus images, but first we need to stitch them together.

- Open the Geoprocessing pane (Analysis Tab). Search for and open “Mosaic to New Raster”.
- For Input Rasters select one by one each of the Campus images by clicking the drop down arrow.
- In Output location, click on the browse button and select your Exercise3 folder.
- For Raster Dataset Name with Extension type “TAMIU.tif”
- Type 3 in the Number of Bands section and click Run. The tool will take a couple of minutes to run.

When the tool finishes running, you will still not see the TAMIU layer on the map.

Many times, the originator of the data has information about the projection that was utilized to construct it. Other times, you have to try to find the correct projection by trial and error. For this case, we are going to pretend the originator of the campus image used a State Plane projection and that is all the information we have. We need to modify the current map projection until the campus image fits into the area where it is supposed to be.

- Right click the Map2 under The Table of Contents and click on the Coordinate System section.
- We know the campus image uses a State Plane projection. Under the XY Coordinate Systems Available, expand the Projected coordinate system section and then expand the State plane section.

We need to try the Texas South Central (FIPS 4205) and Texas S Central (FIPS 4204) under the following sections:

NAD 1983 (Meters)  
NAD 1983 (US Feet)

- To choose a projection, click on the Name of the projection and then click OK on the Map2 properties window.
- If you get a warning message click Cancel.
- If the current projection you chose matches that of the campus image, it will appear aligned with the Basemap imagery. If nothing happens, go back to the properties window and select the next one.
- Once you identify the correct projection, make a note of it.

12. Correct projection: \_\_\_\_\_

Now that we have found the correct projection, we need to assign it to the layer.

- Type "Define Projection" Geoprocessing pane, click on the tool (Data Management).
- For input dataset choose the TAMIU layer.
- Click on the drop down arrow for Coordinate System and select Current Map [Map2] to use the State Plane projection that the map is currently using.
- Click Run.

When the tool finishes running open the properties of the TAMIU layer and check the Source section to verify that the coordinate system has been applied.

Save your project and close ArcGIS Pro,

Examine the following maps and determine propert(ies) preserved (conformal, equivalence, equidistance, azimuthality, none) and class of projection (conic, cylindrical, psuedo-cylindrical, or azimuthal). **Hint: refer to USGS map projection guide.**

(<http://egsc.usgs.gov/isb/pubs/MapProjections/projections.html>)

13.



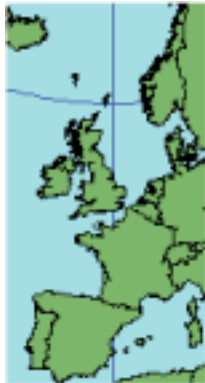
Property Preserved

\_\_\_\_\_

Projection Class

\_\_\_\_\_

14.



Property Preserved

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Projection Class

---

Hint: This projection is used in one of the Planar Coordinate Systems discussed in lecture 2. Note that this map represents six degrees of longitude.

15.



Property Preserved

---

Projection Class

---

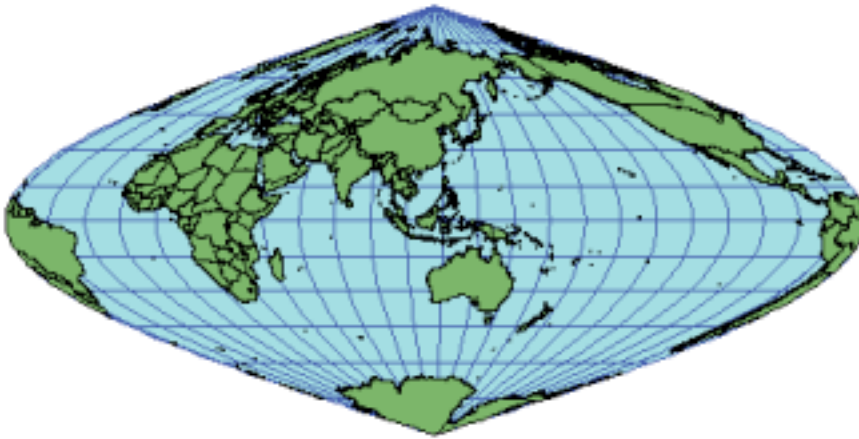
16.





Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

17.



Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

**BIOL 4460/5460 and GEOL 4460 Introduction to GIS**  
**ASSIGNMENT 3 – ANSWER SHEET**

**Name:** \_\_\_\_\_

1. Record the following:

Name \_\_\_\_\_ WKID \_\_\_\_\_ Datum \_\_\_\_\_

Semimajor Axis \_\_\_\_\_

Semiminor Axis \_\_\_\_\_

Inverse Flattening \_\_\_\_\_

2. Record the following:

Name \_\_\_\_\_ WKID \_\_\_\_\_ Datum \_\_\_\_\_

Semimajor Axis \_\_\_\_\_

Semiminor Axis \_\_\_\_\_

Inverse Flattening \_\_\_\_\_

3. Why are these numbers negative?

4. How wide and tall is each grid in decimal degrees? \_\_\_\_\_

5. Use the Explore tool in the Map tab, click on the grid square where Laredo is located and identify the following:

PageName \_\_\_\_\_

PageNumber \_\_\_\_\_

6. Deselect the circles and grid layers as needed so you can see them independently. In what area of the map does the least distortion occur?

7. Identify the coordinate system of each of the layers.

States1 \_\_\_\_\_

States2 \_\_\_\_\_

States3 \_\_\_\_\_

8. Turn on and off the three layers so you can analyze if they line up. Which of the layers line up?

---

9. What state do these islands belong to? \_\_\_\_\_

10. Why are these islands on the right side of the map and not attached to the rest of the state on the left side of the map?

11. What is the spatial reference of the Campus layer?

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12. Correct projection: \_\_\_\_\_

13. Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

14. Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

15. Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

16. Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_

17. Property Preserved \_\_\_\_\_ Projection Class \_\_\_\_\_