GIS: Exploring Map Projections

Summary

Introduces concept of distortion in map projections. Compares distortion in shape, distance, and area for several common map projections.

Materials

ArcVoyager or ArcView GIS

- Activity sheet Map_proj.pdf

Background for Teachers

Map projections are ways of transferring information from a 3-D sphere (the globe) to a 2-D plane (a piece of paper or a computer screen). Understanding map projections is important to anyone working with GIS because a three dimensional object cannot be represented perfectly in two dimensions. Some information must be distorted. Map projections allow the mapmaker to select which quality (or qualities) should be preserved in a map. The choice of map projection can affect not only the aesthetics (beauty) of the map but also any analyses performed using that map. The ArcView Help system includes a description of all supported map projections.

This exercise explores several map projections and illustrates how map features are distorted in different ways by different map projections. The exercise focuses on projections designed for world maps but could be adapted to include projections for maps of a continent or a single country. The instructions assume familiarity with basic ArcView GIS functions such as adding themes, setting the View Properties, and using the drawing tools. If you need detailed instructions for any of these operations, consult the ArcView online Help.

Instructional Procedures

A. Comparing map projections

1. Create a world base map including Countries, Major Cities, and Ocean grid

Create a new view and add the themes Country.shp, World30.shp, Cities.shp

Set the Theme Properties for the Cities theme to show only a few key cities, such as New York City, Los Angeles, your state's capital, Honolulu, Sydney.

Verify the View Properties: Map Units should be decimal degrees, Distance Units should be miles.

2. Create a second base map and set the map projection to Peters

Copy and paste themes from View1 to View2

Under View Properties, set the map projection to Peters and set the Distance Units to miles.

3. Create another view and set the map projection to The World from Space

Copy and paste themes from View1 to View3

Under View Properties, set the map projection to World from Space; set the Distance Units to miles.

4. Create another view and set the map projection to Mercator

(Repeat steps a & b above.)

5. Create another view and set the map projection to one of your choice, set the Distance Units to miles

6. Compare the maps

Arrange these View windows so you can see all of them and compare the maps:

What appears distorted in each of the Views?
Are there obvious limitations to any of the map projections? What are they?

B. Customizing a map projection

7. Find View3 (The World from Space) and focus the map on Honolulu
Confirm that "The World from Space" is the projection Type. Click the button for "Custom"; enter Honolulu's
longitude (-157.8) as the Central Meridian and its latitude (21.3 N) as the Reference Latitude.
8. Change the focus of View3 to Sydney, Australia (150.9 E, -33.8 S)
9. Change the focus of View3 to your hometown or favorite place

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C. Map projections and distance

10. Measure the distance from New York to Los Angeles in each view and record the distances below:
View1:
View2:
View3:
View4:
View5:
11. Create another view and select an equidistant map projection centered on New York City (-74.1 W, 40.7 N)
Measure the distance from New York to Los Angeles and record the value: View6:
Which of the five Views above gave the "truest" distance?
When would it be important to use a map projection that preserves distance?

D. Map projections and shape

12. Using the drawing tool, draw several circles on View1
Using the drawing tool, draw a circle inside one of the 30x30 degree squares
Copy and paste it into several more squares
Change the map projection to Mercator. What happens to the circles?
Change the map projection to Robinson. What happens to the circles?
Change the projection to another of your choice. What happens to the circles?
Which of the projections distorted the shape of the circles most severely?
When would it be important to use a map projection that preserves shape/angles?

E. Map projections and area

13. Change the map projection to Mollweide and record the area of several circles
Using the pointer, select one of the circles near the equator and record its area
Select a circle in the mid-latitudes and record its area.
Select a circle near a pole and record its area.
14. Change the map projection to Behrmann; record the area of several circles
Equator:

Mid-latitudes:
Pole:
Are the areas of the circles the same as you recorded above? Why?

15. Change the map projection to Mercator; record the area of several circles

Equator:
Mid-latitudes:
Pole:
Are the areas of the circles the same as you recorded above? Why?

16. Change the map projection to another of your choice; record the area of several circles

Equator:
Mid-latitudes:
Pole:
Are the areas of the circles the same as you recorded above? Why?
When would it be important to use a map projection that preserves area?

F. Next steps

Explore the other categories of map projections (Projections of the United States, UTM, State Plane) using a base map of the United States or of a single state. Refer to the ArcView online Help for an explanation of each projection's properties and recommended uses.

Bibliography

Authors

Utah LessonPlans