# ArcView 8.2 GIS Exercise 21 – Basics of Map Projections

## Coordinate Systems and Map Projections[1]

## Coordinate Systems

The features on a map reference the actual locations of the objects they represent in the real world. The positions of objects on the earth's spherical surface are measured in geographic coordinates. While latitude and longitude can locate exact positions on the surface of the earth, they are not uniform units of measure; only along the equator does the distance represented by one degree of longitude approximate the distance represented by one degree of latitude. To overcome measurement difficulties, data is often transformed from three-dimensional geographic coordinates to two-dimensional projected coordinates.

Geographic coordinates are a measurement of a location on the earth’s surface expressed in degrees of latitude and longitude.

Projected coordinates are a measurement of locations on the earth’s surface expressed in a two-dimensional system that locates features based on their distance from an origin (0,0) along two axes, a horizontal x-axis representing east–west and a vertical y-axis representing north–south. A map projection transforms latitude and longitude to x,y coordinates in a projected coordinate system.

## Map projections

Because the earth is round and maps are flat, getting information from a curved surface to a flat one involves a mathematical formula called a map projection, or simply a projection. This process of flattening the earth will cause distortions in one or more of the following spatial properties:

- Distance
- Area
- Shape
- Direction

No projection can preserve all these properties; as a result, all flat maps are distorted to some degree. Fortunately, you can choose from many different map projections. Each is distinguished by its suitability for representing a particular portion and amount of the earth's surface and by its ability to preserve distance, area, shape, or direction. Some map projections minimize distortion in one property at the expense of another, while others strive to balance the overall distortion. As a mapmaker, you can decide which properties are most important and choose a projection that suits your needs.

## About map projections

Whether you treat the earth as a sphere or a spheroid, you must transform its three-dimensional surface to create a flat map sheet. This mathematical transformation is commonly referred to as a map projection. One easy way to understand how map projections alter spatial properties is to visualize shining a light through the earth onto a surface, called the projection surface. Imagine the earth's surface is clear with the graticule drawn on it. Wrap a piece of paper around the earth. A light at the center of the earth will cast the shadows of the graticule onto the piece of paper. You can now unwrap the paper and lay it flat. The shape of the graticule on the flat paper is very different than on the earth. The map projection has distorted the graticule.

A spheroid can't be flattened to a plane any easier than a piece of orange peel can be flattened—it will rip. Representing the earth's surface in two dimensions causes distortion in the shape, area, distance, or direction of the data. A map projection uses mathematical formulas to relate spherical coordinates on the globe to flat, planar coordinates. Different projections cause different types of distortions. Some projections are designed to minimize the distortion of one or two of the data's characteristics. A projection could maintain the area of a feature but alter its shape.

**1. ArcGIS Desktop Help**

## To determine the projected coordinate system (map projection) of your data:

1. Right-click the data fame and click “Properties”.
2. Click the Coordinate System tab. The details of the current data frame coordinate system display in the dialog box. (Note: Changing the coordinate system of a data frame doesn't alter the coordinate system of the source data contained in it.)

## To change the displayed projected coordinate system (map projection) of your displayed data:

1. Right-click the data frame click Properties.
2. Click the Coordinate System tab.
3. Double-click Predefined.
4. Navigate through the folders until you find the coordinate system you want and click it.
5. Click OK. All layers in the data frame will now be displayed with that coordinate system.

Note: Changing the coordinate system of a data frame doesn't alter the coordinate system of the source data contained in it.

## Setting the units for reporting length and displaying coordinates

1. Right-click the data frame and click Properties.
2. Click the General tab.
3. Click the Map dropdown arrow and click the appropriate units. The map units option is only available when your data has no coordinate system information associated with it.
4. Click the Display dropdown arrow and click the appropriate units.
5. Click OK.

Note:

- When you measure lengths or find places by their coordinates, you can choose what units—meters, miles, or feet—you want to use. Set the Display Units property as needed.
- Changing the coordinate system of a data frame does not alter the coordinate system of the source data contained in it.
- Map units are a property of the coordinate system defined with your data. You can change the map units by modifying the coordinate system. Right-click the data frame containing your data and click the Coordinate System tab. Here you can modify the parameters of the coordinate system.