

Working With Spatial Data

GIS I: Organizing Principles



- Identify ArcToolbox functions
- Explain differences between geographic and projected coordinate systems
- Apply geoprocessing tools to change and define projections



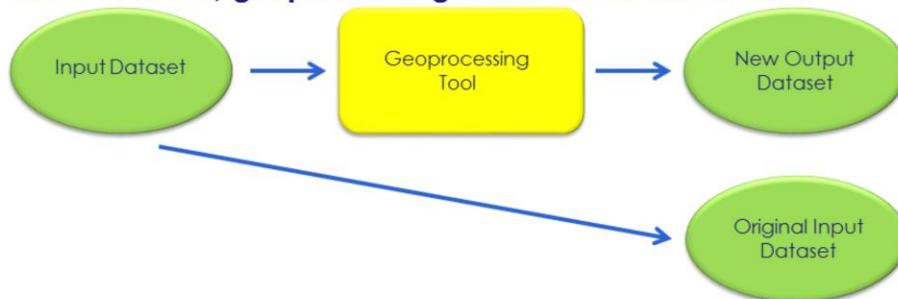
By the end of this module, you will be able to....

- Identify ArcToolbox functions
- Explain differences between geographic and projected coordinate systems
- Apply geoprocessing tools to change and define projections

- Any operation that transforms spatial data

- Data management
- Transformations
- Spatial analysis
- Automation/modeling of tasks

- In most cases, geoprocessing tasks create a new dataset



Geoprocessing is any operation that transforms spatial data.

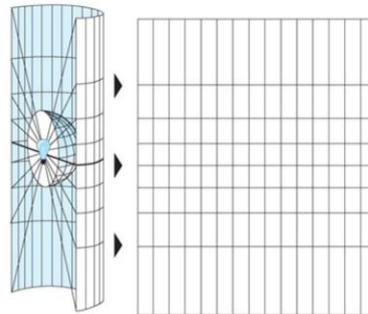
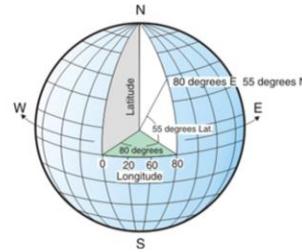
Geoprocessing is done via the use of tools that perform different functions on your data.

With these tools, you can do

- Data management
- Transformations
- Spatial analysis
- Automation/modeling of tasks
- And Much More!

- **Geographic Coordinate Systems**
 - Attempts to recreate a 3D model of earth
 - Angular units (decimal degrees)

- **Projected Coordinate Systems**
 - Attempts to flatten a 3D model to a 2D area
 - Linear units (feet, meters)



In this module, we're going to introduce a few ArcToolbox tools on important topic: coordinate systems.

CS are essential in GIS because we are dealing with spatial data which must be referenced in space – they provide the reference info.

Two types of coordinate systems:

Geographic Coordinate System (GCS)

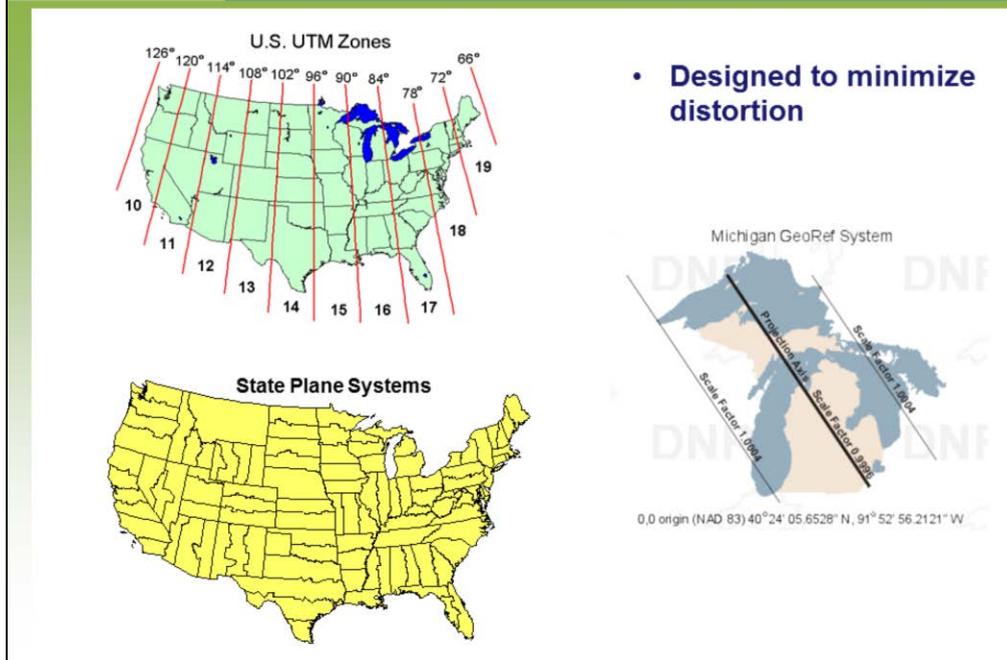
Referencing data by recreating a model of the earth as a sphere. Locate where you are using angular measurement (latitude/longitude). Two most common GCSs are WGS 1984 and NAD 1983.

Projected Coordinate System (PCS)

PCS are based on a GCS. It's taking the GCS and translating it to something flat. Not just one way to do this, so there are multiple projected coordinate systems. Locate where you are using linear/Cartesian measurements (feet or meters). Imagine taking an orange peel and trying to flatten it – things get a little distorted.

Coordinate systems in general are often called projections – kind of confusing.

Different coordinate systems do make a difference in **display** as well as impact the **accuracy of analyses** so it's important to know which system your data are in. This is a topic we will continue to discuss.



There are some specific types of projected coordinate systems that we use in the U.S. when we are mapping individual states that you might have seen/heard – these are designed to minimize distortion (improve accuracy of measures) within the state. Each state tends to have one “standard” system that they use most often that is best suited for their geography.

Some of the common ones are the UTM zones system and State Plane System. Some states have their own unique systems (VA, FL, MI).

Does anyone know what their state standard is?

**We have found those systems for you.

HI: NAD_1983_UTM_Zone_4N

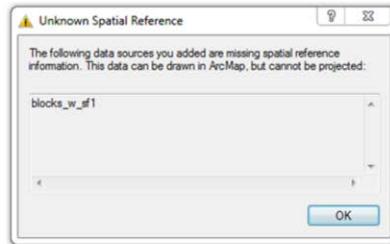
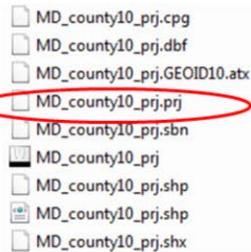
MD: NAD_1983_2011_StatePlane_Maryland_FIPS_1900 (Meters)

MN: NAD1983_UTM_Zone15 or State plane 1983 meters

NY: NAD_1983_UTM_ZONE_18N

Usually, coordinate system information will be found in documentation that comes along with your data.

- Data with a defined coordinate system will have a .prj file

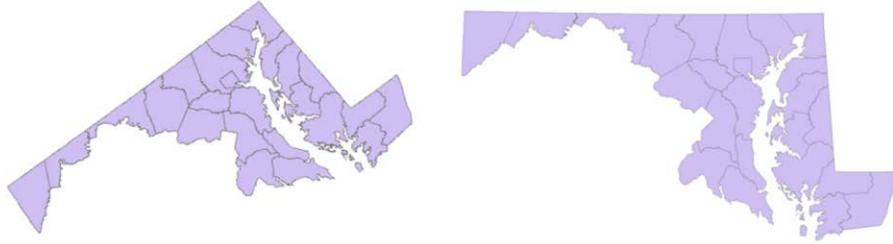


- Data and data frame have coordinate systems
- First piece of data you put in sets the data frame
- Additional data will be reprojected “on-the-fly” to match the data frame

What does this mean when we are working with spatial data?

- All spatial data have an inherent coordinate system. The question is whether or not it's been defined. Data with a defined coordinate system will have a .prj file. Having a prj file or a projection does not mean it's in a projected coordinate system. Some may be in GCS and not PCS.
- Data and data frame have coordinate systems
- First piece of data you put in sets the data frame
- Additional data will be reprojected “on-the-fly” to match the data frame. ArcGIS is smart - it can transform your data instantaneously so that it displays correctly on the map. This is kind of confusing – can make you think things are correct even when they aren't.
 - Projection on the fly does not change the underlying coordinate system of the data. Not permanent.

- **Spatial misalignment or distortion occurs if:**
 - **Coordinate system is not defined or is defined incorrectly**
 - **Data and data frame have different coordinate systems**



- **Defined:** Not all data has a coordinate system defined. If it doesn't, you have to define it – correctly.
- **Data vs data frame:** Important to have all your data and your data frame in the same system, GCS or PCS!

Everyone encounters problems with coordinate systems – even people with many years of experience.

They are challenging but fixable.

There are things we can do and check to work through them.

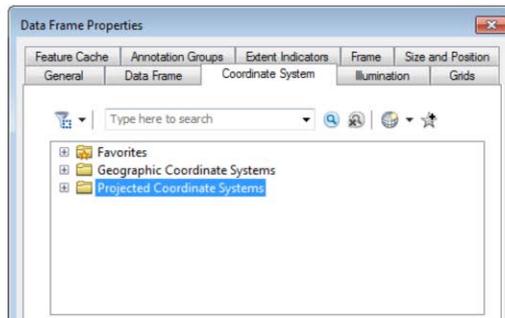
- **Data Layer**

 `md_carto_prj.shp` → Actual data projection

- **.Prj file**

 `md_carto_prj.prj` → A "Dictionary" to explain the projection of the data

- **Data frame**



What projection to display

Geographic

Layer Properties

Extent: Top: 45.945377 dd, Bottom: 42.479686 dd, Left: -104.057739 dd, Right: -96.436472 dd

Geographic Coordinate System: GCS_North_American_1983

Projected

Layer Properties

Extent: Top: 5100360.932661 m, Bottom: 4706114.773511 m, Left: 88100.352850 m, Right: 709932.320858 m

Projected Coordinate System: NAD_1983_UTM_Zone_14N

Undefined

Layer Properties

Extent: Top: 45.016659 ??, Bottom: 42.726850 ??, Left: -73.437905 ??, Right: -71.465039 ??

Coordinate System: <Undefined>

Data Frame

Data Frame Properties

Coordinate System

Current coordinate system: GCS_North_American_1983

How can we check?

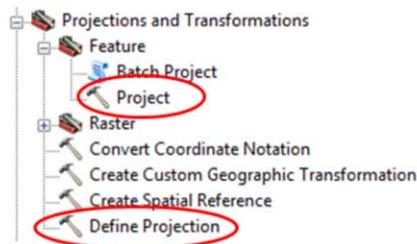
As we explored in the layer properties, the source tab tells us this information. Can tell by the units in the extent box as well as the data source box.

Can also go into data frame properties > coordinate systems tab and look at the data frame.

What do we do if it's undefined or need to be changed?

- If data has no coordinate system defined
 - Define Projection tool

- If you want to change data from one coordinate system to another
 - Project tool



We have some tools from ArcToolbox that can help us.

Define projection is used when your data do not have a coordinate system already defined or associated with the file. Could be that prj is lost or deleted or that it never had one. This is becoming more rare, but it happens.

Project is used when you want to convert from one coordinate system to another (i.e. you already have some coordinate system defined). Want to go from GCS to PCS from GCS to GCS or PCS to PCS.

Important to remember the difference because they will be used in different cases.

Let's get some practice with the exercise.