12. Find the GIS data clearinghouse for your state at the Geospatial One-Stop website (**http://www.geodata.gov/).** Go to the clearinghouse website. Does the website use a common coordinate system for the statewide data sets? If so, what is the coordinate system? What are the parameter values for the coordinate system? Is the coordinate system based on NAD27 or NAD83?
13. Explain how a UTM zone is defined in terms of its central meridian, standard meridian, and scale factor.
14. Which UTM zone are you in? Where is the central meridian of the UTM zone?
15. How many SPC zones does your state have? What map projections are the SPC zones based on?
16. Describe how on-the-fly projection works.

APPLICATIONS: COORDINATE SYSTEMS

This applications section has four tasks. Task 1 shows you how to project a shapefile from a geographic coordinate system to a custom projected coordinate system. In Task 2, you will also project a shapefile from a geographic to a projected coordinate system but use the coordinate systems already defined in Task 1. In Task 3, you will create a shapefile from a text file that contains point locations in geographic coordinates and project the shapefile onto a predefined projected coordinate system. In Task 4, you will see how on-the-fly projection works and then reproject a shapefile onto a different projected coordinate system.

All four tasks use the Define Projection and Project tools in ArcToolbox, which are available in ArcCatalog as well as ArcMap. The Define Projection tool defines a coordinate system. The Project tool projects a geographic or projected coordinate system. ArcToolbox has three options for defining a coordinate system: selecting a predefined coordinate system, importing a coordinate system from an existing data set, or creating a new (custom) coordinate system. A predefined coordinate system already has a projection file. A new coordinate system can be saved into a projection file, which can then be used to define or project other data sets.

This applications section uses shapefiles for all four tasks. ArcToolbox has separate projection tools in the Coverage Tools/Data Management/Projections toolset to work with coverages (these tools require an ArcInfo license). ArcToolbox also has a separate tool in the Data Management Tools/Projections and Transformations/Raster toolset for projecting rasters.

Task 1: Project a Shapefile from a Geographic to a Projected Coordinate System

What you need: *idll.shp,* a shapefile measured in geographic coordinates and in decimal degrees. *idll.shp* is an outline layer of Idaho.

For Task 1, you will first define *idll.shp* by selecting a predefined geographic coordinate system and then project the shapefile onto the Idaho transverse Mercator coordinate system (IDTM). A custom coordinate system, IDTM has the following parameter values:

Projection Transverse Mercator
Datum NAD83
Units meters
Parameters
  scale factor: 0.9996
  central meridian: −114.0
  reference latitude: 42.0
  false easting: 2,500,000
  false northing: 1,200,000

1. Start ArcCatalog, and make connection to the Chapter 2 database. Highlight *idll.shp* in the Catalog tree. On the Metadata tab, the FGDC summary information lists the coordinate system as geographic. Click the link to Spatial Reference Information. The

information shows that the coordinate system is GCS_Assumed_Geographic_1, an assumed coordinate system.

2. First define the coordinate system for *idll.shp.* Click Show/Hide ArcToolbox Window to open the ArcToolbox window in ArcCatalog. Right-click ArcToolbox and select Environments. Click the General Setting dropdown arrow and select the Chapter 2 database for the current workspace. Double-click the Define Projection tool in the Data Management Tools/Projections and Transformations toolset. Select *idll.shp* for the input feature class. The dialog shows that *idll.shp* has an unknown coordinate system. Click the button for the coordinate system to open the Spatial Reference Properties dialog. Click Select. Double-click Geographic Coordinate Systems, North America, and North American Datum 1927.prj. Click OK to dismiss the dialogs. Check the spatial reference information of *idll.shp* again. The Metadata tab should show GCS_North_American_1927.
3. Next project *idll.shp* to the IDTM coordinate system. Double-click the Project tool in the Data Management Tools/Projections and Transformations/Feature toolset. In the Project dialog, select *idll.shp* for the input feature class, specify *idtm.shp* for the output feature class, and click the button for the output coordinate system to open the Spatial Reference Properties dialog. Click the New dropdown arrow and select Projected. In the New Projected Coordinate System dialog, first enter idtm for the Name. Then you need to provide projection information in the Projection frame and for the Geographic Coordinate System. In the Projection frame, select Transverse_Mercator from the Name dropdown list. Enter the following parameter values: 2500000 for False_Easting, 1200000 for False_Northing, –114 for Central_Meridian, 0.9996 for Scale_Factor, and 42 for Latitude_ Of_Origin. Make sure that the Linear Unit is Meter. Click Select for the Geographic Coordinate System. Double-click North America, and North American Datum 1983.prj. Click Finish to dismiss the New Projected Coordinate System dialog. Click Save As in the Spatial Reference Properties dialog, and save the projection file as *idtm83.prj* in the Chapter 2 workspace. Dismiss the Spatial Reference Properties dialog.
4. A green dot appears next to Geographic Transformation in the Project dialog. This is because *idll.shp* is based on NAD27 and IDTM is based on NAD83. The green dot indicates that the projection requires a geographic transformation. Click Geographic Transformation's dropdown arrow and select NAD_1927_To_NAD_1983_NADCON. Click OK to run the command.
5. On the Metadata tab, you can verify if *idll.shp* has been successfully projected to *idtm.shp.*

Q1. Summarize in your own words the steps you have followed to complete Task 1.

Task 2: Import a Coordinate System

What you need: *stationsll.shp,* a shapefile measured in longitude and latitude values and in decimal degrees. *stationsll.shp* contains snow courses in Idaho.

In Task 2, you will complete the projection of *stationsll.shp* by importing the projection information on *idll.shp* and *idtm.shp* from Task 1.

1. On the Metadata tab, verify that *stationsll.shp* has an assumed geographic coordinate system. Double-click the Define Projection tool. Select *stationsll.shp* for the input feature class. Click the button for the coordinate system. Click Import in the Spatial Reference Properties dialog. Double-click *idll.shp* to add. Dismiss the dialogs.

Q2. Describe in your own words what you have done in Step 1.

2. Double-click the Project tool. Select *stationsll.shp* for the input feature class, specify *stationstm.shp* for the output feature

class, and click the button for the output coordinate system. Click Import in the Spatial Reference Properties dialog. Double-click *idtm.shp* to add. Dismiss the Spatial Reference Properties dialog. Click the Geographic Transformation's dropdown arrow and select NAD_1927_To_NAD_ 1983_NADCON. Click OK to complete the operation. *stationstm.shp* is now projected onto the same (IDTM) coordinate system as *idtm.shp.*

Task 3: Project a Shapefile by Using a Predefined Coordinate System

What you need: *snow.txt,* a text file containing the geographic coordinates of 40 snow courses in Idaho.

In Task 3, you will first create an event layer from *snow.txt.* Then you will project the event layer, which is still measured in longitude and latitude values, to a predefined projected (UTM) coordinate system and save the output into a shapefile.

1. Launch ArcMap. Rename the new data frame Tasks 3&4 and add *snow.txt* to Tasks 3&4. (Notice that the table of contents is on the Source tab.) Click the Tools menu and select Add XY Data. In the next dialog, make sure that *snow.txt* is the input table, longitude is the X field, and latitude is the Y field. The dialog shows that the spatial reference of the input coordinates is an unknown coordinate system. Click the Edit button to open the Spatial Reference Properties dialog. Click Select. Double-click Geographic Coordinate Systems, North America, and North American Datum 1983.prj. Dismiss the dialogs, and click OK on the warning message stating that the table does not have Object-ID field.
2. *snow.txt Events* is added to ArcMap. You can now project *snow.txt Events* and save the output to a shapefile. Click Show/Hide ArcToolbox Window to open the ArcToolbox window in ArcMap. Double-click the Project tool in the Data Management Tools/Projections and Transformations/Feature toolset. Select *snow.txt Events* for the input dataset, and specify *snowutm83.shp* for the output feature class. Click the button for the output coordinate system. Click Select in the Spatial Reference Properties dialog. Double-click Projected Coordinate Systems, UTM, NAD 1983, and NAD 1983 UTM Zone 11N.prj. Click OK to project the data set.

Q3. You did not have to ask for a geographic transformation in Step 2. Why?

Task 4: Convert from One Coordinate System to Another

What you need: *idtm.shp* from Task 1 and *snowutm83.shp* from Task 3.

Task 4 first shows you how on-the-fly projection works in ArcMap and then asks you to convert *idtm.shp* from the IDTM coordinate system to the UTM coordinate system.

1. Right-click Tasks 3&4, and select Properties. The Coordinate System tab shows GCS_North_American_1983 to be the current coordinate system. ArcMap assigns the coordinate system of the first layer (i.e., *snow.txt Events*) to be the data frame's coordinate system. You can change it by clicking Import in the Data Frame Properties dialog. In the next dialog, double-click *snowutm83.shp.* Dismiss the dialogs. Now Tasks 3&4 is based on the NAD 1983 UTM Zone 11N coordinate system.
2. Add *idtm.shp* to Tasks 3&4. Although *idtm* is based on the IDTM coordinate system, it registers spatially with *snowutm83* in ArcMap. (A couple of snow courses are supposed to be outside the Idaho border.) ArcGIS can reproject a data set on-the-fly (Section 2.5.3). It uses the spatial reference information available to project *idtm* to the coordinate system of the data frame.
3. The rest of Task 4 is to project *idtm.shp* to the UTM coordinate system and to create a new shapefile. Double-click the Project tool. Select *idtm* for the input feature class, specify

idutm83.shp for the output feature class, and click the button for the output coordinate system. Click Select in the Spatial Reference Properties dialog. Double-click Projected Coordinate Systems, UTM, NAD 1983, and NAD 1983 UTM Zone 11N.prj. Click OK to dismiss the dialogs.

Q4. Can you use Import instead of Select in step 3? If yes, how?

4. Although *idutm83* looks exactly the same as *idtm* in ArcMap, it has been projected to the UTM grid system.

Challenge Task

What you need: *idroads.shp* and *mtroads.shp.*

The Chapter 2 database includes *idroads.shp* and *mtroads.shp,* the road shapefiles for Idaho and Montana respectively. *idroads.shp* is projected onto the IDTM, but it has the wrong false easting (500,000) and false northing (100,000) values. *mtroads.shp* is projected onto the NAD 1983 State Plane Montana FIPS 2500 coordinate system in meters, but it does not have a projection file.

1. Use the Project tool and the IDTM information from Task 1 to reproject *idroads.shp* with the correct false easting (2,500,000) and false northing (1,200,000) values, while keeping the other parameters the same. Name the output *idroads2.shp.*
2. Use the Define Projection tool to first define the coordinate system of *mtroads.shp.* Then use the Project tool to reproject *mtroads.shp* to the IDTM and name the output *mtroads_idtm.shp.*
3. Use the Metadata tab in ArcCatalog to verify that *idroads2.shp* and *mtroads_idtm.shp* have the same spatial reference information.

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