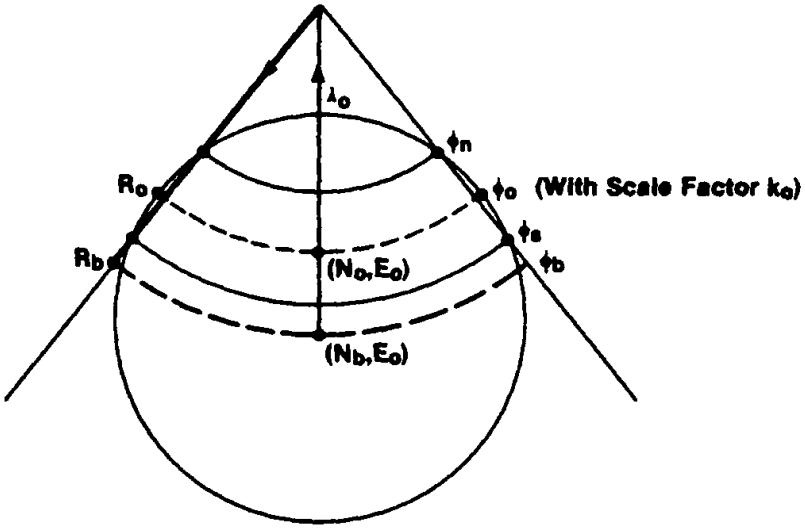
Projections and Coordinate Systems

Using Corpscon, the Projector! Extension in ArcView, and Project in ArcInfo

Maryland's stateplane coordinate system is based on a Lambert Conformal Conic projection. This projection is based on the mathematics of a cone intersecting a sphere (Earth) at two different latitudes such that the area where the cone and sphere are approximately tangent corresponds to the geographic location of Maryland. The figure below illustrates the basic idea:

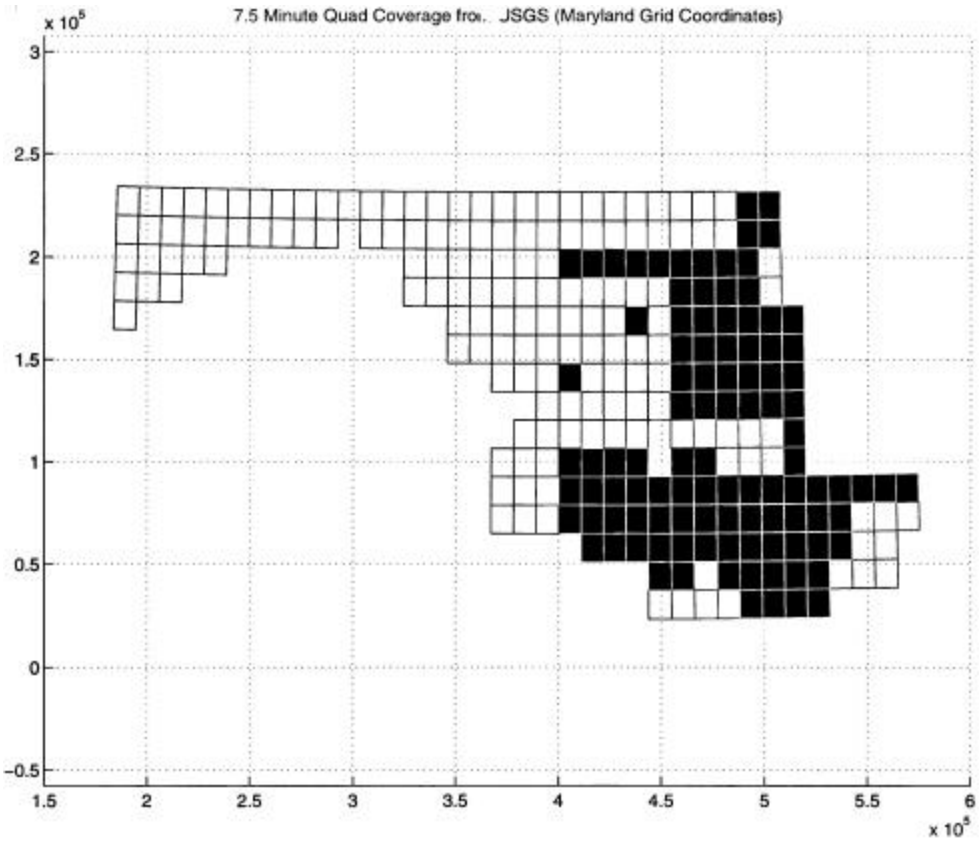
PARAMETERS OF A LAMBERT PROJECTION



For the state of Maryland, the indicated constants are:

ϕ_n = 39.45 degrees	(northern standard parallel)
ϕ_s = 38.30 degrees	(southern standard parallel)
ϕ_b = 37.67 degrees	(latitude of grid origin)
λ_o = 77.00 degrees	(central meridian – longitude of grid origin)
N_b = 0.0	(false northing)
E_o = 400,000 meters	(false easting)

The figure at the top of the next page illustrates the 7.5 minute USGS quads that completely cover the state of Maryland. The x and y axes of this graph are in Maryland stateplane coordinates in units of meters. (Note that x=400,000 meters corresponds to the 77 degree meridian.). Another common projection you may encounter is the Universal Transverse Mercator (UTM) projection. The figure on the next page also illustrates the zones 10-19 which span the United States. Note that western Maryland (west of 78 degrees) is in zone 17, while eastern Maryland is in zone 18.



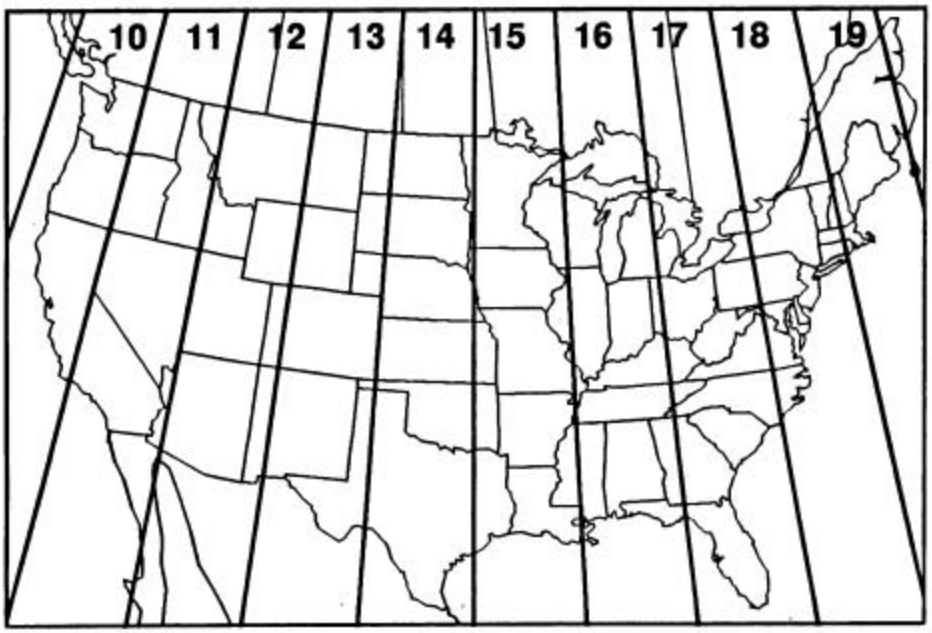


Figure 4.7 Universal Transverse Mercator zones in the 48 contiguous states.

Performing Projections on the Computer

There are three facilities: one stand-alone, one in ArcView, and one in ArcInfo that allow you to convert information from one coordinate system to another. The stand-alone facility is a program produced by the Topographic Engineering Center of the U.S. Army Corps of Engineers called "Corpscon". The ArcView facility is an extension produced by ESRI called "Projector!" that allows you to project vector data. The ArcInfo facility is more powerful than the "Projector!" extension and can project vector and grid data. It is not as user-friendly as "Projector!" but must be used if you wish to project grids or vector data (under certain circumstances).

Corpscon

The Corpscon program is available for download free of charge from:

http://crunch.tec.army.mil/software/corpscon/corpscon.html

Once installed, the use of Corpscon is fairly intuitive. Menu choices controlling the input and output formats must first be defined. For both input and output, you must select a horizontal and vertical coordinate system, datum, and system of units. For instance, suppose our conditions are the following:

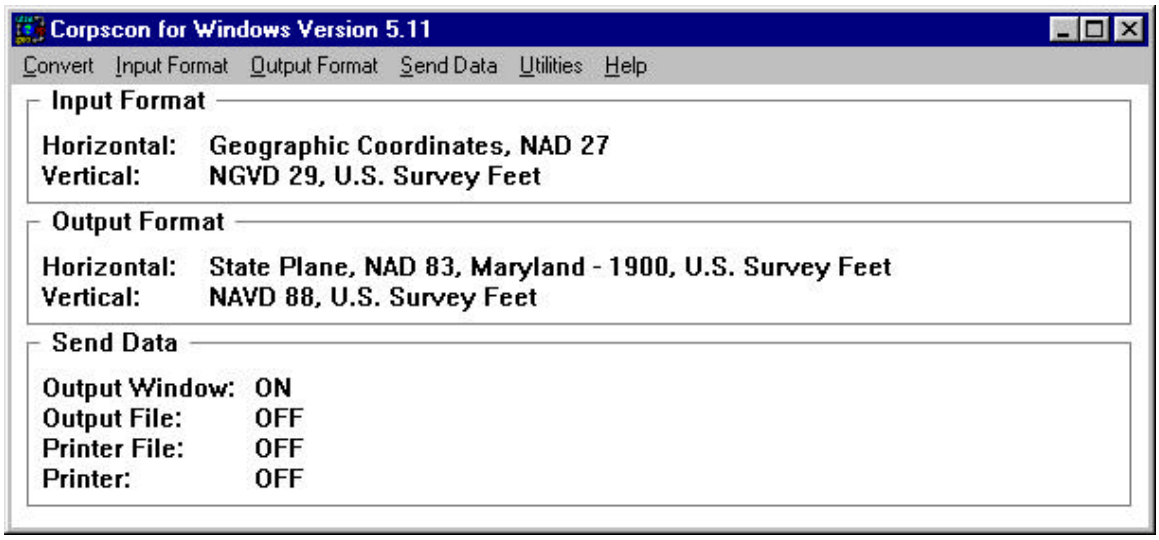
Input Specifications:

Horizontal Coordinate System:	Geographic
Datum:	NAD 1927
Units:	Decimal Degrees
Vertical Datum	NGVD 1929
Units:	U.S. Feet

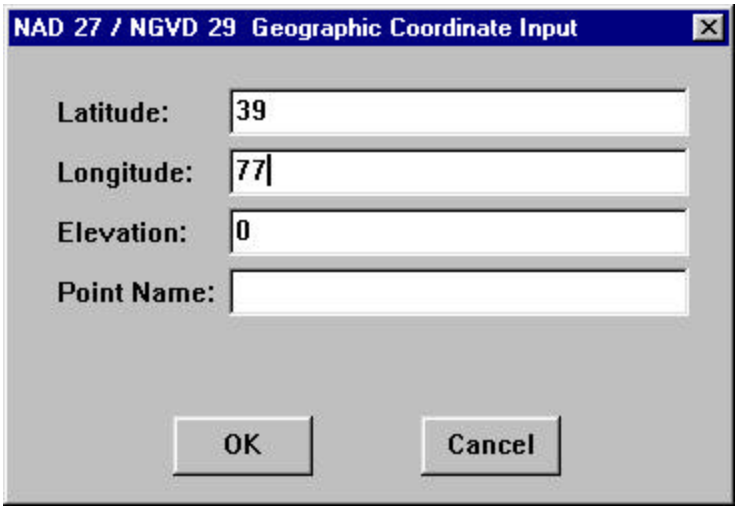
Output Specifications:

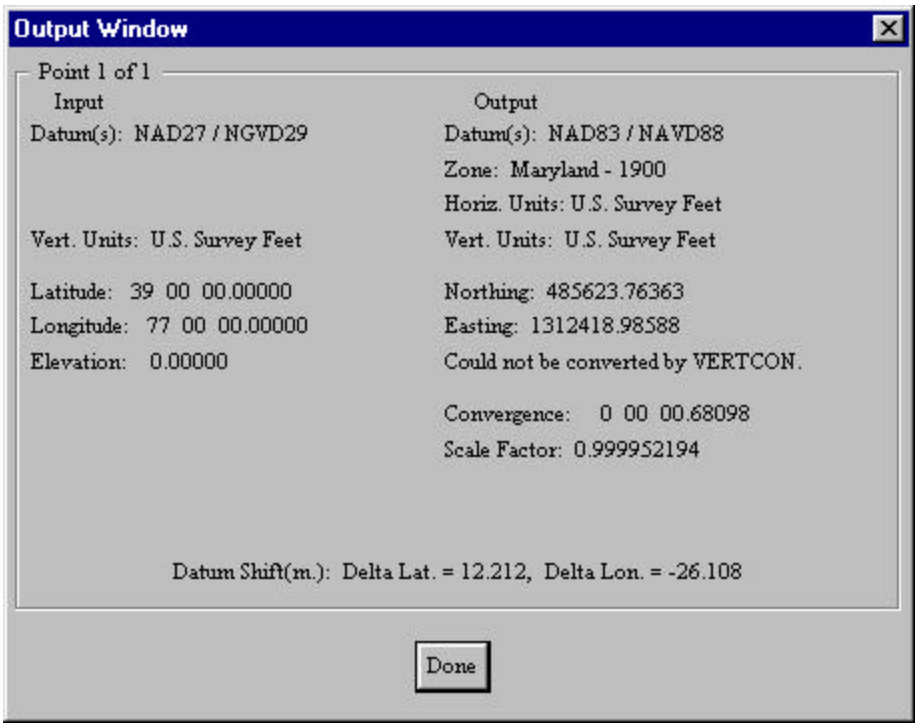
Horizontal Coordinate System:	Stateplane (Maryland)
Datum:	NAD 1983
Units:	U.S. Feet
Vertical Datum	NAVD 1988
Units:	U.S. Feet

After specifying these conditions for input and output formats, the Corpscon communication window would look as shown on the next page:



There are several options for data conversion: single point (manual input), Corpscon batch file, and user-defined input file. The help utility supplied with Corpscon addresses the latter two options. We will discuss the single point option which is the simplest, but perhaps least powerful choice. Selecting this choice, you will be prompted with input consistent with your previously defined input format. For example, say we wanted to convert the point at 39 degrees north, 77 degrees west, with an elevation of 0.00 feet: We would enter this information in the pop-up window as shown at left. Clicking the "OK" button produces the illustrated output window at the top of the next page. This window conveniently summarizes the input/output formats specified/calculated coordinates in both coordinate systems. As illustrated, we have selected the "send data to output window" choice, but you can also send data to an output file or directly to a printer. When working with a single point, the output window selection probably makes the most sense, however for batch files, you would probably prefer to use the output file option.





Projector! Extension

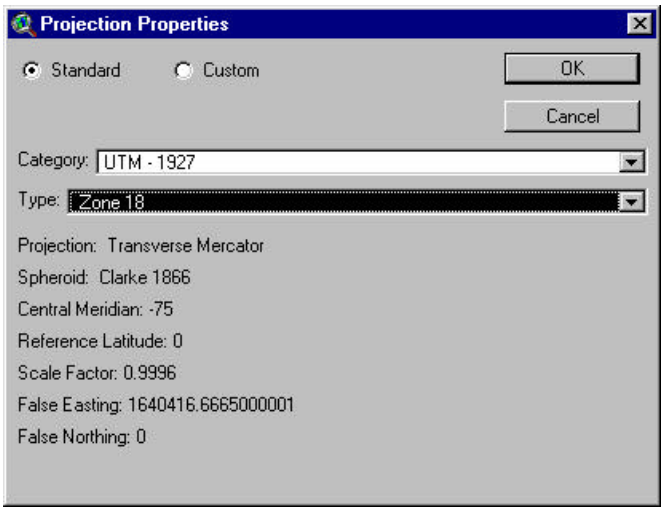
The Projector! extension is enabled in the same fashion that the Spatial Analyst extension was enabled previously: with the "View" window active in ArcView, choose "File: Extensions..." and then click the box to the left of "Projector!" and select the "OK" button to enable this choice. The Projector! extension can be used to project any ArcView feature (vector) theme from one coordinate system to another. This extension will create a new theme (in the form of a new shapefile) which can then be used in subsequent tasks. Using Projector! is not as straightforward as Corpscon but adhering to the following rules should lead to success:

Rules for using Projector!:

1. It doesn't make sense to have themes in two different coordinate systems displayed in the same view window. Create a "View1" and "View2" windows and use them for your input and output coordinate systems, respectively.
2. With the "View1" window active, choose "View: Properties...". Under the "Map Units" entry you will need to specify either decimal degrees, feet, meters, or whatever units the information in the "View1" window is reported in.
3. Select the "Projector!" button and you will be prompted for the input projection (unless the input projection is Geographic). A sample input projection dialog box is shown below. Under "Category" you would likely enter either UTM or Stateplane and simultaneously specifying the

datum (e.g. 1927 or 1983). Under "Type" you would likely specify either the zone (for UTM) or state (for stateplane) for example either zone 18 for UTM or Maryland.

4. Once you have selected the input specifications, you will be prompted first for the output units followed by the output projection category and type.
5. You will be prompted "Recalculate the area, perimeter, and length fields (if present) using [the output units]". Click on the appropriate "yes" or "no" button. Choose "yes" if these fields exist and you plan future calculations based on these table entries in the projected theme.



6. You will then be asked whether you want to "Add projected shapefile(s) as theme(s) to the a view?" Click on the "yes" button. ArcView will prompt whether you want to add the theme to "View1", "View2", or a "<New View>". As stated in rule1, "View2" is the assumed destination for the output coordinate system. Select "View2" and click on the "OK" button.
7. Completing the step in rule 6 will result in a File Browser dialog popping up. This is ArcView's way of prompting for the output file path and file name. Reply as desired, paying special attention to your response as this will govern the future location of your projected theme. Once clicking the "OK" button the process is complete and the projected theme will appear in "View2".

(**Special Note:** the Projector! extension assumes the NAD '83 datum if Geographic coordinates are selected for either input or output. In other words, you cannot project to or from Geographic coordinates in the NAD '27 datum. If you must perform such a projection, you will need to resort to ArcInfo to do this. I assume future releases of ArcView will address this oversight.)

Project in ArcInfo

Using ArcInfo is generally beyond the scope of this course, but if grids must be projected it is currently necessary to perform this task using this software. The following will address the minimum you must know to project grid data.

ArcInfo is only available on the Glue machines and is accessed similarly to ArcView. A sample session is shown below:

unix-prompt> tap arc
unix-prompt>arc

Arc: grid (puts ArcInfo into Grid mode)
Grid: &wo /homes/moglen/ce688z (changes working directory to ce688z)
Grid: newgrid = project(oldgrid, #, #, newresolution) (this is the key command)

Please define the input and output map projections. (ArcInfo will echo this information to the screen)
Use INPUT to define the input projection, OUTPUT to define the output projection, and END to finish.

Project: input (begin specifying the input parameters)
Project: projection utm (identify the input projection)
Project: units feet (identify the input horizontal units)
Project: datum nad27 (identify the input datum)
Project: zone 18 (identify the input zone)
Project: parameters ("spacer" between input and output)
Project: output (begin specifying the output parameters)
Project: projection stateplane
Project: units meters
Project: datum nad83
Project: zone 4126 (see help files – this is Maryland's zone)
Project: parameters ("spacer")
Project: end (indicates to Grid you are done)

The above dialogue illustrates the projection of a grid called "oldgrid" to a new resolution of "newresolution" (this should be a number). The resulting projected grid will be called "newgrid". The projection illustrated goes from UTM, Zone 18, NAD 1927, feet to Maryland Stateplane, NAD 1983, meters. In some cases, you will not need to identify an input projection if that information is already stored in the "oldgrid". It is strongly encouraged to consult the help files associated with the ArcInfo "project" command. To access this information, type "help" at the "Arc:" prompt and wait for the help window to appear. Choose "index" and then select "Project () (Grid function).

References:

Stern, J. E., 1990. "State Plane Coordinate System of 1983". NOAA Manual NOS NGS 5, U.S. Department of Commerce, Rockville, Maryland.