ESRI® North American Datum Transformation

November 4, 2013

Background

The North American Datum of 1927 (NAD27) is a datum based on the Clarke ellipsoid of 1866, the origin for which is located at Meades Ranch in Kansas. Use of this datum is gradually being replaced by the North American Datum of 1983. It should also be noted that this datum was not derived upon GPS data, and hence was not as accurate of a reference frame as compared to the GPS derived systems.

The North American Datum of 1983 (NAD83) is an earth-centered datum based on the GRS 80 ellipsoid. The size and shape of the earth was determined through measurements made by satellites and other sophisticated electronic equipment. The model accurately represents the earth to within two meters.

There are differences in the two datums (NAD27 and NAD83) ranging from 200-300 feet in the western US to several tens of feet in the central and eastern US, so there are issues with maintaining different datasets in these two coordinate systems.

Converting NAD27 to NAD83

There are several ways to convert between these two systems. Many desktop GIS software have conversion routines built in. Additionally you can use online calculators, download the underlying software program, or purchase a geographic calculator.

NADCON (NGS)

The readjustment of the North American Datum of 1927 (NAD 27), Old Hawaiian Datum and Puerto Rico Datum to the North American Datum of 1983 (NAD 83) in July 1986 was both a change in reference ellipsoid and a "cleanup" of nearly 200 years of surveying data held by NGS. Based on this re-adjustment and redefinition, positions of points can change between 10 and 100 meters, in the conterminous United States, more than 200 meters in Alaska, Puerto Rico and the Virgin Islands, and in excess of 400 meters in Hawaii. Consequently, the shift between the various datums are not uniform across the United States, and there is no single value that can be applied to latitudes or longitudes based on old datums to convert them to NAD 83. NADCON was developed in order to facilitate conversion between the datums. The grids used by the program are based on more than 150,000 horizontal control points whose coordinates reside in the NGS database and provide transformed positions based on the shifts of the control nearest to the input position.

Advances in the accuracies now obtainable in geodetic surveys, specifically through the use of differential GPS, has allowed for the creation of High Precision Geodetic Networks (HPGNs), also referred to as High Accuracy Reference Networks (HARNs) throughout the country. NAD 83 coordinates based on the HPGN/HARN surveys changed approximately 0.2 to 1.0 meter relative to the original NAD 83 (1986) adjustment. As these high accuracy networks have been completed, the horizontal geodetic network of each state has been re-adjusted to be consistent with its network of A- and B-order control, thus creating a need for grids that allow for the transformation from the NAD 83(86) adjustment to the new adjusted values. These grids carry the designation 'HPGN' to distinguish them from the grids created from the original NAD 83(86) adjustment.

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The accuracy of transformations between NAD 27 and NAD 83 (1986) are typically 12-18 cm and 5-6 cm between NAD 83 (1986) and HPGN.

NADCON is the Federal standard for NAD 27 to NAD 83 datum transformations.

Issues with continued use of NAD27

Since NAD27 was not created using GPS, any data collected using GPS will have to undergo this approximation calculation to obtain the associated coordinates for this datum, introducing the calculation errors. This alone is not necessarily detrimental, but when you compound this with the variable error of the GPS data collection system, the errors are magnified.

It is important to understand that this calculation error will never get better or more accurate, and these errors will always throw the tolerances of your GPS into a wider range and reduce your overall GIS accuracy. Transformation calculations are a complex algorithm designed to create a best fit for the conversion from one datum to another. They are NOT an exact calculation.

It is also important to understand that GPS coordinate systems are dynamic and are built on a factor of time. Therefore, transformations between datums are dynamic but are rarely treated as such (in GIS). In turn, it should be understood that the transformation of new data to an old system will become increasingly less accurate as time progresses.

Procedure

When working with GPS data, it is recommended that data in the NAD27 datum be re-created in the NAD83 datum. This procedure can be performed in either ArcCatalog™ or ArcMap™.

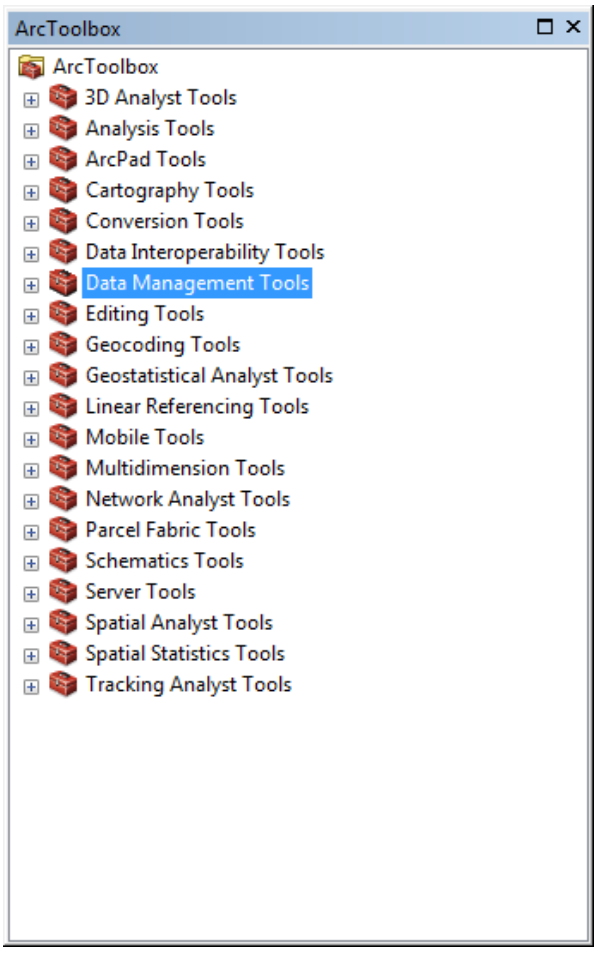
This procedure will be outlined for ArcCatalog; however, the only difference for ArcMap is that you must load the data layer you wish to transform, and then follow the same procedure.

With ArcCatalog and ArcToolbox™ open, navigate to your Geodatabase.

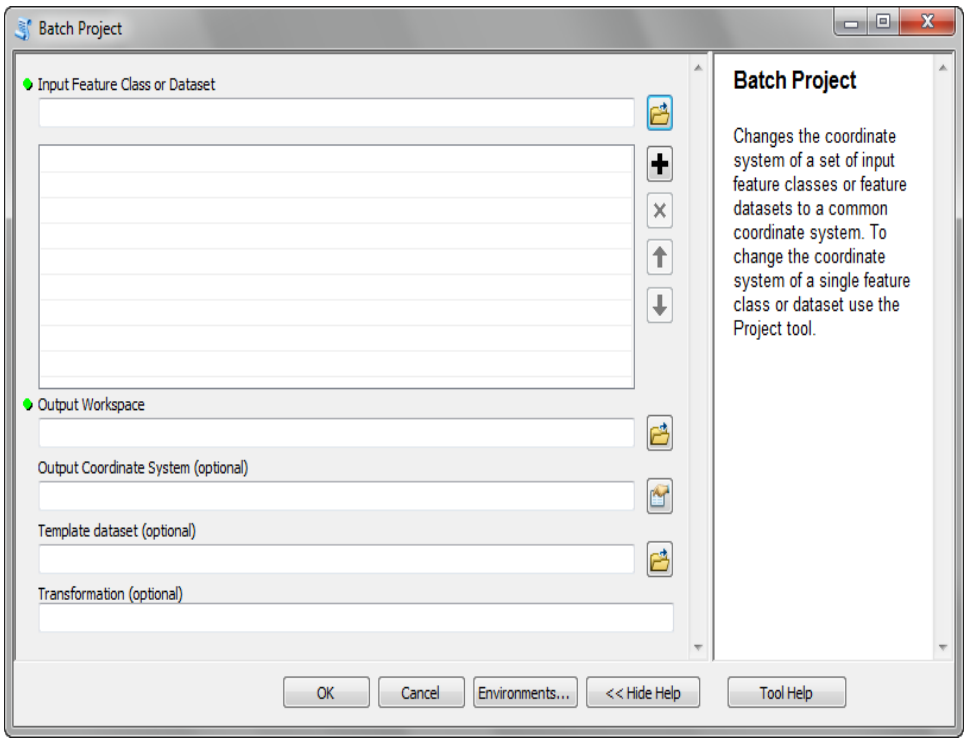
In ArcToolbox, navigate to Data Management Tools/ Projections and Transformations/Feature.

The Batch Project tool will allow you to transform entire Feature Classes all at the same time.

Double-click the Batch Project tool.



1. You can now drag and drop your *Feature Datasets* from the ArcCatalog tree into the *Input Feature Class or Dataset* Field or use the browse option to add in your dataset or feature classes.



2. Select your Output Work-space.

Note: You can select the same geodatabase where you are currently working, or you can create a new geodatabase.

3. Select the Output Coordi-nate System.

The Transformation field (marked as optional) does not need to be selected for this transformation. ESRI will be able to decipher which transformation to use based upon your current defined coordinate system for your datasets.

4. Click OK.

Transformation Process will begin.

When the process is complete you will have new feature classes/datasets that are in the new reference frame within the output workspace that you selected. If you selected the pre-existing geodatabase, you can either delete the old datasets, or rename them and save them for historical datasets.

If you created a new geodatabase, but have aerial photography or other raster datasets that you wish to have in the new geodatabase, you can simply drag and drop them from one geodatabase to the next.

Note: This transformation will introduce 12-18 cm or error into your datasets. You will need to do the same process for your imagery, but use the Data Management Tools/Projections and Transformations/Raster/ Define Projection

References and Additional Information:

For more information on NAD27 and NAD83 and the various realizations of each, please consult any of the following references:

National Geological Survey http://www.ngs.noaa.gov/TOOLS/Nadcon/Nadcon.shtml

ESRI http://www.esri.com/news/arcuser/0401/datum.html

Wikipedia http://en.wikipedia.org/wiki/North_American_Datum

Information on GRS 80 http://www.gfy.ku.dk/~iag/HB2000/part4/grs80_corr.htm