BACKGROND ON

Improving the National Spatial Reference System

—From a White Paper by Dr. Dru Smith

The future of positioning is GNSS[1]. The underlying reference frames for all GNSS systems are geocentric. The International Terrestrial Reference Frame (ITRF), used for globally consistent scientific applications such as the determination of sea level change has become progressively more geocentric over the last ten years, so that now the origin of the ITRF coincides with Earth's center to about 1 centimeter of accuracy. Furthermore, countries are increasingly choosing GNSS as their primary tool to access a vertical datum, minimizing their reliance on not monitored passive control.

In the United States, the official geometric, historically called "horizontal", datum, NAD 83[2], has a known non-geocentricity of over two meters and the official vertical datum, NAVD 88[3], is accessed through a set of passive control that is fragile, inaccurate, and rapidly deteriorating.

The National Geodetic Survey (NGS) at the National Oceanic and Atmospheric Administration (NOAA) is working to define and adopt a geocentric reference datum for the United States to replace NAD 83. The Agency is also working to compute an accurate geoid model which will serve as the defining surface of a new vertical datum accessed through GNSS technology and which replaces NAVD 88.

These two changes are dependent upon one another in a variety of ways and are currently planned to occur simultaneously. The decision to proceed with these changes was both obvious and difficult as NGS is cognizant of two important but conflicting needs in the user community: accuracy and constancy. To fulfill its mandate to provide the geodetic reference frame for all geospatial activities in the United States, NGS must strive to be as scientifically accurate as possible.

After much internal discussion, NGS determined that it must address serious issues of inaccuracy in the current realizations of NAD 83 and NAVD 88. However, NGS recognizes that significant user resources have been invested in the current realizations of the two datums.

In order to continue improving accuracy while minimizing the impact of new reference frame paradigms, NGS is working to implement this transition over the next ten years. This will allow time for the user community to voice concerns, for NGS to address them, and to ensure that the transition will go as smoothly as possible.

Replacing the North American Vertical Datum of 1988 as the official U.S. Vertical Datum

Significant changes to the science and methodology of geodetic leveling occurred during the mid-20th century. A widespread multi-agency effort to collect terrestrial gravity measurements, development of new corrections to leveling and a deeper understanding of the differences between local mean sea level (LMSL) at disparate tide gages all called into question the accuracy and reliability of the National Geodetic Vertical Datum of 1929 (NGVD 29). These improvements in scientific knowledge, and the new 625,000 km of leveling (including 81,500 km of 1st order re-leveling) performed post-NGVD 29 were used to create the North American Vertical Datum of 1988 (NAVD 88).

NAVD 88 was a major improvement over NGVD 29, however no nationwide effort to re-adjust NAVD 88 has been made since its inception. Some localized leveling has allowed for original heights to be superseded, and in some cases (e.g. Louisiana) a number of questionable heights have been removed in favor of updated leveling and GPS-based heights. Without an active maintenance plan, current regional distortions in the network are already impacting its value and effectiveness.

Because of known problems in the original realization of NAVD 88, and ongoing problems in the very nature of a passive-mark based system of vertical geodetic control, NGS proposed in their 10 year plan (NGS, 2008) that "a new geopotential datum… is defined and realized through the combination of GNSS technology and gravity field modeling." There are six major issues with NAVD 88 which warrant its replacement:

1) Cross-country accumulation of errors from geodetic leveling;
2) Fragility and location of passive marks;
3) Bias in the NAVD 88 H=0 reference surface as compared to the geoid;
4) Subsidence, uplift, and other crustal motions;
5) Sea level change; and
6) Changes to Earth's gravity field.

The entire document is accessible at [http://www.ngs.noaa.gov/2010Summit/.

1 Global Navigation Satellite Systems—All constellations of positioning satellites including GPS, Galileo (Europe), GLONASS (Russia) and Compass (China). [2] The North American Datum of 1983. [3] The North American Vertical Datum of 1988.