NGS formulates a new 10-year work plan

A Change for the Better

—by Dru Smith and Ilse Genovese

In a dynamic world, people expect to have access, in real time, to the most accurate and up-to-date information which exists for a site on which they are trying to position themselves. Providing such information is the business of the National Geodetic Survey of the National Oceanic and Atmospheric Administration; NGS has been doing that for two hundred years, with commendable success. The National Spatial Reference System defined by NGS contains two of the best geodetic datums in the world—NAD 83 and NAD 88. A growing demand on NGS to provide access to positioning information in an increasingly more efficient manner necessitated that NGS take a hard look at how this goal can be advanced. The result is the new 10-year plan released by NGS in early 2007 for public comment.

By the time the ACSM Bulletin interviewed Dr. Dru Smith, Chief Geodesist and—as he describes his role—the "editor" of the plan—on April 4, a number of comments have already been received. Smith saw this interview as an opportunity to address some of the concerns raised, while continuing to keep the plan in the public's eye. "The more people review the plan," he said, "the better the plan will be and the better agency NGS will become."

The 2007 plan of NGS embraces the fact that the Earth is dynamic (that it's constantly changing). The agency's mandate of providing solid positioning information is as valid now as it was 200 years ago, but to perform its mission successfully in this dynamic world, NGS must modernize and adapt to change. The effort to modernize and adapt has been embodied in five technical improvements that the agency aims to implement in the coming decade.

DYNAMIC WORLD

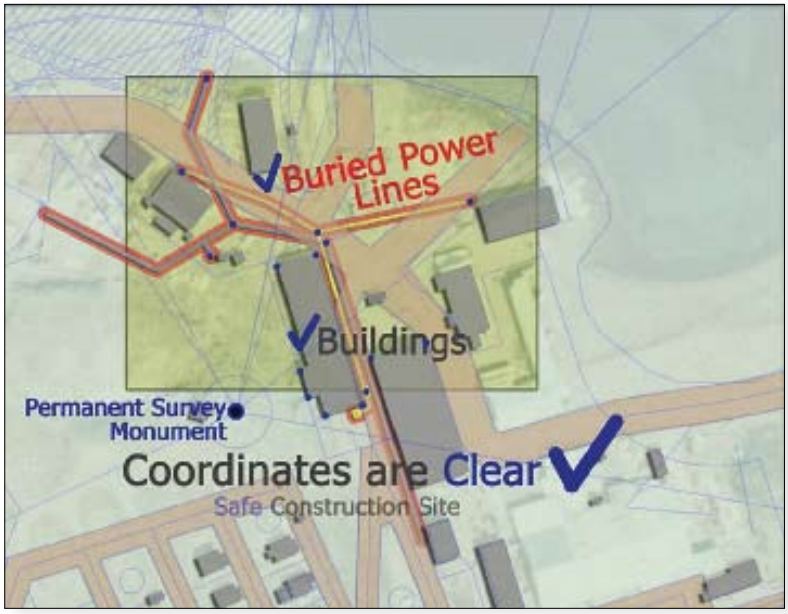
"The National Geodetic Survey has known for a long time that, eventually, we'll need to address the dynamic world around us," said Smith. "We realized this working with the California Reference System on the West Coast and with the Corps of Engineers in Louisiana. We know that their work can be greatly improved through more accurate, timely positioning information." Motion of the crust, glacial retreat, land subsidence, changing flood plain heights, these are all changes on a large scale, and responding to them in positioning is part of the new focus of NGS' new 10-year plan. This is not to say that local issues are not on their minds; they aim to help people measure accurately water withdrawal, say in Texas, and velocity issues in southwest Louisiana—because everything around us is in motion. It is the acknowledgement of this motion that's new in NGS' 2007 plan.

NGS believes that to become a leader in dynamic positioning and a leader in geospatial activities—the two goals of NGS in the next decade—it needs to modernize access to the National Spatial Reference System. For over two centuries, NGS has carried the responsibility of making sure that our government, our industry, our private businesses have access to the geospatial coordinates they need for their work—at the place of interest to them, at any time they need them, and at any accuracy they determine to be useful to them. "That goes to more than just where is my latitude and longitude or height," remarks Smith. "Some of our clients now need to know such things as acceleration of gravity at a particular location, for instance." This is just another coordinate for NGS, and Smith feels that they should be able to provide any coordinate that's needed in a more efficient way.

Technology is and will continue to be a major influence on how NGS modernizes. The American GPS, Russian GLONASS, and, looking to the future, the European Union's Galileo, have been playing an increasingly greater role in positioning. "Already in the 1994 plan, GPS positioning was given a prominent role in NGS' work, but most of that positioning was on passive marks in the ground," said Smith. Passive positioning will continue to be used for some time, but NGS would like to see us progressing toward a quicker, more accurate, more efficient access to the NSRS without surveyors and mappers having to visit passive marks.

Does this mean that NGS will do away with pas-

sive markers? "Certainly not!" Smith emphasized. "Passive markers will always have a role to play in positioning work. The danger, of course, is that the coordinates of the permanent markers may no longer be accurate. They might have been the known coordinates, say 10 years ago, but if the marker is in an area that's very dynamic, and it has not been revisited during the intervening time, then the likelihood that the coordinates are still valid is rather slim." In California, where the tectonic plates are constantly on the move, and in Louisiana, where there is measurable subsidence, the difference in the published and actual coordinates of a passive marker can be substantial, within a relatively short period of time. "We wouldn't be doing our job," said Smith, "if we did not give our clients and partners an alternate method for positioning themselves in such volatile areas—such as, tracking the motion of CORS (Continuously Operating Reference Stations) in an area, so that surveyors could survey themselves relative to velocity at the station on a given day." After Hurricane Katrina, it became clear that it's not enough to know how high the levies were when they were built, but by how much the land would sink over time.



PLANNING FOR THE FUTURE

The new long-term plan of NGS identifies five major areas of technical improvement needed to modernize the agency's response to the dynamic world in which it operates. The method by which these areas were identified is very instructive—methodical (like the agency itself) and collaborative. They started with a multitude of ideas put forth by all the six division chiefs of NGS, the director, the deputy director, the operations director, the branch chiefs, and all the managers. "At a minimum, thirty people had direct input into the plan initially," said Smith. Then, the pool was expanded to the approximate two hundred employees of NGS, and the draft produced was offered for comment in the public domain.

The plan was formulated pretty much in the order it is written now. "We did not move forward until we all agreed on what NGS' mission is," said Smith. It was critical to write down, black on white, who NGS is and how its mission defines the agency in terms of the mandate given it by Congress and the Executive Branch. The next step was to develop the vision—where NGS is and where it should be in the future in terms of its mission. Once the future was determined, they started thinking of how to achieve that future. "And, it's very interesting," remarked Smith, "that the ideas on how to do this naturally sorted themselves into five distinct categories." Three purely technical—modernizing CORS, improving gravity modeling, and migrating coastal mapping into an integrated ocean and coastal mapping program—and two that speak to the professionalism of NGS, namely, improving core capabilities and becoming a global leader in geospatial activities. All five were selected to effect "a change for the better."

MODERNIZING CORS

"A change for the better needs to be measurable," said Smith. "If we are able to increase the efficiency with which our partners and clients access the NSRS, in other words, enable them to do what they are doing today with our products and services more accurately and faster, then that's a measurable change. This pretty much means modernizing CORS, which may take the shape of expanding the satellite constellation supported or adding new equipment, or improving data processing and data formats, or creating what we started calling a "Foundation CORS." There was some concern that our CORS modernization may eventually lead to an end of CORS as it is now. NOT SO!"

The CORS program is one of NGS' most successful collaborative programs, the very essence of the agency's mandate. It's a model of how science,

CORS locations around the U.S. [www.oceanservice.noaa.gov]

technology, and partnerships can work together for the greater benefit of society. "We value OPUS (Online Positioning User Service) and OPUS RS (Rapid Static), and we value our CORS partners with whom we produce these products," said Smith. "Our vision is for our CORS partners to continue to be a strong component of the program, and growing stronger in the future."

However, NGS does have a legal responsibility to ensure that our Nation can connect to the NSRS efficiently, without downtime, and without gaps in coverage. Hence, Foundation CORS. In Smith's words, it will be the minimum that NGS has to have as a federal government agency responsible for maintaining access to the NSRS. "We have a responsibility from Congress to maintain such a foundation. This involves embracing the partnership, certainly. But in doing so, we also are obligated to sustain the program's capabilities, at all times, without gaps, should the unthinkable happen."

Foundation CORS is not meant to replace the CORS network; rather, make it stronger. For years, all with a stake in CORS have been asking questions such as, How many CORS stations do we need? What should be their spacing? What should CORS look like? Foundation CORS can an provide answer to some of these questions, by providing the most minimum access to the NSRS at all times. "For this to happen," said Smith, "we'll need a handful of stations to serve as Foundation CORS. These stations will be under government control; there will be guidelines to follow. NGS does not need to operate these stations directly; but, the type of data collected and the method of collecting them will be specified through memoranda of agreement, so that changes are not made without consultation.

NGS does not anticipate running current OPUS off the rather sparse Foundation CORS. But what the agency does want to do is modernize the CORS network by running certain stations as the network's foundation. These stations will have real-time data streaming capability, governed by rigid guidelines; they will be equipped with backup power, and there will be co-location with other geodetic sites. NGS would, for instance, also very much like to have an absolute gravity site in Foundation CORS in order to track gravity on a regular basis.

"These things may already exist on some sites, which makes them natural candidates for Foundation CORS," said Smith. Some partners may already be doing exactly what NGS needs to have this core positioning capability, and if they are in the right spot, then NGS would very much like for them to run their stations as part of Foundation CORS.

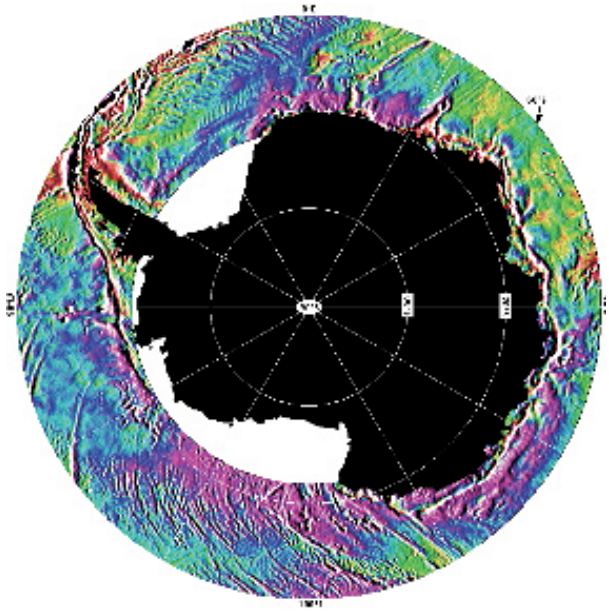
There is absolutely no plan to take any stations out of the network! "We now realize that the terms we used in the plan—"National CORS" and "Cooperative CORS"—are somewhat misleading," said Smith. "We also realize that the place where the data resides is not a reasonable way of categorizing CORS network stations. Foundation CORS will be CORS stations; they will be in the mix just like any other station. The only difference is that they will serve as a back up and the foundation for access to the NSRS."

Not surprisingly, foundation CORS stations are conceived to be the most advanced CORS sites possible, the showcases of NGS' cutting edge technological expertise. They will work to very specific sets of guidelines with regard to how the GPS signals are received and how the data is streamed to NGS; they will be equipped with the latest technology (real-time GPS, GLONASS and, eventually, Galileo receivers); and they will serve as examples of the research going into developing advanced CORS sites. Last but not the least, Foundation CORS will also have an important external component. Through Foundation CORS we'll tie the NSRS to the international systems, the ITRF (International Terrestrial Reference of Frames) or IGS. As a result, foundation CORS stations will be in geographical areas where they interact and strengthen the global reference frame.

Modernizing CORS is partly a technology issue, and partly a cooperative issue. There is also the issue of resources. Because of the growing size of CORS, NGS is already experiencing a crunch in day-to-day maintenance of the network. "Say, an antenna is switched on without informing us, or the data does not show up and we have no idea why that is so, or there are problems with the station itself. All this puts pressure on NGS to fix the problems," said Smith. If CORS grows by, say, 1000 more sites, OPUS-RS will become much better. At this magnitude, NGS will no longer be able to handle day-to-day station maintenance, and the responsibility will likely fall on station operators.

IMPROVING GRAVITY FIELD MODELING

Research on gravity is tied to research on heights. Using gravity field measurements, we can compute a model of the geoid. From the geoid we can



Gravity field over the Antarctic Ocean [www.ngdc.noaa.gov]

then compute metric data defining the sea level on flood plain maps. This in turn will increase the efficiency with which the orthometric height component of the NSRS is accessed through GPS. "The problem is," Smith remarked, "we have an imperfect theory about the way gravimetric measurements help model the geoid itself. We have been using "gravi-measurements" since the early 1800s—under a certain approximation. And that's the issue here—"under certain approximation." To this day, we still have certain approximations built into the mathematical equations that convert the measurements on the ground into a geoid." NGS feels it's long overdue that these approximations are either removed from the equations or defined to below a millimeter.

Perfect equations is only part of the issue, however, the other is, imperfect data. Because the Earth is dynamic, the gravity in some places has changed; and because terrestrial gravity has not been tracked consistently, we don't know by how much. According to Smith, the Nation is lacking in up-to-date, consistent terrestrial gravity measurements, especially along the coast.

With precise geoid modeling, NGS will be able to provide more accurate orthometric heights for mapping in flood prone areas. NGS has been collaborating with several state agencies on modernizing height measurements—in what has been called the "height mod program." There is clear national, scientific need to modernize the method of deriving orthometric heights—no one has an issue with this need. What is at issue is whether a national need should be financed by federal earmarks to states, or through some other funding mechanism coordinated by the government.

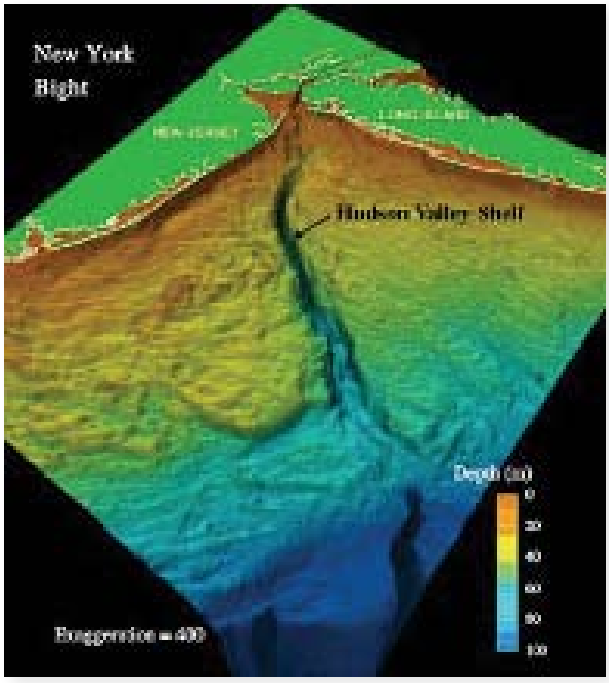
INTEGRATED OCEAN AND COASTAL MAPPING

The National Geodetic Survey has long had a mandate of delineating the official shoreline of the United States; the work of the Survey, and currently the Coastal Mapping Program within NOAA, has produced our national nautical charts. The national shoreline is part of the NSRS—as one more of its components, as another tool for consistent access to positions.

Modernizing this tool will mean utilizing digital cameras, rather than film-based photography, using LiDAR to collect elevation at the tide gauges, and improving gravity measurement. The objective in all this is to improve the hydro-dynamic modeling of the wet surface. Currently, this work is accomplished by a variety of different programs. To avoid duplicating effort, and save taxpayers' money, the new NGS plan envisages greater sharing of resources and data.

CORE CAPABILITIES

Since the establishment of its predecessor agency in the early 1800s, NGS has been looked upon as a leader in providing accurate coordinates on a point. According to Smith, "this is all about standards, specifications, and guidelines on how to measure these coordinates." One of NGS' goals over the



Basymetry of the coastal ocean in the New York - New Jersey metropolitan area [www.oceanexplorer.noaa.gov]

next decade thus is to introduce consistency in all its products and services, by improving its guidelines and field procedures and updating its manuals so that NGS' "partners and clients can all have consistent field procedures which embrace the latest technology and scientific research."

This will require improvements in NGS' core capabilities—in staffing, but also in such mundane areas as operating system. "An agency considered to be at the cutting edge of technological advancement should not be running geodetic information on DOS," Smith points out. "Another area is the Internet. There are so many ways to utilize it that we are not taking advantage of at the moment. We have a number of our existing tools written in valid but historically limiting languages; it would be beneficial to our clients and NGS if these programs were updated so that the data they provide can be shared through modern web services."

Imagine the efficiency of automatic updating of local databases through automatic linking to the NGS database—no manual requests, faster solutions! Or, how about improving the format in which NGS provides data. Currently, it's done using an 80-column ASCI text "data sheet." "I'm not saying that we should do away with this format," Smith points out. "There is a huge body of users outside NGS who know this format and have written programs to read it and do other things with it. So, we can't just turn it off all of a sudden, but we can start building new tools which would enable us to customize the data sheets to meet more of the clients' needs, and provide the information in the format they find most useful, say in XML or Google Earth language, KML.

The National Geodetic Survey is embarking on developing a questionnaire which would solicit opinions from clients and partners on these issues. The feedback will be evaluated during 2008, and recommendations considered to be most pertinent for modernizing NGS' data delivery formats will be implemented.

IMPLEMENTING A GLOBAL LEADERSHIP STRATEGY

In the 1970s and 1980s, NGS worked with some of the greatest, world-renowned geodesist of that time. The visiting scientists worked with NGS scientists, producing a body of truly ground breaking knowledge on positioning. Today, we have a continuing obligation, as a scientific agency, to be familiar with the international body of geodetic research. This includes embracing all GNSS systems (GPS, GLONASS, and Galileo to begin with), as well as evaluating their potential for our Nation. There are policy issues with all three systems; but that's not (and should not be) our concern. We won't achieve our goal of modernizing and adapting if we don't learn about, take part where appropriate in, or encourage other geodetic research.

"Our goal is to be a national leader in geodetic and geospatial issues, and as the leader on such issues, we need to strengthen our interaction with others," concludes Smith. "Hence, as part of our global leadership strategy, we plan to resurrect the visiting scientists program at NGS, send staff on sabbaticals, improve our publication record, become directly involved in international geodetic efforts—in other words, achieve critical international exposure by encouraging immersion in international geodetic endeavor.

A CHANGE FOR THE BETTER ..... WHO BENEFITS?

Surveyors and mappers are the classic customers of NGS. Environmentalists, weather and transportation experts, lawyers, and many others daily need accurate geospatial information in decision making. The number of agencies and companies who need accurate positional information is growing exponentially, as does public awareness of the phenomenon "accurate position." Statements such as, "I never knew I need to know my coordinates accurately in order to do my job properly," tell how pervasive this need is becoming. That's impact! To fill this need.