USGS National Hydrography Dataset Newsletter
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by Jeff Simley, USGS

NHD Management Team Annual Meeting

The high resolution National Hydrography Dataset first provided nationwide coverage in 2007, but this was just the beginning of the possibilities the NHD could provide for water science, resource management, and mapping. To better guide the development of these possibilities, an oversight team was formed called the NHD Management Team. The team's charter states "The NHD Management Team will provide the vision and direction of the NHD program based on the overall needs of the user community and within the basic resources that can be reasonably provided." The team is composed of three non-USGS federal agencies, two state agencies, and four USGS representatives. The NHD Management team meets twice monthly and once a year meets in person for an annual three day summit meeting. This year's annual face-to-face meeting was held in Reston, Virginia, December 9-11. A number of subjects were discussed. Three of those subjects are of particular importance.

<u>NHD Data Model:</u> The model used to implement the NHD has a long history, starting in the 1990's as a conceptual framework to the point where it stands today as an implementation in an ArcGIS geodatabase. This implementation has four basic objectives: (1) To represent hydrography features for use in a geographic information system, (2) to provide a change management system for these data as they are maintained, (3) to allow navigation through a flow network, and (4) to allow the linking of information to the hydrography features. These capabilities have all been successfully implemented in the ArcGIS geodatabase, which provides a relational database for representing features, relational tables for tracking the features, a geometric network for navigation, and a linear referencing system for linking information. Users of the NHD have been enormously successful at exploiting these capabilities to produce better science, resource management, and mapping.

However, the implementation has been necessarily complicated. On the one hand the model provides tremendous power to accomplish science, but on the other hand, the complexity of the model is an "Achilles Heel" to the NHD, making using and editing the NHD a less than simple task. It had been hoped that technology interface tools such as the NHD Update Tool would mitigate the complexity, but this has been difficult to achieve. There is also a situation where as moderate complexities interact, they can result in severe complexities. When this happens, a moderate error or series of errors can proliferate into a major problem. The current NHD data model both helps and hurts the NHD.

The NHD Management Team intends to investigate the development of a NHD model that can provide the necessary analytical power without being overly complicated. Doing this may mean going back to original concepts and taking a "clean slate" approach to the NHD. As an example, networking currently relies on flowlines, a series of linear elements connected together with flow direction to allow navigation through the resulting network. This is simple enough for "single-line" flowlines, but wider streams that require representation as polygons need artificial paths to create the network. In concept this in not particularly complicated, but it can degenerate into more complex situations that are difficult to enforce and maintain. Another complication is the need for the flowlines to be precisely connected together. Again, this is simple in concept, but often a challenge to make work in a GIS. Small gaps inexplicably creep into the data and disrupt the network. A potential solution is the use of nodes in a virtual network that don't have to physically connect. In such as case, a stream entering a lake would not need a linear artificial path to connect with an outlet, but rather connect between inlet and outlet through a virtual node connection. Another example is the linking of information, which currently relies on linear referencing and a scheme to use reach codes in the addressing system. In principle the use of reach codes is straightforward, but in practice the system can quickly degenerate as geometry is changed in maintenance. An alternate approach may be the use of drainage catchments to reference linked information.

To better explore the possibilities for a more streamlined data model implementation of the NHD, the NHD Management Team will form a subcommittee to investigate new data modeling techniques that will continue to support the basic analytical capabilities of the NHD.

Stewardship: The concept of the NHD has always revolved around a collaboration of data users coming together to build, manage, and maintain the data. From the very beginning of the NHD, users have immediately wanted to participate in improving the data. It is believed that the NHD is best maintained by those who know the landscape the best. Often this knowledge is provided by state agencies managing water resources in a particular area they are familiar with. This often involves federal land managers such as the U.S. Forest Service and the Bureau of Land Management. Data maintenance is also performed by the USGS in national-scope campaigns such as improving network integrity. To equip agencies that want to maintain and improve the NHD with a maintenance system, the USGS established a stewardship program. This grants authority to stewards to change the NHD through data maintenance. To do so they must undergo a training program and be granted access to the NHD Update Tool and the data checkout/checkin system.

The stewardship program works very well in some cases, only moderately well in other cases, and is not in place at all in many other cases. In other words, some parts of the country have wonderfully maintained and up-to-date NHD, while other parts of the country have received little or no attention. The disparity has not been a significant problem because the NHD is generally satisfactory throughout the nation. However, it is a situation that can be optimized. Of particular concern is the large number of users "in the middle." These are users who want and need to make updates, but for various reasons are not capable of mastering the NHD and the NHD Update Tool well enough to make edits or simply don't have the time or resources to make edits.

A potential solution may be to establish a team of NHD editing experts at the USGS that could perform edits on behalf of the stewards. The stewards, and perhaps the entire user community, could identify needed changes through a markup tool and the USGS editing team would then perform the edits based on priorities and resources available. At the same time, successful stewards would still have the ability to continue their processes.

The NHD Management Team will form a subcommittee to explore how data maintenance through stewardship can better be performed in the future.

Hydrographic Classification: Like the rest of mapping, hydrography is tasked with converting the real world into an abstraction that can be represented in a graphic, or more specifically in the case of GIS, into a set of database elements. One real world feature that can be hard to represent is a stream. That is because the water that is supposed to represent the stream can come and go. A stream is defined as "a body of flowing water." For a stream that flows perennially this is not a significant problem and such streams are usually mapped at "normal" bank-to-bank flows. For streams that flow intermittently this is a bigger problem. For part of the year there may be no water at all. None-the-less there is usually a channel incised into the landscape and that channel suffices for the stream. In the case where the stream flows ephemerally, that is infrequently, the case for the stream remains important for many users, and the incised channel again suffices for the stream. For a big part of the NHD these conditions were field checked when the original topographic maps were made and it was known that there was a record of water in the streams. Over the years those flows overall have not changed.

The problem is that now new streams are coming into the NHD for which there is no knowledge of water permanence. Although it can be inferred that there must be water, it is not known if these streams are perennial, intermittent, or ephemeral in flow. Because the degree of water permanence is known in almost all of the NHD to a generally good level of accuracy, water science has been able to take advantage of this to accurately model landscapes and ecosystems. Now many new streams are recorded simply as a stream with no permanence classification. When some of these streams are examined on aerial imagery, there is barely any evidence of a channel. Sometimes it's just damp soil in a cornfield. Scientists have to know to what extent these are actually streams. Cartographers have to know whether a user on the landscape will actually encounter a stream as depicted on the map.

The challenge to the NHD is to come up with a scheme that will faithfully represent what is known about the flowline. To date, attempts to fulfill this requirement have not been fully acceptable. However, a solution must be put in place now, before too many unclassified streams degrade the value of the NHD. The NHD Management Team will form a subcommittee to implement a method soon.

Mapping Alaska's Water, hydrography challenges in the last frontier by Kacy Krieger

The Alaskan landscape, rugged, diverse and complex, is home to some of the highest and largest mountain ranges and flattest regions of the U.S. It is also a landscape defined by water. Alaska's water resources account for nearly 40 percent of the nation's surface water. There are more than 12,000 named streams and rivers stretching nearly 1,370,000 km (850,000 miles), three million mapped lakes, expansive snowfields, more than 600 named glaciers and an estimated 100,000 glaciers scattered across the state. Alaska's mapped coastline measures more than 75,600 km (47,000 miles) long. The state's longest river, the Yukon, is the third longest river in the nation, and measures nearly 2000 miles from its headwaters in Canada to its massive delta that empties into the Bering Sea. Despite the abundant water resources, the ruggedness and vast size of the state has proven to be a challenge in maintaining modern, accurate hydrography.

Harsh terrain, remote locations, rapidly changing landscapes and coastlines, seasonal extremes, dense cloud cover, tidal ranges, complex braided channels, expansive wetlands, and subsurface flow further challenge efforts to map the state's water. Compared to other states, Alaska lags behind. While consistently mapped at 1:24,000 or better in the contiguous U.S., the NHD in Alaska was taken from 1950s-era USGS Historical Topographic Maps at 1:63,360-scale, and has seen few improvements or enhancements over the years. The dataset contains many errors including streams outside their channels, misrepresentations of flowlines, disconnected streams and omission of existing streams.

Many of these issues stem from a lack of statewide coordination on mapping and funding in the past. Hydrography editors from multiple agencies are scattered across a vast and diverse state, each having worked to fulfill their agency's business needs, but not necessarily working to adopt or enhance the NHD. This has resulted in numerous statewide, regional and local hydrography datasets being created, managed, distributed and used over a number of years. Given the current hydrography situation in Alaska, there is a pressing need in the state to correct these issues and improve the NHD to meet the needs of federal, state, and local agency partners. Current efforts are bringing together key partners and consolidating efforts, but a lot of work remains to effectively and accurately map Alaska's water.

To learn more, contact Kacy Krieger, Alaska Hydrography Coordinator, kacy.krieger@uaa.alaska.edu

NHD and WBD Web Site by Dave Arnold

The public hydrography site for the National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD) is located at: http://nhd.usgs.gov. This site includes pages related to both the NHD and

WBD including, current and archived NHD Newsletters and Photos of the Month, a Frequently Asked Questions section, and a status page for projects the USGS is currently working on that will improve the NHD. The Get Data section instructs visitors on the various methods to download NHD and WBD data for use with GIS software. The User Resources section provides a number of fact sheets about hydrography, diagrams of both the NHD and WBD data models, and a user guide and feature catalog. Site visitors can also download tools and utilities to use with the hydrography data, find contact information for both state stewards and USGS representatives, and contact the USGS at nhd@usgs.gov with general questions or to inquire about becoming a hydrography steward. As a reader of the NHD Newsletter and likely user of the NHD and WBD, we would like to reach out to the community for any suggestions, improvements, or additions you believe might be valuable to this site. If you have input you would like to share, please contact Dave Arnold at darnold@usgs.gov.

New Members of USGS Hydrography Staff

Hello! My name is Ryan Teter and I am a Colorado Native. I earned a Bachelor's of Science in Land Use with a concentration in Geographic Information Systems from Metropolitan State University of Denver in May 2014. Previously, I earned a two Associate's Degrees in Psychology and Outdoor Education. I served in the active duty US Army from 2004 to 2006 as a tanker, and I have served as a paratrooper in the Colorado Army National Guard since then. I deployed in support of Operation Iraqi Freedom from 2007 to 2008. My girlfriend Lisa is a resident at Saint Anthony's North Hospital. We share a passion for rock and ice climbing, mountaineering, backcountry skiing, and photography. We live in Edgewater, Colorado with our mutt Gundy. I am very excited to be working here!

My name is Tanya Buxton Torres and I am excited to join the NGTOC team! In addition to working with GIS, I have a multidisciplinary science background including environmental biology, marine biology, fisheries science and management, and sustainable resource management. I was born at the US Air Force Academy in Colorado but being a military family we moved around frequently. After graduating from high school in Fairfax, VA I returned to Colorado to attend the University of Colorado Boulder where I received degrees in Biology and Psychology. I found my way to Costa Rica where I lived for five years working as an environmental consultant, research assistant and scuba diving instructor/dive safety officer. I then attended Nova Southeastern University's Oceanographic Center in Florida while working for the International Game Fish Association where I collaborated with individuals across 94 countries. After years of field work and project assistance I understood the importance of integrating geospatial analysis in ecological research and decided to complete a Master's Degree in Environmental Science and specialize in GIS. My husband and I love to travel and spend time in the mountains camping, hiking and skiing/snowboarding. We are both professional scuba divers and although we no longer work in the industry we love to travel to new dive destinations.

Network Improvement Project Status by Cynthia Ritmiller

Highlights:

- New employee Ryan Teter will be working on Alaska.
- Region 6 is in the final process of Double checks. Only 1 of the 4 subregions requires edits.
- Several regions (03, 06, and 16) have only one or two subbasins left in work.
- Region 19 is the final Initial phase Network Improvement Region in work and is being edited as part of preparing the Alaska Hydro Image Integration project.
- Preparation of the NHD Geodatabase for the NHDPlus contract is occurring in Region 01, 06, and 12.

Initial Network Improvement Regions Completed:
01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, and 22.

Initial Phase Network Improvement – Remaining

Region 19 (Alaska) is being completed by Charles Bowker and Ryan Teter as part of the Hydrographic Image Update project using the 2012 Horizon Systems QA/QC check results.

Double Check Network Improvement Regions Completed:
01, 02, 06, 07, 09, 12, 13, 14, 15, 18, 20, and 21.

Double Check Phase Network Improvement- Status

- Region 01- Cynthia Ritmiller has fixed sub-Basin 01080103 (Job 57687), this job required population of the Reach Code Maintenance and Reach Cross Reference tables. The remainder of Sub-Region 0108 has about 1,500 lakes without reach codes and these Sub-Basins will need to wait for a new tool update before assigning.
- Region 02- new pre-staged Sub-Regions were received and QA/QC checks will need to be run. Subbasins will then be assigned.
- Region 03- sub-basin 03070205 needs to complete the Double Check phase. All other subbasins have been completed.
- Region 04-needs to go through the Double Check phase. Before starting a Region the POC in the area will be contacted.

The Network Value Added Attribute of the Month

Do you know your VAA's? This NHD Newsletter article is the eleventh in a series to describe each of the Network Value Added Attributes. The flow network embedded in the NHD is what gives the NHD its analytic power. The Network VAA's boost this power by pre-calculating a number of network characteristics to make network analysis richer and easier to exploit. This month will examine ArbolateSum.

ArbolateSum takes advantage of the LengthKM field in NHDFlowline, which measures the length of the flowline in kilometers. By accumulating all the upstream flowlines, the lengths can be added to provide a grand total of the upstream drainage network from the bottom of the current flowline. This is the ArbolateSum.

NHD Photo of the Month

This month's photo is by Mason Lacy. See ftp://nhdftp.usgs.gov/Hydro_Images/Havasu_Creek.jpg. It is a picture of his brother Spencer Lacy paddle boarding Havasu Creek in the Grand Canyon. According to StreamStats, the drainage basin for Havasu Creek is 2,551 square miles with mean annual precipitation of 14.2 inches and a mean basin elevation of 6,030 feet. StreamStats also calculates that the drainage basin has a total of 5,040 miles of streams with an average density of 1.98 miles of stream per square mile. Submit your photo for the NHD Photo of the Month by sending it to jdsimley@usgs.gov.

November Hydrography Quiz / New December Quiz

Michael Wiedmer of the University of Washington was the first to guess the November NHD quiz as Pearl Harbor on Oahu in Hawaii. See ftp://nhdftp.usgs.gov/Quiz/Hydrography112.jpg. Michael formerly worked for the Alaska Department of Fish and Game. He is now conducting research in the College of the Environment of the University of Washington in Seattle. He is lead author on the paper "Late Quaternary megafloods from Glacial Lake Atna, Southcentral Alaska, U.S.A." published in the journal Quaternary Research. The paper's research indicates that one of the largest fresh-water floods in Earth's history happened about 17,000 years ago and inundated a large area of Alaska.

Others with the correct answer (in order received) were: James Sherwood, Dan Saul, John Lynam, Jim Seay, John Kosovich, Jeff Dietterle, Roger Barlow, Steve Shivers, Matt Rehwald, Jonathan Mulder, Myra McShane, Bruce Nielsen, Gerry Daumiller, Dennis Dempsey, Donna Knifong, Nick Salcedo, Evan Hammer, Ed Clark, Drew Decker, Chuck Johnson, Janet Kellam, Chris Morse, and Kent Barbara.

This month's hydrography quiz can be found at ftp://nhdftp.usgs.gov/Quiz/Hydrography113.jpg. This is a new twist on the quiz. The objective is to determine the drainage area flowing into Lake Dillon in Colorado. Finding the answer is fairly easy using StreamStats, but one has to know the basic procedure. This is multiple choice. Answer's are: (1) 556 mi^2, (2) 498 mi^2, (3) 452 mi^2, (4) 385 mi^2, or (5) 334 mi^2. Send your guess to jdsimley@usgs.gov.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.
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The NHD Newsletter is published monthly. Get on the mailing list by contacting jdsimley@usgs.gov.
You can view past NHD Newsletters at http://nhd.usgs.gov/newsletter_list.html
Jeff Simley, USGS, assumes full responsibility for the content of this newsletter.