NHD Plus – the Evolution of a Surface Water Geofabric

July 22, 2015
ESRI User Conference
San Diego, CA

National Hydrography Dataset Plus News
Overview

- Concepts
- Data
- Tools
- Applications
- Resources
But first, some fun with water ...

**Question:** Explain one of the processes by which water can be made safe to drink.

**Answer:** “Flirtation make water safe to drink because it removes larger pollutants like grit, sand, dead sheep and canoeists.”

**Question:** How is dew formed?

**Answer:** “The sun shines down on the leaves and make them perspire.”

**Question:** What causes the tides in the oceans?

**Answer:** “The tides are a fight between the earth and the moon. All water tends to flow towards the moon, because there is no water on the moon, and nature hates a vacuum. I forget where the sun joins in this fight.”

**Question:** Where is the water at any point in time?

**Answer:** “We’re still working on that … here’s what we have so far.”
Acknowledgements

- NHDPlus Team
  - Tommy Dewald / EPA Office of Water
  - Cindy McKay / Horizon Systems Corporation
  - Tim Bondelid / Consultant
  - Al Rea / USGS National Geospatial Program
  - Craig Johnston, Rich Moore / USGS Water
  - (Greg Schwarz, Kernell Ries, Dave Wolock / USGS Water)
The NHD*Plus Team (with friends)
The **National Hydrography Dataset** is the Foundation

The NHD is comprised of the surface water features found on topographic maps combined to form a stream network with addresses.
NHDPlus – integrates the ...

National Hydrography Dataset (NHD)

Watershed Boundary Dataset (WBD)

National Elevation Dataset (NED)
NHDPlus (National Hydrography Dataset Plus)

Developed by USEPA and USGS–Water to provide flow volume and velocity estimates for pollution dilution modeling on the NHD network

- Primary ingredient datasets
  - National Hydrography Dataset
  - National Elevation Dataset
  - Watershed Boundary Dataset
- Additional stream attributes include
  - stream order
  - flow volume and velocity
- Catchments and attributes
  - precipitation
  - temperature
  - land cover
  - large user-developed collection
- Flow direction and accumulation grids

Catchments tie the landscape to the stream network forming a ‘surface water geofabric’
An Evolving Surface Water Geofabric

<table>
<thead>
<tr>
<th></th>
<th>EPA/USGS-W</th>
<th>EPA/USGS-W</th>
<th>USGS-M</th>
<th>USGS-M</th>
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<tbody>
<tr>
<td>Integrated Geofabric</td>
<td>1982</td>
<td>2012</td>
<td>5-10 yrs?</td>
<td>10-15 yrs?</td>
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<tr>
<td>RF1</td>
<td>Med Res</td>
<td>High Res</td>
<td>NHDPlus</td>
<td>NHDPlus</td>
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<td>NHDPlus V2</td>
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**Base Layers**

- *Network (NHD)*
  - *500k*
  - *100k*
  - *24k or better*

- *Elevation*
  - *100m*
  - *30m*
  - *10m*
  - *3m*

- *Hydrologic Units (WBD)*
  - *24k or better*

(*24k or better = patchwork quilt that includes LiDAR-based data)
NHDPlus – Data News

- Completed – HI, USVI, Puerto Rico
- Under development
  - Pacific Trust Territories (Guam, American Samoa, Northern Mariannas)
  - Time of travel estimates
  - Denormalized Vector National Seamless FGDB pilot
- Assessing feasibility – Alaska for Matsu, Kenai and other areas with water quality impairments
... Streamflow Estimates

* Completed
  * 30Yr mean annual flow and velocity
  * 30Yr mean monthly flow and velocity

* Under development
  * 7Q10 flows (evaluating different regionalized estimation techniques in FY15–16)
  * Mean daily flows (planned by USGS Water Census)
  * Forecasting future flows (substituting forecasted streamflow estimation model inputs)
  * Open Water Data Initiative – National Flood Interoperability Experiment pilot

* Open for discussion
  * How can we improve our stream characteristics?
NHDPlus – Tool News

* Script that confirms available updates to your local NHDPlus holdings
* Desktop tools – data prep script, navigation, watershed delineation, and catchment attribute allocation and accumulation (CA3T)
* Web Services
  * EPA – ESRI mapping and analytical services including navigation, watershed delineation and report
* Open Water Data Initiative pilot
  * ESRI and open source mapping services with flow direction and network/non-network flowline breakout for denormalized vector seamless FGDB
  * Analytical services are up next
Planned Cloud-based Scalable Performance
Email poll (4/17/2013)

Please send us a simple one line description for each of your NHDPlus applications. Within a week, we received 50 responses from the following organizations describing over 100 applications.

- EPA – HQ (6), regions (6), labs (4)
- USGS – HQ & Water Science Centers (6)
- Other feds – COE, NOAA, USFS, NPS,
- States (6)
- NGO – Nature Conservancy (4 offices), Conservation Fund Institute
- ESRI

Technical support requests (5/2013 – 9/2014)

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<td>com</td>
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<td>edu</td>
<td>27</td>
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<td>us (state)</td>
<td>10</td>
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<tr>
<td>org</td>
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<td>mil</td>
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</tr>
<tr>
<td>total</td>
<td>81</td>
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</table>
Google It!

- Text search for 'nhdplus' found 'About 15,400 results’
- Images search for 'nhdplus’ found a rich collection ...
How is NHDPlus Being Used?

* Classic applications
  * EPA National Aquatic Resource Surveys
  * EPA Reporting on water quality
  * EPA Pesticide risk assessments
  * USGS SPARROW water quality modeling
  * DTRA ICWater spill response

* Others
  * Open Water Data Initiative
  * South Carolina Stream Assessment
  * Idaho Lake Monitoring Plan
EPA National Aquatic Resource Surveys

*NHDPlus* serves as the basis for establishing the NRSA and NLA survey sample frames – from which a representative set of sample sites are randomly selected. >>

<< *NHDPlus* is also used to support data analysis, such as delineating drainage areas and associated attributes for sampled sites.

Drainage Area = 114.24 km²
NLCD 2001 Land Cover:
- Residential = 7.86 km²
- Forest = 86.42 km²
- Agriculture = 12.64 km²
- Wetlands = 7.32 km²

(epa.gov/type/watersheds/monitoring/aquaticsurvey_index.cfm)
How much surface water have we assessed in the continental United States?

- Coastal: >35,000 square miles
- Lakes: >110,000 lakes
- Rivers/streams: >1.9 million miles
- Wetlands: >62,000,000 acres

EPA National Aquatic Resource Surveys

Comprehensive, consistent, and statistically-valid assessments
Coastal Assessments

National Coastal Condition Report III

SPARROW results are useful in evaluating load assessments to receiving waters

Predicted Nitrogen Load (kg/year) Delivered to Long Island Sound from States within the Connecticut River Watershed

(rgrore@usgs.gov)
Clean Water Act Section 303(d) Performance Measures
Modeling Possible Effects on Endangered Species from Pesticide Use

Chemical X Input (any stream with use)
Chemical X Downstream (exceeds threshold)
Chemical X
West Virginia Chemical Spill Response

**Model velocity**

**Measured velocity**

Discharge, cubic feet per second

Most recent instantaneous value: 41,200 01-13-2014 11:00 EST

Stream velocity, feet per second

Most recent instantaneous value: 3.07 01-13-2014 11:00 EST

USGS 0319000 KANAWHA RIVER AT CHARLESTON, WV

USGS 0319000 KANAWHA RIVER AT CHARLESTON, WV

West Virginia

Spill site

Intake

**Model velocity**

(william.b.samuels@leidos.com)
Open Water Data Initiative
- Use Cases -

**Use Case 1:**
National Flood Interoperability Experiment

**Water Supply**
- Flood - Jefferson City, MO

**Use Case 2:**
Drought Water Supply Decision Support

**Water Quality**
- Drought - Texas
- Chemical Spill – Charleston, WV

**Use Case 3:**
Spill Response

Subcommittee on Spatial Water Data
South Carolina Stream Assessment
Conservation Planning Tool

Downstream Cumulative Effects
(Spatial View)

Watershed
- Green: Upstream
- Orange: Modified
- Green: Downstream

Stream Order: 1
Area: 86
Cumulative Area: 86
Dams: 1 (1)
Cultivated: 45% (45%)
Precip: 1217 (1217)

Stream Order: 2
Area: 89
Cumulative Area: 256
Dams: 0 (3)
Cultivated: 2% (26%)
Precip: 1220 (1219)

Stream Order: 2
Area: 106
Cumulative Area: 522
Dams: 1 (6)
Cultivated: 30% (31%)
Precip: 1196 (1212)

Stream Order: 1
Area: 160
Cumulative Area: 160
Dams: 2 (2)
Cultivated: 40% (40%)
Precip: 1208 (1208)

Dams
- Number of dams (count)

Cultivated
- Areas used for production of crops (% area)

Precip
- Annual Precipitation (mean mm)

Ex: Cumulative Cultivated %
C1: 31% X 81 = 25.11
C2: 45% X 86 = 38.7
C3: 02% X 89 = 1.78
C1 + C2 + C3 = 65.9/256 = 26%
C4: 40% X 160 = 64
C5: 30% X 106 = 31.8
C1 + C2 + C3 + C4 + C5 = 161.39/522 = 31%

(scottm@sc.dnr.gov)
Developing a Strategic Lake Monitoring Plan
Idaho Department of Environmental Quality

NLCD (2000) Land Use Description

<table>
<thead>
<tr>
<th>Land Use Description</th>
<th>Disturbance Rank</th>
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<tbody>
<tr>
<td>Barren Land (Rock/Sand/Clay)</td>
<td>0</td>
</tr>
<tr>
<td>Cultivated Crops</td>
<td>3</td>
</tr>
<tr>
<td>Deciduous Forest</td>
<td>0</td>
</tr>
<tr>
<td>Developed, High Intensity</td>
<td>4</td>
</tr>
<tr>
<td>Developed, Low Intensity</td>
<td>2</td>
</tr>
<tr>
<td>Developed, Medium Intensity</td>
<td>3</td>
</tr>
<tr>
<td>Developed, Open Space</td>
<td>1</td>
</tr>
<tr>
<td>Emergent Herbaceous Wetlands</td>
<td>0</td>
</tr>
<tr>
<td>Evergreen Forest</td>
<td>0</td>
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<tr>
<td>Grassland/Herbaceous</td>
<td>0</td>
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<tr>
<td>Mixed Forest</td>
<td>0</td>
</tr>
<tr>
<td>Open Water</td>
<td>0</td>
</tr>
<tr>
<td>Pasture/Hay</td>
<td>2</td>
</tr>
<tr>
<td>Perennial Ice/Snow</td>
<td>0</td>
</tr>
<tr>
<td>Shrub/Scrub</td>
<td>0</td>
</tr>
<tr>
<td>Woody Wetlands</td>
<td>0</td>
</tr>
</tbody>
</table>

Final Upstream Accumulation Catchment Area with NHDFlowlines

(jim.szpara@deq.idaho.gov)
NHDPlus Resources

Web site (on the move to EPA Drupal environment)

• User Guide
• Exercises
• Web-based training (under development)
• Data and metadata
• Core tools and web services
• Applications directory with contacts (share your work!)
• Presentations
• Technical support and application consultation

On the Web – Google …

• ‘nhdplus’ for data, tools, documentation
• ‘epa waters’ for EPA applications, web services
NHD Plus – Other News

* New USGS–EPA Memorandum of Understanding formalizes shared maintenance of NHD, NHD Plus & WBD

* Leveraging partner contributions
  * EPA Office of R&D catchment attributes
  * USGS–Water network updates
  * USGS–NGP production tool improvements

* Medium and High Resolution NHD Plus
  * Same core production team
  * Improvements to existing production tools (including data model) for high res NHD Plus will benefit any future medium res production
  * Planning for same data model
Upcoming Events

* JAWRA Issue on Open Water Data Initiative
  * Fall 2015
* National Water Quality Monitoring Conference
  * May 2016 – Tampa, FL
* EPA Total Maximum Daily Load Workshop
  * Jun 2016 – Shephardstown, WV
* ESRI User Conference
  * Jun–Jul 2016 – San Diego, CA
* AWRA Specialty Conference on GIS and Water Resources
  * Jul 2016 – Sacramento, CA
Ruth Patrick (1908–2013) was a pioneer in studying the health of freshwater streams and rivers who laid the scientific groundwork for modern pollution control efforts. She thought that, ultimately, the reason for studying all this was to help to improve human life and the life of the natural world.

Questions?
(We welcome your ideas and feedback)