Arc Hydro in ArcGIS Pro: The Next Generation of Tools for Water Resources

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Topics

• Definitions
• Review of core hydro tools
  - Difference between “hydro” and “Arc Hydro”
• What is Arc Hydro?
• Arc Hydro Pro development plan and status
• What’s new with Arc Hydro
• Getting involved
• Questions
Hydro Analysis in ArcGIS is used to model the flow of water across a surface.

What are the primary objectives of hydrologic analysis in a GIS?
- Extract hydro information and drainage system characteristics from a digital elevation model.
- To know where the water comes from, and where it is flowing to.
GIIS for Hydro Modeling “Cycle”

- **GIS** is used for landscape characterization and model parametrization.
- **Hydrology and Hydraulics (H&H)** is used for determination of flows, depths and velocities.
- **GIS** is used for result postprocessing and visualization.
- **GIS** and H&H modeling are closely connected as one impacts the other... and many arrow in between
Review of Core Hydro Tools
Hydrology Tools

ArcMap / ArcGIS Pro

ArcGIS Pro

ArcGIS Image Server
Fill
Fills sinks in a surface raster to remove small imperfections in the data.

- Remove smaller imperfections and noise in surface raster.
- Remove larger sinks and pits in the terrain.
- Provide depth filter using Z-Limit.
Flow Direction: D8
Create a raster of flow direction from each cell to its steepest downslope neighbor using D8 method.

D8 Method
Flow Direction: D-Infinity

Creates flow direction as the steepest downward slope on eight triangular facets formed in a 3x3 cell window centered on the cell of interest.

- D-Infinity best for modeling distributed hydrologic processes, such as runoff generation or erosion.

Flow Direction: Multiple Flow Direction (MFD)

- Better flow accumulation maps in low-relief areas
- Flow partitioning is adaptive to local terrain conditions.

Flow Accumulation

Creates a raster of accumulated flow into each cell. A weight factor can optionally be applied. Select from D8, D-Infinity or MFD flow methods.
Flow Distance

- Compute vertical/horizontal downslope distance to streams over single or multiple flow paths.
- Supports D8, D-Infinity and MFD algorithms for computing flow distance.
- In case of multiple flow paths, minimum, weighted mean, or maximum flow distance can be computed.
- Used in computation of Height Above Nearest Drainage (HAND). Flooding occurs when water depth is greater than HAND.
Watershed
Determines the contributing area above a set of cells in a raster.
Ready-to-use services on ArcGIS Online: Create Watershed & Trace Downstream
How to Use the Analysis Services
In ArcGIS Online
National Water Model

Flows and anomalies

• Mid-range (10 days ahead)
• Short-range (18 hours ahead)
• Velocity estimate added
• New, more scalable architecture
What is Arc Hydro?
“Provide practical GIS framework for development of integrated analytical systems for water resources market.”
**Brief History**

1999 – 2002

- Project to demonstrate geodatabase capabilities in water resources.
- Worked with Dr. David Maidment at the University of Texas.
- Focused on the Arc Hydro Data Model.
- Released in 2002 as a data model, a toolset, and an Esri Press book (Arc Hydro).
  - Initial set of ~ 30 tools (8.3) developed by Esri (PS) as a complement to the data model.
Brief History

Since 2003:

- **Arc Hydro tool development through projects.**
  - This added ~300+ tools over the years.
- **Tool maintenance** (version updates, move to Pro, etc.).
- **User support** (Web pages, GeoNet, response to emails, etc.).
  - [https://community.esri.com/community/gis/solutions/arc-hydro](https://community.esri.com/community/gis/solutions/arc-hydro)
- **Training classes** (managed as standard Esri training and are delivered by PS).
- **Arc Hydro Groundwater**
  - Added in 2007.
  - Aquaveo provides extensions (fee) and support
Arc Hydro Tools Summary

Functionality Grouping

Foundation

- Administration
  - ID mgmt.
  - QA
  - Configuration

- Terrain preprocessing
  - Streams
  - Sinks
  - Flow patterns

Living Atlas

- Watershed delineation
- Downstream tracing
- Floodplain delineation

Customer Specific

- Nebraska DNR
- USFS GRAIP-Lite
- Illinois DNR

Scientific model integration

- HEC-HMS
- HEC-RAS
- ICPR

General implementation domains

Watershed delineation

- Watershed
- Sub-watershed
- Batch processing

Floodplain delineation

- Streams
- Lakes
- Forecast

Watershed characterization

- Pollutant loads
- Impervious areas
- Runoff characteristics

Stormwater

- Built infrastructure
- Surface drainage
- Connectivity
Arc Hydro Tools Key Concepts

- Build foundation for **analytical** capabilities
  - Start with landscape (e.g. terrain)
  - Identify drainage patterns
  - Define necessary characteristics
  - Define node-link representation
  - Support scientific/engineering models (I/O)

- While maintaining spatial and referential integrity (collocation, IDs, vector/raster references, remove redundancy in processing, …)
Product Capability Summary

• “No fee” downloadable offerings:
  - Data model
  - Tools
  - Workflows
  - Documentation
  - Available now:
    - ArcMap tools - all versions up to 10.7.1
    - Pro tools - all versions up to 2.4
    - Web services in the Living Atlas

• Optional offerings:
  - Training (paid)
  - Consulting (paid)

- Average of 1000 views per month of the download page
Arc Hydro Data Model and Tool Development General Approach

Water Resources

Arc Hydro

Floodplain

WQ

Permitting
Arc Hydro Users

- Fed / State / Local Government
  - USGS, FEMA, NWS, EPA, …
- Water Management Districts
- Defense / Intelligence
- Private consultants
  - Engineering companies
  - Hydro professionals
- Anyone involved in water resources / environmental activities
Arc Hydro Adoption Over the Past 15+ Years

- Arc Hydro: ~ 1,000 views/downloads per month
- Projects: ~ 100 projects for Arc Hydro-related work
- Training: over 1,600 customers reached through ~120 classes for Arc Hydro and H&H on 4 continents

2019 Projects (PS)
- NWS/NWC – NWM-based floodplain modeling
- EPA/USFS – GRAIP Lite (watershed scale erosion assessment)
- Missouri DNR – modernization of tracing and characterization services
- Novel-T (Switzerland) – custom training
Arc Hydro Pro Development Plan and Status
Key Driver

- Enable our users to efficiently use Arc Hydro within their organization and workflows
  - Simplify
  - Streamline
  - Advance
  - Document
  - Disseminate
  - Engage
Arc Hydro Tools Summary

Pro Implementation Status
Baseline Critical Functionality

Network dependency
Green = None
Light Yellow = Some
Red = Show stopper

- ID mgmt.
- QA
- Configuration

- Streams
- Sinks
- Flow patterns

- Watershed delineation
- Downstream tracing

- Watershed delineation
- Sub-watershed
- Batch processing

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- Nebraska DNR
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- Illinois DNR

- HEC-HMS
- HEC-RAS
- ICPR

- Customers Specific

Scientific model integration

Living Atlas
Arc Hydro Pro Transition Activities

• Design
  - GN replacement tools (Trace Network).
  - Updated workflows.

• Tool categories
  - Terrain preprocessing.
  - Floodplain delineation.
  - Watershed delineation.
  - Watershed characterization.
  - Modeling / model integration.

• Documentation
  - Tools.
  - Processes.

• Programming
  - Python first
  - Open source
  - Systematic programming framework

• Testing
  - Tools.
  - Processes.
  - Release.

• Release
Arc Hydro Pro Release Plan Overview
Baseline Critical Functionality – 244 tools

- Activities synchronized with core development teams.
  - Trace Network, Spatial Analyst
- Beta release – February 2020 (FedUC)
- Full release – July 2020 (UC)
- Continuing maintenance and transition of other Arc Hydro tools not in the Baseline Critical Functionality release – continuous past July 2020
## Arc Hydro Applicability Matrix

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<th>Watershed delineation and character.</th>
<th>Stormwater</th>
<th>Wetlands</th>
<th>Hydrology</th>
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<th>Flood</th>
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Arc Hydro Demo
Presenter(s)
What’s New with Arc Hydro
What’s New With Arc Hydro

- Stormwater (not so new – already in Pro)
- Wetlands identification model (already in Pro)
- Floodplain analysis and tie into forecasting (NWM) and impact analysis
Stormwater Concepts

- Two “systems” in play:
  - Collection system – takes overland flow and places it into the conveyance system.
  - Conveyance system – takes the collected water and moves it through
- Overland flow does NOT interact with pipes directly

- These systems interact through open channels and inlets.
Stormwater delineation - pipe

Global (in the pipe)

Local (same as land)
Stormwater delineation - stream

Global

Local
Wetlands Identification Model

- Machine learning approach to wetlands identification using geomorphological characteristics based on Lidar-derived DEM
Wetlands Identification Model

71% of wetland area detected

31% of wetland area detected

High detection of depression-like features that are not wetlands*
Flood Impact Forecasting

WHEN:
National Water Model

WHERE:
Arc Hydro Tools

WHO:
Local County GIS Data
WHO: Flood Impact Short Range Forecast Ops Dashboard

Affected Population: 1,244
Residential: 482
Commercial: 108
Industrial: 4
Other: 39

Forecast Time: 4/26/2023, 8:00 AM
Forecast End: 4/27/2023, 1:00 AM

Dave Sekkes, Chester County EOC
Getting Involved
Getting involved

- Arc Hydro GeoNet: https://community.esri.com/community/gis/solutions/arc-hydro
- archydro@esri.com
- ddjokic@esri.com

- Soon to be released industry pages for Arc Hydro and water resources
Work in Progress

• Goal for Pro 2.6 (summer 2020)
  - Completion of code transfer for baseline capability
  - Model integration (HEC-RAS, HEC-HMS, ICPR4)
  - Floodplain and impact assessment tools and workflows
  - Documentation, documentation, documentation
    - Getting started with Arc Hydro
    - Domain specific workflows, docs

• Prioritization of further updates
  - Talk to us!!!
Questions?
Print Your Certificate of Attendance

Print Stations Located in 150 Concourse Lobby

**Tuesday**
- 12:30 pm – 6:30 pm
  - Expo
  - Hall B
- 5:15 pm – 6:30 pm
  - Expo Social
  - Hall B

**Wednesday**
- 10:45 am – 5:15 pm
  - Expo
  - Hall B
- 6:30 pm – 9:30 pm
  - Networking Reception
  - Smithsonian National Museum of Natural History
Please Share Your Feedback in the App

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Select the session you attended

Scroll down to “Survey”

Log in to access the survey

Complete the survey and select “Submit”