Arc Hydro Tools Overview

Version 1.2, April 2007

ESRI 380 New York St., Redlands, CA 92373-8100, USA • TEL 909-793-2853 • FAX 909-793-5953 • E-MAIL info@esri.com • WEB www.esri.com

Copyright © 2007 ESRI
All rights reserved.
Printed in the United States of America.

The information contained in this document is the exclusive property of ESRI. This work is protected under United States copyright law and other international copyright treaties and conventions. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, except as expressly permitted in writing by ESRI. All requests should be sent to Attention: Contracts Manager, ESRI, 380 New York Street, Redlands, CA 92373-8100, USA.

The information contained in this document is subject to change without notice.

Table of Contents

INTRODUCTION TO ARC HYDRO 1
INTRODUCTION TO ARC HYDRO TOOLS 1
TOOLS LIST 1
Terrain Preprocessing *2*
Terrain Morphology *3*
Watershed Processing *4*
Attribute Tools *5*
Network Tools *6*
Buttons and Tools *6*

Introduction to Arc Hydro

Arc Hydro is an ArcGIS-based system geared to support water resources applications. It consists of two key components:

- Arc Hydro Data Model
- Arc Hydro Tools

These two components, together with the generic programming framework, provide basic database design and set of tools that facilitate analyses often performed in the water resources area. Arc Hydro is intended to provide the initial functionality that can then be expanded by adding to it database structures and functions required by a specific task or application.

Introduction to Arc Hydro Tools

The Arc Hydro tools operate in the ArcGIS environment. Some of the functions require the Spatial Analyst extension. The tools are accessed through the Arc Hydro Tools toolbar, where they are grouped by functionality into six menus and seven tools.

Menu	Description
Terrain Preprocessing	Functions preprocessing of Digital Elevation Model (DEM). These functions are mostly used once in order to prepare spatial information for later use.
Terrain Morphology	Functions performing an initial analysis of a non-dendritic terrain (e.g. terrains with sinks).
Watershed Processing	Functions performing watershed and subwatershed delineation and basin characteristic determination. These functions operate on top of the spatial data prepared in the terrain preprocessing stage.
Network tools	Functions generating or manipulating properties of geometric (hydro) network.
ApUtilities	Functions managing the properties of the Arc Hydro project. These functions will be seldom used and are not detailed in this overview document.
Buttons and Tools	▪ Flow Path Tracing ▪ Interactive Flow Path Tracing ▪ Point Delineation ▪ Batch Point Generation ▪ Assign Related Identifier ▪ Global Delineation ▪ Trace By NextDownID Attribute

The Arc Hydro tools have two key purposes. The first purpose is to manipulate (assign) key attributes in the Arc Hydro data model. These attributes form the basis for further analyses. They include the key identifiers (such as HydroID, DrainID, NextDownID, etc.) and the measure attributes (such as LengthDown). The second purpose for the tools is to provide some core functionality often used in water resources applications. This includes DEM-based watershed delineation, network generation, and attribute-based tracing.

The functionality of Arc Hydro tools is expected to grow over time. They have been implemented in a way that allows easy addition to their functionality, either internally (by adding additional code) or externally, by providing additional functionality through the use of key Arc Hydro data structures.

Tools list

The tools will be presented by their grouping in the user interface (menus). The ApUtilities tools will not be addressed here, as they are general-purpose utilities not related to the functionality of Arc Hydro tools.

Terrain Preprocessing

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Level DEM	Fill the selected polygons (e.g. lakes) up to the FillElev value.		x
DEM Reconditioning	Enforce linear drainage pattern (vector) onto a DEM (grid). Implements AGREE methodology.		x
Assign Stream Slope	Assign relative elevation to from nodes and to nodes of input streams. Elevations decrease with the digitized direction.		
Burn Stream Slope	Burn linear stream slope into a DEM to force the direction of the flow in the stream.		x
Build Walls	Build walls in a DEM (grid) at the boundary of selected input polygons.		x
Sink Prescreening	Prescreen the input DEM by filling in the pits that do not match the criterion defining a potential sink.		x
Sink Evaluation	Generate and characterize the potential sinks for a DEM.		x
Depression Evaluation	Generate and characterize the potential depressions for a DEM.		x
Sink Selection	Select the potential sinks that should be considered as real sinks.		
Fill Sinks	Fill sinks for an entire DEM (grid).		x
Flow Direction	Create flow direction grid for a DEM grid.		x
Flow Direction with Sinks	Create flow direction grid for a DEM with sinks that ensures that each cell within a sink flows		x
Adjust Flow Direction in Lakes	Modify input flow direction grid within the input lakes with streams to ensure that each cell within a lake flows toward the closest stream within the lake.		x
Flow Accumulation	Create flow accumulation grid from a flow direction grid.		x
Stream Definition	Create stream grid with cells from a flow accumulation grid that exceed used-defined threshold.		x
Stream Segmentation	Create a stream link grid from the stream grid (every link between two stream junctions gets a unique identifier).		x
Sink Segmentation	Create a sink link grid from the sink polygons.		x
Catchment Grid Delineation	Create a catchment grid for segments in the stream link grid or sinks in the sink link grid. It identifies areas draining into each link.		x
Catchment Polygon Processing	Create catchment polygon feature class out of the catchment grid.		x
Drainage Line Processing	Create streamline line feature class out of the stream link grid.		x
Adjoint Catchment Processing	Create adjoint catchment polygon for each catchment in the catchment polygon feature class. An adjoint catchment is total upstream area (if any) draining into a single catchment.		
Drainage Point Processing	Create a drainage point at the most downstream point in the catchment (center of a grid cell with the largest value in the flow accumulation grid for that catchment).		x
Longest Flow Path for Catchments	Create longest flow path segments for each catchment.		x

Longest Flow Path for Adjoint Catchments	Create longest flow path for each adjoint catchment.		x
Slope	Create a slope grid for a DEM.		x
Slope greater than 30	Create a grid showing the cells having a slope greater or equal to 30%.		x
Slope greater than 30 and facing North	Create a grid showing the cells having a slope greater or equal to 30% and facing north.		x
Weighted Flow Accumulation	Create weighted flow accumulation from a weight grid and a flow direction grid.		x

Terrain Morphology

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Drainage Area Characterization	Generate elevation, area, and volume curves for a set of selected drainage areas.		x
Drainage Boundary Characterization	Generate 3D boundary lines for selected drainage areas and compute width, perimeter, and cross-section area associated with slices of these boundaries.		x
Drainage Connectivity Characterization	Generate information about the connectivity between drainage areas.	x	x

Watershed Processing

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Batch Watershed Delineation	Create a watershed for every point in the batch point feature class. Results are stored in a watershed polygon feature class. Watersheds are overlapping if points are on the same stream.		x
Batch Subwatershed Delineation	Create a subwatershed for every point in the batch point feature class. Results are stored in a subwatershed polygon feature class. Subwatersheds are non-overlapping if points are on the same stream.		x
Batch Global Watershed Delineation	Create a global watershed and compute selected characteristics for every points in the batch point feature class.		x
Batch Watershed Delineation for Polygons	Create a watershed for every selected polygon feature in the batch polygon feature class. Results are stored in a watershed (polygon) feature class		x
Delineate from Multiple Inlets and Outlets	Create a watershed for input inlet and outlet points. Result is stored in a watershed (polygon) feature class and source points in a watershed point feature class.		x
Drainage Area Centroid	Create a point at the centroid of each polygon in a drainage area feature class and store it in a point feature class.		
Longest Flow Path	Create a line following the longest flow path in a drainage area based on steepest descent as defined by the flow direction grid.		x
Longest Flow Path for Watersheds	Create a line following the longest flow path in a watershed based on steepest descent. More efficient implementation of Longest Flow Path based on preprocessed data.		x
Longest Flow Path for Subwatersheds	Create a line following the longest flow path in a subwatershed based on steepest descent. More efficient implementation of Longest Flow Path based on preprocessed data.		x
Longest Flow Path USGS Method	Create a line following the longest flow path in a drainage area based on steepest descent as defined by the flow direction grid and USGS methodology.		x
Construct 3D Line	Build 3D lines from a selected set of 2D lines by exctracting elevations from a DEM.		
Smooth 3D Line	Smooth 3D lines linearly along the downstream direction of the line.		
Flow Path Parameters from 2D Line	Compute the length, slope and 10-85 slope of a longest flow path by extracting elevations from a DEM.		
Flow Path Parameters from 3D Line	Compute the length, slope and 10-85 slope of a 3D longest flow path by extracting elevations from the line.		
Basin Length Points	Generate inlet and outlet points for a drainage area based on associated longest flow path. Used as input by Basin Length.		x
Basin Length	Create a cost path line from the inlet point to the outlet point of a basin traveling through a cost surface that has minimum values toward the center and maximum values at the boundary.		x

Attribute Tools

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Assign HydroID	Assigns a unique identifier (HydroID) to a feature. HydroID is unique across an Arc Hydro geodatabase.		
Generate From/To Node for Lines	Generates from-node/to-node topology based on physical line connectivity for a line feature class. Nodes are defined as ends of lines. They are not created as a separate feature class, but rather just identified and accounted for internally. This tool does not require a hydro network.		
Find Next Downstream Line	Find the HydroID of the next downstream linear feature and store it in the NextDownID field of the feature. The directionality is based on the digitized direction. Connectivity is established by the physical connection of the linear features (does not require hydro network).		
Calculate Length Downstream for Edges	Calculate length from the downstream end of a hydro edge to the outlet of the hydro network (requires hydro network). The length is stored in the LengthDown field.	x	
Calculate Length Downstream for Junctions	Calculate the length from a hydro junction to the outlet of the hydro network. The length is stored in the LengthDown field. This tool requires a hydro network.	x	
Find Next Downstream Junction	Find the HydroID of the next downstream junction and store it in the NextDownID field of the junction feature. This tool requires a hydro network.	x	
Store Area Outlets	Identify the most likely hydro junction that drains an area. The HydroID of that junction is stored in the JunctionID field for the area feature class.		
Consolidate Attributes	Summarize the values of a numerical attribute of a feature class and store them in a field in another (or same) feature class. Relationship between the from and the to feature class is established through related IDs. Operators include sum, min, max, average, median, mode, standard deviation, and count. User specifies the from and the to feature classes, what field to summarize and in what field to store the summarized values. The tool can use the same feature class as both from and to objects to operate on.		
Accumulate Attributes	Summarize the values of a numerical attribute of a feature class and store them in a field in another (or same) feature class. The tool selects the upstream objects by tracing either using the geometric network or a NextDownID relationship, and summarizes the selected objects. Operators include sum, min, max, average, median, mode, standard deviation, and count. The selectable objects are either the traceable objects, or can be in an ID-related feature class (using existing relationship classes). User specifies the from and the to feature classes, what field to summarize, and in what field to store the summarized values		
Display Time Series	Display the values of the selected parameter as a function of time.		
Transfer ID	Establish relationship between a source feature class with an existing Time Series table and a target feature class that needs to be linked to Time Series data.		
Transfer Value	Generate a Time Series table for a polygon feature class based on an existing polygon feature class and its associated Time Series table.		

Compute Local Parameters	Compute parameters for local watersheds (e.g. area, average elevation, maximum elevation, minimum elevation, relief, slope, land cover, precipitation, etc). All data needed to compute the parameters need to be available in the map. User can configure additional parameters in the XML.		x
Compute Global Parameters	Compute parameters for global watersheds.		x

Network Tools

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Hydro Network Generation	Generate a hydro network (hydro edges and hydro junctions) from drainage lines, catchments, and drainage points. The function updates all the connectivity fields in input feature classes.	x	
Node/Link Schema Generation	Generate schematic (node-link) network by connecting centers of catchments/drainage areas and junctions, and connecting junctions and junctions. Connectivity is established through connectivity fields (attributes), not physical connectivity.		
Store Flow Direction	Store information about hydro (geometric) network element's directionality into an attribute of the feature matching the element.	x	
Set Flow Direction	Define flow direction for a geometric network based on digitized direction or an attribute for the feature.	x	

Buttons and Tools

Tool	Description	Requires ArcInfo or ArcEditor	Requires Spatial Analyst
Flow Path Tracing	Trace the downstream path, based on the steepest descent, from a user specified point to the edge of the DEM by using a flow direction grid.		x
Interactive Flow Path Tracing	Generate flow path feature, based on the steepest descent, from a user specified point to the boundary of the drainage area by using a flow direction grid.		x
Point Delineation	Interactively delineate a watershed for a user specified point based on the preprocessed DEM.		x
Batch Point Generation	Add user specified point to a batch point feature class. This point feature class can be used as an input to the batch watershed and subwatershed delineation functions.		
Assign Related Identifier	Interactively assign a value of a field in a source feature to a field in the target feature. User specifies both the source and target feature classes and fields.		
Global Point Delineation	Interactively delineate a watershed for a user specified point based on a set of preprocessed geographic units tied together by a geometric network. Compute global parameters.		x

Trace By NextDownID Attribute	Trace upstream, downstream, or in both directions from a selected location using the attribute relationship established through NextDownID field. The final selected features can include the objects selected through the trace, and/or ID-related objects by using the existing relationship classes.		