# Hydrologic and Hydraulic Analyses Using ArcGIS

Two day training class

## *Overview*

ArcGIS and Arc Hydro provide strong foundation for support of hydrologic and hydraulic (H&H) analyses. This two-day course presents GIS techniques that can be used for terrain analyses, hydrologic and hydraulic characteristics extraction, numerical model input and output, modeling process automation, and result mapping. HEC's GeoHMS and GeoRAS and USGS's StreamStats, each built upon foundation methodologies, data model, and toolset provided by Arc Hydro, form the modeling backbone for H&H analyses used in this course. The class will take full advantage of ArcGIS and its extensions in order to support a variety of requirements that H&H analyses pose to GIS technology.

Participants will gain hands-on experience in developing HMS and RAS model inputs through use of GIS and analyzing and mapping of model results. Utilization of GIS infrastructure for support of other H&H models will be discussed as well. While H&H analyses are at the core of this class, the focus is on what functionality GIS provides to H&H modeling, not on performing H&H analyses. Opportunities for GIS use in post model analyses such as mapping and flood damage estimation will also be discussed.

## *Audience*

The course is geared towards H&H professionals and GIS professionals supporting H&H analyses. Experience with H&H and GIS technology is recommended. The lectures and exercises do not require extensive GIS or H&H background thus the class does not have any prerequisites but experience with Arc Hydro is strongly recommended. The class will cover the essentials of both H&H and GIS to provide background material needed to complete and understand the class. Advanced H&H or GIS users will have an opportunity to work with their own data during the class exercises.

## *Goals*

- Understand core GIS functionality and data models used in H&H analyses
- Arc Hydro as the foundation for H&H analyses and database design
- TIN and GRID data structures for efficient terrain surface representation
- GIS as spatial and temporal integrator
- Hydrologic statistical modeling – NSS and StreamStats
- Hydrologic physical modeling – HMS and GeoHMS

- Hydraulic modeling – RAS and GeoRAS
- Floodplain mapping
- Process automation and integration

## *Topics Covered*

Introduction to ArcGIS and Arc Hydro? Basic principles of GIS as spatial data management technology and why is it is so useful in water resources analyses. Overview of Arc Hydro as the starting point for database design and analyses in water resources.

Data sources for H&H analyses. Terrain data, water features, precipitation, land use, soils, flows, curve numbers, roughness, ... (NED, WBD, NHD, NHDPlus, Nexrad, LIDAR, STATSGO, SURRGO, LU …). What to expect and what not.

Terrain representation for H&H analyses. Vector (TIN and Terrain Dataset) and GRID structures. Precision vs. generality. Size considerations. Managing large TIN and GRID datasets I - is it really necessary. Managing large TIN and GRID datasets II – divide and conquer.

USGS StreamStats – national regression equations for high and low flow estimation. Developing a StreamStats database. Watershed delineation and characterization. Running NSS.

HEC-GeoHMS – ArcGIS preprocessor for HEC-HMS. DEM preprocessing. Building a GeoHMS project. Extracting basin characteristics. HMS parameters computations. HMS schema generation. Export data to HMS.

HEC-GeoRAS – ArcGIS pre and post-processor for HEC-RAS. Terrain preparation – developing consistent terrain representation from multiple data sources. Building a GeoRAS project – required and optional data. Developing RAS-required information. Export data to RAS.

Running HMS and RAS. Special considerations when building an integrated HMS-RAS model. Supplementing HMS and RAS with additional required data. Running HMS and RAS. Passing information between the two. Post-processing of HMS results (time series). Post-processing of RAS results – floodplain delineation.

Putting it all together. GIS support for floodplain mapping (FEMA), real-time operations, emergency management, and climate change evaluations. Using model builder as the application integrator.

## *Prerequisites*

General GIS and/or water resources background. Familiarity with ArcGIS (ArcMap in particular) required and HEC-RAS and HEC-HMS desirable. Arc Hydro training or experience in its use recommended.

## *Instructor*

The class will be presented by Dr. Dean Djokic, lead developer of HEC-GeoHMS and HEC-GeoRAS and Arc Hydro tools.

## *Price*

See class schedule.

## *Outline of Topics*

### Introduction

- Logistics
- Course overview
- Introduction to participants
- Student feedback

### Overview of ArcGIS technology and Arc Hydro

- What is ArcGIS
- Geodatabase principles
- Relationships, networks, raster and vector data formats
- ArcCatalog, ArcMap, and ArcToolbox
- Template data models
- Arc Hydro – template model for water resources
- Arc Hydro tools – watershed delineation, characterization, time series management, …

### Typical data sources for H&H analyses

- Terrain data
- Rainfall – design, current, forecasted
- Flows – historical, current
- Land use

- Soils
- Issues of scale and data quality – how much impact does it really have

## Terrain representations

- TIN and GRID terrain surface representation
- Building terrain surfaces from various data sources – issues of scale and detail
- Imposing drainage patterns onto TINs and GRIDs
- Dealing with large terrain datasets
- Dealing with non-dendritic terrain

## StreamStats – peak and low flow estimation

- Why and when to use regression equations
- Arc Hydro as the starting point
- Watershed delineation
- Watershed characterization
- Running NSS

## HEC-GeoHMS and HEC-HMS

- Hydrologic modeling – HEC-HMS
- HEC-GeoHMS – HMS pre and post-processor
- DEM preprocessing – Arc Hydro as a starting point
- GeoHMS model development – basin partitioning and characterization. Lumped and distributed modeling
- HMS parameters computations and model export
- Running HMS – additional model input and execution
- Dealing with results (hydrographs)

## HEC-GeoRAS and HEC-RAS

- Hydraulic modeling – HEC-RAS
- HEC-GeoRAS – RAS pre and post-processor
- GeoRAS model development – laying out streams and cross-sections and ancillary data
- RAS parameters computations and model export
- Running RAS – additional model input and execution
- Dealing with results – floodplain delineation
- Floodplain mapping – FEMA and other users

## Integrated analyses

- Combining hydrology and hydraulics through GIS – data exchange points in space and time
- Documenting and automating GIS analyses through model builder
- Model builder as H&H model run manager – real-time operations
- Incorporating your other favorite H&H models
- GIS support for post H&H analyses