PROSPECT Course #352

Advanced 1D/2D Modeling with HEC-RAS

April 8-12, 2024

Objectives

This is an advanced course in applying computer program HEC-RAS. The course provides participants with the knowledge to effectively use computer program HEC-RAS to analyze difficult hydraulic conditions in natural and constructed channels, utilizing one-dimensional and two-dimensional modeling techniques.

Topics include: Developing terrain models for 2D modeling; developing Manning's n layers; creating and modifying a 2D computational mesh; boundary conditions for 2D Flow Areas; hooking up 1D elements to 2D Flow Areas; running a combined 1D/2D model; viewing 1D/2D results with RAS Mapper; hydraulic structures inside of 2D areas; and detailed channel and floodplain modeling with 2D flow areas. Special topics for dam and levee breaching, and using 2D modeling for hydraulic structures, will also be included.

Prerequisites

Participants must have a good background in open channel hydraulics and be familiar with the HEC-RAS software. Basic HEC-RAS input and output data requirements will not be covered in this class. Students must be experienced engineers who have attended Steady Flow with HEC-RAS, and have also either attended Unsteady Flow Modeling with HEC-RAS or have experience applying HEC-RAS using the Unsteady Flow modeling components. Participants must be in positions where they are currently engaged in using HEC-RAS in hydraulic investigations

Instructors

Cameron Ackerman (Course Coordinator)
Stanford Gibson
Mark Jensen
Alex Kennedy
Alex Sanchez
Eric Tichanksy
Anton Rotter-Sieren
Steve Piper (RMA Contractor)

Materials

https://www.hec.usace.army.mil/confluence/prospect/352-advanced-1d-2d-modeling-with-hec-ras-fy24

Day 1

Time		Topic	Objective	Instructor
0800-0900	**L0**	**Introductions and pre-course activities**	Welcome and discussion of class expectations	Ackerman
0900-0945	**L1.1**	**Example HEC-RAS Modeling**	Overview of HEC-RAS capabilities using example applications for 2D modeling Introduction to the validation and verification of HEC-RAS. A demonstration of using HEC-RAS to create a 2D model will conclude the discussion.	Gibson
1000-1015		**Break**		
1015-1100	**L1.2**	**Introduction to the 2D Equations**	This presentation discusses the underlying 2D hydraulic equations used in HEC-RAS. Diffusion Wave and Full Shallow Water Equations in HEC-RAS will be discussed as well as scenarios where the equations are appropriate is also provided.	Sanchez
1100-1145	**L1.3**	**Subgrid Bathymetry**	Discussion on the use of sub-grid bathymetry for finite volume computations in HEC-RAS. The benefits of variable cell size on computational performance will be discussed.	Ackerman
1145-1245		**Lunch**		
1245-1345	**L1.4**	**Creating an HEC-RAS Terrain**	Developing a terrain model and creating dataset for 2D modeling. Introduction to terrain download capabilities.	Nygaard
1345-1445	**W1.5**	**Creating an HEC-RAS Terrain Workshop**	Hands- on work creating an HEC-RAS Terrain dataset	Ackerman/ Kennedy
1445-1500		**Break**		
1500-1545	**L1.6**	**Mesh Generation and Refinement**	This presentation will discuss the basic concepts of creating a 2D Mesh in HEC-RAS and then how to improve and refine a 2D Mesh with Breaklines and Refinement Regions. Examples of mesh quality will be reviewed.	Gibson
1545-1700	**W1.7**	**Mesh Generation and Refinement Workshop**	This workshop will provide hands-on experience in using HEC-RAS Mapper to create a 2D flow area mesh and refine it to capture high ground using breaklines and refinement regions	Gibson/ Kennedy/ Rotter-Sieren

Day 2

Time		Topic	Objective	Instructor
0800-0845	**L2.1**	**Boundary and Initial Conditions**	The different types of boundary conditions and establishing initial conditions will be discussed.	Tichansky
0845-0930	**L2.2**	**Computational Parameters**	Discussion of essential parameters and computational options for running a 2D model including equation choice, cell size considerations, and time step considerations.	Ackerman
0930-0945		**Break**		
0945-1100	**W2.3**	**Creating a Simple 2D Model Workshop**	Students will create their first 2D model. Refinement of the model will be performed to understand the effect of model parameters.	Ackerman/ Sanchez
1100-1130		**Review**		Ackerman
1130-1230		**Lunch**		
1230-1315	**L2.4**	**Visualization of HEC-RAS Results in HEC-RAS Mapper**	An introduction to RAS Mapper is provided, specifically for visualizing HEC-RAS results.	Kennedy
1315-1345	**D2.5**	**HEC-RAS Mapper Demonstration**		Kennedy
1345-1400		**Break**		
1400-1430	**L2.6**	**Land Classification Data**	This discussion will cover creating an Land Classification dataset for use with Manning's n values in RAS Mapper.	Gibson
1430-1515	**W2.7**	**Land Classification Data**	Student will learn how to bring land cover data into a Land Classification dataset and associated Manning's n values.	Gibson/ Rotter-Sieren
1515-1545		**Review**		Gibson
		Kahoot!		
1545-1630	**L2.8**	**Advanced Computation Options**	Discussion of more advanced parameters and computational options for running a 2D model including equation choices, turbulence, and matrix solvers.	Sanchez
1630-1700	**L2.9**	**1D vs 2D Modeling**	This presentation discusses 1D vs 2D modeling and how to choose the appropriate modeling method.	Sanchez

Day 3

Time		Topic	Objective	Instructor
0800-0830	**L3.1**	**Combined 1D/2D Modeling**	Discussion of modeling channels with 1D rivers reaches/cross sections combined with floodplains/ levees using 2D Flow Areas	Tichansky
0830-0930	**W3.2**	**Combined 1D/2D Modeling Workshop**	Use a combined 1D/2D model to evaluate a protected area using 2D Flow Area and a Lateral Structure to define a levee. Levee over-topping and breaching will also be analyzed.	Tichansky/ Jensen
0930-1000		**Review**		Tichansky
1000-1015		**Break**		
1015-1045	**L3.3**	**Dam Breach with 2D Flow Area**	Discussion of how to use 2D Flow Areas with 1D reaches and storage areas to perform a dam breach analysis. Discussion on using the SA/2D Connection for modeling a dam, outlets, and the dam breach.	Gibson
1045-1115	**L3.4**	**Determination of Dam Breach Parameters**	This presentation will discuss estimating dam breach parameters for modeling dam breach scenarios.	Gibson
1115-1215		**Lunch**		
1215-1345	**W3.5**	**Dam Breach with 2D Flow Areas Workshop**	Students will create an HEC-RAS model to utilize the breach functionality and evaluate parameters.	Gibson/ Ackerman
1345-1415		**Review**		Gibson
1415-1430		**Break**		
		Kahoot!		
1430-1500	**L3.6**	**SA/2D Connections**	Discussion of how to use SA/2D Connections in a 2D Flow Area	Ackerman
1500-1530	**D3.7**	**Terrain Modifications Demonstration**	Introduction to cloning a terrain and adding a simple terrain modification.	Ackerman
1530-1700	**W3.8**	**SA/2D Connections**	In this workshop, students will utilize 2D Connections (internal hydraulic structures) inside of a 2D Flow Area to improve the river hydraulics model by overriding terrain elevations.	Tichansky/ Ackerman

Day 4

Time		Topic	Objective	Instructor
0800-0830		**Review**		Tichansky
0830-0930	**L4.1**	**Troubleshooting Strategies**	Discussion on common model stability issues, trouble shooting strategies, and more.	Sanchez
0930-0945		**Break**		
0945-1030	**L4.2**	**Bridge Modeling**	Discussion on modeling a bridge using a 2D Connection using the 1D bridge modeling method as well as developing a detailed mesh to represent the flow constriction.	Jensen
1030-1200	**W4.3**	**Bridge Modeling Workshop**	Students will utilize the 1D bridge modeling approach to modeling as well as develop a detailed bridge model to evaluate water surface elevations and velocities in detail.	Jensen/ Sanchez
1200-1300		**Lunch**		
1300-1330		**Review**		Jensen
1330-1345		**Break**		
		Kahoot!		
1345-1430	**L4.4**	**Precipitation and Wind**	This presentation will discuss the use of the Precipitation and Wind boundary condition in HEC-RAS.	Sanchez
1430-1515	**L4.5**	**DEMO Rain on Mesh**	Students will walk through building a watershed scale mesh, adding precipitation data, and building an infiltration layer in RAS mapper.	Tichansky
1515-1630	**W4.6**	**Precipitation and Wind Workshop**	Students will utilize precipitation to create a rain on grid model.	Sanchez/ Tichansky
1630-1700		**Review**		Sanchez

Day 5

Time		Topic	Objective	Instructor
0800-0900	**L5.1**	**1D/2D Direct Connections**	Learn about hooking a 1D reach directly into a 2D Flow area, as well as having a 1D reach come out of a 2D Flow Area. The concept of 1D to 2D iterations will be introduced.	Gibson
0900-0930	**L5.2**	**Introduction to the 3D Viewer**	An introduction to RAS Mapper is provided, specifically for visualizing HEC-RAS results.	Rotter-Sieren
0930-1000	**D5.3**	**3D Viewer Demonstration**	The 3D Viewer will be demonstrated interactively	Rotter-Sieren
1000-1130		**Course Closing**	Post-test, course evaluations, oral critique, and closing remarks	Ackerman