Advanced 1D/2D Modeling Using HEC-RAS

July 15-19, 2019
Davis, California

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. Nominees must be assigned (a) Occupational Series: Selected 0800 and 1300; (b) Grade: GS-7 or above. Students must be experienced engineers who have attended Steady Flow with HEC-RAS (Course Control No. 114), and have also either attended Unsteady Flow Modeling with HEC-RAS (Course Control No. 188) 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
Gary Brunner (Course Coordinator)
Mark Jensen
Alex Kennedy
Alex Sanchez

Contractor:
Steve Piper (RMA Contractor)

Monday, Day 1:

8:00 - 9:00 a.m. **INTRODUCTIONS, COURSE OVERVIEW, AND PRE-TEST** (Director, Brunner)

9:00 - 9:15 a.m. BREAK

9:15 - 10:15 a.m. 1.1 Lecture: **OVERVIEW OF 1D/2D UNSTEADY FLOW MODELING WITH HEC-RAS** (Brunner)
Overview of HEC-RAS capabilities for performing combined 1D and 2D unsteady flow modeling. Example Applications. Guidelines on 1D-2D-3D modeling choices, and when to use 2D flow areas instead of 1D channels/storage areas.

10:15 - 10:30 a.m. BREAK

10:30 - 11:30 a.m. 1.2 Lecture: **INTRO TO 1D/2D UNSTEADY FLOW RIVER HYDRAULICS AND EQUATIONS** (Sanchez)
Description and comparisons of the Equations (e.g., 1-D, 2-D, Diffusion Wave, Full Saint Venant etc.). Introduction to the 2D unsteady flow equations and solution technique. Introduction to the finite-volume methodology. Discussion of when to use Full Saint Venant equations vs Diffusion Wave.

11:30 - 12:45 p.m. LUNCH

12:45 - 1:45 p.m. 1.3 Lecture: **DEVELOPING A TERRAIN DATA SET FOR 1D AND 2D HYDRODYNAMIC MODELING** (Ackerman)
This lecture will cover how to obtain terrain data from multiple sources; combining terrain information; developing channel data; and making a combined terrain model for use in HEC-RAS.

1:45 – 2:15 p.m. 1.4 Lecture: **DEVELOPING A LAND COVER DATA SET AND ASSOCIATING MANNING'S N VALUES**. (Ackerman)
This lecture will describe how to create a Land Cover data set; associate Manning's n values to Land Cover; and override Manning's n values with 2D Manning's n value regions

2:15 - 2:30 p.m. BREAK

2:30 - 3:30 p.m. 1.5 Lecture **DEVELOPING A 2D COMPUTATIONAL MESH** (Jensen)
This lecture will show students how to create a computational mesh with a user entered polygon and nominal computational cell size. The lecture will also cover: break lines; mesh refinement regions; and editing the mesh (moving points; deleting points; adding points, etc…).

3:30 - 5:00 p.m. 1.6 Workshop: **DEVELOPING A TERRAIN MODEL AND 2D COMPUTATIONAL MESH** (Jensen, Ackerman)

This workshop will be used to learn how to develop a terrain model within HEC-RAS and to develop a good 2D computational mesh that accurately describes the terrain. Editing and modifying the computational mesh will also be discussed, as well as following all of the computational rules for developing a mesh.

Tuesday, Day 2:

8:00 - 8:30 a.m. **REVIEW:** Workshop 1.5 (Jensen)

Review previous workshop on developing a terrain model and 2D computational mesh.

8:30 -9:30 a.m. 2.1 Lecture: **Boundary and Initial Conditions for 2D Modeling** (Sanchez)

This lecture will cover all of the available boundary condition types that can be linked directly to 2D Flow Areas. This lecture will also cover the options for establishing initial conditions in a 2D Flow Area

9:30 – 9:45 a.m. BREAK

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9:45 - 10:30 a.m. 2.2 Lecture: **Running a Combined 1D/2D Model** (Ackerman)

Students will learn how to run a model that contains 2D Flow areas in HEC-RAS. Discussions will include cell size and time step selection; variable time step; computational options; output options, performing the computations, and viewing results.

10:30 - 11:30 noon 2.3 Lecture: **Viewing 1D and/or 2D Output Using RAS Mapper** (Kennedy)

This lecture will cover how to view combined 1D and 2D model output inside of HEC RAS-Mapper. Discussions will include: displaying depth inundation maps, velocity maps, depth times velocity, animating results, creating static maps, plotting hydrographs and profiles.

11:30 - 12:30 p.m. LUNCH

12:30 - 2:45 p.m. 2.4 Workshop: C**hannel and Floodplain modeling in 2D** (Ackerman, Kennedy)

In this workshop students will develop a single 2D Flow Area model that includes a channel and floodplain area. Students will model multiple grid sizes to see the effects of grid resolution and time step on the answers.

2:45 – 3:15 p.m. **REVIEW:** Workshop 2.5 (Ackerman)

3:15 - 3:30 p.m. BREAK

3:30 - 4:30 p.m. 2.5 Lecture: **Combined 1D River and 2D Floodplain/Levee Areas** (Brunner)

Students will learn about modeling channels with 1D river reaches/cross sections and floodplains/levees with 2D flow areas.

Wednesday, Day 3:

8:00 - 10:00 a.m.	3.1 Workshop:	**Combine 1D River/Floodplain with 2D areas behind Levees (Levee Breaching)** (Brunner, Sanchez)

In this workshop, students will convert a storage area being used to model the interior area protected by a levee, to a 2D flow Area. The 2D flow area will be hooked to the 1D reach with Lateral structures, which will also be used to represent the levee. Levee overtopping and breaching will also be analyzed.

10:00 – 10:30 a.m.	**REVIEW**	Workshop 3.1 (Brunner)
10:30 - 10:45 a.m.	BREAK	
10:45 - 11:45 a.m.	3.2 Lecture:	**1D Channels directly into and out of a 2D Flow Areas** (Piper)

In this lecture students will 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.

11:45 - 12:45 p.m.	**LUNCH**	
12:45 – 1:15 p.m.	3.3 Lecture:	**1D/2D Boundary and Initial Conditions** (Piper)

This lecture will cover how to establish boundary and initial conditions for models that contain 1D elements connected to 2D flow areas.

1:15 – 3:00 p.m.	3.4 Workshop:	**1D River directly into 2D Flow Area** (Piper, Ackerman)

In this workshop, students will put together a model that has a 1D river and floodplain that goes into a wide flat area in which water can go in multiple directions (this area will be modeled with a 2D flow area).

3:00 – 3:30 p.m.	**REVIEW**	Workshop 3.3 (Piper)
3:30 - 3:45 p.m.	BREAK	
3:45 - 4:45 p.m.	3.5 Lecture:	**Dambreak Analysis with Combined 1D and 2D** (Brunner)

In this lecture, students will learn all the ways that 2D flow Areas can be used with 1D reaches and storage areas for performing Dambreak analyses. Students will also learn how to use the hydraulic connection feature for modeling the dam, hydraulic outlets, and the dam breach.

Thursday, Day 4:

8:00 - 10:00 a.m.	4.1 Workshop:	**Dam Break Analyses with 1D and 2D** (Brunner, Ackerman)
	Students will develop a Dam Break model from scratch using 1D and 2D flow elements.	
10:00 – 10:30 a.m.	**REVIEW**	Workshop 4.1 (Brunner)
10:30 - 10:45 a.m.	BREAK	
10:45 - 11:45 a.m.	4.2 Lecture:	**Modeling Hydraulic Structures inside of 2D Flow Areas** (Piper)
	This lecture will discuss how to use Hydraulic structures inside of a 2D flow Areas.	
11:45 - 12:45 p.m.	**LUNCH**	
12:45 - 2:45 p.m.	4.3 Workshop:	**2D Flow Area with Internal Hydraulic Structures** (Piper, Brunner)
	In this workshop, students will develop a model with hydraulic structures inside of a 2D Flow Area in order to more accurately represent the hydraulic structure.	
2:45 – 3:15 p.m.	**REVIEW**	Workshop 4.3 (Piper)
3:15 - 3:30 p.m.	BREAK	
3:30 - 4:30 p.m.	4.4 Lecture:	**Detailed modeling with 2D Flow Areas** (Brunner)
	This lecture will cover how to use the new 2D Flow Area capability to perform very detailed multi-dimensional hydraulic analyses. Students will learn how to set up a model to get detailed water surfaces and velocities. Several specific example applications will be covered.	

Friday, Day 5:

8:00 - 10:00 a.m.	5.1 Workshop:	**Detailed 2D Bridge Analysis** (Brunner, Jensen)
	In this workshop students will develop a detailed 2D Bridge model in order to evaluate water surface elevations and velocities in detail.	
10:00 – 10:30 a.m.	**REVIEW**	Workshop 5.1 (Brunner)
10:30 - 11:30 a.m.	**POST TEST, COURSE CRITIQUE, AND CLOSING REMARKS** (Brunner)	