Hydrologic Engineering Center

Training Course on

Sediment Transport Analysis with HEC-RAS

Davis, California

Course Summary

One dimensional numerical modeling of river channel aggradation and degradation will be covered in this class. Lectures and workshops will focus on utilizing the mobile bed, sediment routing functionalities of HEC RAS. Topics will include data acquisition, model construction, performing calculations, visualizing results, calibration, troubleshooting and case study.

Monday, Day 1:

8:00 – 8:45 a.m. **INTRODUCTIONS, COURSE OVERVIEW AND PRE-TEST**

8:45 – 9:45 a.m. 1.1 Lecture: **INTRODUCTION TO RIVER BEHAVIOR, PROCESSES AND PROBLEMS**

Interaction and importance of fluvial processes with reference to the Corp's mission. History of sediment issues and modeling and an overview of the current context and potential applications of sediment transport modeling.

9:45 – 10:00 a.m. Break

10:00 – 11:00 a.m. 1.2 Lecture **GEOMORPHOLOGY AND HD CALCULATORS**

Basic principles of geomorphology and approaches to channel design. Channel forming flow and implications of Lane's balance on channel straightening, widening, or meandering as well as various quantitative approaches to channel design will be covered.

11:00 – 12:00 noon 1.3 Lecture **QUANTIFYING SEDIMENT SOURCES**

Overview of watershed and channel sources of sediment, potential sinks and methods for quantifying loads generated or abstracted by these processes.

12:00 – 1:00 p.m. Lunch

1:00 – 2:15 p.m. 1.4 Lecture: **SEDIMENT PROPERTIES AND PROCESSES**

Introduction to the physical properties of sediment and transport processes. Topics will include grain size classification, settling velocity, density of deposited material, transport processes, deposition, erosion and compaction.

2:15 – 2:30 p.m. Break

2:30 – 3:30 p.m. 1.5 Lecture: **HEC-RAS OVERVIEW AND HYDRAULIC COMPUTATIONS FOR SEDIMENT ANALYSES**

Overview of steady flow hydraulics HEC-RAS uses for the hydrodynamic computations in its sediment transport functionalities. Introduction to sediment modeling framework, dialogs and files in RAS.

3:30 – 5:00 p.m. 1.6 Lecture: **PRINCIPLES OF SEDIMENT TRANSPORT COMPUTATIONS**

Computational approach and assumptions implemented in HEC-RAS. Calculation of transport capacity and potential, solution of the Exner equation, temporal and source limiters of erosion and deposition and geometry updated in response to bed change.

Tuesday, Day 2:

8:00 – 9:00 a.m.	2.1 Lecture	**COLLECTING SEDIMENT DATA**
	Methods and considerations for collecting sediment data.	
9:00 – 9:15 a.m.	Break	
9:15 - 10:00 a.m.	2.2 Lecture	**INPUTTING SEDIMENT DATA IN RAS**
	Description of the sediment data required and boundary condition formats available in HEC-RAS.	
10:00 – 12:00 noon	2.3 Workshop	**DATA PROCESSING WORKSHOP**
	Students will find, download and process pertinent data for a specified location and enter the sediment data into HEC-RAS.	
12:00 – 1:00 p.m.	Lunch	
1:00 – 1:45 p.m.	2.4 Lecture	**INPUTTING QUASI-UNSTEADY DATA AND PERFORMING A SEDIMENT ANALYSIS**
	Introduction to the "Quasi-unsteady" approximation for sediment studies. Overview of the RAS Quasi-Unsteady flow editor. Will include guidelines on flow step generation and selection of computational increments	
1:45 – 2:30 p.m.	2.5 Lecture	**VIEWING SEDIMENT OUTPUT**
	Demonstration of the output available for HEC-RAS sediment analysis including, schematic, profile and time series data. Will also overview the output control options.	
2:30 – 2:45 p.m.	Break	
2:45 – 4:30 p.m.	2.6 Workshop	**INITIAL SEDIMENT RUN WORKSHOP**
	Students will build a basic sediment model from an existing HEC-RAS hydraulic model. This will include generating a quasi-unsteady flow series, selecting computational increments, generating bed gradation templates, populating sediment data, executing the model and viewing results.	
4:30 – 5:00 p.m.	**Review:** Workshop 2.6	

Wednesday, Day 3:

8:00 – 9:00 a.m. 3.1 Lecture **SELECTING A SEDIMENT TRANSPORT FUNCTION**

Overview of the fundamental theory behind the seven different transport functions included in HEC-RAS including discussion of their applicability.

9:00 - 10:30 a.m. 3.2 Lecture **USING RAS FOR RESERVOIR SEDIMENTATION**

The student will know the general type of reservoir sedimentation problems that can be analyzed with HEC-RAS.

10:30 – 10:45 a.m. Break

10:45 - 12:00 noon 3.3 Workshop **RESERVOIR WORKSHOP**

The student will know how to set up a reservoir problem and analyze the results to answer the question, "Will the sediment deposited during normal operations of a low head dam be flushed out of the reservoir when flood flows occur?"

12:00 – 1:00 p.m. Lunch

1:00 – 1:30 p.m. **Review:** Workshop 3.3

1:30 - 2:30 p.m. 3.4 Lecture **PRINCIPLES OF GRADED SEDIMENT TRANSPORT AND COMPUTATIONAL BED MIXING**

Introduction to principles of graded sediment transport theory including, hiding, preferential transport, the equal mobility theory and static vs. dynamic armoring. Will include explanation of bed mixing algorithms focusing on the computations performed in HEC-RAS.

2:30 – 3:15 p.m. 3.5 Lecture **ADDITIONAL RAS SEDIMENT CAPABILITIES**

Highlights sediment transport features in HEC-RAS that are not covered in other lectures including us of the dredging function, cohesive algorithms, Inline Weirs, and aggradation or degradation at a Bridges.

3:15 – 3:30 p.m. Break

3:30 - 5:00 p.m. 3.6 Workshop **COHESIVE AND DREDGING WORKSHOP**

Thursday, Day 4:

8:00 – 8:30 a.m.	**REVIEW:** WORKSHOP 3.6	
8:30 – 9:30 a.m.	4.1 Lecture	**DAM REMOVAL AND ECOHYDRAULICS**
9:30 – 9:45 a.m.	Break	
9:45 – 11:15 a.m.	4.2 Lecture	**CALIBRATION OF SEDIMENT TRANSPORT MODELS**
	The student will know that a formal procedure exists for calibrating a computational sedimentation model; there are systematic steps to follow to apply that procedure; and the reference should be cited in the study report.	
11:15 – 12:00 noon	4.3 Workshop	**ROBUSTNESS AND NUMERICAL STABILITY WORKSHOP**
	The student will know how to test a model for numerical stability and for robustness.	
12:00 – 1:00 p.m.	Lunch	
1:00 – 1:45 noon	4.3 Workshop	**CALIBRATION WORKSHOP** Continued
1:45 – 2:15 p.m.	**REVIEW:** WORKSHOP 4.3	
2:15 – 3:15 p.m.	4.4 Lecture	**TROUBLESHOOTING A SEDIMENT IN RAS MODEL**
	This lecture will focus on common problems with sediment models in HEC-RAS as well as tools and methods for tracking down model problems.	
3:15 – 3:30 p.m.	Break	
3:30 – 5:00 p.m.	4.5 Workshop	**TROUBLESHOOTING WORKSHOP**
	Students will be provided with several data sets that do not work and will be asked to find the problem with each.	

Friday, Day 5:

8:00 – 8:30 a.m.	**REVIEW:** WORKSHOP 4.5	
8:30 – 9:30 a.m.	5.1 Lecture	**CASE STUDY:** Missouri River Degradation Project
9:30 – 9:45 a.m.	Break	
9:45 – 10:30 a.m.	5.2 Lecture	**PHYSICAL AND MULTIDIMENSIONAL MODELING**
	There are applications where a one-dimensional sediment model is not appropriate. In these instances multi-dimensional models or even physical models might be required to make necessary predictions. Applicability and types of multidimensional and physical models will be covered.	
10:30 – 11:00 a.m.	5.3 Lecture	**MODELING AND MODEL SELECTION PHILOSOPHY**
11:00-11:45 a.m.	Post Test, Course Critique, and Closing Remarks	