

Mechanics of Sediment Transportation and River Changes

Course number: DMP382E

Instructor: Dr. Shinji Egashira

Term / Time: Fall through Winter

1. Course Description

Sediment transportation is usual in rivers and takes place in various forms such as bed-load, suspended load, debris flow etc. Imbalance of sediment transportation that is naturally observed causes channel changes as usually seen in river bed degradation and aggradation, side bank erosion, sand bar formation, channel shifting etc. Such channel changes, which are suitable for ecological systems within allowable level of magnitude of their changes, will result in flood- and sediment- disasters if they are over some allowable level. Present subject intends to provide basic principles of sediment mechanics and tools for evaluating sediment transport processes and corresponding river changes as well as methods for river managements.

2. Course Outline

Week

1: Introduction (Physical property of sediment particles and sediment layer)

- Mass density, shape, size (diameter) etc.
- Concentration, porosity, pore (void), friction coefficient (friction angle) etc.
- Uniform sediment, non-uniform sediment, particle size distribution, mean size,
- Cohesive material, non-cohesive material

2: Introduction (Sediment transportation)

- Forms of sediment transportation
- Dynamics of sediment transportation (Field equations)
- River changes and associated issues

3: Mechanics of sediment transportation

- Fluid force and equation of motion for a single particle
- Critical condition for initiating bed load
- Critical condition for initiating suspended load

4: Mechanics of sediment transportation

- Treatments of bed load and bed load formulas

5: Mechanics of sediment transportation

- Constitutive relations of water-sediment mixture flow
- Bed load formula derived from the constitutive relations

- Debris flow characteristics derived from the constitutive relations

6: Mechanics of sediment transportation

- Treatment of suspended load

7: River morphology

- Bed forms and flow resistance
- Channel morphology

8: River changes

- Governing equations corresponding to demanded levels for resolutions, focusing on mathematical expressions such as 1-D, 2-D and 3-D as well as on phenomenological scales such as sediment sorting / armoring, sediment transport forms, bed forms etc.

9: River changes

- Prediction of river bed variation
- Prediction of channel morphology
- Prediction of debris flow process

10: Local scouring

- Scouring around artificial structures
- Bank protection

11: Reservoir sedimentation and associated issues

- Sediment transport process in reservoir
- Impact of reservoir sedimentation

12: Sediment management in drainage basins

- Methods for evaluating sediment transport process in drainage basins

13: Sediment management in drainage basins

- Methods for sediment controls from mountain areas to the river mouth

14: Comprehensive sediment management

15: Examination

3. Grading

50 points for reports and short quizzes

50 points for the examination at the end of semester

4. Textbooks

4-1 Required

Egashira, S. (2009): Mechanics of Sediment Transportation and River Changes, Lecture note prepared for present course.

4-2 Others

Sturm, T. W. (2001): Open Channel hydraulics, McGraw-Hill.

Graf, W. H. (1997): Fluvial Hydraulics, Wiley.