Syllabi by Discipline :: Environmental Studies

Course Title: Environmental Studies/Geophysics: River Hydrology and Hydraulics

Instructor: Dr. Douglas Thompson

School: Connecticut College

Categories:
Environmental Studies, Physics

Syllabus:

Fall 1999
Office Hours: MTW 11:30 AM - 12:20 PM (Please stop by with questions).
Lecture (Bill 404): MWF 10:30 - 11:20 A.M.
Lab (Bill 404): M 1:30 - 4:20

Text: Gordon, McMahon & Finlayson, 1992. Stream Hydrology: An Introduction for Ecologists, John Wiley

Catalogue Description: The development and evolution of natural channel systems will be investigated. Special emphasis on environmental river restoration and aquatic habitat. Topics include the physics of flowing water, sediment transport by rivers, flow and substrate characterization techniques and flood hydrology. Laboratory requires the students to jointly design a river restoration project for an environmentally degraded channel.

Detailed Course Description: The River Hydrology and Hydraulics course focuses on the application of fluvial geomorphology to an environmental river restoration effort on the College campus. With the large number of streams and rivers negatively impacted by human land-use and disturbance, a growing number of public agencies and private interest groups are focused on recreating, restoring or enhancing aquatic habitat. River restoration is an interdisciplinary field that combines ecological knowledge of aquatic habitat requirements from fisheries biologists, with design and implication work for instream structures from civil engineers and knowledge of the physical evolution of natural river systems from geomorphologists.

As geomorphologists we will need to understand how the local hydrology has influenced the shape and characteristics of the local channel systems through time. The aquatic habitat is best characterized by the physical creation and maintenance of a pool and riffle morphology in the channel. The course will focus on a geomorphic understanding of the pool and riffle morphology, and its importance in river restoration. An investigation of erosion and deposition within natural and anthropogenically-influenced stream channels is an integral part of these types of studies.

We will apply this understanding to help develop a restoration design for an incised channel on the Connecticut College campus. We will investigate a small channel that drains the northeast comer of the main campus and flows north of the College Athletic Complex to the Thames River. The channel has a serious erosion problem that has resulted in over 2 meters of vertical incision into the hillside and sedimentation of a local wetlands. Students will produce a final report and channel design that may result in the implementation of a restoration project following the guidelines outline in the student plan.

Course Objectives: River Hydrology and Hydraulics is a course that can potentially benefit the individuals involved, the College campus and the larger community. Students will be exposed to the challenges and rewards inherent in conducting large environmental projects. The course is designed to provide a valuable educational experience and produce a restoration project that will result in tangle improvements for the local environment. Because the course will involve work on an existing local problem, unforeseen problems are likely. Much of the success of the course and the associated river restoration design will be dependent on the effort and quality of work of the involved students. If the final restoration design is successful, there is a high probability that the restoration work will proceed when finding is obtained. Ultimately, I hope the course will provide students with an opportunity to gain a new perspective on the importance of their education by working together to solve real-life, environmental problem.

Prerequisites: Environmental Studies/Geophysics 210 or Environmental Studies/Geophysics 314 are listed as prerequisites for the course. Students without the necessary prerequisites may still qualify for the course but should see me**.** The prerequisite courses are intended to insure that students have a basic familiarity with the geoscientific approach to research and writing, and previous exposure to hydrology and the driving forces important on the surface of the earth.

Classroom Time: The classroom time will be used to help develop the necessary background in fluvial geomorphology to complete the restoration project. We will begin with an investigation of the underlying hydrologic problem in this area. The course will also cover the physics involved in erosion and deposition by water. One mid-semester exam will cover the topics covered in the first portion of the class. The remainder of the semester will focus on the current state of river restoration approaches used in the United States and abroad. This portion of the course will rely heavily on the scientific literature in the form of journal articles.

The River Hydrology and Hydraulics Field Laboratory!
The laboratory portion of ES/GPH 4 10 will require a large amount of outdoor work on the college stream. Most of this fieldwork will have to be conducted regardless of weather conditions. In fact, fieldwork during rain events is ideal because it will allow for direct observation of the channel during flood stage. These observations may be critical in properly designing the restored channel. Students should wear appropriate warm clothing and/or rain gear. A small backpack and bottle of water are also advisable. Students should be prepared for outdoor work when they arrive for lab.

The laboratory is an integral portion of the course. The laboratory time will be used to gather the information necessary to complete a restoration design. Numerous site characterization techniques will be used with a variety of associated equipment. We will also have an optional a Saturday fieldtrip to see channel restoration efforts applied in different portions of the state. The Saturday trip will be important to show how restoration efforts change when fish habitat is a major goal of the project. A second Saturday laboratory time is reserved in the event that the data collection effort cannot be completed during the normal laboratory period.

Many labs will require a short write up (3-5 pages) and some calculations. These intermediate assignments will be used to assess peoples progress on the final project. Laboratory reports should be typed. All values should be clearly labeled and include appropriate units to allow for identification of the calculation processes. Illegible or indecipherable work may be returned and will be graded as late. Avoid the use of spiral binders or please cut away the paper fringe that develops on this style of paper. It is advisable to start the assignments early enough to allow time for questions that may arise.

The course requires a large amount of cooperation between individuals, including group projects. However, it is also important that each individual understands the principles behind the lab assignments

and final project. On many labs, it will be helpful to work on labs with a partner or in groups. I encourage interaction and peer support. However, it is important that each person completes the individual lab assignments independently. Students should not hand in the same computer generated graphs, worksheets or written statements. If this practice becomes evident, I will divide the final grade on the lab by the number of people with identical work. A grade of W.C. on a lab may be given if the student will be required to see the writing center before resubmitting a lab.

Final Presentation: At the end of the semester, the students in the course will present their preliminary design to a panel of experts. The experts will likely include a representative from the local wetlands commission, a fisheries biologist from the Connecticut Department of Environmental Protection, a civil engineering consultant, a Connecticut College representative from Capital Projects and a representative from the College Arboretum. Students will prepare a Microsoft PowerPoint presentation and jointly describe the scope of the project, the site history, the methods of investigation, the results obtained, the proposed channel-restoration design, and a rough estimate of the cost for implementing the project. Individual students will be responsible for preparing and presenting one segment of the project. At the end of the semester, the Powerpoint presentation will be posted as a web-page on the course web-site.

Final Report: Input from the panel experts will be used to revise any portion of the project that may need updating. A single final report is required that details the scope of the project, the site history, the methods of investigation, the results obtained, the proposed channel restoration design, and a final estimate of the cost for implementing the project. Once again, students will be asked to work cooperatively to produce this report with individual tasks divided among the class. I anticipate this report will be relatively large, over 25 pages. Students will also be asked to submit a 4-6 page individual report that discusses your general impressions of the project, including a critique of the final restoration design.

Course Grading and Attendance: You should plan on attending 11 classes and labs. Students must come to all classes prepared to take notes and answer relevant questions. You are responsible for any material missed including assignments and announcements. Frequent unexcused absenteeism (4 or more) may result in a failing final grade. Although I will not confront students who come to class late, this activity disrupts class. Therefore, continued late arrival can also adversely influence final grades.

Students who miss the laboratory section will receive a zero on the associated lab assignment. Students need to obtain a note from their dean to avoid this consequence. 'My laboratory assignment deadlines are intended to provide fairness for all members of the class. Consequently, all late assignments will be penalized a full grade (10 points) per day. If unusual circumstances occur, students should approach me before the assignment is due or obtain a note from their dean (I do not want to hear excuses).

Course Grading*

Laboratory Reports 35%
Final Presentation 25%
Final Group Report 25%
Final Individual Report 10%
Class and Lab Participation 5%

Geomorphology Image Database: A database of photographs exists for use in the ES/GPH 314 and ES/GPH 410 courses. The photographs include slides shown in class to demonstrate important principles and geomorphic features. I have included a brief description with each slide to aid in the use of this database.

Date Class Topic

9/2 Overview of Course
9/6 Introduction to Project Design
Textbook: Chp. I & 2
Lab (FIELD): Field Reconnaissance and Photo Replication
9/8 Introduction to Project Design (Project Goals Determination)
9/10 Project Evaluation and Monitoring
Reserve: Kondolf and Micheli, 1995. 'Evaluating Stream Restoration Projects.'
9/13 Site Characterization: Data Sources
Textbook: Chp. 3
Lab (FIELD): Streamflow-gaging, X-section Monumenting and Bank Characterization
Computer Reserve: Harrelson et al., 1994. 'Stream Channel Reference Sites.'
9/15 Permitting and Legal Issues: (local expert-time may change)
Reserve: xx Local Regulations xx
9/17 Site Characterization: Drainage Basins
Textbook: Chp. 4
9/20 No Class
No Lab
9/22 Site Characterization: Drainage Basins
Reserve: Kondolf & Downs, 1996. 'Catchment approach to planning channel restoration.'
9/24 Surveying Methods
Textbook: Chp. 5
9/27 Basin Hydrology
Reserve: xx to be determined xx
Lab (FIELD): Channel Platform and Cross-section Surveying
9/29 Basin Hydrology
10/1 Effects of Urbanization
Reserve: Booth, 199 1. 'Urbanization & natural drainage system-impacts, solutions & prognoses.'
10/4 Discharge Measurement and Streamflow-gaging Stations
Lab (FIELD): Channel Platform and Cross-section Surveying
10/6 Flow Frequency and Magnitude
Textbook: Chp. 8
10/8 No Class
10/11 Unit Hydrographs
Reserve: Carson, 1999. 'Independent Study Report'
Lab (FIELD): Channel-bed and Large Woody Debris Characterization
10/13 River Mechanics
Textbook: Chp. 6
10115 River Mechanics
SATURDAY LAB (IF NEEDED):
10/18 Open Channel Hydraulics
Reserve: Dingman xx?
La b (FIELD): Laboratory Sediment Analysis
10/20 Open Channel Hydraulics
10/22 Computer Flow Modeling
10/25 Introduction to Powerpoint
Lab (FIELDWORK IF NEEDED): Finish Fieldwork Independently
10/27 No Class
10/29 Sediment Transport
Textbook: Chp. 7
11/1 Sediment Transport and Competence
Reserve: Costa, 1983. 'Paleohydraulic reconstruction of flash-flood peaks from boulder deposits in the Colorado Front Range.'

Lab: HEC-RAS Computer Modeling
11/3 Hydraulic Geometry and Dominant Discharge
Reserve: Leopold and Maddock, 1953. The Hydraulic Geometry of Stream Channels and Some Physiographic Implications.'
11/5 Channel Morphology: Stream Patterns and Landforms
11/8 Channel Morphology: Pools and Riffles
Reserve: Jackson and Beschta, 1982. 'A model of two-phase bedload transport in an Oregon Coast Range Stream.'
Lab: HEC-RAS Computer Modeling and Sensitivity Analysis
11/10 Channel Morphology: Incision and Knickpoint Migration (Stream Table Demonstration)
Reserve: Schumm, 1973. 'Geomorphic thresholds & the complex response of drainage systems.'
Channel Classification
Textbook-. pg. 403-423, Reserve: Rosgen, 1994. 'A classification of natural rivers' **SATURDAY LAB (OPTIONAL):** Site visits to restoration projects in Connecticut
11/15 Riparian Vegetation: (Bill Niering, Scott Warren or Glenn Dreyer)
Reserve: Goodwin et al., 1997. 'Riparian restoration in the western United States.'
Lab: Flume Experimentation: Procedures and Scaling Issues
11/17 Engineering Approaches: Stormwater Management
Reserve: Tourbier, 1994. 'Open space through stormwater management.'

11/19 Engineering Approaches: Grade Control and Bank Stabilization
Reserve: Harvey and Watson, 1986. 'Fluvial processes and morphological thresholds in incised channel restoration.'
11/22 Engineering Approaches: Instream Structures
Computer Reserve: Seehorn, 1985. 'Stream Habitat Improvement Handbook.'
Lab: Flume Experimentation: Restoration Design Testing
11/24 No Class
11/26 No Class
11/29 Engineering Approaches: Fish Habitat (DEP expert or Consultant)
Textbook: pg. 424-473
Lab: Budgeting Considerations (DEP expert or Consultant)
12/1 Instream Flow Requirements
Reserve: Hill et al., 199 1. 'Ecological and geomorphological concepts for instream and out-of channel flow requirements.'
12/3 Practice Presentation
12/6 Case Study: (DEP expert or Consultant)
Lab: Final Presentation for Expert Panel
12/8 Case Study: Merrick Brook, CT
12/10 Case.Study: Blackledge River, CT
12/13 Project Summary: Final Considerations
Lab: Work on Final Project
Final Project Due 12/16 (No Final Exam)

Likely List of Outside Experts (one from each list)
Connecticut College Arboretum
Glenn Dreyer, Arboretum Director
Bill Niering, former Arboretum Director and Associate Editor for *Restoration Ecology*

Connecticut College Buildings and Grounds, Capital Projects
Stephen George, Manager of Capital Projects
Al Lesage, Capital Projects

Connecticut Department of Environmental Protection

Brian Murphy, Fisheries Biologist, Habitat Conservation and Enhancement
Rick Jacobson, Fisheries Biologist and Associate Editor for N.A. *Journal of Fisheries Management*

City of New London
Richard Brown, City Manager
Susan Brant, Zoning Enforcement Officer

Engineering Consultant
Laura Wildman, Milone & MacBroom
John Deering, Special Consultant, John W. Deering Inc.

Additional Work Accomplished in Anticipation of the ES 410 Course
Independent Study on the Hydrology of the Impacted Area
Two streamflow-gaging stations have been installed.
Detailed rainfall data has been collected for the campus. Infiltration measurements have been conducted in the impacted basin.
By the end of the semester I anticipate a rainfall-runoff model that will allow the students in the ES 4 10 course to predict runoff in the campus stream based on estimated rainfall amounts.

Student Employee
Acquired a large number of important articles on channel restoration. These articles will comprise the majority of reserve readings and will also provide reference material for the students final project.
Review of critical terminology needs for selected articles.
Assistant with various field projects.

Computer-based Work
One color, electronic reserve has been created, additional electronic reserves may be used for the course.
A digital database of slide images is being created for web-based use by the students.