Report for 2003PR13B: FIELD METHODS IN HYDROLOGY AND HYDRAULIC

There are no reported publications resulting from this project.

Report Follows

SYNOPSIS

Project Number: 2003PR13B

Start: 3/1/2003
End: 2/1/2004

Title: Field Methods in Hydrology and Hydraulic

Investigators: Padilla, Ingrid Y., Zapata, Raul

Focus Categories: Education, Hydrology, Methods

Congressional District:

Descriptors: Field Methods, Hydrologic Measurements

Problem and Research Objectives:

The Department of Civil Engineering and Surveying at the University of Puerto Rico, Mayagüez begun a Doctoral program in Environmental and Water Resources Engineering during the year 2002. This program generated the need for a new and innovative curriculum of graduate courses to train scientist in these vital areas. It is also necessary to provide the students with practical field experience, which will bilaterally strengthen the theoretical and analytical skills developed during the forming years.

The Water Resources and Environmental Research Institute is taking an active role in promoting higher level education and helping to fill the gab between theoretical and applied engineering science. One major obstacle to fulfill this task is the lack of appropriate equipment for field measurements. By supplying instrumentation for the creation of the "Hydrologic and Hydraulic Field Measurement" course, this proposal is a step forward and a major contribution to improve the formation of new scientists in the water resources and environmental areas.

This project requested the instrumentation necessary to create an applied measurements course titled "Hydrologic and Hydraulic Field Measurement". The course objective is to provide graduate students from the MS and PhD program in Water Resources and Environmental Engineering with field experience in measurement of hydrologic and hydraulic parameters, as well as field reconnaissance work for research and applied engineering applications.

Methodology:

The course was initially created at the departmental and institutional level to be offered as an official graduate course. It was created as a graduate course that can be taken by entry-level M.S., as well as senior Ph.D. students having fundamental knowledge in hydraulics and hydrology. The course creation had involved four faculty members from surface water and groundwater hydrology and hydraulics.

Seven field/experimental activities were initially planned and scheduled as shown in the attached syllabus and briefly summarized in Table 1. Each of the field activities were preceded by a lecture explaining the methods to be used. The field/experimental activities were followed by periods of data evaluation, analysis, and documentation. All students were required to prepare written reports student for each of the activities.

Table 1. Field/experimental activities included in the course "*Field Methods in Hydrology and Hydraulic*".

Activity	Topic	Description
1	Climatic Variable Analysis	Students install a portable weather station, collect climatic data from this and other USGS' and NWS' weather stations around the island, and perform various data analyses. Climatic variables measured include rainfall, temperature, wind speed and direction, solar radiation, humidity, and vapor pressure. Lectures include techniques for collecting and presenting the data, operation principles of the instrumentation, and procedures for the analyses. The analyses include, but are not limited to, statistical analyses, completeness and consistency tests, and frequency analysis.
2	Evaporation and Evapotranspiration	Students take daily measurements from and maintain a Class A Evaporation Pan during the entire semester. The data collected is used to calibrate various evaporation models. The students model evaporation in different sites and assess the results. The models take into energy balance, aerodynamics, and combined evaporation principles. Evapotranspiration is assessed by means of a lysimeter built by the students. The data is used to calibrate some models and to develop relationships between evaporation, and actual and potential evapotranspiration. The data is also applied to determine the monthly pan evaporation coefficient.
3	Infiltration	Students install field infiltrometers and perform infiltration tests in the on different types of soils. The data collected is used to assess the infiltration characteristic of the soils tested and to calibrate different empirical models. Parameter estimation of most commonly used models are emphasized.
4	Surface Water Hydraulic Measurement	Students are trained in the use of a variety of field equipments to measure fundamental hydraulic and geometric parameters, which are required for river or channel studies. The classroom lecture includes presentation and demonstration of the different field tests and their importance in river hydraulics. Several selected stream reaches are selected and surveyed by the students. Cross section elevation and station points are surveyed and located using GPS equipment for accurate location. Students learn to tale stage and stream discharge measurements using a stage markers, topographic surveys, and flow propeller. A depth sounder is used to obtain channel elevation below the water surface. The range finder and the inclinometer allow a quick estimation of the river width and the banks height.
5	Sediment Transport	Students are initially offered a review lecture on fundamentals of sediment transport, where the equipment and sampling procedures are presented and demonstrated. The lecture is followed by field reconnaissance of at least two sediment sampling sites. The sampling equipment is set at the selected sites and field measurements of discharge and suspended and bed sediments are taken to obtain sediment loads. Bed, bank and flood plain materials are collected from representative sites for sediment size distribution analysis in the laboratory. The students select, from previous class discussion, several sediment transport functions and apply them to the field data. Results are compared with measured values for selection of the more appropriate equations and sediment loads are modeled.

Table 1. Field/experimental activities included in the course "*Field Methods in Hydrology and Hydraulic*" – Continued.

6	Pumping and Specific Capacity Test	This activity requires the installation of a pumping well. The well is to be installed at the UPRM campus for instructional purposes. The specific capacity test involves pumping a production well at a given (design) flow rate while monitoring water levels, drawdowns, and flow rates at the well. Once water levels have reached "steady state" at the well for a given flow rate, the pumping rate is instantaneously changed to a higher flow rate while continuously monitoring water levels, drawdown, and flow rates. This procedure is repeated at least four times to establish the relationship between well yield and drawdown. Regression analysis and groundwater analytical models are then used to analyze the data and determine well yield capacity.
7	Aquifer Test and Groundwater Sampling	This activity requires the installation of a pumping well and an observation well. The aquifers test involves pumping a production well at a constant rate for 2 days, while monitoring water levels and drawdowns at the pumping well and the nearby observation well. Flow rates at the pumping rate are also monitored throughout the test. Once the data is collected, it is analyzed using groundwater flow analytical models. Groundwater is collected at the discharge point from the production well and sampled from the observation well using a bailer. The samples are analyzed for temperature, pH, conductance, and TDS. The data is used to model aquifer properties and production capacity.

Principal Findings and Significance:

The course was created as a Civil Enginnering course (INCI 6116) and offered during the fall semester of the 2003-2004 academic year. Although a civil engineering course, it is open to graduate students from other areas, as long as they possess fundamental knowledge on hydrology and hydraulics concepts. Five graduate civil engineering students registered: 3 were at the M.S. level and 2 were at the Ph.D. level.

The course scheduled followed the attached *Course Syllabus* (Apendix 1). All field activities were conducted successfully as planned and described in Table 1, except for the last 2 activities related to groundwater hydrology ad hydraulics. The groundwater field activities were delayed because, although all the documentation was submitted months prior to the commencement of the academic semester, the permit for well drilling and installation was not obtained on time. This permit must be given by the Puerto Rico Department of Natural and Environmental Resources prior to any well drilling and installation activity.

Most of the field activities were successfully implemented and carried out. Students leaned about the instrumentation and methods of hydrologic and hydraulic field activities and applied theoretical concepts on the analysis of the measured parameters. Some problems were encountered in the installation and data analysis of the lysimeters and infiltrometers, but those problems have been solved for the next time the course is offered.

Although the issues related to the well installation permit have been resolved at this time, they were not resolved prior to the end of the academic semester when the course (INCI 6116) was offered. At the end of the semester it was then decided to extend the course to the following semester to allow time for permit approval and give the students the opportunity to conduct the proposed, groundwater-related activities. Unfortunately, the permits and contract were not issued

on time and the proposed groundwater field activities were not completed. The students were taken to nearby observation wells were use groundwater and GPS instrumentation to measure water levels, well location, and elevation. The data obtained was used to determine groundwater potentiometric elevation and flow directions. Because this activity lack a significant component of the proposed groundwater work, the field procedures and methods were thoroughly explained and data from other specific capacity and aquifer tests were then provided to the students for analysis. Evaluation of the groundwater field work was based on the field work conducted in the nearby observation wells and on the data analysis of the specific capacity and aquifer tests. All well installation permits have been and the institution is making all the pertinent arrangements for well installation in September, 2004. All students will be invited to see the well installation equipment and methods.

The learning objectives for the course were evaluated from written reports submitted by the students. The final grades were based on 6 individual written report grades. The general objectives of the course were accomplished in this project. Students learned the practical and theoretical principles of hydrologic and hydraulic measurements in the field. This course has further exposed them to the instrumentation and difficulties and errors involved in field measurements and data interpretation. It has given them the basis to understand and visualize the data they often encounter for analysis and decision making.

TRAINING ACCOMPLISMENTS

List all students participating in Section 104 projects.

Field of study	Academic Level				Total
	Undergraduate	MS	Ph.D.	Post Ph.D.	
Chemistry					
Engineering:					
Agricultural					
Civil		3	2		5
Chemical					
Computer					
Electrical					
Industrial					
Mechanical					
Geology					
Hydrology					
Agronomy					
Biology					
Ecology					
Fisheries, Wildlife, and Forestry					
Computer Science					
Economics					
Geography					
Law					
Resources Planning					
Social Sciences					
Business Administration					
Other (specify)					
Totals					

APPENDIX 1

University of Puerto Rico
Mayagüez Campus
College of Engineering

Syllabus & Instructor Information Sheet Form

A. COURSE SYLLABUS

1. General Information:

Course Number: INCI 6116
Course Title: Hydrologic and Hydraulic Field Measurement Methods
Credit-Hours: 3

2. Course Description:

This course provides graduate students at masters and doctoral levels the knowledge and skills required for using field equipment, sampling techniques, and data analysis for hydrologic and hydraulic applications. The course uses widely accepted and tested measurement techniques and equipment. The course provides students with useful measurement tools, skills for equipment use, and data analysis methodologies for climatologic, river hydraulics, and field measurements for their independent research needs. It requires extensive field work.

3. Pre-requisites: None

4. Textbook, Supplies and Other Resources:

Class Notes

5. Purpose:

The purpose of the course is to provide students with useful measurement tools, skills for equipment use, sampling techniques and data collection and analysis in hydrologic and hydraulic sciences and engineering.

6. Course Goals: By the end of this course, the students will be able to …

- Know, comprehend, apply and analyze fundamental hydrologic and hydraulic measurement techniques.
- Apply field measurement techniques to collect and analyze hydrologic and hydraulic data.
- Conduct sampling and testing of surface water, groundwater and sediments.
- Conduct field reconnaissance work for research and applied engineering applications.
- Analyze and interpret hydrologic and hydraulic field data.
- Report and present data analysis and results.

7. Requirements:

- Compulsory fieldwork attendance.
- Intensive fieldwork participation.
- The use of personal computers is required. Written reports, graphs, diagrams, and drawings are to be made through personal computers using word processors, electronic spreadsheets, and presentation graphics.
- Turn in the homework, special problems and project, and reports on time.
- Follow safety and security procedures.
- Keep all notes in an accessible field notebook.
- **E-mail:** All students must have an e-mail account to receive important course notes, updates, and changes. The e-mail address will be provided to the instructor, via e-mail. Students are responsible ton check for material sent through e-mail.

8. Laboratory/Field Work (If applicable):

No laboratory work. See attached schedule for fieldwork.

9. Department/Campus Policies:

9a. **Class attendance:** Class and fieldwork attendance is compulsory. The University of Puerto Rico, Mayagüez Campus, reserves the right to deal at any time with individual cases of non-attendance. Professors are expected to record the absences of their students. Frequent absences affect the final grade, and may even result in total loss of credits. Arranging to make up work missed because of legitimate class absence is the responsibility of the student (see Bulletin of Information Undergraduate Studies, 2002-2003).

9b. **Absence from field work:** Students are required to attend field work. If a student is absent, he or she will receive a grade of zero in the fieldwork component.

9c. **Final examinations:** Final written examinations must be given in all courses unless, in the judgment of the Dean, the nature of the subject makes it impracticable. Final examinations scheduled by arrangements must be given during the examination period prescribed in the Academic Calendar, including Saturdays. (see Bulletin of Information Undergraduate Studies, 2002-2003).

9d. **Partial withdrawals:** A student may withdraw from individual courses at any time during the term, but before the deadline established in the University Academic Calendar. (see Bulletin of Information Undergraduate Studies, 2002-2003).

9e. **Complete withdrawals:** A student may completely withdraw from the University of Puerto Rico, Mayagüez Campus, at any time up to the last day of classes. (see Bulletin of Information Undergraduate Studies, 2002-2003).

9f. **Disabilities:** All the reasonable accommodations according to the Americans with Disability Act (ADA) Law will be coordinated with the Dean of Students and in accordance with the particular needs of the student.

9g. **Ethics:** Any academic fraud is subject to the disciplinary sanctions described in article 14 and 16 of the revised General Student Bylaws of the University of Puerto Rico contained in Certification 018-1997-98 of the Board of Trustees. The professor will follow the norms established in articles 1-5 of the Bylaws.

10. General Topics:

Lecture	Topic	Reading Material
1 (8/13)	Introduction & Safety Issues	Handout, References
2 (8/19)	Climatic Variable Analysis	Handout, References
3 (8/26)	Evaporation and Evapotranspiration	Handout, References
4 (9/2)	Infiltration	Handout, References
5 (9/9)	SW Hydraulic Measurement	Handout, References
6 (9/16)	Sediment Transport	Handout, References
7 (9/30)	Pumping and Specific Capacity Test	Handout, References
8 (10/21)	Aquifer Test and Groundwater Sampling	Handout, References

FIELDWORK SCHEDULE

Laboratory	Topic	Report Due Date	Reading Material
1 (8/20, 8/27)	Climatic Variable Analysis	9/2	Handouts, References
2 (9/3)	Evaporation and Evapotranspiration	11/18	Handouts, References
3 (9/10)	Infiltration	9/16	Handouts, References
4 (9/17, 9/24)	SW Hydraulic Measurement	10/7	Handouts, References
5 (9/17, 9/24)	Sediment Transport	10/14	Handouts, References
6 (10/1)	Pumping and Specific Capacity Test	10/21	Handouts, References
7 (10/22)	Aquifer Test and Groundwater Sampling	11/4	Handouts, References

University of Puerto Rico
Mayagüez Campus
College of Engineering

B. Instructor Information Sheet

1. General Information:

Instructor: Dr. Walter Silva
Title: Professor
Office: Stefani 110A
Phone: 832-4040 ext. 3494
E-mail: wsilva@uprm.edu
Office Hours: MWF 10:30-12:30
(Other hours by Appointment)
Co-Instructors: Dr. Jorge Rivera-Santos, Raul Zapata, Dr. Ingrid Padilla
e-mail: riveraj@uprm.edu, Zapata@ce.uprm.edu, Ingrid@ce.uprm.edu

2. Course Description:

Course Number: INCI 6116
Course Title: Hydrologic and Hydraulic Field Measurement Methods
See element number 2 (Course Description) of Course Syllabus Section.

3. Purpose:

See element number 5 (Purpose) of Course Syllabus Section.

4. Course Goals:

See element number 6 (Course Goals) of Course Syllabus Section.

5. Instructional Strategy:

- Conference
- Fieldwork
- Sampling
- Testing
- Oral/written Reports

6. Evaluation/Grade Reporting:

Grades will be based on attendance, fieldwork participation, written reports, and oral presentations. Special problems and short projects may also be given at the instructor's discretion. The weighting will be as follows: Attendance and fieldwork participation (45%), written reports (45%), and oral presentation (10%).

In general, 90-100% = A, 80-89% = B, 70-79% = C, 60-69% = D, <60% = F

9. Deadlines for Assignments (Optional):
The instructor will give deadlines for each activity. All work must be turned during class, on the day is due. After that, 5 points will be taken off per day for 5 days. No assignment will be accepted after 5 days of its due date.

10. Student Assistance (If applicable):

11. Attendance and Behavior:

- Attendance to class and fieldwork is mandatory. If you miss a class, you need to present a written excuse to the professor. Missing class more than 3 times may be grounds to lower your final grade at the professor's discretion. After 3, each absence will result in 1 point off the final class grade.
- Students are required to attend all fieldwork. If you miss a (one) field activity for a justifiable reason acceptable to the professor, you need a written excuse. Otherwise, a grade of zero will be given to the missed fieldwork component. Missing more than one field activity you will be given the opportunity to withdraw from the class or you will receive an F".
- Students are encouraged to share, discuss, and interact; however, all graded work must be done independently, except as noted by instructor. Plagiarism: the penalty for academic dishonesty is failure on the piece of work.
- **Use of beepers and cellular phones is prohibited during class hours**

12. Instructor Responsibilities (If applicable):

- Help to obtain and prepare samples, plan fieldwork standard procedures, assist in fieldwork preparation, provide tutorial support to students.
- Preliminary schedule will be announced at the beginning of the semester, but the dates and times are subjected to changes. If rescheduling is necessary, the new dates and times will be announced with at least one week in advance.

13. Course Outline And Schedule:

a) **Course Outline.** See element 10 (General Topics) of course Syllabus for topics. General topics to be covered follow in approximate order. The instructor may, if necessary, change the order of the topics.

b) **Approximate Schedule.** Approximate schedule for reports and presentation follows. The instructor may, if necessary, change the scheduled dates in coordination with the students.

i. Written Report- See element 10 (General Topics) of course Syllabus.
ii. Oral Presentation – November 26, 2003; December 3, 2003.

14. Additional References:

i. Biedernharn, Elliot and Watson, *The West Stream Investigation and Streambank Stabilization Handbook*, U.S. Army Corps of Engineers, 1997.
ii. Dahmen and Hall, *Screening of Hydrologic Data*, ILRI Publication No. 49, 1990.
iii. Dawson, K.J. and Istok, J.D., *Aquifer Testing: Design and Analysis of Pumping and Slug Tests*, Lewis Publishers, 1991.
iv. Driscoll, F.G., *Groundwater and Wells*, 2nd ed., Johnson Division, 1986.
v. Ferguson, *Stormwater Infiltration*, Lewis Publishers, 1994.
vi. Fetter, C. W., *Applied Hydrogeology*, 4th ed., Prentice Hall, 2001.
vii. Goldman, Jackson, and Burszdynsky, *Erosion and Sediment Control Handbook*, McGraw Hill, 1986.
viii. Heath, R., *Basic Ground-Water Hydrology*, U.S. Geological Survey Water-Supply Paper 2220, 1989.
ix. Kasenow, M., *Applied Ground-water Hydrology and Well Hydraulics*, Water Resources Publications, LLC, 2000.
x. Lal, R., *Soil Erosion Research Methods*, Soil and Water Conservation Society, 1994.
xi. Meadows and Walski, *Computer Applications in Hydraulic Engineering*, Haestad Methods, 2002.
xii. Roberson,,J.A., J. Cassidy, and Chaudhry, *Hydraulic Engineering*, 2nd Ed., John Wiley, 1997.
xiii. U.S. Army Corps of Engineers, *Hydrographic Surveying*, EM 1110-2-1003, 1991.
xiv. Yang, C.T., *Sediment Transport Theory and Practice*, McGraw Hill, 1996.