

DEVELOPMENT OF AN INTERDISCIPLINARY WATERSHED RESEARCH LABORATORY FOR UNDERGRADUATE EDUCATION

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ABSTRACT: In 1999 Shippensburg University was awarded a National Science Foundation grant to establish the “Burd Run Interdisciplinary Watershed Research Laboratory.” This project: (1) strengthens laboratory and field experiences for undergraduate students, (2) develops interdisciplinary links between departments, courses, and faculty, and (3) encourages students to build and integrate scientific skills throughout their education using the watershed as a common case study. Students have been responsible for developing a GIS database to support integrated analysis of watershed hydrology, geology, groundwater, geomorphology, soils, vegetation, land use, water quality, and aquatic biology. The database forms the basis of an effort to integrate learning across the science curriculum. The project emphasizes relationships between watershed characteristics, water quality, and aquatic ecology by linking faculty and scientific perspectives across courses in geography, earth science, biology, and education. In addition, the laboratory involves students in long term monitoring of environmental change and impacts of human disturbance. Our experience illustrates that the Burd Run watershed is an ideal setting for an environmental laboratory due to its proximity to campus, its manageable scale, and its diverse physical characteristics. Upstream from the university campus the stream drains a 53km² watershed characterized by varied topography, geology, land use, and water quality. This wide variability of physical environments and related water management concerns provides an excellent field laboratory for course projects and student research. Because similar opportunities exist at many campuses, the Burd Run project serves as a useful conceptual model for improving water resources curricula nationally.

KEY TERMS: undergraduate education, water resources, watershed, laboratory.

INTRODUCTION

In 1999 Shippensburg University (SU) was awarded a National Science Foundation grant to establish the Burd Run Interdisciplinary Watershed Research Laboratory. This paper describes the educational goals of this project, the components of the Laboratory, and the methods of assessment used to measure project success. The general aim of both this paper and the Laboratory is to provide a conceptual model for improving water resources education nationally. Further information can be obtained from the project web site at: www.ship.edu/~geog/burdrun.

IMPROVING WATER RESOURCES EDUCATION

The Burd Run project is conceptually based on improving undergraduate education through use of a watershed case-study to promote interdisciplinary learning. The use of case study methods in undergraduate education is supported by research finding that students are more likely to retain information when theories and methods discussed in the classroom have been

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applied to “real world” case studies (Watson 1975, Meyers and Jones 1993). The interdisciplinary focus on a watershed case study mirrors national trends in natural resources management (Environmental Protection Agency 1996) and ecological sciences (Taylor et al. 1995). Educational approaches emphasizing integrative, interdisciplinary studies of watersheds exist at several other institutions, including Pennsylvania State University (Ferreri et al. 1997), Skidmore College (Kirk et al. 1997), and Indiana University-Purdue University Indianapolis (Lindsey and Jewett 1997).

The Burd Run project is innovative in that it integrates learning across the science curriculum. Many single courses use watershed case studies, often incorporating team teaching to support interdisciplinary studies (e.g. Kirk et al. 1997). The Burd Run project goes a step further, linking faculty and scientific perspectives across courses in geography, earth science, biology, and education. Repeated exposure to this common case study throughout students’ undergraduate education facilitates learning of complex, interdependent environmental systems that are difficult to address within a single course. For example, ecology students are able to integrate water quality, geology, soils, and land use data to test hypotheses of aquatic invertebrate distributions. Geomorphology students are able to link research on floodplain development to upstream geology, soils, land use, and hydrology. The watershed laboratory also integrates faculty research, student research, and classroom instruction, which provides benefits in terms of both student learning and faculty interest in student learning (Schratz 1990).

THE BURD RUN INTERDISCIPLINARY WATERSHED RESEARCH LABORATORY

Watershed description

The Burd Run watershed is an ideal setting for an environmental laboratory due to its proximity to SU (the stream flows through campus), its manageable scale, and its diverse physical characteristics. Burd Run at the SU campus drains a watershed of 53km², similar in size to the Crooked Creek, Indiana watershed that has also proven to work well as a teaching laboratory (Lindsey and Jewett 1997).

Burd Run heads atop South Mountain, the northern part of the Blue Ridge, at an elevation of 591m. There, two mountain tributaries flow across sandy soils developed on Cambrian quartzite within the Michaux State Forest. Near the base of South Mountain, these tributaries combine and flow across thick Pleistocene colluvial deposits that support mixed forestry and agriculture eventually emerging into the Cumberland Valley. As the colluvium thins with distance from the base of the mountain, several units of Ordovician and Cambrian limestone are exposed (Root 1965), some of which include solution cavities and other karst features (Shirk 1980). Agriculture is the primary land use on the silt loam and clay loam limestone soils until the stream flows into the Borough of Shippensburg. Urban land uses dominate the lower watershed, where the stream eventually flows across the SU campus at an elevation of 189m.

Water quality varies considerably with geology and land use. For example, water in the forest/quartzite environment is acidic (pH = 4.5), whereas water flowing through the limestone terrain of the Cumberland Valley is buffered (pH = 7.8). Temperature, dissolved oxygen, nutrient concentrations and other water quality parameters also vary considerably in the different watershed environments. This variability among topography, geology, land use, and water quality provides an excellent field laboratory for a wide range of course projects and investigations.

Project goals and objectives

The Burd Run Laboratory enhances undergraduate education through student-faculty collaborative studies focused on collection and analysis of watershed data. Through a variety of courses and research projects, students are responsible for using laboratory equipment to collect field data. Development and application of a digital watershed library are based on geographic information systems (GIS). Curricular materials developed by project faculty are also shared via the project web site.

Project field and laboratory equipment include instruments for: (1) automated monitoring of stream discharge, water quality, and meteorologic variables; (2) field studies in geomorphic mapping, surface and groundwater hydrology, wetlands, soils, aquatic biology, and land use; and (3) quantitative and spatial data analyses, presentation, and exchange.

The digital watershed library includes spatial data covering the entire drainage area as well as point data. Student projects have contributed to the GIS database of watershed conditions, including hydrography (streams, springs, and wetlands), geomorphology (floodplain mapping and sedimentology), bedrock and surficial geology, groundwater, soils, land use, urban water management, water quality, and aquatic biology. Watershed point data include continuously monitored discharge and basic water quality parameters (temperature, pH, dissolved oxygen, specific conductivity) sampled on the SU campus as well as periodic sampling of several sites throughout the watershed. Similarly, meteorologic data include daily temperature, rainfall, and snowfall measurements from the SU weather station supplemented by student projects using portable meteorological instruments. Detailed precipitation data are provided by a student study of rainfall variability among 20 sampling sites.

A curricular library is also under development, and will provide field and laboratory instructional materials, results from courses and student research, and evaluations of course projects. Instructional materials emphasize field and laboratory methods, hypothesis development and testing, mapping and spatial analysis, quantitative analysis, and interdisciplinary analysis (e.g. ecological studies, watershed management plans).

PROJECT ASSESSMENT

A 17-member Laboratory Advisory Board was developed to provide project assessment and guidance. This board includes environmental science consultants, government agency personnel, faculty from other universities, and environmental education experts. The advisory board is asked to critically review annual reports that describe ongoing watershed monitoring efforts, student field and laboratory projects, and course and curricular materials.

CONCLUSIONS

The Burd Run Interdisciplinary Watershed Research Laboratory provides a conceptual model for improving environmental science education in general and water resources education in particular. The successes of this laboratory are based largely on the following three factors: (1) the project addresses specific educational goals (e.g. increasing interdisciplinary case-study learning, facilitating hands-on field experiments); (2) the selected study watershed is accessible, a manageable scale, and includes a diversity of watershed conditions (e.g. geology, land use, water quality); and (3) project assessment allows for continuous adaptation based on input from an advisory board of experts from private consulting firms, government agencies, and other academic institutions.

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