Attracting bright students to pursue studies in soil science: A case study

Stephen H. Anderson[A]

[A]Dept. of Soil, Environmental & Atmospheric Sciences, Univ. of Missouri, Columbia, MO, USA, Email andersons@missouri.edu

Abstract
A major challenge facing soil science education is responding to insufficient enrollment in undergraduate programs. This issue has prompted many institutions of higher education to discontinue soil science offerings. The objective of this research was to evaluate a case study highlighting recent changes in a traditional undergraduate soil science degree program designed to increase enrollment and participation through a new environmental science curriculum. The case study details the addition of an environmental science program within a traditional soil science department at the University of Missouri. In 2004, a new environmental science curriculum was developed and offered for entering freshmen students. Over the next few years, five new required courses were developed by Soil Science Faculty for environmental science students. The effect of this offering has been to increase undergraduate departmental majors by approximately 45 to 50, with slight increases in incoming test scores. Participation by these students in soil science courses, soil judging activities, and other departmental offerings has enhanced soil science and increased the number of graduates with Bachelor of Science degrees pursuing careers related to soil science.

Key Words
Education, environmental science, soil science curriculum, undergraduate enrolment.

Introduction

Challenges with enrollment in soil science classes at the undergraduate level have caused many institutions of higher education to discontinue offerings of traditional soil science (Arnalds 2006; Baveye 2006; Baveye *et al.* 2006). These issues have occurred due to low interest of enrolling secondary school seniors in soil science, since they are unaware of opportunities in this significant discipline. Many students who wish to pursue careers in science do not understand how soil science can provide them with excellent career options.

How do soil science educators develop curriculum to attract secondary school seniors? One major area related to soil science to which secondary school seniors are attracted is the study of environmental science. These students need to be provided with the opportunity to see the advantages of studying the earth system as a way to develop their credentials and allow them to pursue their interests in helping to solve environmental challenges that face society today. If soil science educators participate in the development and offering of Environmental Science curricula, more students will have opportunities to study soil science. Many disciplines may wish to develop programs that cater to the interests of secondary school students in environmental issues. As a result, disagreements among different University colleges and departments can erupt over who "owns" Environmental Science and is permitted to develop environmental science programs. Such campus politics may stymie the active participation of Soil Science faculty in the development of environmental science programs.

The University of Missouri began offering a new Environmental Science undergraduate degree program in 2004. This program was established as an emphasis area in the Department of Soil, Environmental and Atmospheric Sciences due in part to this department being under the umbrella of the School of Natural Resources. In order to develop depth as well as breadth, the Environmental Science program at Missouri has three tracks: Land Management, Water Quality, and Air Quality. The objective of this paper is to present a case study on how a traditional undergraduate soil science degree program was re-designed to increase enrollment and participation through integration into a new environmental science curriculum.

History of soil science at the University of Missouri

The teaching of soil science at the University of Missouri began in the College of Agriculture and Mechanic Arts which was established in 1870 (Mumford, 1944). The Department of Agronomy was formed in 1904 and was split into the Departments of Soils, Farm Crops, and Agricultural Engineering in 1914 (Mitchell, 2004). The Department of Soils first employed an atmospheric scientist in 1949 (Woodruff, 1990). In 1967, a separate Department of Atmospheric Science was formed and the Departments of Field Crops and Soils were

1 – 6 August 2010, Brisbane, Australia. Published on DVD.

re-combined that year into the Department of Agronomy (Mitchell, 2004). In 2005, the Departments of Agronomy, Entomology, Horticulture, and Plant Pathology were dissolved and joined together in the Division of Plant Sciences. Soil Science teaching and research faculty had previously transferred from the Department of Agronomy to the School of Natural Resources in 1990. The Department of Atmospheric Science joined them in 1992, and the name changed to the Department of Soil and Atmospheric Sciences. After some challenges in 2002, a new Department of Soil, Environmental and Atmospheric Sciences were formed in 2003 in the School of Natural Resources.

Environmental science curriculum

Since Soil Science faculty were part of the School of Natural Resources, proposals were made to develop an Environmental Science curriculum. The new Environmental Science curriculum was instituted as an emphasis area within the Department of Soil, Environmental and Atmospheric Sciences and offered in 2004. The curriculum is shown in Table 1 and features a strong emphasis in basic science courses and new environmental science courses (Table 2). Three tracks are offered in the degree program: land management, water quality, and air quality. The land management track prepares students to pursue careers related to soil science; other faculty within the School of Natural Resources assist in offering the water quality track; and the Atmospheric Science faculty offer a track in air quality.

The curriculum was developed with input from representatives of state and federal agencies. A required three credit hour internship gives students real-world experiences. Part-time employment as a field or laboratory technician assessing land management and water quality or conducting environmental monitoring can fulfill this requirement. These internships provide valuable experience for students pursuing professional careers. State and federal agencies likely to recruit environmental science interns include the Missouri Department of Conservation, the Missouri Department of Natural Resources, the U.S. Department of Agriculture-Natural Resources Conservation Service, and the U.S. Geological Survey. Private groups, such as environmental consulting firms and a diverse selection of industries and environmental advocacy groups, also provide internship opportunities. In addition to the Environmental Science major, a dual degree in Environmental Science and Biochemistry is offered. This is a very challenging curriculum with excellent employment opportunities for students pursuing this option. Students may also choose an undergraduate minor in Environmental Science.

New courses developed for environmental science

Several new courses have been developed for the new curriculum. These courses are listed in Table 2 and are taught by Soil Science faculty. These classes are in addition to the regular undergraduate Soil Science courses which include: Introduction to Soil Science, Soil Science Laboratory, Environmental Soil Physics, Environmental Soil Physics Laboratory, Soil Conservation, Environmental Soil Microbiology, Soil Fertility and Plant Nutrition, Soil Fertility and Plant Nutrition Laboratory, Environmental Soil Chemistry, and Genesis of Soil Landscapes. During the past couple of years, Environmental Science students have taken Soil Science courses selected within the track-specific options. Thus, by offering Environmental Science courses, Soil Science Faculty have also slightly increased enrollment in Soil Science courses.

Undergraduate enrollment levels

Undergraduate student enrollment numbers within the Department of Soil, Environmental and Atmospheric Sciences for the past 20 years are shown in Figure 1. Data in Figure 1 from 1990 through 1999 were obtained from the School of Natural Resources, University of Missouri; data from 2000 through 2009 were obtained from the Registrar, University of Missouri.

These numbers reflect several changes over the past 20 years. In 1990, all students shown were enrolled in Atmospheric Science, since Soil Science faculty taught courses to undergraduates in the Department of Agronomy for the prior 23 years. In 1992, a curriculum was developed for Soil Science undergraduates that were offered in the new Department of Soil and Atmospheric Sciences. This curriculum, which is still being offered, attracted between five and ten undergraduates within a given year. The Atmospheric Science curriculum experienced a significant increase in enrollment from 26 in 1992 to 90 in 2003 (97 total, including 7 Soil Science students). Beginning in 2004, subsequent enrollment increases in the department were due to the new Environmental Science curriculum. Thus, enrollment at present for the department has increased to 140 with about 45 to 50 undergraduates in Environmental Science. Growth in Environmental Science was gradual since it was offered as an emphasis area and interest spread due to word of mouth.

Table 1. Required semester courses for Environmental Science Program at the University of Missouri.

Requirements	Course Titles	Required Credit Hours
General Requirements		
English	Exposition and Argumentation	3
History or Political Science	US History or Political Science	3
Mathematics	College Algebra, Calculus, Statistics	9
Social Sciences	Economics, Sociology, Communications, Policy	12
Humanistic Studies & Fine Arts	Humanities, Fine Arts, Language	9
Science Requirements		
Biological Science	Biological Systems, Botany, Ecology	15
Chemistry	General Chemistry (Recommend Organic Chemistry)	8
Geology	Principles of Geology or Environmental Geology	4
Physics	Physics or Environmental Physics	4
Departmental Requirements[A]		
Atmospheric Science	Meteorology	3
Soil Science	Introduction to Soils, Soil Science Laboratory	5
Environmental Science	Introduction to Environmental Science, Soils and the Environment, Pollutant Fate and Transport, Hydrologic and Water Quality Modeling	12
Computer Science	Computing and Information Systems or Introduction to GIS	3
Track Specific	Land Use Management or Water Quality & Natural Resource Management or Atmospheric Physics & Weather Briefing	3
	Environmental Science Internship	3
	Five courses in Environmental Science or related areas (includes Soil Science courses)	15
Capstone Experience	Natural Resources Practicum	3
Electives		
Elective Courses	Other courses	14

[A]Two courses in the curriculum must be designated Writing Intensive.

Table 2. New courses developed by Soil Science Faculty and offered for the Environmental Science Program at the University of Missouri.

Course Number	Course Title	Year First Offered
1100	Introduction to Environmental Science	2006
3290	Soils and the Environment[A]	2000
3330	Environmental Land Use Management	2009
3500	Pollutant Fate and Transport	2009
4320	Hydrologic and Water Quality Modeling[A]	2002
4940	Environmental Science Internship	2006

[A]Courses offered in Soil Science prior to formation of the Environmental Science Program.

Comparison of entering freshmen average test scores (American College Testing, ACT) indicates the School of Natural Resources has increased 5.5% over 10 years relative to the campus which remained unchanged. Department scores have increased 5.3% over 5 years relative to the School. Despite these small score differences, more bright students are graduating with interests in soil science compared to 10 years ago.

Effects on soil science

A direct impact of the new program on soil science is the participation of environmental science students in traditional soil science courses (~3 current soil science undergraduates but about 30% higher enrollment in courses than 10 years ago). Traditionally, students in environmentally-related disciplines (forestry, fisheries and wildlife, geology, etc.) have taken the Introductory Soil Science course. However, environmental science students are now taking additional soils courses beyond the introductory course. In addition, the soil judging team is now composed primarily of environmental science students. Graduates from this program have been

hired by the USDA-Natural Resources Conservation Service as well as consulting firms who have traditionally hired soil science graduates.

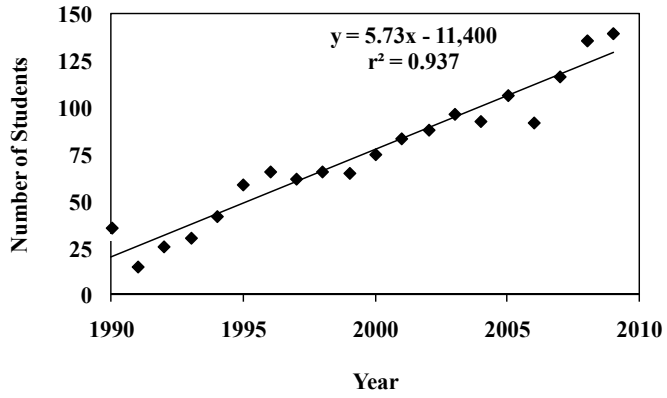

Figure 1. Number of undergraduate students in the Department of Soil, Environmental and Atmospheric Sciences at the University of Missouri as a function of year. Student numbers include Atmospheric Science, Soil Science and Environmental Science (beginning in 2004).

Conclusion

Low enrollment is a significant challenge facing undergraduate soil science programs today. This paper suggests that offering an environmental science undergraduate program can address the challenge. The case study concerns the addition of an environmental science program within a traditional soil science department at the University of Missouri. In 2004, a new Environmental Science curriculum was developed and offered for entering freshmen students at the University of Missouri. Five new courses required for environmental science students were developed by Soil Science faculty. The effect of this offering has been to increase undergraduate departmental majors by approximately 45 to 50. Participation by these students in soil science courses, soil judging activities, and other departmental offerings has enhanced soil science and increased the number of graduates with Bachelor of Science degrees pursuing careers in soil science (0 BS graduates pursuing graduate degrees 10 years ago vs. 6 BS graduates currently pursuing graduate degrees). Attracting students into environmental science with exposure to soil science has increased the number of students pursuing careers in soil science. Development of environmental science programs may help enhance enrollment in soil science programs at institutions of higher education.

References

Arnalds O (2006) The future of soil science. In 'The Future of Soil Science'. (Ed AE Hartemink) pp. 4-6. (International Union of Soil Sciences: Wageningen, The Netherlands).

Baveye P (2006) A future for soil science. *Journal of Soil and Water Conservation* **61,** 148A-151A.

Baveye P, Jacobson AR, Allaire SE, Tandarich J, Bryant R (2006) Whither goes soil science in the US and Canada? Survey results and analysis. *Soil Science* **171,** 501-518.

Mitchell RL (2004) Agronomy, soils and atmospheric science at the University of Missouri: 100 years, 1904-2004. Special Report 554, College of Agriculture, Food and Natural Resources, University of Missouri.

Mumford FB (1944) History of the Missouri College of Agriculture. Bulletin 483, College of Agriculture, University of Missouri.

Woodruff CM (1990) A history of the Department of Soils and Soil Sciences at the University of Missouri. Special Report 413, College of Agriculture, University of Missouri.