Environmental Sciences

Stephen H. Anderson, Program Coordinator
Environmental Sciences
School of Natural Resources
College of Agriculture, Food, and Natural Resources
329 Anheuser-Busch Natural Resources Building
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Earth’s environment provides conditions conducive for life: an oxygenated atmosphere; water resources; and soil as a medium for plant growth. Environmental processes occurring on the planet govern the movement of air, energy, matter, and water. Through the study of Environmental Sciences, students will learn the science and experience the beauty of the outdoor environment. This degree program addresses how human activities can adversely alter some environmental processes and environmental quality, techniques to improve environmental quality, modeling of environmental processes and practices that minimize human impacts on the environment. The Environmental Sciences degree provides a strong science foundation through general science coursework and specialized studies of the atmosphere, land and soil, water, and environmental outreach and education. The degree combines interests in predicting and understanding weather patterns, monitoring environmental change, conserving and managing soil and biological organisms, assuring healthy streams and adequate water supplies, and improving environmental quality with the shaping of new policies and educating others about the natural environment and environmental issues. Example careers include Atmospheric Scientist, Climatologist, Environmental Specialist, Environmental Technician, Hydrologist, Land Manager, Meteorologist, Soil Scientist, and Water Quality Specialist. Employment may occur in a variety of sectors, including federal, state, county and city government agencies, non-government agencies (NGOs), and private consulting firms.

School of Natural Resources
The School of Natural Resources is one of six Divisions in the College of Agriculture, Food and Natural Resources. It is Missouri’s and the Midwest’s only school with comprehensive academic and research programs focused on biological, physical, and social aspects of natural resources science and management. The School applies an integrated, scientific approach to develop sustainable solutions to environmental challenges and to train the next generation of natural resources and recreation professionals and leaders. This integrated approach results in creative course offerings, enhanced educational opportunities, stimulation of novel research, advanced understanding of natural systems, and expanded knowledge and management of human interactions with the environment. The School is housed in the Anheuser-Busch Natural Resources Building containing state-of-the-art teaching, research and outreach extension facilities.

Faculty

Professor Emeritus C. J. Gantzter, P. P. Motavalli
Assistant Professor N. Aloysius, A. Argerich, D. Hall, C.J. Li, R. North, R. Rotman
Associate Professor R. J. Miles, S.E. Mudrick
Extension Associate Professor P. E. Guinan*
Instructor E. Aldrich, P. Quackenbush
Research Professor R. P. Udawatta **

Environmental Sciences

Research Assistant Professor S. Bardhan*, J. D. Wood*
Adjunct Assistant Professor K.S. Veum*
Adjunct Associate Professor C. Baffaut*, F. Eivazi*, R. N. Lerch**, M. Nathan, J. Yang*
Adjunct Professor N. R. Kitchen**, R. J. Kremer*, P. C. Scharf*, W. G. Stevens*, C. K. Wike*

Graduate

Options for graduate study in SEAS will be offered through the MS in Natural Resources with an emphasis in SEAS (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/naturalresources/ms-soil-environmental-atmospheric-sciences/) and the PhD in Natural Resources with an emphasis in SEAS (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/naturalresources/phd-soil-environmental-atmospheric-sciences/).

Focus areas in soil science, environmental science or atmospheric science are available through these options. Details on both degree programs, including recommended preparation, admission criteria, required application materials, degree requirements and financial aid, are provided in the graduate tab of the Natural Resources section (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/naturalresources/).
#graduate
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of the catalog under the College of Agriculture, Food and Natural Resources.

**ATM_SC 1050: Introductory Meteorology**
(same as GEOG 1050). Physical processes of atmosphere in relation to day-to-day changes in weather.

**Credit Hours:** 3

**ATM_SC 1050H: Introductory Meteorology - Honors**
(same as GEOG 1050H). Physical processes of atmosphere in relation to day-to-day changes in weather.

**Prerequisites:** Honors eligibility required

**Credit Hours:** 3

**ATM_SC 2150: Natural Hazards**
A survey of natural hazards, including severe thunderstorms, tornadoes, flooding, tropical storms, ocean movements, earthquakes, tsunamis, volcanoes, asteroids, solar weather, managing risk and human impacts. Graded on A-F basis only.

**Credit Hours:** 3

**Prerequisites:** ATM_SC 1050 or equivalent, or instructor's consent

**ATM_SC 2720: Weather Briefing**
Student participation in daily discussions of current weather patterns and forecasts and their applications to weather sensitive activities including aviation, agriculture and industry.

**Credit Hours:** 2

**Prerequisites:** ATM_SC 1050

**ATM_SC 2792: Weather Communication**
Methods of surface and upper air weather observation. How such data are distributed to users in the meteorological community is also addressed.

**Credit Hour:** 1

**Prerequisites:** ATM_SC 1050; sophomore standing

**ATM_SC 3000: Independent Study in Atmospheric Science**
Independent study of a topic dealing with meteorological theory or application of meteorological science to the solution of relevant problem.

**Credit Hour:** 1-3

**Prerequisites:** ATM_SC 1050

**Recommended:** Upper level standing

**ATM_SC 3600: Climates of the World**
(same as GEOG 3600). A study of the world distribution of climates based on ‘cause and effect’ relationships. Special attention is given to the impacts of climate on humanity.

**Credit Hours:** 3

**Prerequisites:** ATM_SC 1050 or graduate standing

**ATM_SC 4001: Topics in Atmospheric Science**
Development of theory and applications for selected topics in atmospheric science.

**Credit Hour:** 1-99

**Prerequisites:** junior standing and instructor's consent

**ATM_SC 4110: Broadcast Meteorology I**
An introduction to broadcast meteorology including the business of media, use of meteorological data to produce a forecast, and television and radio presentation skills. Graded on A-F basis only.

**Credit Hours:** 2

**Prerequisites:** ATM_SC 1050, ATM_SC 2720, or equivalents

**ATM_SC 4310: Atmospheric Thermodynamics**
(cross-leveled with ATM_SC 7310). Thermodynamics of dry and moist air, atmospheric hydrostatics, convection, and development of the fundamental equations of geophysical fluid dynamics.

**Credit Hours:** 4

**Prerequisites:** ATM_SC 1050, MATH 1700 (C or better), and one physics course

**ATM_SC 4320: Atmospheric Dynamics**

**Credit Hours:** 4

**Prerequisites:** ATM_SC 4310 or ATM_SC 7310

**ATM_SC 4350: Mesoscale Meteorology and Dynamics**
(cross-leveled with ATM_SC 7350). Survey of mesoscale phenomena, observing systems, analysis techniques, and modeling. Topics include fronts, jet streaks, gravity waves, organized convection, tornadoes, and severe local storm forecasting and structure.

**Credit Hours:** 3

**Prerequisites:** ATM_SC 4720 or ATM_SC 7720 and MATH 2300

**ATM_SC 4400: Micrometeorology**
(cross-leveled with ATM_SC 7400). Study of transport processes in the surface boundary layer. Important applications in pollution will be discussed.

**Credit Hours:** 3

**Prerequisites:** ATM_SC 4310 or PHYSCS 2760, MATH 2300

**ATM_SC 4510: Remote Sensing for Meteorology and Natural Resources**
(cross-leveled with ATM_SC 7510). Principles of remote sensing with emphasis on the properties of atmosphere and the earth's surface from airborne and satellite sensors. The techniques for using geosynchronous and orbiting satellite platforms for assessing weather and natural resource features.

**Credit Hours:** 3

**Prerequisites:** ATM_SC 1050, MATH 1500, junior standing or instructor's consent

**ATM_SC 4520: Environmental Biophysics**
(same as GEOG 4520; cross-leveled with ATM_SC 7520, GEOG 7520). Students will learn techniques and principles used to describe the microenvironment of living organisms and use quantitative expressions
to estimate missing values, and mass transfer laws to estimate flux of energy, water and gas.

Credit Hours: 3
Prerequisites: College Physics and Calculus I

ATM_SC 4550: Physical Meteorology
(cross-leveled with ATM_SC 7550). Physics of atmospheric nucleation-condensation, cloud droplet and precipitation formation, associated electrical phenomena, radiation transfer and remote sensing.

Credit Hours: 3
Prerequisites: MATH 1500
Recommended: 1 year of college Physics, CHEM 1320

ATM_SC 4650: Long-Range Forecasting

Credit Hours: 3
Prerequisites: ATM_SC 4050 or ATM_SC 7050 or ATM_SC 3600

ATM_SC 4710: Synoptic Meteorology I
(cross-leveled with ATM_SC 7710). Meteorological Data. Basic techniques for surface and upper air analysis, using selected examples of weather patterns.

Credit Hours: 4
Prerequisites: ATM_SC 1050, MATH 1700 (C or better)
Recommended: one physics course

ATM_SC 4720: Synoptic Meteorology II
(cross-leveled with ATM_SC 7720). Graphical analysis and interpretation of physical, kinematical and dynamical properties of the atmosphere. Analysis techniques applicable to atmospheric research.

Credit Hours: 4
Prerequisites: ATM_SC 4710 or ATM_SC 7710

ATM_SC 4720W: Synoptic Meteorology II - Writing Intensive
(cross-leveled with ATM_SC 7720). Graphical analysis and interpretation of physical, kinematical and dynamical properties of the atmosphere. Analysis techniques applicable to atmospheric research.

Credit Hours: 4
Prerequisites: ATM_SC 4710 or ATM_SC 7710

ATM_SC 4730: Advanced Forecasting Laboratory
Advanced principles of weather forecasting will be addressed via online electronic modules and weekly laboratory exercises. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ATM_SC 4720

ATM_SC 4800: Numerical Methods in Atmospheric Science and Natural Resources
(cross-leveled with ATM_SC 7800). Examines numerical methods used in solving differential equations, filtering data sets, and Fourier decomposition of discrete data sets.

Credit Hours: 3
Prerequisites: senior standing
Recommended: Math through Calculus III

ATM_SC 4949: Internship in Meteorology
Practical professional work experience with professional or scientific meteorologists in off-campus work environment. Graded on S/U basis only.

Credit Hour: 1-6
Prerequisites: junior standing
Recommended: Math through Calculus III

ATM_SC 4950: Undergraduate Research in Atmospheric Science
Research apprenticeship with a faculty mentor. Students are expected to develop initial concept for the research, design experiments, collect data, and analyze data with faculty input, oversight, and guidance.

Credit Hour: 1-4
Prerequisites: STAT 1400, MATH 1500
Recommended: 10 hours of Atmospheric Science courses

ATM_SC 7310: Atmospheric Thermodynamics
(cross-leveled with ATM_SC 4310). Thermodynamics of dry and moist air, atmospheric hydrostatics, convection, and development of the fundamental equations of geophysical fluid dynamics.

Credit Hours: 4
Prerequisites: ATM_SC 1050, MATH 1700 (C or better), and one physics course

ATM_SC 7320: Atmospheric Dynamics
(cross-leveled with ATM_SC 4320). Dynamics and kinematics of atmospheric flow. Manipulation of fundamental equations, numerical modeling of atmosphere.

Credit Hours: 4
Prerequisites: ATM_SC 4310 or ATM_SC 7310

ATM_SC 7350: Mesoscale Meteorology and Dynamics
(cross-leveled with ATM_SC 4350). Survey of mesoscale phenomena, observing systems, analysis techniques, and modeling. Topics include fronts, jet streaks, gravity waves, organized convection, tornadoes, and severe local storm forecasting and structure.

Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720 and MATH 2300

ATM_SC 7400: Micrometeorology
(cross-leveled with ATM_SC 4400). Study of transport processes in the surface boundary layer. Important applications in pollution will be discussed.

Credit Hours: 3
ATM_SC 7510: Remote Sensing for Meteorology and Natural Resources
(cross-leveled with ATM_SC 4510). Principles of remote sensing with emphasis on the properties of atmosphere and the earth's surface from airborne and satellite sensors. The techniques for using geosynchronous and orbiting satellite platforms for assessing weather and natural resource features. Graduate student credit is dependent upon completion of additional advanced research assignments. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: ATM_SC 1050, MATH 1500, junior standing or instructor's consent

ATM_SC 7520: Environmental Biophysics
(same as GEOG 7520; cross-leveled with ATM_SC 4520, GEOG 4520). Students will learn techniques and principles used to describe the microenvironment of living organisms and use quantitative expressions to estimate missing values, and mass transfer laws to estimate flux of energy, water, and gas.
Credit Hours: 3
Prerequisites: college physics, calculus I

ATM_SC 7550: Physical Meteorology
(cross-leveled with ATM_SC 4550). Physics of atmospheric nucleation-condensation, cloud droplet and precipitation formation, associated electrical phenomena, radiation transfer and remote sensing.
Credit Hours: 3
Prerequisites: MATH 1500
Recommended: 1 year of college Physics, CHEM 1320

ATM_SC 7590: Radar Meteorology
(cross-leveled with ATM_SC 4590). Course concerns the theory and application of radar in meteorology. Graduate students will be required to conduct an independent research project using radar, in addition to the undergraduate requirements for the class. May be repeated for credit.
Credit Hours: 3
Prerequisites: MATH 1700, PHYSCS 2760

ATM_SC 7650: Long-Range Forecasting
(cross-leveled with ATM_SC 4650). Course concerns the theory and application of radar in meteorology. Graduate students will be required to conduct an independent research project using radar, in addition to the undergraduate requirements for the class. May be repeated for credit.
Credit Hours: 3
Prerequisites: ATM_SC 4050 or ATM_SC 7050 or ATM_SC 3600

ATM_SC 7710: Synoptic Meteorology I
(cross-leveled with ATM_SC 4710). Meteorological Data. Basic techniques for surface and upper air analysis, using selected examples of weather patterns.
Credit Hours: 4
Prerequisites or Corequisites: one physics course
Prerequisites: ATM_SC 1050, MATH 1700 (C or better)
ATM_SC 8500: Radiation in the Atmosphere
Physics of solar and infrared radiative transfer in the atmosphere, including energy conversion effects, atmospheric optics, and photochemical processes.
Credit Hours: 3
Prerequisites: one year College Physics and MATH 1700

ATM_SC 8550: Nowcasting
Students will learn the science of nowcasting through the study of the various methods used and apply their knowledge in the design of the elements of a nowcast system and practical nowcasting exercises.
Credit Hours: 3
Prerequisites: ATM_SC 8500, instructor's consent

ATM_SC 8600: Advanced Climate Dynamics
Study of global climate; application of large scale atmospheric dynamics; conservation of various forms of energy, climatic evaluation, large scale climatic modification.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320 and ATM_SC 8400 or ATM_SC 3600

ATM_SC 9085: Problems in Atmospheric Science
Independent study by graduate students in atmospheric science.
Credit Hour: 1-99

ATM_SC 9087: Seminar in Atmospheric Science
Seminar in Atmospheric Science.
Credit Hour: 1-99

ATM_SC 9090: Doctoral Research in Atmospheric Science
Original investigation in atmospheric science in support of a doctoral dissertation. Graded on S/U basis only.
Credit Hour: 1-99

ATM_SC 9300: Introduction to Chaos Theory
Atmospheric predictability and related topics are examined as they relate to governing equations of motion and their non-linear solutions.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320, MATH 4100

ATM_SC 9350: Advanced Dynamic Meteorology
Application of perturbation dynamics, advanced dynamics, and numerical methods to study of atmospheric circulations.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320

ATM_SC 9590: Advanced Applications of Weather Radar
This course will investigate quantitative uses of weather radar data that go beyond standard reflectivity and velocity image interpretation, particularly those that use new techniques such as dual-polarization. Students will develop methods to analyze and display meteorological radar data. Graded on A-F basis only.

ATM_SC 9700: Advanced Synoptic Meteorology
Detailed examination of vertical motions, their forcing, and how each is diagnosed (quasigeostrophic theory, the Trenberth approximation, Q-vectors). Current issues in synoptic meteorology and operational forecasting are discussed.
Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720

ATM_SC 9712: Convection and Lightning
Cumulus convection and cloud physics topics that will facilitate a deeper understanding of cloud electrification and lightning production are studied. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: ATM_SC 4710 or ATM_SC 7710, ATM_SC 4720 or ATM_SC 7720, MATH 2300; instructor's consent

ATM_SC 9800: Numerical Weather Prediction
Examination of finite difference and objective analysis techniques, basic physical concepts, and parameterization of physical processes. Experience with a range of models (1-D cloud to operational PE models) stressed.
Credit Hours: 3
Prerequisites: instructor's consent

ENV_SC 1100: Introduction to Environmental Science
This class provides an opportunity to develop an understanding of environment, physical and social causes of environmental problems, their impacts, and strategies to manage these issues.
Credit Hours: 3
Prerequisites: Enrollment restricted to College of Agriculture, Food and Natural Resources undergraduates and students minoring in Environmental Science

ENV_SC 2001: Topics in Environmental Science - General
Organized study of selected topics. Subjects and credit may vary from semester to semester.
Credit Hour: 1-99

ENV_SC 2600: Sustainability Foundations: An Introduction to Sustainability
(same as BIOL_EN 2600). This course introduces fundamental concepts of sustainability from sustainable development to sustainability science. It focuses on human-environment systems, the characteristics of these systems, and patterns of change. Course materials interrogate taken-for-granted assumptions that shape human relationships with the natural world. You will learn to identify common dynamics leading to social and environmental problems with the aim of identifying alternative actions (solutions) for transitioning towards sustainability. Sustainability integrates the social and biophysical sciences; and implementing solutions requires the integration of the social justice, the arts, and humanities. Through a variety of interdisciplinary perspectives and frameworks, you will
learn about current sustainability research and be able to develop an understanding of what sustainability means to you and your field of study. Graded on A-F basis only.

Credit Hours: 3

ENV_SC 2600H: Sustainability Foundations: An Introduction to Sustainability - Honors
(same as BIOL_EN 2600). This course introduces fundamental concepts of sustainability from sustainable development to sustainability science. It focuses on human-environment systems, the characteristics of these systems, and patterns of change. Course materials interrogate taken-for-granted assumptions that shape human relationships with the natural world. You will learn to identify common dynamics leading to social and environmental problems with the aim of identifying alternative actions (solutions) for transitioning towards sustainability. Sustainability integrates the social and biophysical sciences; and implementing solutions requires the integration of the social justice, the arts, and humanities. Through a variety of interdisciplinary perspectives and frameworks, you will learn about current sustainability research and be able to develop an understanding of what sustainability means to you and your field of study. Graded on A-F basis only.

Credit Hours: 3

ENV_SC 3085: Problems in Environmental Science
Special individualized projects or readings in environmental science.

Credit Hour: 1-99

ENV_SC 3250: Pollutant Fate and Transport
(same as CV_ENG 3250). Introduction to concepts governing pollutant fate and transport in the environment, including pollutant interactions within and migration through environmental systems, as well as analytical techniques and tools necessary to quantify conditions and movement.

Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100 or CV_ENG 3200; and CHEM 1320

ENV_SC 3290: Soils and the Environment
(same as SOIL 3290). Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.

Credit Hours: 3
Prerequisites: SOIL 2100, ENGLISH 1000. Recommended 3 hours of CHEM courses

ENV_SC 3290W: Soils and the Environment - Writing Intensive
(same as SOIL 3290W). Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.

Credit Hours: 3
Prerequisites: SOIL 2100, ENGLISH 1000. Recommended 3 hours of CHEM courses

ENV_SC 3330: Environmental Land Use Management
An introduction to environmentally sustainable use and management of land.

Credit Hours: 3

ENV_SC 3400: Water Quality and Natural Resources Management
(same as NAT_R 3400). Introduction to broad aspects of water quality science, management, and policy. Topics include aquatic ecology, eutrophication, lake and coastal management, water supply and treatment, watershed management with respect to agriculture and urban development, and toxicology. Graded on A-F basis only.

Credit Hours: 3
Recommended: CHEM 1320 and ENV_SC 1100 or NAT_R 1070

ENV_SC 3500: Pollutant Fate and Transport
This course introduces students to concepts governing pollutant fate and transport in the environment, and it provides students with the quantitative tools necessary to estimate the fate and transport of pollutants in the environment.

Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100, and CHEM 1320

ENV_SC 4001: Topics in Environmental Science - General
Organized study of selected topics in environmental science.

Credit Hour: 1-99

ENV_SC 4024: Foundations of Environmental Education
(same as NAT_R 4024; cross-leveled with NAT_R 7024). This course provides a theoretical foundation to environmental education (EE). The purpose of this course is to develop the knowledge and skills for developing quality, age-appropriate EE for students in both formal and non-formal education setting. The emphasis is on EE curriculum materials, resources, and programs that can be used with students in settings at classrooms, nature centers, museums, and parks. This course involves training in the Missouri Department of Conservation Discover Nature School educational materials, and in observing and teaching EE lessons in a local nature center. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 1010 or ENV_SC 1100 or NAT_R 1060 or NAT_R 1070 or NAT_R 2160 or Instructor's consent

ENV_SC 4085: Problems in Environmental Science
Special individualized research projects or readings in environmental science.

Credit Hour: 1-99

ENV_SC 4100: Lake Ecology
(same as NAT_R 4100; cross-leveled with ENV_SC 7100, NAT_R 7100). Ecology of inland waters with emphasis on productivity. Graded on A-F basis only.

Credit Hours: 3
Recommended: senior standing or BIO_SC 3650
ENV_SC 4200: Stream Ecology and Hydrology
(cross-leveled with ENV_SC 7200). This senior/grad course in stream ecology will provide students an opportunity to increase their knowledge about the ecology of flowing waters. The course will cover physical and biological elements of fluvial ecosystems, with a focus on mechanisms and processes and the discussion of critical issues associated with the conservation and management of streams and their biota. The course is built around lectures, assigned readings, and class and home activities. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: 60 credit hours, MATH 1100
Recommended: BIO_SC 3650 or FOREST 4320

ENV_SC 4300: Methods in Aquatic Ecology
(same as NAT_R 4300; cross-leveled with ENV_SC 7300, NAT_R 7300). Methods used for quantitative assessment of water quality and quantity in inland waters. Graded on A-F basis only.
Credit Hours: 3
Recommended: senior standing or BIO_SC 3650 and ENV_SC 4100/ NAT_R 4100 or ENV_SC 3400/NAT_R 3400 or FOREST 4390

ENV_SC 4305: Environmental Soil Physics
(same as SOIL 4305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.
Credit Hours: 3
Prerequisites: SOIL 2100
Recommended: PHYSCS 1210 or equivalent

ENV_SC 4306: Environmental Soil Physics Laboratory
(same as SOIL 4306). Introduction to the methodology and equipment for measurement of soil physical properties and processes.
Credit Hours: 2
Prerequisites or Corequisites: ENV_SC 4305

ENV_SC 4312: Environmental Soil Microbiology
(same as SOIL 4312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformation bioremediation, etc.
Credit Hours: 3
Prerequisites: SOIL 2100
Recommended: general microbiology

ENV_SC 4318: Environmental Soil Chemistry
(same as SOIL 4318 and GEOL 4318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.
Credit Hours: 3
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330; junior standing or instructor's consent

ENV_SC 4320: Hydrologic and Water Quality Modeling
(same as NAT_R 4320). Introduction to models for simulating hydrologic and water quality processes. Emphasis is placed on watersheds to provide experience with the use of simulation models for natural resource decision making.
Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100

ENV_SC 4396: Agroforestry for Watershed Restoration
Agroforestry for watershed restoration will focus on integrated approaches for improved water quality, soil health, and economic benefits. Students will learn principles and practices, critical analysis and application of agroforestry practices to improve overall environmental quality. May be repeated for credit. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: FOREST 4385 or FOREST 7385

ENV_SC 4400: Environmental Law, Policy, and Justice
(cross-leveled with ENV_SC 7400, AAE 7400). This course will examine the intersection of environmental law, policy, and justice. We will first cover the building blocks of U.S. environmental law, including common law and statutes such as the Clean Air Act and the Clean Water Act. We will then turn to international environmental policy issues such as climate change, marine pollution, and the hazardous waste trade. We will approach these laws and treaties through the lens of equity and environmental justice. The course will use a variety of teaching methods, including lecture and classroom discussion using cold calling and the Socratic Method. We will also have student presentations, guest speakers, a moot court, a negotiation simulation, and a field trip in the Columbia, Missouri area. Graded on A-F basis only.
Credit Hours: 3
Recommended: Junior, senior, or graduate student status

ENV_SC 4400W: Environmental Law, Policy, and Justice - Writing Intensive
(cross-leveled with ENV_SC 7400, AAE 7400). This course will examine the intersection of environmental law, policy, and justice. We will first cover the building blocks of U.S. environmental law, including common law and statutes such as the Clean Air Act and the Clean Water Act. We will then turn to international environmental policy issues such as climate change, marine pollution, and the hazardous waste trade. We will approach these laws and treaties through the lens of equity and environmental justice. The course will use a variety of teaching methods, including lecture and classroom discussion using cold calling and the Socratic Method. We will also have student presentations, guest speakers, a moot court, a negotiation simulation, and a field trip in the Columbia, Missouri area. Graded on A-F basis only.
Credit Hours: 3
Recommended: Junior, senior, or graduate student status

ENV_SC 4600: Sustainability Science Problem Solving
This course introduces fundamental concepts of sustainability science. It provides a survey of perspectives, frameworks, and competencies to engage in sustainability problem-solving. Students will develop an understanding for integrating critical concepts from economics and business, social and public policy, and environmental science and law to address pressing sustainability challenges. Through student-selected and student-led individual or group projects, principles learned will be used to analyze complex social-ecological problems to design alternative pathways towards sustainability. Graded on A-F basis only.
Credit Hours: 3  
Prerequisites or Corequisites: ENV_SC 2600 or BIOL_EN 2600

ENV_SC 4940: Environmental Science Internship  
Supervised professional experience with an approved public or private organization. Graded on S/U basis only.  
Credit Hour: 1-99

ENV_SC 4950: Undergraduate Research in Environmental Science  
Research apprenticeship with a faculty mentor. Students are expected to develop initial concept for the research, design experiments, collect data, and analyze data with faculty input, oversight, and guidance.  
Credit Hour: 1-4  
Prerequisites: ENV_SC 1100, STAT 1200  
Recommended: 9 hours of Environmental Science with at least 3 hours above the 3000-level

ENV_SC 7001: Topics in Environmental Science  
Organized study of selected topics in environmental science. Intended for graduate students.  
Credit Hour: 1-99

ENV_SC 7100: Lake Ecology  
(same as NAT_R 7100; cross-leveled with ENV_SC 4100, NAT_R 4100). Ecology of inland waters with emphasis on productivity. Graded on A-F basis only.  
Credit Hours: 3  
Recommended: BIO_SC 3650

ENV_SC 7120: Hydrologic and Water Quality Modeling  
(same as NAT_R 7320). Introduction to models for simulating hydrologic and water quality processes. Emphasis is placed on watersheds to provide experience with the use of simulation models for natural resource decision making.  
Credit Hours: 3

ENV_SC 7180: Environmental Soil Chemistry  
(same as SOIL 7312 and GEOL 7318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.  
Credit Hours: 3  
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330

ENV_SC 7200: Stream Ecology and Hydrology  
(cross-leveled with ENV_SC 4200). This senior/grad course in stream ecology will provide students an opportunity to increase their knowledge about the ecology of flowing waters. The course will cover physical and biological elements of fluvial ecosystems, with a focus on mechanisms and processes and the discussion of critical issues associated with the conservation and management of streams and their biota. The course is built around lectures, assigned readings, and class and home activities. Graded on A-F basis only.  
Credit Hours: 3  
Prerequisites: 60 credit hours, MATH 1100  
Recommended: BIO_SC 3650 or FOREST 4320

ENV_SC 7260: Methods in Aquatic Ecology  
(same as NAT_R 7300; cross-leveled with ENV_SC 4300, NAT_R 4300). Methods used for quantitative assessment of water quality and quantity in inland waters. Graded on A-F basis only.  
Credit Hours: 3  
Recommended: senior standing or BIO_SC 3650, ENV_SC 4100 or NAT_R 4100 or NAT_R 3400 or FOREST 4390

ENV_SC 7305: Environmental Soil Physics  
(same as SOIL 7305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.  
Credit Hours: 3  
Prerequisites: SOIL 2100, PHYSCS 1210 or equivalent

ENV_SC 7306: Environmental Soil Physics Laboratory  
(same as SOIL 7306). Introduction to the methodology and equipment for measurement of soil physical properties and properties and processes. Prerequisites or Corequisites: SOIL 4305.  
Credit Hours: 2

ENV_SC 7312: Environmental Soil Microbiology  
(same as SOIL 7312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic degradation and bioremediation, soil quality and pathogen regulation in the environment. Nitrogen fixation, mycorrhizal processes are discussed.  
Credit Hours: 3

ENV_SC 7318: Environmental Soil Chemistry  
(same as SOIL 7318 and GEOL 7318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.  
Credit Hours: 3  
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330

ENV_SC 7320: Hydrologic and Water Quality Modeling  
(same as NAT_R 7320). Introduction to models for simulating hydrologic and water quality processes. Emphasis is placed on watersheds to provide experience with the use of simulation models for natural resource decision making.  
Credit Hours: 3

ENV_SC 7340: Environmental Law, Policy, and Justice  
(same as with AAE 7400; cross-leveled with ENV_SC 4400). This course will examine the intersection of environmental law, policy, and justice. We will first cover the building blocks of U.S. environmental law, including common law and statutes such as the Clean Air Act and the Clean Water Act. We will then turn to international environmental policy issues such as climate change, marine pollution, and the hazardous waste trade. We will approach these laws and treaties through the lens of equity and environmental justice. The course will use a variety of teaching methods, including lecture and classroom discussion using cold calling and the Socratic Method. We will also have student presentations, guest speakers, a moot court, a negotiation simulation, and a field trip in the Columbia, Missouri area. Graded on A-F basis only.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Prerequisites/Recommended</th>
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</thead>
<tbody>
<tr>
<td>ENV_SC 8090</td>
<td>Masters Research in Environmental Science</td>
<td>Original investigations in environmental science for presentation in a thesis. Graded on S/U basis only.</td>
<td>3</td>
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<tr>
<td>ENV_SC 8400</td>
<td>Solute Transport in the Vadose Zone (same as SOIL 8400)</td>
<td>Transport of water and solutes in geomedia with emphasis on development of the equations of flow. Evaluation of analytical and numerical solutions to equations describing transport phenomena.</td>
<td>1-10</td>
<td>ENV_SC 7305 or SOIL 7305</td>
</tr>
<tr>
<td>SOIL 2100</td>
<td>Introduction to Soils (same as PLNT_S 2100)</td>
<td>Introduction to soil sciences with emphasis placed on physical, biological, and chemical properties and application to land use, plant growth and environmental problems.</td>
<td>3</td>
<td>3 hours of Chemistry</td>
</tr>
<tr>
<td>SOIL 2106</td>
<td>Soil Science Laboratory</td>
<td>Laboratory application of fundamental soil science concepts.</td>
<td>2</td>
<td>SOIL 2100</td>
</tr>
<tr>
<td>SOIL 3001</td>
<td>Topics in Soil Science</td>
<td>Organized study of selected topics in soil science.</td>
<td>1-99</td>
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<tr>
<td>SOIL 3085</td>
<td>Problems in Soil Science</td>
<td>Special individualized research projects or readings in soil science.</td>
<td>3</td>
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<tr>
<td>SOIL 3290</td>
<td>Soils and the Environment (same as ENV_SC 3290)</td>
<td>Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.</td>
<td>3</td>
<td>SOIL 2100 and ENGLISH 1000</td>
</tr>
<tr>
<td>SOIL 3290W</td>
<td>Soils and the Environment - Writing Intensive (same as ENV_SC 3290W)</td>
<td>Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.</td>
<td>3</td>
<td>SOIL 2100 and ENGLISH 1000</td>
</tr>
<tr>
<td>SOIL 4085</td>
<td>Problems in Soil Science</td>
<td>Special individualized non-thesis research projects or readings in soil science.</td>
<td>1-99</td>
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<tr>
<td>SOIL 4305</td>
<td>Environmental Soil Physics (same as ENV_SC 4305; cross-leveled with ENV_SC 7305, SOIL 7305)</td>
<td>Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.</td>
<td>3</td>
<td>SOIL 2100</td>
</tr>
<tr>
<td>SOIL 4306</td>
<td>Environmental Soil Physics Laboratory (same as ENV_SC 4306; cross-leveled with ENV_SC 7306, SOIL 7306)</td>
<td>Introduction to the methodology and equipment for measurement of soil physical properties and processes.</td>
<td>2</td>
<td>SOIL 4305</td>
</tr>
<tr>
<td>SOIL 4308</td>
<td>Soil Conservation (cross-leveled with SOIL 7308)</td>
<td>Conservation of soil with respect to topsoil, soil productivity, and fertility.</td>
<td>3</td>
<td>SOIL 2100</td>
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<tr>
<td>SOIL 4312</td>
<td>Environmental Soil Microbiology (same as ENV_SC 4312; cross-leveled with SOIL 7312, ENV_SC 7312)</td>
<td>Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformation bioremediation, etc.</td>
<td>3</td>
<td>AG_S_M 4420</td>
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<tr>
<td>SOIL 4313</td>
<td>Soil Fertility and Plant Nutrition (same as PLNT_S 4313; cross-leveled with SOIL 7313, PLNT_S 4313)</td>
<td>Explanation of principles of delivery of plant nutrients to plants, discussion of the role of each essential nutrient in crop plants and introduction to the management of soil amendments.</td>
<td>3</td>
<td>SOIL 2100 or instructor's consent</td>
</tr>
<tr>
<td>SOIL 4318</td>
<td>Environmental Soil Chemistry (same as ENV_SC 4318 and GEOL 4318; cross-leveled with ENV_SC 7318, GEOL 4318, SOIL 7318)</td>
<td>Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330; junior standing or instructor's consent

SOIL 4320: Genesis of Soil Landscapes

Credit Hours: 4

Recommended: introductory soil science or introductory geology course

SOIL 4360: Precision Agriculture Science and Technology
(same as AG_S_M 4360, PLNT_S 4360; cross-leveled with SOIL 7360, AG_S_M 7360, PLNT_S 7360). Precision agriculture is an information-based approach to farming whereby variability is managed to optimize crop production and reduce environmental pollution. This course provides an overview of precision agriculture technologies (like GIS, GPS, remote sensing), mapping methods, and case studies illustrating decisions and management.

Credit Hours: 3

Prerequisites: PLNT_S 2100 or SOIL 2100, or PLNT_S 2110; MATH 1100; AG_S_M 1040

SOIL 4940: Soil Science Internship
Supervised professional experience with an approved public or private organization. Course may be repeated for credit. Graded on S/U basis only.

Credit Hour: 1-12

Prerequisites: Soil and Atmospheric Sciences majors only, instructor's consent

SOIL 7001: Topics in Soil Science
Organized study of selected topics in soil science. Intended for graduate students.

Credit Hour: 1-99

SOIL 7085: Problems in Soil Science
Special individualized non-thesis research projects or readings in soil science.

Credit Hour: 1-99

Prerequisites: graduate standing

SOIL 7305: Environmental Soil Physics
(same as ENV_SC 7305; cross-leveled with SOIL 4305, ENV_SC 4305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.

Credit Hours: 3

Prerequisites: SOIL 2100, PHYSCS 1210 or equivalent

SOIL 7306: Environmental Soil Physics Laboratory
(same as ENV_SC 7306; cross-leveled with ENV_SC 4306, SOIL 4306). Introduction to the methodology and equipment for measurement of soil physical properties and properties and processes.

Credit Hours: 3

Prerequisites or Corequisites: SOIL 4305

SOIL 7308: Soil Conservation
(cross-leveled with SOIL 4308). Conservation of soil with respect to topsoil, soil productivity, and fertility.

Credit Hours: 3

Prerequisites: SOIL 2100

Recommended: AG_S_M 4420

SOIL 7312: Environmental Soil Microbiology
(same as ENV_SC 7312; SOIL 4312, ENV_SC 4312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformations bio remediation, etc.

Credit Hours: 3

Prerequisites: general microbiology, SOIL 2100, or instructor's consent

SOIL 7313: Soil Fertility and Plant Nutrition
(same as PLNT_S 7313; cross_leveled with SOIL 4313, PLNT_S 4313). Explanation of principles of delivery of plant nutrients to plants, discussion of the role of each essential nutrient in crop plants and introduction to the management of soil amendments.

Credit Hours: 3

Prerequisites: SOIL 2100 or instructor's consent

SOIL 7314: Soil Fertility and Plant Nutrition Laboratory
(same as PLNT_S 7314; cross_leveled with SOIL 4314, PLNT_S 4314). The application of elementary analytical procedures to the evaluation of the nutrient status of soils and crop plants.

Credit Hours: 2

Prerequisites or Corequisites: SOIL 7313

SOIL 7320: Genesis of Soil Landscapes

Credit Hours: 4

Prerequisites: introductory soil science or introductory geology or permission of instructor

SOIL 7360: Precision Agriculture Science and Technology
(same as AG_S_M 7360 and PLNT_S 7360; cross-leveled with SOIL 4360, AG_S_M 4360, PLNT_S 7360). Precision agriculture is an information-based approach to farming whereby variability is managed to optimize crop production and reduce environmental pollution. This course provides an overview of precision agriculture technologies (like GIS, GPS, remote sensing), mapping methods, and case studies illustrating decisions and management.

Credit Hours: 3

Prerequisites: PLNT_S 2100 or SOIL 2100, or PLNT_S 2110; MATH 1100; AG_S_M 1040
SOIL 8001: Topics in Soil Science
Organized study of selected topics in soil science. Intended for graduate students.
Credit Hour: 1-99

SOIL 8085: Problems in Soil Science
Special individualized non-thesis research projects or readings in soil science.
Credit Hour: 1-99

SOIL 8090: Masters Research in Soil Science
Original investigations in soil science for presentation in a thesis. Graded on S/U basis only.
Credit Hour: 1-10

SOIL 8400: Solute Transport in the Vadose Zone
(same as ENV_SC 8400). Transport of water and solutes in geomedia with emphasis on development of the equations of flow. Evaluation of analytical and numeral solutions to equations describing transport phenomena.
Credit Hours: 3
Prerequisites: ENV_SC 7305 or SOIL 7305

SOIL 8500: Chemistry of the Vadose Zone
(same as ENV_SC 8500). Chemical reactions occurring in geomedia with emphasis on understanding molecular scale processes occurring at the solid-water interface, aqueous geochemistry, and soil organic matter.
Credit Hours: 3
Prerequisites: SOIL 7318 or GEOL 7300 or instructor's consent

SOIL 8095: Problems in Soil Science
Special individualized non-thesis research projects or readings in soil science.
Credit Hour: 1-99

SOIL 9087: Seminar in Soil Science
In-depth development of advanced aspects of soil science through reviews of results of research in progress and current scientific publications.
Credit Hour: 1

SOIL 9090: Doctoral Research in Soil Science
Original investigations in soil science for presentation in a dissertation. Graded on S/U basis only.
Credit Hour: 1-10

SOIL 9422: Pedology
Three one-hour lectures. Detailed study of processes of soil horizonization and current topics in soil genesis including quantitative assessment of spatial and temporal variability and application of GIS in landuse planning.
Credit Hours: 3
Prerequisites: SOIL 7320, one statistics course beyond ANOVA