

Bachelor of Science in Environmental Science

-- Guidelines for Majors --

**Department of Soil, Water and Environmental
Science**

The University of Arizona

2009-2010

BACHELOR OF SCIENCE DEGREE
in Environmental Science

Shantz Building Room 429

520-621-1646

www.aq.arizona.edu/swes

REVISED Aug 2009

INTRODUCTION

Environmental science is the study of human impacts on natural systems from molecular to global scales. These natural systems include soil, water, air, and ecosystems.

The Bachelor of Science Degree program in Environmental Science is coordinated by the Department of Soil, Water and Environmental Science (SWES) and includes classes offered by departments throughout the University. To allow for maximum flexibility, this program offers several different focal areas, while providing a strong background in biological, chemical, and physical sciences. All environmental science students take several classes in common, while typically selecting a focal area during the second half of their academic program.

CAREER OPPORTUNITIES

With this degree, students will be well-prepared for careers in private and government agencies, educational institutions, and private consulting firms. Some titles associated with these jobs include: Environmental Scientist, Environmental Engineer, Industrial Hygienist, Environmental Health Specialist, Earth Scientist, Ecologist, Forester, Environmental Chemist, Environmental Microbiologist, Meteorologist, Soil Scientist, Environmental Lawyer, and Natural Resources Manager. Students will also be prepared for an advanced degree in a variety of fields, such as environmental health, resource management, engineering, law, and public policy.

COURSEWORK

The Bachelor of Environmental Science Degree comprises general education, core, and focal area classes typically taken over eight semesters. A suggested course sequence is listed at the end of this brochure.

Note: Some classes have prerequisite requirements; it is important to check the U of A online Schedule of Classes (<http://garnet.ccit.arizona.edu/cgi-bin/schedule/schedule.cgi>) to confirm course availability and class prerequisites.

A. General Education. These classes give undergraduates a diverse academic background to complement each major.

<u>Foundation Courses</u> English Composition Mathematics (satisfied by MATH 124/125)	6 Units	<u>Tier 1</u> Traditions and Cultures Individuals and Societies	6 Units 6 Units
<u>Pre-Major</u> Communications (satisfied by SWES 408)		<u>Tier 2</u> Humanities Arts Individuals and Societies	3 Units 3 Units 3 Units
<u>Second Language</u> Second semester proficiency	variable		

B. Basic Science Core.

All students take these foundation science courses (38-40 units).

<p><u>Chemistry</u> CHEM 151 General Chemistry I (4), I, II CHEM 152 General Chemistry II (4), I, II CHEM 241a Lectures in Organic Chemistry (3), I, II CHEM 243a Organic Chemistry Lab (1), I, II</p>	<p><u>Physics</u> *PHYS 102 Intro Physics (3), I, II, SUM PHYS 181 Intro Physics Lab (1), I, II, SUM I *Or PHYS 131 and 181 for Chem or Env Sci/Tech Focal Areas</p>
<p><u>Math</u> MATH124 or 125 Calculus I (3 or 5), I, II MATH 263 Statistical Methods (3) I, II or MGMT 276 (3), I, II or PSYC 230 (3), I, II, SUM</p>	<p><u>Soil, Water & Environmental Science</u> SWES 200 Soils (3), I, II SWES 201 Soils Lab (1), I, II SWES 210 Fund Env Sci & Sustainability (3), I,II</p>
<p><u>Microbiology</u> MCB 181R Intro Biology I (3), I, II MCB 181L Intro Biology Lab I (1), I MIC205 A/L General Microbiology (3/1), I, II, SUM I</p>	<p><u>Careers</u> SWES 195a Careers in Env Sci (1), I, II</p>

C. Environmental Science Core.

All students take these courses during their junior and senior years (21-22 units).

<p><u>Required Courses</u> AREC 350 Economics, Ethics & Env Mgmt (3), II CHEM 322 Principles of Analysis I (2), II, SUM I CHEM 323 Principles of Analysis I Lab (1), II, SUM II SWES 305 Pollution Sci (3), II SWES 430A/L Env Mon/Remed (Capstone)* (4), II</p>	<p><u>Select one of the following</u> ENGL 308 Technical Writing (3), I, II SWES 408/508 Sci Writ Env Ag/Life Sci (3), II</p>
<p><u>Select one of the following</u> SWES 393/493 Internship (3-4), I, II SWES 397a, Teaching Workshop (3-4), I, II SWES 399/499 Independent Study (3-4), I, II</p>	<p><u>Select one of the following</u> SWES 418 Intro Human Health Risk (3), II SWES 444 Applied Env Law (3), I SWES 461 Soil/Water Cons (3), Pre-session/odd yrs</p>

*Students must complete SWES 305, CHEM 241, MATH 124 or MATH 125, MIC 205a, and PHYS 102 prior to enrolling in SWES 430A/L

D. Environmental Science Focal Area Coursework.

Students may pursue one of the following.

1. Biology Focus (30-31 units):

This focus centers on the influence of the environment on living organisms, populations, communities, landscapes, and vice versa. It emphasizes agricultural and aquacultural impacts on the environment, use of plants to clean up the environment (phytoremediation), and management of freshwater and marine systems.

Advisor: Dr. Kevin Fitzsimmons, 626-3324, kevfitz@ag.arizona.edu

<p>Required Courses (18 units) CHEM 241b Organic Chemistry (3), I, II ECOL 182 Intro Biology II R/L (4), I (without lab), II ECOL 206 Environmental Biology (4), II ECOL 335 Evolutionary Biology (4), II SWES 461 Soil/Water Cons (3), PreSession/odd yrs</p>	<p>Options (9 units) BIOC 460 Gen Protein/Metabolic Biochem (3), I, II, SUM ECOL 320 Genetics (4), I, II ECOL 406 R/L Conservation Biology (4), I ECOL 487R Animal Behavior (3), I ENTO 415R Insect Biology (3), I GEOS 412A Ocean Sciences (4), II MIC 328R Microbial Physiology (3), I RNR 355 Introduction to Wildland Fire (3), I RNR 384 Natural Resource Management (3), II RNR 403 Appl of Geog Info Sys (3), I, II SWES 280 Microbes in the Environment (3), I SWES 316 Soil Fertility/Plant Nutrition (3), II SWES 417 GIS for Natural Resources (3), I SWES 425 Environmental Microbiology (3), I SWES 453 Remote Sensing of the Environment (3), I SWES 456A Watersheds & Ecosys Function (3), II SWES 474 Aquatic Plants & the Environ (4), I SWES 475 Freshwater & Marine Algae (4), II WFSC 441 Limnology (4), I</p>
<p>Select one (3-4 units) ECOL 302 Ecology (4), I RNR 316 Nat Resources Ecol; (3), I RNR 403 Appl Geog Info Sys (3), I</p>	

2. Remote Sensing and Geospatial Analysis (24 units):

This focal area concentrates on the principles of remote sensing and geographic information systems analysis tools and their applications to the study of the environment, global change, and the impact of humans on the environment.

Advisors: Dr Alfredo Huete, 621-3228, ahuete@ag.arizona.edu
 Dr. Phil Guertin, 621-1723, phil@nexus.snr.arizona.edu

<p>Required Courses (9 units) RNR 417 Geog Info Sys Nat Resources (3), I SWES 330 Intro Remote Sensing (3), I SWES 453 Remote Sensing of the Environment (3), I</p>	<p>Options (6 units) GEOG 303 Field Studies of Env Geography (3), I, II, SUM GEOG 357 Geog Research Methods (3), I, II GEOG 416A Computer Cartography (3), I GEOS 251 Physical Geology (4), I, II GEOS 478 Global Change (3), I OPTI 531 Image Processing Lab (3), I (not offered Fall 08) OPTI 550 Fundamentals of Remote Sensing (3), II (requires instructor approval) RNR 271 Nat Resource Computer Appl (3), II RNR 321 Nat Resource Measurements (3), II RNR 473 Spatial Analysis/Modeling (3), I SWES 418 Intro Human Health Risk Assess (3), II SWES 420 Environmental Physics (3), I SWES 461 Soil/Water Cons (3) PreSession (odd yrs) SWES 470 Soil Physics (3), II</p>
<p>Select three (9 units) GEOS 251 Physical Geology (4), I, II RNR 419 Carto Modeling for Nat Resources (3) II RNR 420 Advanced Geog Info Sys (3) II SWES 483 Geog Appl Remote Sensing (3), II SWES 490 Remote Sensing Planet Earth (3), II</p>	

3. Science and Technology Focus (46 units):

This focus was developed with the Chemical and Environmental Engineering Department. It prepares students to deal with environmental pollution and to solve complex environmental problems requiring an interdisciplinary background. It is recommended for those interested in an advanced degree (see note below).

Advisor: Dr. Mark L. Brusseau, 621-3244, brusseau@ag.arizona.edu

Required courses (31 units) CE 214 Statics (3), I, II, SUM CE 218 Mechanics of Fluids (3), I, II CHEE 370R Environmental & Water Engineering (3), I, II CHEE 370L Environmental & Water Engineering (1), I, II CHEE 478 (CE 478) Intro Hazardous Waste (3), I, II CHEM 480a Physical Chemistry (3), I, II MATH 129 Calculus II (3), I, II MATH 223 Vector Calculus (4), I, II MATH 254 Differential Equations (3), I, II PHYS 132 Intro Physics w/Calculus II (4), I, II PHYS 182 Intro Lab II (1), I, II	Options (12 units) ATMO 469A Air Pollution I: Gases (3), I ATMO 469B Air Pollution II, (3) II (odd years) CHEE 400R Water Chemistry (3), I CHEE 400L Water Chemistry (1), I HWR 423 Hydrology (3), I HWR 431 Hydrogeology (4), I SWES 420 Environmental Physics (3), I SWES 425 Environmental Microbiology (3), I SWES 440 Biodegradation (3), II (even years) SWES 453 Remote Sensing of the Environment (3), I SWES 462 Env Soil & Water Chem (3), II SWES 464 Environmental Chemistry (3), I SWES 470 Soil Physics (3), II
Select one (3 units) SWES 418 Intro Human Health Risk Assess (3), II SWES 444 Appl Env Law (3), I	

4. Chemistry Focus (35 units):

This focus integrates physical and chemical sciences within a quantitative framework applied to the environment. It includes the study of sources, reactions, transport, effects and fates of chemical species in water, soil, air, and living environments.

Advisors: Dr. Joan Curry, 626-5081, curry@ag.arizona.edu
Dr. Jon Chorover, 626-5635, chorover@ag.arizona.edu

Required Courses (23 units) CHEM 480A Physical Chemistry (3), I, II HWR 450 Environmental Hydrology (3), II MATH 129 Calculus II (3), I, II PHYS 132 Intro to Physics II w/Calculus (4), I, II PHYS 182 Intro Physics Lab II (1), I, II SWES 418 Intro Human Health Risk Assess (3), II SWES 462 Environ Soil & Water Chem (3), II SWES 464 Environ Chemistry (3), I	Options (continued) CHEE 400L Water Chem for Eng (Lab) (1), I, II CHEE 476A Water Treatment System Design (3), I CHEE 478 Intro to Hazardous Waste Mgmt (3), II CHEM 404 Inorganic Chemistry (3), I CHEM 481 Biophysical Chemistry (3), II GEOS 400 Intro to Geochemistry (3), I MSE 412 Physical Chemistry of Materials (3), I PTY5 407 Chemistry of the Solar System (3), I SWES 401 Mgt of Arid Lands & Salt Aff. Soils (even years) (3), II SWES 405 Environ Soil, Water Chem. (Lab) (odd years) (3), II SWES 420 Environmental Physics (3), I
Options (12 units) ATMO 469A Air Pollution I: Gases (3), I ATMO 469B Air Pollution II (3), II, (odd years) CHEE 400R Water Chem for Engr (3), I	

Note: Students pursuing either the Science and Technology or Chemistry Focal areas have the option of completing a Masters Degree in Chemical and Environmental Engineering after only one additional year of coursework. Students selecting this option will have an Bachelor's Degree in ENVS and a Master's Degree in CHEE. For complete information please consult the SWES departmental Website:

<http://ag.arizona.edu/SWES/instruction/undergradhome.htm>

5. Sustainable Land/Water Management (28 units):

This focuses on landscape-level processes in environmental science. It investigates human-caused deforestation and desertification, ecological restoration; water, soil and air pollution, and global change.

Advisors: Dr. Edward P. Glenn, 626-2664, eglenn@ag.arizona.edu
 Dr. Allan D. Matthias, 621-7226, matthias@ag.arizona.edu
 Dr. James J. Riley, 591-4019, jjriley@ag.arizona.edu

<p>Required Courses (7 units) GEOS 251 Physical Geology (4), I, II SWES 462 Environ Soil & Water Chem (3), II</p>	<p>Options (12 units) ECOL 406 R/L Conservation Biology (4), I GEOS 450 Geomorphology (4), I GEOS 478 Global Change (3), I SWES 316 Soil Fertility/Plant Nutrition (3), II SWES 401 Mgt of Arid Land/Salt-affected Soils (3), II (even yrs) SWES 420 Env Physics (3), I SWES 425 Env Microbiol (3), I SWES 426 Env Microbiol Lab (2), I SWES 431 Soil Genesis, Morph & Taxon (3), I SWES 440 Biodegradation of Pollutants (3), II (even yrs) SWES 453 Remote Sensing of Env (3), I SWES 454 Water Harvesting (3), II SWES 456A Watersheds & Ecosys Function (3), II SWES 461 Soil/Water Conserv (3), Pre-session (odd yrs) SWES 464 Environmental Chemistry (3), I SWES 470 Soil Physics (3), II SWES 474 Aquatic Plants & the Environment (4), I SWES 475 Fresh Water & Marine Algae (4), II</p>
<p>Select one (3 units) HWR 250 Principles of Hydrology (3), I WSM 460 Watershed Hydrology (3), I</p>	
<p>Select one (3 units) SWES 418 Intro Human Health Risk Assess (3), II SWES 444 Applied Env Law (3), I</p>	
<p>Select one (3 units) RNR 403 Appl Geog Info Sys (3), I, II SWES 453 Remote Sensing of the Environment (3), I</p>	

6. Microbiology Focus (23 units):

This focus primarily addresses issues such as the remediation of contaminated sites and natural processes of decomposition, as well as water and food quality (pathogens).

Advisors: Dr. Raina Maier, 621-7231, rmaier@ag.arizona.edu
 Dr. Ian Pepper, 626-3328, ipepper@ag.arizona.edu
 Dr. Christopher Rensing, 626-8482, rensingc@ag.arizona.edu

<p>Required Courses (8 units) CHEM 241b Organic Chemistry (3), I, II SWES 425 Environ Microbiology (3), I SWES 426 Environ Microbiology Lab (2), I</p>	<p>Options (continued) BIOC 460 Gen Protein & Gen Metab Biochem (3), I, II, SUM ECOL 320 Genetics (4), I, II MCB 410 Cell Biology (3-4), I, II MCB 411 Molecular Biology (3-4), I, II MCB 473 Recomb DNA Methods/Apl (4), I, II MIC 328R Microbial Physiology (3), I MIC 421b Microbiological Techniques (3), I RNR 316 Natural Resources Ecology (3), I SWES 280 Microbes in the Environment (3), I SWES 440 Biodegradation of Pollutants (3), II (even years) SWES 475 Freshwater and Marine Algae (4), II WFSC 441 Limnology (4), I</p>
<p>Options (select 15 units) BIOC 462a Biochemistry (4-5), I ECOL 206 Environmental Biology (4), II ECOL 302 Ecology (4), I</p>	

7. Science and Policy Focus (24 Units):

This focus emphasizes environmental science policy issues. It includes courses in a variety of disciplines, from public policy to ecology. This focal area is ideally suited for Pre-Law students.

Advisors: Dr. Robert G. Varady, 884-4393, rvarady@u.arizona.edu
 Dr. Edella Schlager, 621-5840, eschlager@bpa.arizona.edu
 Dr. Dennis Cory, 621-4670, dcory@ag.arizona.edu

<p>Required Courses (6 units) POL 201 American Nat Gov (3), I, II (Tier II INDV) AREC 476 Env Law/Econ (3), II</p>	<p>Options (6 units) ANTH 307 Ecol Anthro (3), II ANTH 424A Political Ecology (3), I AREC 375 Land/Water in the American West (3), II AREC 377 Econ of Env Resource Conserv (3), II AREC 464 Econ of Policy Analysis (3), I AREC 479 Econ of Water Management/Policy (3), II ATMO 336 Weather, Climate, and Society (3), I, II COMM 411 Comm/Conflict Management (3), I, II ECOL 406 R/L Conserv Biol (4), I ENGL 306 Advanced Composition (3), I, II GEOG 461 Env & Resource Geography (3), II HIST 355 U.S. Env Hist (3), II HIST 356 Global Env Hist (3), I, II PA 406 Bureaucracy, Politics, & Policy (3), I PA 461 Global Climate Change Policy (3), I, II PA 480 Formation of Public Policy (3), II PA 481 Env Policy (3), I PSYC 374 Env Psych (3), I RNR 480 Nat Resource Policy/Law (3), II RNR 485 Nat Resource /Econ & Planning (4), I SOC 313 Collective Behavior/Social Movements (3), I, II MN E 422 Engineering Sustainable Development (3), I</p>
<p>Select One (3 units) SWES 444 Appl Env Law (3), I SWES 418 Intro Human Health Risk Assess (3), II</p>	
<p>Select One (3 units) PHIL 323 Env Ethics (3), I, II, Summer (Tier II INDV) PHIL 322 Business Ethics (3), II</p>	
<p>Select One (3 units) PA481 Env Pol (3), I RNR 480 Natl Resource Policy/Law (3), II</p>	
<p>Select one (3 units) HIST 355 U.S. Env History (3), II HIST 356 Global Env History (3), I, II GEOS 220 Env Hist of Southwest (3), I</p>	

8. Soil Science Focus (28 units):

This focus emphasizes the properties and uses of soils, their classification, and their management and conservation as critically important natural resources. This focal area qualifies graduating students to be hired as soil scientists or soil conservationists by U.S. Government agencies (i.e. Natural Resources Conservation Service or Forest Service).

Advisors: Dr. Craig Rasmussen, 621-7223, crasmuss@ag.arizona.edu
 Dr. Thomas Wilson, 621-9308, twilson@ag.arizona.edu

<p>Required Courses (19 units) GEOS251 Physical Geology (4), I, II SWES316 Soil Fertility/Plant Nutrition (3), II SWES401 Mgt Arid Land/Salt Soils (3), II (even yrs) SWES431 Soil Genesis, Morph & Taxon (3), I SWES462 Env Soil & Water Chem (3), II SWES470 Soil Physics (3), II</p>	<p>Options (6 units) GEOS478 Global Change (3), I RNR403 Appl Geog Info Sys (3), I RNR417 GIS for Natural & Social Sci (3), I SWES330 Intro to Remote Sensing (3), I SWES444 Applied Env Law (3), I SWES453 Remote Sensing of the Env (3), I SWES461 Soil/Water Conserv (3) Pre-session (odd years)</p>
<p>Select one (3 units) HWR250 Principles of Hydrology (3), I WSM460 Watershed Management (3), I</p>	

NOTE: Students can take an exam during their final semesters to become certified as a **Certified Professional Soil Scientist** with the Soil Science Society of America. The Council of Soil Science Examiners (CSSE) offers exams in October and March each year, a first step toward becoming a Licensed Professional Soil Scientist. The following classes help prepare for the exam: SWES200/201, SWES316, SWES462, and SWES470.

E. Related Minors.

Prerequisites of MATH 110 or 112 and CHEM 151

Environmental Science Minor (20 units)

Note: 20 units are required for the Environmental Science minor, even if the major department guidelines differ. Nine units must be unique to this minor.

<u>GENERAL SCIENCE COURSES (14 units)</u> MCB 181R Intro Biol (3), I SWES 195A Careers in Env Sci (1), I, II SWES 200 Soils (3), I, II SWES 201, Soils Lab (1), I, II SWES 210 Fund. Env. Sci & Sustain (3), I, II WSM 460 Watershed Hydrology (3), I	<u>UPPER DIVISION COURSES (6 units)</u> Select from AREC, ATMOS, HIST, HWR, POL, RNR, SWES or other relevant courses.
--	---

Soil and Water Science Minor (20 units)

<u>GENERAL SCIENCE COURSES (11 units)</u> GEOS 251 Physical Geology (4), I, II SWES 200 Soils (3), I, II SWES 201 Soils lab (1), I, II Plus 3 units of relevant coursework selected with an advisor.	<u>UPPER DIVISION COURSES (9 units)</u> SWES 305 Pollution Science (3), II SWES 316 Soil Fertility/Plant Nutrition (3), II SWES 401 Mgt Arid Land/Salt Soils (3), II (even years) SWES 431 Soil Genesis, Morph/Taxon (3), I SWES 461 Soil/Water Cons (3) Pre-session/odd yrs SWES 462 Env Soil/Water Chem (3), II SWES 470 Soil Physics (3), II
---	---

Environmental Science Major Schedule Planning Worksheet

FIRST SEMESTER (Fall)				SECOND SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
CHEM 151	4			CHEM 152	4		
ENGLISH 101	3			ENGLISH 102	3		
SWES 195A	1			SWES 200	3		
SWES 210	3			SWES 201	1		
Tier I course	3			Tier I Course	3		
1 st Year Colloquia	1			1 st Year Colloquia	1		
TOTAL	15	TOTAL		TOTAL	15	TOTAL	

THIRD SEMESTER (Fall)				FOURTH SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
Tier I course	3			Tier I course	3		
MCB 181 R/L	4			PHYS 102	3		
CHEM 241a	3			PHYS 181	1		
CHEM 243a	1			AREC 350	3		
MATH 124	5			MATH 263	3		
				Focal Area Class	3		
TOTAL	16	TOTAL		TOTAL	16	TOTAL	

SWES Scholarships

Scholarship funds include the following; check with your Advisor for more details.

Scholarship	Criteria
Buehrer, T-PR	Undergrad/grad in soils/water sci. or env. sci. demonstrating academic excellence/leadership. Named by Dean with approval of OSFA.
Fuller, W.H.	Outstanding undergrads and grads involved in soils and water sci. to svc agriculture in AZ; Recipients must demonstrate academic excellence; good character; professional promise; Nominated by Dept Head of SWES; OSFA apprv.
Jones, Geo-PR	Upper division & grad students in crop production area of AG. 3.0 cum gpa. This award amount to be distributed in consultation with Plant Sciences. Approved by Dean & OSFA.
Smith, H Schol-PR	Upper division; Soils, Water, Eng or Nutri. Schol. sub-committee nominates, Dean/OSFA approves.

Department of Soil, Water, and Environmental Science Desired ENV5 Undergraduate Outcomes

1. Be able to understand and describe the source and extent of current environmental pollution problems, and understand U.S. laws governing pollution and remediation.
2. Learn and integrate basic scientific principles involved in preventing soil and water degradation, and remediation of contaminated land and water.
3. Understand factors governing fate and transport of water and contaminants in the soil and vadose zone.
4. Have and appreciation and knowledge of the Earth with emphasis on a basic understanding of soils and water sources as critical entities in natural and human-impacted ecosystems.
5. Understand soils as natural entities and the factors of soil formation and erosion.
6. Understand important physical, chemical and biological properties of soils as they relate to their mineralogy, fertility, genesis and classification, biology and biochemistry, and land use management.
7. Understand important physical, chemical and biological properties of water with emphasis on water quality as it relates to human health, sustainable soil-plant systems and the preservation of the natural environment.
8. Understand how to properly collect soil and water samples, identify and implement appropriate analytical techniques, and interpret results.
9. Be proficient in writing a technical report or proposal in the field of Environmental Science.
10. Be able to create a hypothesis, design an experiment to test that hypothesis, analyze the results, and draw appropriate conclusions.