

Bachelor of Science in Environmental Science

-- Guidelines for Majors --

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

The University of Arizona

2008-2009

BACHELOR OF SCIENCE DEGREE
in Environmental Science

Shantz Building Room 429

520-621-1646

www.aq.arizona.edu/swes

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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 to pursue careers in business and industry, government agencies, educational institutions, and private consulting firms. In addition, a BS degree in Environmental Science prepares students for an advanced degree in a variety of fields, including environmental health, resource management, engineering, law, and public policy.

Some titles associated with available 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.

COURSEWORK

Note: This course guide is designed to be used with the U of A online Schedule of Classes (<http://garnet.ccit.arizona.edu/cgi-bin/schedule/schedule.cgi>). Use this site to confirm course availability and prerequisites. For further information about the degree program go to: <http://ag.arizona.edu/swes/instruction/esundergradhandbook.pdf>

A. General Education. This coursework gives 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 (35 units).

<p><u>Chemistry</u> CHEM 151 Fundamentals of Chemistry (4), I, II CHEM 152 Fundamentals of Chemistry (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 Introductory Physics (3), I, II PHYS 181 Intro, Physics Lab (1), I, II *Or PHYS 131 and 182 for ENV Chem or Env Sci/Tech Focal Areas</p>
<p><u>Math</u> MATH125 or 124 Calculus (3 or 5), I, II MATH 263 Statistical Methods or PSYC 230 (3), I, II</p>	<p><u>Soil, Water, Environmental Science</u> SWES 200 Soil Science (3), I, II SWES 201 Soil Science Lab (1), I, II SWES 210 Fund Env Sci & Sustainability (3), II</p>
<p><u>Microbiology</u> MIC205 A/L General Microbiology (3/1), I SUM I MCB 181R/L Introductory Biology I (3/1), I (Note: MCB 181 is offered in Spring w/o Lab)</p>	<p><u>Careers</u> UNVR 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 units).

<p><u>Required Courses</u> AREC 350 Economics, Ethics & Env Mgmt (3), II CHEM 322 Principles of Analysis (2), II, SUM I CHEM 323 Principles of Analysis I Lab (1), II, SUM II SWES 305 Pollution Sci (3), II SWES 430 Env Mon/Remed (Capstone) (3), I</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 Int Human Health Risk (3), II SWES 444 Applied Env Law (3), I SWES 461 Soil/Water Cons (3) Pre-session/odd yrs</p>

D. Environmental Science Focal Area Coursework.

Students may pursue one of the following.

1. Biology Focus (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.

Employment opportunities: Resource agencies, environmental consultants, utilities, engineering firms, etc.

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), 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 ECOL 320 Genetics (4), I ECOL 406 R/L Conservation Biology (4), I ECOL 587R Animal Behavior (3), I ENTO 415R Insect Biology (3), I GEOS 412A Ocean Sciences (4), II RNR 384 Natural Resource Management (3), II RNR 403 Appl of Geog Info Sys (3), I RNR 438 Fire Ecology (3), II SWES 316 Soil Fertility/Plant Nutrition (3), II SWES 328 Microbial Physiology (3), I SWES 417 GIS for Natural Resources (3), I SWES 425 Environmental Microbiology (3), I SWES 453 Remote Sensing of the Environment (3), I 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 Mat Resources Ecp; (3), I RNR 403 Appl Geog Info Sys (3), I</p>	

2. Remote Sensing and Geospatial Analysis (27 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 man on the environment.

Employment Opportunities: Environmental Consultant, Environmental Analyst, etc.

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) SWES 330 Intro Remote Sensing (3), II SWES 417 Geog Info Sys Nat Resources (3), I SWES 453 Remote Sensing of the Environment (3), I</p>	<p>Options (6 units) ECE 531 Image Process Lab Rem Sensing (3), I (requires instructor approval) GEOG 303 Field Studies of Environmental Geography (3), II GEOG 357 Geog Research Methods (3), II GEOG 416A Computer Cartography (3), I GEOG 478 Global Change (3), I OPTI 450 Fundamentals of Remote Sensing (3), I RNR 271 Nat Resource Computer Appl (3), II RNR 321 Nat Resource Measurements (3), II RNR 425 Decision Analysis Env Planning/Conservation (3), I RNR 473 Spatial Analysis/Modeling (3), I SWES 418 Intro Human Health Risk Assess (3), II SWES 420 Environmental Physics (3), I SWES 470 Soil Physics (3), II</p>
<p>Select three (9 units) RNR 419 Carto Modeling for Nat Resources (3) II RNR 420 Advanced Geog Info Sys (3) I RNR 422 Resource Mapping (3) PreSession SWES 461 Soil/Water Cons (3) PreSession (odd yrs) SWES 483 Geog Appl Remote Sensing (3), II SWES 490 Remote Sensing Study of Planet Earth (3), II</p>	

3. 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).

Employment Opportunities: Federal/state/local resource/planning agencies, environmental consultants, water utilities, pharmaceutical and biotechnology firms, analytical labs.

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) ECOL 320 Genetics (4), I, II MCB 410 Cell Biology (3-4), II MCB 411 Molecular Biology (3-4), I, II MBC 473 Recomb DNA Methods/Appl (4), II MIC 421a Microbiological Techniques (3), I NSC 470 Food Microbiology/Sanitation (3), II RNR 316 Natural Resources Ecology (3), I SWES 440 Biodegradation of Pollutants (3), II (even years) SWES 475 Freshwater and Marine Algae (4), II WFSC 441 Limnology (4), I MCB 460 Gen Protein & Gen Metab Biochem (3), II</p>
<p>Options (select 15 units) BIOC 462a Biochemistry (4-5), I ECOL 206 Environmental Biology (4), II ECOL 302 Ecology (4), I</p>	

4. 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.

Employment opportunities: Environmental scientist or environmental compliance officer in industry, interdisciplinary scientist in environmental regulatory agencies, or technical specialist in an environmental consulting firm.

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

<p>Required courses (34 units) CE 214 Statistics (3), I, II CE 218 Mechanics of Fluids (3), I, II CHEE 370R Water/Wastewater Systems (3), I, II CHEE 370L Water/Wastewater Systems (1), I, II CHEE 478 (CE 478) Intro Hazardous Waste (3), I, II CHEM 480a Physical Chemistry (3), I, II MATH 129 Calculus (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), II PHYS 182 Intro Lab II (1), I, II</p>	<p>Options (12 units) ATMO 469A Air Pollution (3), I CHEE 400R Water Chemistry (3), I CHEE 400L Water Chemistry (1), I HWR 407 Subsurface Hydrology (3), II HWR 423 Hydrology (3), I HWR 431 Hydrogeology (4), I, II HWR 450 Environmental Hydrology (3), II 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), I</p>
<p>Select one (3 units) SWES 418 Intro Human Health Risk Assess (3), II SWES 444 Appl Env Law (3), I</p>	

5. Chemistry Focus (32 units):

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

Employment opportunities: Students with degrees in environmental science can compete for jobs traditionally held by geologists, biologists and chemists. Potential Jobs include: Industrial analytical environmental chemist, industrial chemist in green product development, consultant in chemical & environment, industry water treatment facility specialist, safety & regulatory issue advisor, government environmental agency position, environmental management position

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

<p>Required Courses (20 units) CHEM 480a Physical Chemistry (3), I, II HWR 450 Environmental Hydrology (3), II MATH 129 Calculus (3), I, II PHYS 132 Intro to Physics w/Calculus (4), 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</p>	<p>Options (continued) CHEE 400L Water Chem for Eng (Lab) (1), I CHEE 476 Water & Wastewater Treatment Design (3), I CHEE 478 Intro to Hazardous Waste Mgmt (3), I, II CHEM 404 Inorganic Chemistry (3), I CHEM 481 Biophysical Chemistry (3), II GEOS 452 Strategies in Env Hydrogeochemistry (3), I GEOS 488 Soil Geochemistry (3), I MSE 412 Physical Chemistry of Materials (3), I PTYS 407 Chemistry of the Solar System (3), I SWES 401 Mgt of Arid Lands & Salt Affl. Soils (even years) (3), II SWES 405 Environ Soil, Water Chem. (Lab) (odd years) (3), II SWES 420 Environmental Physics (3), I EOS 400 Intro to Geochemistry (3), I</p>
<p>Options (12 units) ATMO 469a Air Pollution I (3), I ATMO 569b Air Pollution II (3), II CHEE 400R Water Chem for Eng (3), II</p>	

6. Sustainable Land/Water Management (24 - 27 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.

Employment opportunities: Environmental consultants, regulatory agencies, and academic programs

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 Course (3 units) SWES 462 Environ Soil & Water Chem (3), II</p>	<p>Options (12 units) ECOL 406 R/L Conservation Biology (4), I SWES 475 Fresh Water & Marine Algae (4), II 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 Envi Microbiol (3), I SWES 426 Envi 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), II SWES 454 Water Harvesting (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) RNR 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 SWES 453 Remote Sensing of the Environment (3), I</p>	

7. Science and Policy Focus (24 - 27 Units):

This focus is primarily on 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.

Employment opportunities: Environmental Consultants, Regulatory Agencies, etc.

Advisors: Dr. Robert G. Varady, 884-4393, rvarady@u.arizona.edu
 Dr. Edella Schlager, 795-5219, 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), I ANTH 424A Political Ecology (3), I AREC 375 Land/Water in the American West (3), I, II AREC 377 Econ of Env Resource Conserv (3), II AREC 464 Econ of Policy Analysis (3), I AREC 479 Eco of Water Management/Policy (3), II ATMO 330 Weather, Climate, and Society (3), I 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), I HIST 356 Global Env Hist (3), I PA 406 Bureaucracy, Politics, & Policy (3), I PA 480 Formation of Public Policy (3), I PA 481 Env Policy (3), II PSYC 374 Env Psych (3), I RNR 480 Nat Resource Policy/Admin (3), II RNR 485 Nat Resource Manage/Econ (4), I SOC 313 Collective Behavior/Social Movements (3), I, II MN E 422 Engineering Sustainable Development (3), I ANTH 495 Appl Anthro to Env Decision Making (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), II RNR 480 Natl Resource Policy/Admin (3), II</p>	
<p>Select one (3 units) HIST 355 U.S. Env History (3), I HIST 356 Global Env History (3), I GEOS 220 Env Hist of Southwest (3), I Summer</p>	

8. Soil Science Focus (28-29 units):

This focus is primarily on 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, Forest Service).

Employment opportunities: Agronomist, crop consultant, soil surveyor, soil conservationist, environmental consultant, or land use planner with government or private sector.

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 Geol (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), I SWES470 Soil Physics (3), II</p>	<p>Options (6 units) RNR403 Appl Geog Info Sys (3), I RNR417 Intro to Geog Info Sys (3), I RNR478 Global Change (3), II SWES330 Intro to Remote Sensing (3), I SWES444 Applied Env Law (3), I SWES453 Remote Sensing of the Env (3), II 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 upon graduation 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. This is a first step toward becoming a Professional Licensed soil Scientist. The SWES Department will pay the fee for students taking the exam. The following classes help prepare for the exam: SWES200/201, SWES316, SWES462, and SWES470.

E. Related Minors. Generally, 20 units within a department are required for a minor.

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.

<p><u>GENERAL SCIENCE COURSES (14 units)</u> MCB 181R Intro Biol (3), I WSM 460 Watershed Hydrology (3), I SWES 200 Soil Science (3), I, II SWES 201, Soil Science Lab (1), I, II SWES 210 Fund. Env. Sci & Sustain (3), II UNVR 195A Careers in Env Sci (1), I, II</p>	<p><u>UPPER DIVISION COURSES (6 units)</u> Select from AREC, ATMOS, HIST, HWR, POL, RNR, SWES or other relevant courses.</p>
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Soil and Water Science Minor (19-20 units)

<p><u>GENERAL SCIENCE COURSES (10 units)</u> SWES 200 Soil Science (3), I, II SWES 201 Soil Science lab (1), I, II Plus 6 units relevant coursework selected with an advisor</p>	<p><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 SWES 461 Soil/Water Cons (3) Pre-session/odd yrs SWES 462 Env Soil/Water Chem (3), II SWES 470, Soil Physics (3), II</p>
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Environmental Science Major Schedule Planning Worksheet

FIRST SEMESTER (Fall)				SECOND SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
Tier I course	3			Tier I course	3		
ENGLISH	3			ENGLISH	3		
MATH	3			CHEM 152	4		
CHEM 151	4			SWES 200	3		
1 st Yr. Colloq.	1			SWES 201	1		
				1 st Yr. Colloq.	1		
TOTAL	14	TOTAL		TOTAL	15	TOTAL	

THIRD SEMESTER (Fall)				FOURTH SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
Tier I course	3			Tier I course	3		
ECOL 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		
UNVR 195*	1			SWES 210	3		
TOTAL	17	TOTAL		TOTAL	16	TOTAL	

*Required for all students: UNVR 195A Careers in Environmental Science

FIFTH SEMESTER (Fall)				SIXTH SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
Tier II course	3			Tier II Course	3		
MIC 205	4			SWES 305	3		
CHEM 322	2			SWES 393 or SWES 397a	3		
CHEM 323	1			PCOL 302 or SWES 418	3		
Optional SWES 444	3			ENGL 308 or SWES 408	3		
Focal Area Class	3						
TOTAL	16	TOTAL		TOTAL	15	TOTAL	

SEVENTH SEMESTER (Fall)				EIGHTH SEMESTER (Spring)			
Recommended		Your Schedule		Recommended		Your Schedule	
Tier II course	3			Focal Area Class			
SWES 430	3			Focal Area Class			
Focal Area Class				Focal Area Class			
Focal Area Class				Focal Area Class			
Focal Area Class				Focal Area Class			
TOTAL		TOTAL		TOTAL		TOTAL	