

Earth System Science and Policy

<http://essp.und.edu/>

FACULTY: Hammond, Laguette (Chair), Romsdahl, Van Looy (Graduate Director), Zhang and Zheng

Degrees Granted: Master of Science (M.S.), Master of Environmental Management (M.E.M.), and Doctor of Philosophy (Ph.D.)

The graduate program in Earth System Science and Policy is organized around the field of Earth System Science and sustainability and offers three degrees: Master of Environmental Management, Master of Science, and Doctor of Philosophy. Sustainability science has emerged as an intellectually exciting, growing discipline that is a driving concept for major international scientific and environmental policy efforts. By bridging theory with practice, global and local perspectives, and scientific and social disciplines, sustainability science seeks to meet the needs of society while sustaining the life support systems of the planet.

ESSP Mission Statement

To provide an integrated and creative learning environment that fosters intellectual growth, critical thinking, and practical engagement in research and sustainable management of the Earth system and resources.

Departmental Goals

To fulfill the mission, the overall goal is to promote sustainability by pursuing:

1. Excellence in learning through a student-structured curriculum, a multi-disciplinary teaching approach, and experiential learning environments.
2. Excellence in discovery through research driven by societal needs and values and occurs within an Earth System Science paradigm
3. Excellence in engagement through outreach, service, and practical experience, which put knowledge related to Earth System Science and Policy to work.

The overall Student learning outcomes for all graduate degree programs are:

1. A breadth of knowledge in Earth System Science and Policy and the ability to apply that knowledge to address societal-driven sustainability science research, with a broad sense of ethical and professional responsibilities.
2. A strong knowledge of multi-scale processes, cutting-edge computer technology, geographical information systems (GIS), remote sensing, and quantitative analysis.
3. A strong knowledge of environmental policy, and environmental and resource economics related to human-environment interactions.
4. Written and oral communication skills that will facilitate the transfer of knowledge to support actionable decisions.
5. The ability to function within multi-disciplinary teams to accomplish common goals.
6. An awareness of and preparation for a lifetime of learning.

Details pertaining to admission requirements, degree requirements and courses offered can be found in the Degree section.

Master of Science (M.S.)

Mission Statement and Program Goals

The M.S. degree is a research oriented program which involves conducting a research project culminating in the defense of a thesis. The goal of the M.S. degree program is to prepare the students with the necessary skills to

conduct research in the field of Earth System Science and Policy. This degree is designed to help the students develop a career in fields that require research capabilities. In conjunction with the six overall learning outcomes for the department, the M.S. students are able to:

1. Initiate scientific inquiry through critical evaluation of existing knowledge.
2. Synthesize and communicate the results of analysis in a coherent and well-structured report.

Master of Environmental Management (M.E.M.)

Mission Statement and Program Goals

The M.E.M. degree is a professional program which emphasizes practical experience especially through an internship. The goal of the M.E.M. degree program is to help the students develop the capabilities for a career in environmental management, sustainable development, or environmental policy.

In conjunction with the six overall learning outcomes for the department, the M.E.M. students are able to:

1. Implement their knowledge into practical applications especially through a successful internship experience.
2. Holistically apply particular learned skill sets and acquire additional skills needed for development of a desired professional career path.

Doctor of Philosophy (Ph.D.)

Mission Statement and Program Goals

The Ph.D. degree is an advanced research oriented program which involves conducting original research culminating in the defense of a dissertation and in peer reviewed publications. The goal of the Ph.D. degree program is to prepare students for a career in innovative research and/or academia. This degree is designed to train students to become high level researchers who will generate new knowledge in the field of Earth System Science and Policy, and sustainability. In conjunction with the six overall learning outcomes for the department, the Ph.D. students are able to:

1. Critically evaluate and identify gaps in existing knowledge.
2. Generate rigorous scientific inquiry that is original and bridges the identified gap in scientific knowledge.
3. Synthesize and communicate the results of research in the form of a dissertation, peer reviewed publication(s), and professional presentations.

Master of Science (M.S.)

Admission Requirements

Applicants who are seeking admission to School of Graduate Studies must meet all of the minimum general education requirements identified in the graduate catalog. In addition, students must fulfill the requirements below for admission to Earth System Science and Policy M.S. degree program.

1. Hold a bachelor's degree from an accredited college or university.
2. Have satisfactorily completed a minimum of college-level algebra plus 3 credits of college statistics or calculus.
3. Have completed a minimum of 12 semester credits in the natural or physical sciences, e.g., physics, chemistry, geosciences, biology or related sciences.
4. Have earned a minimum average GPA of 3.00 on a 4.00 scale, on all upper division college-level coursework.
5. Submit score from the Graduate Record Examination (GRE) General Test.
6. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

Degree Requirements

Students seeking the Master of Science degree at the University of North Dakota must satisfy all general requirements set forth by the School of Graduate Studies as well as particular requirements set forth by the Earth System Science and Policy Department.

The overarching goal of all the degree programs offered in Earth System Science and Policy is to facilitate the acquisition of skills required to solve environmental problems or to seize opportunities presented by a changing environment. Much of the responsibility for learning rests upon the student.

1. Students enrolled in the MS program will take the following sequences. Students will complete the basic two-semester core sequences of courses during their first year of study.

ESSP 501 & 501R & 501L	Earth System Science and Policy I and Earth System Science and Policy Recitation and Earth System Science and Policy Laboratory I (offered in the Fall)	10
ESSP 502 & 502R & 502L	Earth System Science and Policy II and Earth System Science and Policy Recitation II and Earth System Science and Policy Laboratory II (offered in the Spring)	10

2. A minimum of 36 credits beyond the baccalaureate is required, including six to nine credits for thesis.
3. At least one-half of the credits must be at or above the 500 level.
4. A maximum of one-fourth (usually 8-9 semester credits) of the credit hours required for the degree may be transferred from another institution.
5. By the end of the first semester the student will select a chair of her/his Advisory Committee and, in consultation with that chair, recommend membership on the Advisory Committee. The Advisory Committee will have 3 members, at least two of whom must be from the ESSP faculty. If the student is pursuing a minor concurrently with the MS in ESSP, one of the committee members will be from the department of the minor.
6. Students must file with the School of Graduate Studies an approved program of study before the completion of fifteen credits of coursework.
7. Students must maintain a GPA of 3.00, and comply with the requirements of the School of Graduate Studies. Grades poorer than "C" will not be accepted as fulfilling degree requirements.
8. MS student must complete oral and written examinations to qualify for candidacy in the Master of Science program. These will occur no later than the end of the first year of coursework and will entail a 15 to 30 page written description and an oral presentation of their intended research project.
9. Successful completion, and oral defense, of a thesis is required for the MS degree.
10. All exams will be administered and evaluated by the student's Advisory Committee.

ESSP 501	Earth System Science and Policy I	5
ESSP 501R	Earth System Science and Policy Recitation	3
ESSP 501L	Earth System Science and Policy Laboratory I	2
ESSP 502	Earth System Science and Policy II	5
ESSP 502R	Earth System Science and Policy Recitation II	3
ESSP 502L	Earth System Science and Policy Laboratory II	2
Electives		7-13
ESSP 998	Thesis	4-9
Total Credits		31-42

Master of Environmental Management (M.E.M.)

Admission Requirements

Applicants who are seeking admission to School of Graduate Studies must meet all the minimum general education requirements identified in the graduate catalog. In addition students must fulfill the requirements below for admission to Earth System Science and Policy M.E.M. degree program.

1. Hold a Bachelor's degree from an accredited college or university.
2. Have satisfactorily completed a minimum of college-level algebra plus 3 credits of college statistics or calculus.
3. Have completed a minimum of 6 semester credit hours in natural sciences and 6 semester credits in social sciences, e.g., economics, sociology, psychology, political science, anthropology/archaeology, or related fields.

4. Have earned a minimum average GPA of 3.00 on a 4.00 scale, on all upper division college-level coursework.
5. Submit score from the Graduate Record Examination (GRE) General Test.
6. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

Degree Requirements

Students seeking the Master of Environmental Management degree at the University of North Dakota must satisfy all general requirements set forth by the School of Graduate Studies as well as particular requirements set forth by the Earth System Science and Policy Department.

The overarching goal of all the degree programs offered in Earth System Science and Policy is to facilitate the acquisition of skills required to solve environmental problems or to seize opportunities presented by a changing environment. Much of the responsibility for learning rests upon the student.

1. Students enrolled in the MEM program will take the following sequences. Students will complete the basic two-semester core sequence of courses during their first year of study.

ESSP 501 & 501R & 501L	Earth System Science and Policy I and Earth System Science and Policy Recitation and Earth System Science and Policy Laboratory I (offered in the Fall)	10
ESSP 502 & 502R & 502L	Earth System Science and Policy II and Earth System Science and Policy Recitation II and Earth System Science and Policy Laboratory II (offered in the Spring)	10

2. A minimum of 36 credits, including three to nine credits for Internship is required.
3. At least one-half of the credits must be at or above the 500 level.
4. A maximum of one-fourth (usually 8-9 semester credits) of the credit hours required for the degree may be transferred from another institution.
5. By the end of the first semester the student will select a chair of her/his Advisory Committee and, in consultation with that chair, recommend membership on the Advisory Committee.
6. Students must file with the School of Graduate Studies an approved program of study before the completion of fifteen credits of coursework.
7. Students must maintain a GPA of 3.00, and comply with the requirements of the School of Graduate Studies. Grades poorer than "C" will not be accepted as fulfilling degree requirements.
8. Complete written and oral comprehensive examinations to qualify for candidacy in the MEM program. These will occur no later than one month before leaving for the internship and will entail a 5 to 15 page written description and an oral presentation of their intended internship project.
9. In place of a thesis, MEM students must submit a comprehensive written report of their internship with an appropriate organization. The written report will be in the form of an Independent Study Report, following the guidelines and procedures for such a report set by the School of Graduate Studies. Students shall make a final oral presentation to an audience from the ESSP program, stakeholders affected by their project, and relevant professionals.
10. All exams will be administered and evaluated by the student's Advisory Committee.

ESSP 501	Earth System Science and Policy I	5
ESSP 501R	Earth System Science and Policy Recitation	3
ESSP 501L	Earth System Science and Policy Laboratory I	2
ESSP 502	Earth System Science and Policy II	5
ESSP 502R	Earth System Science and Policy Recitation II	3
ESSP 502L	Earth System Science and Policy Laboratory II	2
Electives		5-11
ESSP 597	Internship	3-9
ESSP 997	Independent Study	2
Total Credits		30-42

Doctor of Philosophy (Ph.D.)

Admission Requirements

Applicants who are seeking admission to School of Graduate Studies must meet all of the minimum general education requirements identified in the graduate catalog. In addition, students must fulfill the requirements below for admission to Earth System Science and Policy Ph.D. degree program.

1. Hold a Master's degree from a recognized college or university.
2. Have satisfactorily completed a minimum of college-level algebra plus 3 credits of college statistics or calculus, AND a minimum of 12 semester credit hours in natural or physical sciences, e.g., physics, chemistry, geosciences, biology or related sciences, AND 6 semester credits in social sciences, e.g., economics, geography, environmental studies, sociology, psychology, anthropology, archeology, political science or related fields.
3. Have earned a minimum average GPA of 3.50 on a 4.00 scale on all graduate-level coursework.
4. Submit score for the Graduate Record Examination (GRE) General Test.
5. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

Degree Requirements

Students seeking the Doctorate degree at the University of North Dakota must satisfy all general requirements set forth by the School of Graduate Studies as well as particular requirements set forth by the Earth System Science and Policy Department.

The overarching goal of all the degree programs offered in Earth System Science and Policy is to facilitate the acquisition of skills required to solve environmental problems or to seize opportunities presented by a changing environment. Much of the responsibility for learning rests upon the student.

1. Students enrolled in the PhD program will take (in most cases) the following sequences. Students will complete the basic two-semester core sequence of courses during their first year of study.

ESSP 501 & 501R & 501L	Earth System Science and Policy I and Earth System Science and Policy Recitation and Earth System Science and Policy Laboratory I (offered in the Fall)	10
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ESSP 502 & 502R & 502L	Earth System Science and Policy II and Earth System Science and Policy Recitation II and Earth System Science and Policy Laboratory II (offered in the Spring)	10
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2. A minimum of 90 credits (30 of which must be taken in the Earth System Science and Policy Program) beyond the baccalaureate, including acceptable master's degree work, and up to 18 credits for dissertation is required for the PhD degree.
3. PhD students will be required to spend a minimum of two semesters, full-time, on the UND campus after receiving a master's degree.
4. Students must complete at least 6 credits of approved academic work per year.
5. By the end of the first semester in the doctoral program, the student will select a chair of her/his Advisory Committee. By the end of the second semester, the student will select membership of the Advisory Committee, in consultation with the chair. The Advisory Committee will have at least five members, at least three of which must be from the ESSP faculty. One of the committee members will be appointed by the Dean of the School of Graduate Studies. That member will be from outside the ESSP Department. The committee will assist the student in course selection and definition of a research topic and will also administer and evaluate all examinations that are required for completion of the degree.
6. ESSP PhD students must file with the School of Graduate Studies an approved program of study by the end of their second semester.
7. Students must maintain a GPA of at least 3.00 with no grades below "B" and comply with the requirements of the School of Graduate Studies. Any student whose GPA falls below 3.00 will be placed on probation and will have one semester to raise the GPA to 3.00 or above.
8. All students must take a qualifying exam to advance to candidacy in the PhD program. Part of the written requirement requires all students to write a dissertation proposal in a style appropriate for submission to a funding

organization or agency. Students will present their proposal for review no later than two years from the date of admission to the ESSP doctoral program. To be advanced to candidacy the PhD student will also take a qualifying exam, which will be administered early in the student's second year. Successful completion, and oral defense, of a dissertation is also required for the PhD degree.

9. All exams will be administered and evaluated by the student's Advisory Committee.

ESSP 501	Earth System Science and Policy I	5
ESSP 501R	Earth System Science and Policy Recitation	3
ESSP 501L	Earth System Science and Policy Laboratory I	2
ESSP 502	Earth System Science and Policy II	5
ESSP 502R	Earth System Science and Policy Recitation II	3
ESSP 502L	Earth System Science and Policy Laboratory II	2
Electives		6-40
ESSP 596	Doctoral Research	24-48
ESSP 999	Dissertation	6-18
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Total Credits		56-126

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Courses

ESSP 501. Earth System Science and Policy I. 5 Credits.

An overview of the fundamental issues from five research areas: Biodiversity and Ecosystem Functioning; Climate and Environmental Change; Land and Resource Management; Environmental Policy, Management, and Communication; and Human Health and the Environment. Material will be presented "situationally" in a problem-based learning environment. ESSP faculty and guest lecturers will present background information relevant to the topics. Students are expected to engage actively in the learning process by 1) determining what further information they need to understand the problem, 2) researching the questions, 3) clearly and concisely presenting the findings of their research to one another. Prerequisites: Graduate standing in ESSP. Corequisites: ESSP 501R and ESSP 501L.

ESSP 501L. Earth System Science and Policy Laboratory I. 2 Credits.

Laboratory session. Will require one or more full day field trips; may require one or more weekend field trips. Prerequisites: Graduate standing in ESSP. Corequisites: ESSP 501 and ESSP 501R. S/U grading.

ESSP 501R. Earth System Science and Policy Recitation. 3 Credits.

Small group discussions to include many parties to an environmental issue. Prerequisites: Graduate standing in ESSP. Corequisites: ESSP 501 and ESSP 501L. S/U grading.

ESSP 502. Earth System Science and Policy II. 5 Credits.

Course follows the design of ESSP 501 but with more emphasis on written reports and team projects. At the beginning of the semester, students will either select or be assigned a topic for an interdisciplinary team project for completion by the end of the semester. The team project helps students acquire an interdisciplinary outlook, and fosters communication and cooperation within a positive multi-disciplinary work environment. This will provide students with skills that are integral to the management of complex environmental problems they will face in the world beyond academia. Prerequisites: ESSP 501, 501R and 501L. Corequisites: ESSP 502R and ESSP 502L.

ESSP 502L. Earth System Science and Policy Laboratory II. 2 Credits.

Laboratory session. Prerequisites: ESSP 501, 501R and 501L. Corequisites: ESSP 502 and 502R. S/U grading.

ESSP 502R. Earth System Science and Policy Recitation II. 3 Credits.

Small group discussion. Prerequisites: ESSP 501, 501R and 501L. Corequisites: ESSP 502 and 502L. S/U grading.

ESSP 506. Ecosystem Services: Valuing Nature in a Market Society. 3 Credits.

Analyzes the services and goods provided by natural and human-made ecosystems with a primary focus on the agroecosystems and grasslands of the northern Great Plains. Explores the scientific framework of ecosystem services, their disruption or disturbance, economic and ecological values, methods of analyzing these values, and policy implications. Prerequisite: Consent of instructor.

ESSP 520. Earth Systems Modeling. 3 Credits.

Introduction to statistical and deterministic approaches for modeling earth systems, including use of modeling to support management and policymaking. Develops systems thinking skills and emphasizes modeling as a framework for environmental analysis and problem solving. Students will learn how different classes and scales of models are used to explore different type of environmental questions. Emphasis will be on the dynamic, interdependent and interactive relationships between human activities and ecosystem function and structure as well as the effects of these activities on biogeochemical cycles, energy flow, and biodiversity. Students will use these analyses to evaluate opportunities to shift toward more sustainable human behavior. Prerequisite: Graduate standing in ESSP or consent of instructor.

ESSP 530. Principles of Environmental Science. 3 Credits.

Provides a basis for understanding the complex responses of plants and animals to environmental change and presents clear explanations and analysis of interactions between organisms and their physical environment. Students will learn the physical principles that explain key Earth system processes, such as water cycle and energy cycle, and key interactions, such as radiative forcing. More importantly, students will learn principles that apply in conducting research and in the interpretation of measurements. Even though this graduate level course is intended for students who are expected to conduct research toward their degree, non-thesis graduate students are also encouraged to enroll as it covers a wide range of physical topics associated with Earth System Science. Prerequisites or Corequisites: Statistics, Calculus, College Physics, and permission of the instructor.

ESSP 540. Advanced Topics in Geospatial Technologies. 3 Credits.

The course's intent is to stay abreast of technological developments in a rapidly evolving field. Course contents will vary according to where the advances have the most immediate impact. The goal is to provide students exposure and hands-on experience needed to apply technologies to significant Earth System problems. Among technologies to be discussed are sensors for satellites and aircraft, data acquisition and image processing tools, verification and validation techniques, precision navigation by Global Positioning Satellites, and advanced uses of Geographic Information Systems. Prerequisite: Consent of instructor.

ESSP 562. Environmental Economics, Policy and Management. 3 Credits.

Examines the principles of economics, natural resource limitations and management, and the role of science in public policy decision-making with the intent of preserving Earth's vital life-support systems while meeting human needs and aspirations. Through case studies, guest speakers, and personal experience, studies how science does or does not inform environmental policymaking. Students apply economic theory and analysis to evaluate environmental problems and policies and apply ecological principles to shape economic policy. Particular emphasis will be on wetland habitats and agroecosystems. Prerequisite: Consent of instructor.

ESSP 570. Communicating Environmental Information. 3 Credits.

The focus of this class is on communication of scientific information to non-science audiences. Students will 1) probe the role of communication in the public perceptions of environmental issues, 2) examine the effectiveness of different tools in raising environmental awareness, 3) explore the barriers that hinder effective communication and subsequent motivation to action, and 4) profile a variety of environmental outreach activities. Ways to convert polarization among differing parties into consensus by communicating accurate, timely information will be explored. Prerequisite: Consent of instructor.

ESSP 590. Colloquium Series. 1 Credit.

Speaker series, approximately weekly, on timely topics and research. An emphasis will be to hear from outside speakers. Speakers may occasionally deliver presentations electronically. Graduate students in ESSP are expected to attend. S/U grading.

ESSP 594. Directed Study. 1-5 Credits.

Directed reading or investigations tailored to the needs of individual students for advanced knowledge in specific areas. Typically requires weekly meetings with the assigned faculty member. Usually culminates in a paper on the specific topical area. Doctoral candidates may repeat once. Prerequisite: Permission of an ESSP faculty member who agrees to serve as supervisor. Repeatable to 10 credits.

ESSP 596. Doctoral Research. 1-9 Credits.

Arranged with student's advisory committee. May be repeated for credit. Prerequisite: Graduate standing in ESSP or consent of instructor. Repeatable. S/U grading. F,S,SS.

ESSP 597. Internship. 3-9 Credits.

Practical experience for ESSP students in a professional environment. Repeatable to 9 credits. Prerequisite: Graduate standing in ESSP. Repeatable to 9 credits. S/U grading.

ESSP 599. Special Topics. 1-6 Credits.

Topics of current interest. May be provided by program or visiting ESSP faculty. May be repeated for credit. Prerequisite: Graduate standing in ESSP or consent of instructor. Repeatable.

ESSP 996. Continuing Enrollment. 1-12 Credits.

Repeatable. S/U grading.

ESSP 997. Independent Study. 2 Credits.

Independent study and preparation of written and oral reports describing internships. Prerequisite: Approval by student's advisor of written proposal describing internship to be completed.

ESSP 998. Thesis. 3-9 Credits.

Academic credit for thesis research that has been approved in advance by a student's advisory committee. May be repeated, but no more than 9 credits will be allowed in a master's degree program. Prerequisite: Graduate standing in ESSP or consent of instructor. Repeatable to 9 credits.

ESSP 999. Dissertation. 3-18 Credits.

Academic credit for doctoral dissertation research that has been approved in advance by a student's advisory committee. May be repeated but no more than 18 credits will be allowed in the degree program. Prerequisite: Consent of instructor. Repeatable to 18 credits.