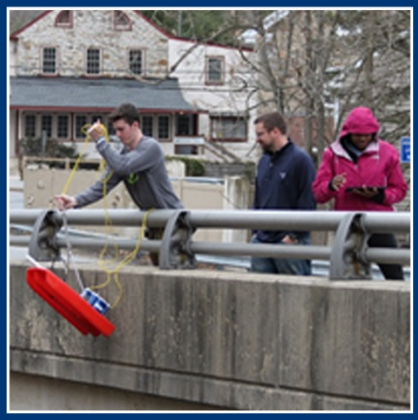
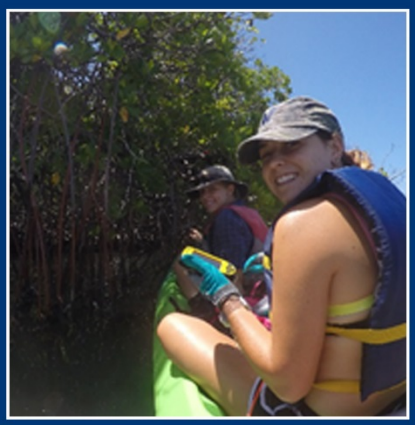
Department of Geography and the Environment

Guide to Graduate Academic Programs







College of Liberal Arts and Sciences | Villanova University

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MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE (MSES)

We are witnessing environmental change that is unique in human history. Human population growth and economic globalization have placed increasing and near-unsustainable demands on natural resources and environmental systems. Increased levels of greenhouse gases are potentially warming Earth's climate and ecosystems are badly stressed and degraded. Rather than continue on this path, we must better understand the scientific processes of the environment to more effectively manage human interactions with natural systems. Therefore, our Master of Science in Environmental Science (MSES) emphasizes integrated thinking and learning at the nexus of science, policy, and human behavior. Our graduates will see beyond linear and fragmented approaches to solving environmental problems to understand the complex interactions between people and the environment.

★★★★★

MISSION STATEMENT AND OBJECTIVES

The mission of the Master of Science in Environmental Science is to have our students become skilled critical thinkers and problem solvers, devoted to a lifetime of learning. The program provides research training and advanced coursework in a broad range of the environmental sciences. At Villanova, the environmental graduate program seeks to build a diverse, intellectual community that enhances the scholarship of its members. The program's curriculum fosters close collaboration among faculty and students within the Department and across the sciences at Villanova by strongly promoting the exchange of ideas and perspectives as an essential part of scholarship. The program requires dedication to excellence in creative and critical thinking, in the analysis and interpretation of existing knowledge, in the execution of research, in teaching, and in communication. Scholarship and research is directed towards an enhanced understanding of environmental systems and their nexus with society. Accordingly, the program offers a diverse array of intellectual experiences, laboratory and field study, and research with highly experienced faculty mentors. Finally, the environmental master's program enhances the College's intellectual atmosphere by developing students who will ascend to intellectual, moral, and professional leadership; develop the fundamentals of critical insight, mature judgment, and independent thinking; and cultivate a sense of moral responsibility and working for the betterment of society.

The program has a single overarching objective: to produce highly educated graduates who can anticipate and respond effectively to the uncertainties of a changing natural environment given the necessary constraints of public policy, economic reality, and human considerations. Our graduates will be able to apply their science education, and the values instilled by the Villanova system, to anticipate uncertainties, solve complex environmental problems, and respond effectively to challenges and ambiguity with confidence and reasoned judgment—supported by excellent research with a faculty mentor.

The program is intended to produce graduates who can:

- Recognize and solve environmental problems existing at the nexus of scientific, political, and human discourse.
- Demonstrate an advanced proficiency in understanding the climatic, geological, biological, chemical, and human factors affecting environmental processes and the management of ecosystems.
- Demonstrate mastery of quantitative research methods as applied to questions related to the natural environment and become effective problem solvers.
- Demonstrate effective oral and written communication necessary to construct, evaluate, and present solutions to environmental problems; and present their findings at professional meetings and in scientific journals.
- Understand the challenges and expectations of environmental careers in environmental planning, government policy, business, non-profits, law administration, environmental consulting, government laboratories, and education.
- Translate their education and research into community outreach and the promotion of sustainable campus programs; and the development and enhancement of partnerships with local communities, thus improving the ecosystems in which they live.
- Recognize moral issues and apply ethical considerations in decision–making and solving environmental problems—our students understand that their education and service as citizens requires them to reflect on the moral implications of situations they encounter.
- Demonstrate the capability and desire to pursue progressive and continued intellectual development.

ACADEMIC ADVISING

The Department of Geography and the Environment is committed to academic advising that accommodates the needs of all graduate students, taking into consideration the schedules of full-time and part-time students, as well as of Department faculty. All students will be placed under the advisorship of the MSES Director, who will assist the student in registering for each semester of courses and will inform the student of the various degree requirements. For thesis students, course selection of free electives will also include recommendations from the student's thesis mentor and advisory committee. Academic advising in the Department is committed to providing guidance for completing the requirements of the MSES degree in a timely manner that are consistent with the:

- Goals and aspirations of the student.
- Mission and objectives of the Master of Science in Environmental Science Program.
- Rules and regulations of the Office of Graduate Studies, College of Liberal Arts and Sciences at Villanova University.

GENERAL DEGREE REQUIREMENTS

The Master of Science in Environmental Science is a 30-credit degree program. All students enroll in 7-10 credits of required foundation courses. The remaining credits are dependent on whether students pursue the Research and Thesis Track, the Non-Thesis Portfolio Track, or the Non-Thesis Capstone Track. For satisfactory completion and continuation of the MSES degree, all students must maintain a cumulative grade point average of 3.0 (i.e., a B) or better.

FOUNDATION COURSES

All students take 7-10 credits of required foundation courses, depending on their chosen track:

GEV 7000: Research Methods in the Environmental Sciences (2 credits) *Analytical and research techniques for environmental scientists to be taken during the first semester of study* – for thesis and capstone tracks only.

GEV 7010: Environmental Colloquium (1 credit) *Attendance at departmental seminars and student presentations. Colloquia will be taped and broadcast online for part-time students* – for thesis and capstone tracks only.

GEV 7020: Advanced Environmental Issues Seminar (3 credits) *Discussion and debate of current environmental issues to be taken during the second semester of study* – for all MSES tracks.

GEV 7041: GIS for Environmental Systems (4 credits) *Application of geotechnical skills to address environmental issues to be taken during the second semester of study for full-time students or any spring semester for part-time students* – for all MSES tracks.

Note: GEV 7040 (Intro to GIS) is required for students without prior GIS experience as a pre-requisite for GEV 7041. If a student must take GEV 7040, it will count towards their free electives.

INDEPENDENT RESEARCH: CARRYING OUT A THESIS OR CAPSTONE

Students have the opportunity to work closely with a faculty member to conduct independent and novel research as a thesis (up to 10 credits) or as a 3- to 5-credit capstone project. In either case, students participate in project conceptualization, design, data collection and analysis, written product and presentation. For the Research and Thesis Track, students will have the opportunity to present their work to other scientists in their discipline at scientific conferences and/or publication of a peer-reviewed article.

PORTFOLIO OPTION

For students less interested in research, those that already participate in environmentally-relevant research activities as part of their employment, and/or prefer to acquire additional skills and knowledge from classroom experiences, our Non-Thesis Portfolio Track is an ideal option. In cooperation with the Program Director, you develop and customize your academic program to best suit your needs and interests, culminating in the creation of an electronic portfolio of your work and acquired skills.

CHOICE OF ELECTIVES

Depending on the chosen track and individual research plans of each student, at least 8 and up to 23 credits of elective courses must be completed, with at least 8 credits coming from laboratory courses for both non-thesis tracks. As a truly interdisciplinary program, we encourage students to enroll in courses offered by other departments on campus. Up to nine credits may be taken from departments other than Geography and the Environment; a list of pre-approved courses from the Departments of Biology, Chemistry, and Public Administration is provided at the end of this catalog.

RESEARCH AND THESIS TRACK

Students enrolled in the Research and Thesis Track will conduct environmental research under the direction of a thesis mentor, culminating in the writing of a thesis and public defense of their thesis research. Research typically includes hypothesis testing, collecting and analysis of original data associated with field, laboratory, and/or geotechnical work. Potential MSES students are encouraged to connect with a thesis mentor as early as possible in their application process. At the latest, students who wish to pursue the Research and Thesis Track must have a faculty mentor who agrees to collaborate with them on a research project before the end of the add/drop period in the student's first semester.

PROGRAM OF STUDY

In addition to the 10 credits of required foundation courses, students on the Research and Thesis Track must take GEV 7030 and GEV 9050. Additionally, they take at least 5 credits of thesis work, but no more than 10 additional credits, depending on the research plan they work out with their thesis mentor.

GEV 7030: Proposal Development (1 credit)

GEV 9050: Thesis Writing (1 credit)

GEV 9001: Thesis Continuation (0 credits)

GEV 9010: Thesis Research I (1 credit)

GEV 9020: Thesis Research II (2 credits)

GEV 9030: Thesis Research III (3 credits)

GEV 9040: Thesis Research IV (5 credits)

- Students registered for Thesis Continuation or any Thesis Research course are required to submit a midterm and final progress report in the fall or spring semesters and a final progress report in summer semesters. Students will receive an IP (in progress) grade at the end of each semester for satisfactory progress of their work. After the successful final defense of their thesis, all IP grades will be converted to S grades on the transcript.
- By the end of the first semester of study or early in the second semester, the student must prepare a written proposal (GEV 7030) of their anticipated thesis research and orally present and defend his/her proposal. Example written proposals can be viewed in the Department's Graduate Office.
- A student may register for Thesis Research (GEV 9010, 9020, 9030 9040) only after his/her thesis proposal has been successfully defended.
- Upon completion of the written thesis (GEV 9050), the student will conduct a public oral defense. Example written theses can be viewed in the Department's Graduate Office.

- The two oral presentations and respective defenses will be scheduled as part of the Department's Environmental Colloquium, if possible.
- Lastly, 8 to 13 credits from elective courses are required, depending on the number of thesis credits obtained. Students should choose courses that complement their research and enhance their environmental skill-set.

THESIS MENTOR

Students pursuing the MSES degree are required to conduct independent research under the direction of a Villanova faculty member, the thesis mentor. The thesis mentor must be a tenured or tenure-track faculty member of the Department of Geography and the Environment. The thesis mentor will have primary responsibility for approving the student's program of study (i.e., formal course work), directing the student's research, and will serve as the chairperson of the student's advisory committee.

ADVISORY COMMITTEE

Two additional faculty (one of whom may be from outside the department) chosen by the student at the discretion of the mentor will form a three-person advisory committee, with the mentor as the chair of the committee. In a general sense, the advisory committee is expected to play an active role in guiding the graduate education and intellectual development of the student. More specifically, working with the student, the advisory committee has responsibility for approving the student's written proposal and thesis, both oral presentations, and both defenses. Committee members may include tenured, tenure-track, full-time non-tenure-track, postdoctoral fellows, and adjunct faculty, as well as suitable researchers or practitioners in a relevant discipline holding a minimum of a Master's degree. If a committee member is not already a member of the Department's graduate faculty, he/she must provide a copy of their curriculum vitae to the Department's graduate office for inclusion in the student's file. All committee members must agree to the Department's regulations for administering thesis research and must be available to attend both the student's proposal and thesis defense. Travel expenses for the outside member (if applicable) should be considered at the time of committee formation; the Department may be able to cover some travel expenses.

RESTRICTIONS ON THESIS RESEARCH

The Department of Geography and the Environment recognizes that not all research can take place within the confines of Mendel Hall. In particular, field research and studies involving equipment and/or facilities that are not available within the Department may dictate that students conduct some or all of their research elsewhere. Students are not prohibited from conducting research elsewhere when doing so is necessary or intellectually justifiable. However, the Department embraces the concept that the intellectual development of graduate students is enhanced through active participation in Departmental activities. Specifically, all graduate students are expected to attend the Department's Environmental Colloquium. Also, participation in informal journal clubs, opportunities for impromptu discussions

between and among students and faculty, opportunities to meet visiting researchers etc. require graduate students to be physically present and to be mentally receptive to being active Departmental citizens.

The Department of Geography and the Environment prohibits students who are gainfully employed as researchers to use the work for which they are paid as thesis research. Thesis research must be an independent activity in which the student has a substantial personal intellectual investment. Under some circumstances, it may be possible for a student to conduct some parts of their research at their place of employment, as long as: (1) the student is not being paid by the employer to conduct the thesis research, (2) the student's thesis research is as independent as research that might be done outside of his/her place of employment, and (3) the research is the intellectual product and property of the student and not of the company. The MSES Director reserves the right to request that a student's employer certify their assent to and/or compliance with these policies in writing. Wherever thesis research is conducted, it will be carried out under the supervision of graduate faculty from the Department of Geography and the Environment as a thesis mentor.

Some students may have the opportunity to participate in fieldwork and research during the summer prior to their first enrollment. This is allowed, but the thesis mentor must ensure that appropriate insurance and liability coverage is available for all research participants.

PROPOSAL DEVELOPMENT

Thesis students will be required to prepare a written proposal of the research study they plan to carry out as part of the MSES. In general, the research is expected to be novel and environmentally relevant, with the ideal goal (although not a requirement) of being publishable in the relevant literature of the discipline.

The written proposal and proposal defense should:

- Demonstrate thorough knowledge of historical and current literature relevant to the proposed research.
- Present a clear statement of hypotheses / research questions, consistent with literature.
- Present a detailed experimental design / methodology.
- Describe the expected results – preliminary data may be included, but are not required.
- Incorporate a plan for future work / time table to complete the thesis.

Suggested Timeline

4 weeks before Defense	• Draft proposal to advisory committee and mentor
3 weeks before Defense	• Schedule date and time for presentation and defense (the entire advisory committee must be available)
2 weeks before Defense	• Completed approval form is due to the MSES Director • Submit final proposal to the Department's main office for review by all faculty
1 week before Defense	• Select a moderator (chosen by the student) • Practice oral presentation and prepare for potential questions

PROPOSAL PRESENTATION AND DEFENSE

For the proposal, the oral presentation is open to the public and moderated by a faculty member, while the defense portion is closed to just the committee members.

- Selection of a Moderator: Eligible moderators must be a faculty member (any rank) in the Department of Geography and the Environment and cannot be a member of the student's advisory committee or mentor. The selection of moderator is entirely at the student's discretion. The moderator will be responsible for introducing the student and committee at the start of the presentation, and managing the public Q&A session. The moderator's primary role is as an advocate for the student.
- Formal oral presentation of ~30-40 minutes.
- Question and answer period from the general audience and faculty that are not members of the advisory committee of ~15 minutes. The advisory committee may not verbally participate during this phase of the defense.
- All audience members, except the three members of the advisory committee, are excused during the formal defense phase when the student answers questions related to his/her proposed research. This phase of the presentation/defense may exceed an additional 15 minutes at the discretion of the thesis mentor.
- The student is excused after all questions have been posed by the advisory committee and to allow them to deliberate about the student's performance and preparation for carrying out his/her thesis work.
- The mentor is responsible for verbally conveying the outcome of the presentation and defense to the student immediately following deliberation, including sharing specific comments related to the proposed thesis work.
- The mentor is responsible for emailing the Department's graduate office with the outcome of the presentation and defense for the student's record.

FINAL THESIS AND DEFENSES

In general, the written thesis should include a relevant literature review, methodology, results, and discussion of the research conducted. The final format should comply with guidelines from the Office of Graduate Studies. Final content is at the discretion of the advisory committee and ultimately, the mentor.

Suggested Timeline for Written Thesis and Associated Defense

6 weeks before Defense	• Draft thesis to advisory committee and mentor; drafts are expected to go through multiple edits prior to submission to the main office
3 weeks before Defense	• Complete form for Request to Defend Thesis; these forms must include original signatures of the student and committee members (electronic signatures are not permissible).

2 weeks before Defense	• Completed form is due to the MSES Director • Submission of final thesis in the Department main office in Mendel Hall G67 for review by all faculty • Schedule date and time for presentation and defense (the entire advisory committee must be available) • Public announcement to all students, faculty, and staff (responsibility of the MSES Director)
1 week before Defense	• Select a moderator (chosen by the student) • Practice oral presentation and prepare for potential questions
2 weeks after Defense	• Resubmit the written thesis incorporating revisions required by advisory committee • Completed Thesis Cover Page, including original signatures of the advisory committee

The oral presentation and associated defense provide an opportunity to publically inform the Department community of the research each student has been conducting as part of his/her thesis. These requirements are an integral part of the scientific process and are considered essential milestones of the Master's degree. Students are expected to be fluent in their area of research, knowledgeable of relevant literature, and critical of their own experiment/project, while both engaging and informing the audience.

All proposal and thesis defenses must comply with the following:

- Selection of a Moderator: Eligible moderators must be a faculty member (any rank) in the Department of Geography and the Environment and cannot be a member of the student's advisory committee or mentor. The selection of moderator is entirely at the student's discretion. The moderator will be responsible for introducing the student and committee at the start of the presentation, and managing the public Q&A session and formal defense immediately following the presentation. The moderator may intervene if inappropriate questions are posed. The moderator's primary role is as an advocate for the student.
- Formal oral presentation of ~30-40 minutes.
- Question and answer period from the general audience and faculty that are not members of the advisory committee of ~15 minutes. The advisory committee may not verbally participate during this phase of the defense.
- All audience members, except the three members of the advisory committee, are excused during the formal defense phase when the student answers questions related to his/her proposed research. This phase of the presentation/defense may exceed an additional 15 minutes at the discretion of the thesis mentor.
- The student is excused after all questions have been posed for the advisory committee and other faculty in attendance to deliberate and requires unanimous vote for satisfactory performance. Unsatisfactory proposal or thesis defenses may be repeated up to one additional time within six weeks of the original defense date.

- The mentor is responsible for verbally conveying the outcome of the oral presentation and defense for the proposal or thesis to the student immediately following deliberation.

The final written thesis is due in the Office of Graduate Studies by mid-April for May graduation, mid-July for September graduation, and late November for December graduation. Please consult the current Academic Calendar for exact deadlines.

REQUIRED FORMS AND DEADLINES

Electronic copies of all forms can be found on the MSES website. It is the student's responsibility to submit the appropriate forms prior to the deadline.

Form	Deadline
Application for the Research and Thesis Track	Before the end of the add/drop period in the first semester of study
Plan of Study - Research and Thesis Track	Before the mid-semester break (fall or spring) in the first semester of study
Request to Defend Proposal	2 weeks before proposal defense
Request to Defend Thesis	2 weeks before thesis defense
Thesis Cover Page	2 weeks after thesis defense

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NON-THESIS CAPSTONE TRACK

Students in the Non-Thesis Capstone Track will complete a Capstone Project under the direction of a capstone mentor to culminate their MSES program in the final semester. The project may take the form of a traditional scientific one-semester research project, be conducted in conjunction with a student's employment, or include curriculum development / testing for working teachers. Overall, the scope for capstone projects is broad, with the aim of enhancing the future goals of our MSES students.

PROGRAM OF STUDY

In addition to the 10 credits of required foundation courses, students on the Non-Thesis Capstone Track must take GEV 9000 and GEV 9005 to complete their capstone project.

GEV 9000: Directed Research (2 credits)

GEV 9005: Capstone Project (1 credit)

- A student may register for additional Capstone Research (GEV 9006, 9007) courses (2 or 3 credits, respectively) to suit the scope and size of the project; the additional course credits will count as elective credits.
- Students must have completed at least two semesters of coursework prior to beginning their capstone project.
- Upon completion of the written capstone (GEV 9005), the student will give a public presentation as part of the Department's Environmental Colloquium.
- Lastly, up to 17 credits from elective courses are required, with at least 8 credits required from laboratory courses. Students should choose courses that complement their research and enhance their environmental skill-set.

THE CAPSTONE, MENTOR, AND PRESENTATION

In general, the written capstone should incorporate background research, significance, methodology, findings, and implications, although the exact format of the final document should best suit the topic and is at the discretion of the capstone mentor. The final document should complement the student's career and professional goals and serve as an example of his/her ability to apply knowledge gained during the MSES program. As a part of their academic advising, the MSES Director can help a student identify faculty with complementary research and academic interests. The faculty presentations in Research Methods (GEV 7000) will highlight current areas of research and may provide a source of inspiration for capstone topics.

Any full-time tenured, tenure-track, or full-time non-tenured faculty member in the Department of Geography and the Environment may serve as a mentor for the Capstone Project; an advisory committee is not required. Students should seek a mentor with interests that match and complement their own interests and research requirements.

The oral presentation provides an opportunity to publically inform the Department community of the research each student has been conducting as part of his/her capstone. These requirements are an integral part of the scientific process and are considered essential milestones of the Master's degree. Students are expected to be fluent in their area of study, knowledgeable of relevant literature, and critical of their own study, while both engaging and informing the audience.

All oral presentations must comply with the following:

- Selection of a Moderator: Eligible moderators must be a faculty member (any rank) in the Department of Geography and the Environment and cannot be the student's mentor. The selection of moderator is entirely at the student's discretion. The moderator will be responsible for introducing the student and mentor at the start of the presentation and managing the Q&A session immediately following the presentation. The moderator may intervene if inappropriate questions are posed. The moderator's primary role is as an advocate for the student.
- Formal oral presentation of no more than 30 minutes.

- Question and answer period from the general audience of no more than 15 minutes, with questions from the mentor posed last.
- No defense period (i.e., private questioning by Department faculty) is required for the Non-Thesis Capstone Track.
- The mentor is responsible for verbally conveying the outcome of the oral presentation to the student immediately following deliberation.

The final written capstone is due in the Department's main office in Mendel G67 by mid-April for May graduation, mid-July for September graduation, and late November for December graduation. Please consult the current Academic Calendar and the deadlines provided for the submission of final theses.

Suggested Timeline for Written Capstone and Presentation

6 weeks before Defense	• Draft capstone to mentor; drafts are expected to go through multiple edits prior to submission to the main office
3 weeks before Defense	• Complete form for Request to Present Capstone; these forms must include original signatures of the student and mentor (electronic signatures are not permissible).
2 weeks before Defense	• Completed form is due to the MSES Director • Submission of final capstone in the Department's main office in Mendel Hall G67 for review by all faculty • Schedule date and time for presentation (the mentor must be available) • Public announcement to all students, faculty, and staff (responsibility of the MSES Director)
1 week before Defense	• Select a moderator (chosen by the student) • Practice oral presentation and prepare for potential questions
2 weeks after Defense	• Resubmit the written capstone incorporating revisions required by his/her mentor • Completed Capstone Cover Page, including original signature of the mentor

REQUIRED FORMS AND DEADLINES

Electronic copies of all forms can be found on the MSES website. It is the student's responsibility to submit the appropriate forms prior to the deadline.

Form	Deadline
Plan of Study – Non-Thesis Capstone Track	Before the mid-semester break (fall or spring) in the first semester of study, updated every semester thereafter
Application for the Non-Thesis Capstone Track	Before the drop/add deadline of the first semester in which the student undertakes Capstone research (i.e., enrolls in any 900x course)
Request to Present Capstone	2 weeks before portfolio discussion

NON-THESIS PORTFOLIO TRACK

Students in the Non-Thesis Portfolio Track will complete a 30-credit course of study culminating in a portfolio (an associated e-portfolio). The portfolio option provides students who already have research experience and/or are not interested in pursuing research in their careers the opportunity to highlight their learning outcomes to current and prospective employers.

PROGRAM OF STUDY

In addition to 7 credits of required foundation courses, students on the Non-Thesis Portfolio Track must complete 23 additional elective credits, with at least 8 credits (2 courses) deriving from 4-credit laboratory courses. In the final semester of study, students will complete a portfolio and e-portfolio of selected work and discuss this portfolio with a panel of faculty.

THE PORTFOLIO

Students select three to four discrete projects completed during graduate coursework that best highlight the skills and knowledge achieved. Papers, poster presentations, and other significant products are valid for inclusion in the portfolio. Students choose the work that is most relevant to their future aspirations and put their abilities in the best light, while also demonstrating the breadth of their knowledge and

abilities. The final document should complement the student's career and professional goals and serve as an example of his/her ability to apply knowledge gained during the MSES program. Students also create an online e-portfolio version that is accessible online to prospective employers.

Once the final portfolio has been submitted and the e-portfolio created, faculty in the Department review and evaluate the portfolios. Students then meet with a panel of faculty to discuss the portfolio, and faculty conduct an oral assessment of the student's learning outcomes to complement the portfolio submission.

The final portfolio is due in the Department's main office in Mendel G67 by mid-April for May graduation, mid-July for September graduation, and late November for December graduation. Please consult the current Academic Calendar and the deadlines provided for submission.

REQUIRED FORMS AND DEADLINES

Electronic copies of all forms can be found on the MSES website. It is the student's responsibility to submit the appropriate forms prior to the deadline.

Form	Deadline
Plan of Study – Non-Thesis Portfolio Track	Before the mid-semester break (fall or spring) in the first semester of study, updated every semester thereafter
Request to Present a Portfolio	2 weeks before portfolio discussion

TRANSFERRING TRACKS

Many students begin their graduate studies in Geography and the Environment with questions about whether a Research and Thesis Track, Non-Thesis Capstone Track, or Non-Thesis Portfolio Track would be more suitable for their own goals. The MSES Director and other faculty in the Department can provide guidance and advice about the different options. The faculty presentations in Research Methods (GEV 7000) will provide further insight on the various types of research conducted in the Department. Transfer from the Research and Thesis Track to the Non-Thesis Capstone or Portfolio Tracks or vice versa is possible, but may result in the loss of some credits and an extension in the length of the student's program. Students considering a change in status should consult with their mentor and the MSES Director as soon as possible in their studies.

ASSISTANTSHIPS AND FELLOWSHIPS

RESPONSIBILITIES

Students with Financial Support

Students receiving financial support while in the MSES Program as Graduate Assistants and Tuition Scholars should review and understand their responsibilities as outlined by the Office of Graduate Studies. In addition to those, the Department requires that all students receiving financial support while pursuing the MSES (including funding through external grants) commit to the following responsibilities:

- Graduate Assistants will be assigned as teaching assistants for undergraduate laboratories in their second and third semesters, with the first and fourth semesters as research assistants.
- Attendance at all Environmental Colloquia in each semester they are enrolled in courses (including thesis / capstone / directed research courses).
- Regular presence on campus; much of scientific and academic interaction often occurs informally amongst fellow graduate students, faculty, and staff. A regular presence on campus and within the Department beyond those required by course attendance facilitates these interactions.
- Become and maintain van driver certification through the Office of Public Safety.
- Service within the Department consistent with their position. These may include meetings with prospective students and faculty, van drivers for undergraduate field trips, refreshments set-up for Colloquia, etc., including activities that occur on the weekends and evenings outside of traditional business hours.

All Students

All MSES students are encouraged to attend the Department's Environmental Colloquium, including via live online access if necessary. Regular participation in Department and other on campus activities facilitates scientific and academic interactions. All students are encouraged to participate in our thriving Department community that incorporates undergraduates, graduates, faculty and staff.

VAN DRIVER CERTIFICATION

All MSES Graduate Assistants are required to become certified van drivers during their first semester. Certification requires a valid U.S. driver's license, watching an online certification and safety video, and participating in a brief test-drive of a 12-passenger van. Other students who require access to the University Fleet for their research and/or academic pursuits, will need to have these needs verified by their mentor, must provide a budget for van use, and will be similarly certified.

SUMMER AND TRAVEL FUNDING

The Office of Graduate Studies provides competitive funding of up to $3000 for June, July, and August for students working on research during the summer and competitive funding for travel to conferences, up to $1000 for a conference in North American and up $1200 for international travel. The Department of Geography and the Environment also has funds available to support graduate student research during the summer months and travel to conferences. Application instructions can be found on online. Eligible students must be in good standing, cannot have an N or NF grade, are limited to two travel grants per fiscal year, and cannot receive total funds in excess of their summer or travel funding needs.

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PRE-APPROVED INTERDISCIPLINARY ELECTIVE COURSES

The following courses have been pre-approved as elective courses for the MSES program. It is the student's responsibility to ensure that he/she has the necessary pre-requisites to enroll in the chosen coursework. It is recommended that students contact the relevant professor with questions pertaining to each course. Special Topics courses offered in a single semester may be added to this list. Students will be notified about offered courses during the pre-registration period each semester.

GEV Elective Lecture Courses (3 credits)

- GEV 7100 Remote Sensing for Environmental Analysis
- GEV 7101 Land Use and Environmental Assessment
- GEV 7102 Sustainable Environmental Systems
- GEV 7103 Environmental Policy and Law
- GEV 7104 Coastal Environments
- GEV 7105 Sustainable Urban Systems
- GEV 7106 Ecosystems Services
- GEV 7107 Advanced Environmental Geology
- GEV 7108 Climate Variability
- GEV 7109 Paleoclimates
- GEV 7110 Sustainable Development
- GEV 7111 Agricultural Sciences
- GEV 7112 Environmental Health
- GEV 7113 Soil Science

- GEV 7114 Air Pollution
- GEV 7115 Energy Systems
- GEV 7116 Coral Reefs
- GEV 7117 Water Resources
- GEV 7118 Energy Policy
- GEV 7119 Oceanography
- GEV 7120 Geology
- GEV 7121 Global Change Science
- GEV 7122 Ecosystem Ecology
- GEV 7123 Green Science
- GEV 7124 Biomimicry
- GEV 7125 Tropical Ecology
- GEV 7126 Process Geomorphology
- GEV 7127 Environmental Systems
- GEV 7128 Environmental Systems Management
- GEV 7129 Environmental Toxicology
- GEV 7200 Advanced Quantitative Analysis
- GEV 7201 Spatial Analysis of Environmental Systems
- GEV 7202 Geo Statistics
- GEV 7203 Environmental Modeling with GIS and Remote Sensing
- GEV 7204 Geospatial Project Management

GEV Elective Lab Science Courses (4 credits)

- GEV 7040 Intro to GIS*
- GEV 8310 Advanced Topics in Environmental Lab Science I
- GEV 8320 Advanced Topics in Environmental Lab Science II
- GEV 8321 Microbial Processes
- GEV 8322 Ocean and Coastal Environments
- GEV 8323 Watershed Biogeochemistry
- GEV 8324 Environmental Systems
- GEV 8325 Environmental Ecology

- GEV 8326 Environmental Geology
- GEV 8327 Geomorphological Environments
- GEV 8328 Climatology
- GEV 8329 Global Change Research
- GEV 8330 Field Methods for Environmental Science
- GEV 8331 Field Research
- GEV 8332 Sustainable Environmental Systems
- GEV 8333 Water and Waste Water Management
- GEV 8334 Biogeochemistry
- GEV 8335 Hydrology and Water Resources
- GEV 8336 Aquatic Environmental Ecology
- GEV 8337 Terrestrial Environmental Ecology
- GEV 8338 Environmental Chemistry

*Required for students without prior GIS experience as a pre-requisite for GEV 7041

Electives in Other Departments

Chemistry Courses (3 credits)

- CHM 7515 Environmental Chemistry
- CHM 7595 Advanced Analytical Chemistry
- CHM 7515 Advanced Biochemistry
- CHM 8643 Toxicology

Biology Courses

- BIO 7105 Vertebrate Ecology (4 credits)
- BIO 7151 Biogeochemistry Lecture (2 credits)
- BIO 7152 Biogeochemistry Lab (2 credits)
- BIO 7805 Biostatistics and Experimental Design (4 credits)
- BIO 7555 Molecular Ecology and Evolution (4 credits)
- BIO 7705 Plant Ecology (4 credits)
- BIO 7755 Plant Ecophysiology (4 credits)
- BIO 7955 Biodiversity and Systematics (4 credits)

- BIO 7970 Special Topics in Ecology, Evolution, and Organismal Biology (2 credits)
- BIO 7980 Advanced Topics in Ecology, Evolution, and Organismal Biology (3 credits)
- BIO 7980 Advanced Topics (Molecular Ecology) (3 credits)
- BIO 7980 Advanced Topics (Behavioral Ecology) (3 credits)
- BIO 7980/7982 Advanced Topics (Global Change Ecology, lecture / lab) (4 credits)
- BIO 8940/8941 Advanced Topics (Tropical Field Ecology, lecture / lab) (4 credits)

Public Administration Courses (3 credits unless otherwise noted)

- MPA 8100 Decision-Making
- MPA 8300 Leadership Ethics
- MPA 8400 Strategic Planning
- MPA 8500 Effective City Management
- MPA 8550 Urban Politics
- MPA 8600 Effective Nonprofit Management
- MPA 8800 Managing Public Networks
- MPA 8900 Public Policy
- MPA 8299 Special Topics in Public Administration (1 credit; suggested topics: land use and zoning, economic development strategies, program evaluation, performance measurement)

GEV
GEOGRAPHY AND THE ENVIRONMENT

FACULTY RESEARCH PROJECTS

Air Quality and Environmental Health, Dr. Kabindra Shakya

Air pollution is one of the leading causes of global deaths. The World Health Organization reports that there were approximately 7 million premature deaths in 2012 due to exposure to air pollution. Specifically, atmospheric particulate matter is of main concern because it has negative effects on human health, climate change, visibility, and acid deposition. Research is focused on investigating the levels, chemical characteristics, sources, and health effects of atmospheric particulate matter ($PM_{2.5}$ and PM_{10}). Students will have the opportunity to develop their own research questions in these areas, participate in field work, laboratory analyses, and apply advanced statistical tools to analyze existing databases.

Biogeochemical Cycling in Coastal Wetlands, Dr. Nathaniel Weston

Coastal wetlands are hot-spots for carbon sequestration and elemental cycling that influence water quality, greenhouse gas exchange, and coastal ecosystem resilience. To better understand biogeochemical cycling in coastal ecosystems, the exchange of carbon, nitrogen, phosphorus, and other important elements between marshes, estuaries, and the atmosphere are analyzed. Research has focused on the intrusion of salt-water into tidal freshwater marshes, the exchange of nutrients between sediments and the water-column, and the role of physicochemical stress on the microbial community that may enhance greenhouse gas production and emission from marsh soils. Field work takes place in coastal systems including the Delaware River estuary and Barnegat Bay, New Jersey.

Biogeochemistry of Rural to Urban Streams, Dr. Steven Goldsmith

Many streams in near Villanova's campus traverse a rural to urban gradient and offer an ideal opportunity to examine the relationship between land use practices and water quality. Research in the Goldsmith Laboratory has focused on determining the sources and fate of contaminants in these systems (including nutrients, sediment, metals, and pharmaceuticals) and devolving practical solutions to ameliorate the associated impacts. Through collaborations with local municipalities and watershed conservation organizations, such as the Lower Merion Conservancy and the Guardians of the Brandywine, students are able to ask questions of environmental significance while gaining real-world problem solving experience.

Climate Change, Hazards, and Societal Impacts, Dr. Stephen Strader

Over the last half-century, the frequency and magnitude of environmental disasters and losses have been increasing due to a combination of natural and societal factors. Recent weather-related disasters such as Hurricane Sandy and the 2011 Joplin, MO tornado are reminders of the devastating consequences often associated with some of nature's most intense phenomena. Modern climate modeling and Geographic Information Science (GIScience) techniques have promoted spatiotemporal examinations of changes in environmental hazard impacts on society. The Northeast U.S., specifically the Boston-New York-Philadelphia-Washington D.C. I-95 corridor, is subject to a number of atmospheric and environmental hazards such as tropical storms, inland flooding, tornadoes, winter storms, heat waves, erosion, etc. Students investigating questions related to these research themes will be provided the opportunity to share their findings with local and regional stakeholders, decision makers, and the public.

The Environmental Security Index: Linking Environmental Change and Violent Conflict, Dr. Francis Galgano

Since the end of the Cold War, linkages between the environment, regional stability, and conflict—that is, environmental security—have become an important paradigm in security planning and policy. The concept of environmental security has emerged as one basis for understanding conflict and global security. This project is a quantitative analysis of processes (e.g., climate change) and factors (e.g., demographics) that occur at the nexus of the human and natural landscape and represents an interdisciplinary blend of policy, geography, and environmental science. However,

we have no overarching sense of which environmental scenarios will lead to conflict in the future. For this reason we are developing a vulnerability index to quantitatively evaluate the relative stability of states and regions, and thus provide a quantifiable index to determine states at risk and potentially predict the tipping point at which a country or region devolves into environmental–triggered conflict.

Environmental Stressors in Marine Ecosystems, Dr. Lisa Rodrigues

Marine environments and the organisms that live in them are impacted by various natural and human-caused stressors, including increased temperature, sedimentation, and pollution. In the Rodrigues Laboratory, research focuses on understanding the impacts of these environmental stressors on marine systems. Students can investigate questions that fit this theme along the northeast coastline and/or in controlled tank experiments at Villanova University.

Interactive Effects of Carbon, Nitrogen and Fire in Peatlands of Northern Alberta, Canada, Dr. Kel Wieder (Dept. of Biology) & Dr. Melanie Vile

Successional development of peatland recovery post fire. Large scale field manipulations are being conducted to determine the impact of pollution on peatland carbon sequestration. Additionally, the role of biological nitrogen fixation in moderating fluxes of methane from peatlands is being investigated. This project is funded by the National Science Foundation.

Mapping and Modeling Ecosystem Service in Social-Ecological Urban Systems, Dr. Peleg Kremer

As urbanization expands, city planners and policymakers need to consider how ecological resources can be strategically developed and sustainably managed to meet the needs of urban populations. Understanding the dynamics of urban ecosystem services is a necessary requirement for adequate planning, management, and governance of urban green infrastructure. Research in this area is focused on the development of models and tools for the spatially explicit quantification of multiple ecosystem services in urban areas. Students interested in this area will engage in theoretical, conceptual and empirical investigations of urban ecosystem services and the comparative analysis of supply, demand and spatial distribution of urban ecosystem services.

Peatlands as Archives of Atmospheric Pollution, Dr. Melanie Vile

Pristine boreal peatlands in northern Alberta, Canada in the absence of anthropogenic disturbance (left) and after severe disturbance as a result of mining operations in peatlands to extract the Oil Sands Resource (right). Historical rates of heavy metal deposition in peat cores that span 150 years and are located in the heart of the Oil Sands Mining Resource (OSMR) of northern Alberta are being determined. Additionally, the effect of increasing nitrogen pollution from the OSMR in a variety of peatland sites across northern Alberta is an active area of research

River Inputs to Nearshore Coral Reefs in Puerto Rico, Dr. Lisa Rodrigues & Dr. Steven Goldsmith

Rivers transport excess nutrients, sediments, and other pollutants from land to the coast causing both acute and chronic stress to coral reef ecosystems. Although these conduits of delivery are well

understood, establishing riverine pollutant thresholds that directly impact coral reef health has remained elusive. To address this problem, dry- and wet-season analyses of river pollutants and associated measurements in nearshore coral reef health in the Guánica region of Puerto Rico are being conducted. In particular, the project seeks to (1) quantify total maximum daily load values for each pollutant throughout the system to discern the threshold for acute stress on coral health; (2) identify point source impacts and mitigation success of existing riparian buffers; and (3) identify the timing of land use thresholds that triggered chronic stress in the past. These efforts are designed to support effective watershed management and healthy coral reef ecosystems. This study is funded by the National Fish and Wildlife Foundation.

Sea-Level Rise and Sediment Supply in Coastal Systems, Dr. Nathaniel Weston

Tidal marshes are productive ecosystems that provide key services to society such as carbon sequestration, storm surge buffering, and water-quality mitigation. The long-term stability of coastal wetlands is explained by interactions among sea level, plant growth, sediment supply, and wetland accretion, but current stability is being threatened by land use change and accelerating rates of sea-level rise. The goals of this study are (1) to understand how past and current land use in watersheds that drain the east coast of the United States has altered sediment concentrations in rivers; (2) to determine how changes in sediment supply influence sediment accretion rates in coastal wetlands; and (3) to project future wetland vulnerability along the east coast under various scenarios of sea level rise and sediment supply. The project is funded by the National Science Foundation.

Structure of Urban Landscapes and Ecological Function, Dr. Peleg Kremer

Defining landscape structure and key relationships between landscape structure and function is challenging in urban areas characterized by patchy spatial patterns. To trace the spatial and temporal patterns of urban landscape structures, compare patterns across cities, or inform urban design principles, we need to classify the landscape in a way that captures context and landscape heterogeneity, while being broadly applied across different cities or landscape variations within a city. This project is focused on the development of urban landscape classifications and the relationship among urban structure, environmental indicators, and ecological function. Students interested in this research will develop GIS and remote sensing data and models for analysis of urban structure, environmental and ecological indicators, and statistical modeling of the relationship among them. Current case studies include NYC and Philadelphia in the United States and Berlin and Leipzig in Germany.

Urban Vacant Land as a Common Good Resource: Potential and Transformation, Dr. Peleg Kremer

Vacant land is a common condition in urban areas across the globe. While not consistently defined or systematically tracked in all cities, existing estimates indicate that vacant land often comprises substantial portions of urban land area. In US cities with populations greater than 250,000 people, the proportion of vacant land has varied between 12.5 and 15% of total land area since the 1950s. Vacant lots may be viewed as places in the urban landscape that serve community needs or hold opportunity for land use transformations, contributing to community development and providing

ecosystem services that support community health and well-being. Vacant land may also be seen as a structural phenomenon, inherent in urban economies and essential to some urban communities. This research project is focused on the practice of vacant land transformation for the public uses. Students interested in this area will conduct field work including surveys, interviews of participants in urban vacant land transformation, and spatial measurements in urban gardens and vacant lots.

Water Quality Impacts of Natural Gas Extraction from the Marcellus Shale, Dr. Steven Goldsmith & Dr. Nathaniel Weston

Extraction of natural gas from the Marcellus Shale through horizontal drilling and hydraulic fracturing ("fracking") has raised significant environmental concerns, while providing economic benefits and a substantial source of domestic energy. Little data exist on the impacts of drilling and fracking on surface stream systems. To address these knowledge gaps, 30+ stream sites in the Susquehanna River basin in northeastern Pennsylvania have been sampled each summer since 2013. A suite of geochemical parameters, including major ions, trace elements, heavy metals, methane, radium, and nutrients will help evaluate changes in water quality over time and in relation to the natural gas extraction activities in each watershed. The goal of this research is to understand what impacts, if any, natural gas extraction activities have on surface waters to inform management and regulatory decisions. This project is funded by a Pennsylvania Sea Grant.