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## EARTH AND ENVIRONMENTAL SCIENCES (Ph.D.)

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*Executive Officer:* Professor Yehuda Klein

The Graduate Center

365 Fifth Avenue

New York, NY 10016

Email: [Ees@gc.cuny.edu](mailto:Ees@gc.cuny.edu)

URL: <http://web.gc.cuny.edu/Ees/home.html>

### **FACULTY (AS OF JULY 2009)**

Terence D. Agbeyegbe n Sean C. Ahearn n Samir A. Ahmed n Stephen Ukpabi Aja n  
Jochen Albrecht n Thomas Angotti n Teresa J. Bandosz n Sunil Bhaskaran n Jeffrey  
A. Bird n Brett F. Branco n Patrick W.G. Brock n Hannes E. Brueckner n Frank S.  
Buonaiuto Jr. n Anthony Carpi n John A. Chamberlain, Jr. n Zhongqi (Joshua) Cheng  
n Nicholas K. Coch n Harold C. Connolly, Jr. n Constantin Cranganu n Eric Delson n  
Timothy T. Eaton n Denton S. Ebel n Niles Eldredge n John J. Flynn n Joshua Fogel  
n Allan Frei n William J. Fritz n Stanley D. Gedzelman n Philip Gersmehl n Vinay  
Gidwani n Hongmian Gong n Cyrena Anne Goodrich n Yuri Gorokhovich n Kenneth  
Alan Gould n Jean Grassman n George E. Harlow n Roger Hart n David Harvey n  
Charles A. Heatwole n N. Gary Hemming n George R. Hendrey n Mohamed Babiker  
Ibrahim n Urs Jans n Cindi Katz n Patricia M. Kenyon n Reza Khanbilvardi n  
Yehuda L. Klein n Athanasios Koutavas n Nir Y. Krakaver n Neil H. Landman n Arthur  
M. Langer n Irene S. Leung n Setha M. Low n Allan Ludman n Z. Johnny Luo n  
Juliana A. Maantay n Shayesteh E. Mahani n Steven Markowitz n John Marra n  
Edmond A. Mathez n Cecilia M. McHugh n Jin Meng n Ines M. Miyares n Alfredo  
Morabia n Fred Moshary n Cherukupalli E. Nehru n Wenge Ni-Meister n Robert P.  
Nolan n Rupal Oza n Hari K. Pant n Marianna E. Pavlovskaya n Stephen F. Pekar n  
Deborah Popper n Wayne G. Powell n Federica Raia n Laxmi Ramasubramanian n  
Jennifer Richmond-Bryant n Alfred L. Rosenberger n Leonid Roytman n Randy L.  
Rutberg n Haydee Salmun n David Elihu Seidemann n John E. Seley n Heather Sloan  
n Neil Smith n William D. Solecki n Jeffrey C. Steiner n Gillian Meg Stewart n Karl-  
Heinz Szekielda n Marco Tedesco n Monica Weiler Varsanyi n John R. Waldman n  
William G. Wallace n Michael K. Weisberg n Margaret Anne Winslow n Chuixiang Yi n  
Pengfei Zhang n Yan Zheng n Sharon Zukin

For the most up-to-date faculty listings and specializations, see the program's Web site.

### **THE PROGRAM**

The Ph.D. Program in Earth and Environmental Sciences offers a wide array of research options with faculty specializations in Geography and Geological Sciences, with focuses on atmospheric sciences, geographic information sciences, geology, geochemistry, geophysics, human geography, hydrology, and physical geography. Many of these areas include environmental sci-

ence applications in ongoing projects. Besides faculty from Geology and Geography, the EES program includes faculty from Anthropology, Biology, Chemistry, Economics, and Engineering.

The Ph.D. Program in Earth and Environmental Sciences cooperates with the Civil Engineering Department at City College, the Center for the Analysis and Research of Spatial Information at Hunter College, and the American Museum of Natural History.

The Earth and Environmental Sciences program's two specializations are centered at one or more CUNY campus. The Geography specialization—including human geography, physical geography, geographic information science, and geographic education—is at Hunter College and at Lehman College. With regard to the Environmental and Geological Sciences specialization, geological sciences, including atmospheric sciences, is at The City College; geology is at Brooklyn College; and environmental geology is at Queens College. When applying for admission, applicants must specify the specialization (Geography or Environmental and Geological Sciences) for which they would prefer to be considered. All applications must be submitted to the Admissions Office at the Graduate Center.

All courses are offered through the Graduate Center. Most required courses and some special topics courses are conducted at the Graduate Center. Laboratory courses and research work are offered at the various campuses of the University.

#### ***En-route M.A.***

Upon completing 45 credits with an average grade of B, passing the First Examination, and satisfactorily completing a major research paper, the student may apply for an M.A. degree. The degree is awarded formally by one of the participating colleges.

#### **SPECIAL REQUIREMENTS FOR ADMISSION**

In addition to the requirements for admission stipulated by the University, applicants to the Earth and Environmental Sciences program are expected to have a minimum average of B in their undergraduate major. The program's Admissions and Awards Committee will consider exceptions to the above for candidates with other strengths. A high score on the Graduate Record Examination is necessary. The applicant is strongly recommended to have completed mathematics through calculus.

#### **SPECIAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY**

The following requirements are in addition to the University requirements stated earlier in this bulletin.

*Course of Study* The curriculum for all doctoral students in the Earth and Environmental Sciences program consists of a minimum of 60 graduate credits beyond the Baccalaureate degree, in addition to courses that may be deemed necessary to be taken to remedy undergraduate training deficiencies. Graduate transfer credits will be accepted subject to the rules pertaining to doctoral students as described in this bulletin.

#### ***THE SPECIALIZATION IN ENVIRONMENTAL AND GEOLOGICAL SCIENCES***

The Environmental and Geological Sciences specialization within the Ph.D. Program in Earth and Environmental Sciences offers research opportunities in a broad spectrum of Earth-

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focused science reflecting the research interests of the faculty – including topics of classical Geology; studies of Earth’s fluid envelopes; and applying combinations of geology, biology, chemistry, and physics to studying Earth’s diverse environments and their ecosystems. These are grouped into four mutually-supportive areas within which faculty expertise and state-of-the-art instrumentation support exciting scientific investigations:

- Atmospheric and Hydrological Sciences
- Terrestrial, Estuarine, and Marine Studies
- Earth Materials and Earth Processes
- Urban Environments and Public Health.

Modern research in Environmental and Geological Sciences commonly crosses the boundaries between these areas, e.g. isotope geochemists and biostratigraphers work with sedimentologists and climatologists to analyze paleoclimates over tens of millions of years; bedrock geologists work with geochemists and hydrogeologists to understand arsenic concentration in groundwater drinking supplies. Our program is designed to emphasize such linkages. A full range of research facilities is available within CUNY, and in addition, students may work at organizations and institutions, such as Brookhaven National Laboratory, the American Museum of Natural History, Lamont-Doherty Earth Observatory, with which our faculty are affiliated.

### ***Core Areas in the Environmental and Geological Sciences Specialization***

#### ***Atmospheric and Hydrological Sciences***

Students with a primary interest in the two fluid envelopes that support life on Earth will find research opportunities in the Atmospheric and Hydrological Sciences area of concentration. CUNY faculty members are leaders in studies of weather, climate and hydrology. Current research addresses topics such as storms, droughts, hurricanes, flooding, groundwater depletion and contamination, and their impacts on society. Recently identified trends in the atmosphere, cryosphere and hydrosphere indicate that anthropogenic climate changes now underway will profoundly alter terrestrial and marine hydrological systems with uncertain consequences for humanity. Our studies in paleoclimatology not only help with understanding the Earth’s climate history, but also can provide clues to what the future holds in store. Current research projects include: development of the history of hurricanes, isotope distributions within hurricanes, remote sensing of atmospheric pollutants, surface enhanced zeolites in groundwater treatment facilities, and paleoclimates recorded in the sediments below Antarctic ice shelves

#### ***Terrestrial, Estuarine and Marine Studies***

The Terrestrial, Estuarine and Marine Studies (TEMS) specialization is designed for students interested in a wide range of environmental sciences encompassing both basic and applied research. TEMS research emphasizes physical, biological, geochemical and ecological interactions. TEMS offers opportunities for research in one of the world’s most densely populated areas, including impacts of urbanization, climate change and invasive species on a variety of areas such as Long Island Sound and of the Hudson River Estuary. World-wide, studies include: impacts of changing atmospheric chemistry on forests of the Upper Mid-west; global change and the intensification of Gulf hurricanes; the role of post-glacial climate change and rising sea

level in the flooding of Eurasian inland seas; arsenic contamination of South Asian water supplies; and many other topics.

### ***Earth Materials and Earth Processes***

Society has become increasingly aware of the importance of geologic constraints on a sustainable economy within a stable and healthy environment. Topics in this core area have traditionally resided in classically oriented Geology programs but are increasingly incorporated in modern, broad-spectrum studies of urban and rural environments. Such studies offer insights into the foundations of Earth's varied environments and evidence from the past as to the nature and rate of environmental change. Doctoral studies can be done in mineralogy and petrology; sedimentology and stratigraphy; paleontology and paleoecology; tectonics; geomorphology; geochemistry; geochronology; seismology and other areas of geophysics; and resource exploration and development. Such work not only advances the frontiers of these disciplines but also improves our understanding of the factors controlling environment and environmental change. Ongoing research includes studies on: tectonic evolution of the Appalachian and Caledonide orogens; deformation mechanisms in ductile and brittle fault systems; geothermometry and geobarometry; fluvial, eolian, glacial, and coast erosion and deposition; and evolutionary paleobiology of sharks.

### ***Urban Environments and Public Health***

Epidemics, tsunamis, earthquakes, volcanism, storms, and their prediction and effects on urban societies have become a subject of intense concern. The Urban Environment and Public Health core area focuses on these and other environmental, geological, and geomedical aspects of urban life. The Graduate Center's unique location in the heart of one of the world's largest urban areas insures that students interested in contributing to improvement in urban life, in the health of urban populations and the preservation of natural ecosystems in urban settings will find unexcelled opportunities at CUNY. Current research in this core area includes studies of: the effect of New York City power station effluents on fish populations; monitoring of heavy metal and organic compounds in benthos/bottom sediment/water in New York City estuaries; repopulation of native species in New York coastal waters; the epidemiology and risk assessment of asbestos, arsenic, silica, talc, polychlorinated biphenyls, and cigarette smoke in human populations.

### ***Curriculum Requirements for the Environmental and Geological Sciences Specialization***

Within their first semester, incoming students are expected to consult with their prospective advisor(s) and devise a personal program of study to acquire command over the skills and methods needed to work in their proposed area of research.

Course work in the Specialization includes the following required courses:

1. EES 71500; Research Opportunities in Environmental and Geological Sciences (1 credit, first semester).
2. EES 71600; Earth Systems I: Origin and Evolution of Earth and Life (3 credits, first semester).
3. EES 71700; Earth Systems II: Earth's Energy Networks (3 credits, second semester).
4. EES 70400; The Nature of Scientific Research (2 credits, second year)
5. EES 80200 Advanced Research Seminar (1 credit, third year).

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### ***Requirements for the Environmental and Geological Sciences Specialization***

From the first stages of matriculation, the student directs his/her program toward the desired research specialization. The major steps occur in the following order: First Examination, Second Examination, Oral Defense of the Dissertation Proposal, Oral Defense of the Dissertation.

*First Examination* The examination is a written and oral examination administered by the Environmental and Geological Sciences Curriculum Committee following the student's successful completion of at least 15 course credits including the following requirements:

A. The three first-year core courses (EES 702, EES 716, EES 717)

B. At least two other graduate-level courses in at least one of the four Environmental and Geological Sciences Subdivisions: Atmospheric and Hydrologic Sciences; Earth Materials and Earth Processes; Terrestrial, Estuarine, and Marine Studies; and Urban Environments and Public Health.

The written part of the first exam will consist of an open-book, take-home exam. The questions will be prepared by members of the Environmental and Geological Sciences Curriculum Committee, based on the content and selective sets of readings for each core course and area of specialization selected by the student. Students will be expected to provide substantive responses to several essay questions, with citations and references to all the salient literature. The committee, following a short period to review the written examination, will meet with the student's and have the opportunity to ask follow-up questions, based on their written responses. The grade (pass/fail) will be based on the student's performance on both the written and oral examinations. A student who fails all or part of the written or oral examinations will be given one opportunity to retake those parts of the examination, no more than 12 months after the original examination.

Upon satisfactory completion of the First Examination, the student selects his/her dissertation committee. This committee sits with the student and selects those additional courses that are relevant to the area of dissertation research. The committee recommends whether or not the student must pass a specific foreign language examination. In consultation with the student, the committee selects an area to test the student's computer proficiency.

*Second Examination* The Second Examination involves the submission and defense of a proposal describing the dissertation research planned by the student. A dissertation committee, comprising a minimum of three members of the doctoral faculty, is appointed to assist the student in preparing for the Second Examination.

*Oral Defense of the Dissertation Proposal* The dissertation proposal must be written in an acceptable research-journal format, and presented to the student's Dissertation Committee for a critical review of content. Dissertation Committee must receive the Proposal at least two weeks prior to the scheduled Second Examination. The Second Examination is an oral examination conducted by the Dissertation Committee during which the student describes and defends all aspects of his/her proposal. The student must be able to explain his/her research in the context of the historical development of the research discipline; relate his/her project to ongoing research in his/her field, and must demonstrate a thorough command of the literature relevant to the research. Normally, the Second Examination takes place upon completion of 60 credits, and requires approximately 2 hours.

The Dissertation Committee will require that the student rectify any errors in the research plan or address specific inadequacies in the literature review through a retake of all or a portion of the exam as specified by the Dissertation Committee no more than 12 months from the date of the first attempt.

*Oral Defense of the Dissertation*

**THE GEOGRAPHY SPECIALIZATION**

The Geography specialization within the Ph.D. Program in Earth and Environmental Sciences at the City University of New York provides an opportunity for doing geographical doctoral studies in one of the world's largest and most dynamic metropolitan locations. The doctoral program aims to provide students with modern training in the discipline of Geography. Given the strengths and interests of the faculty, a focus on the environment, in the broadest sense of that term, animates much of the programmatic work and provides a bridge among specialized concentrations. The specialization has five core areas: Urban and Regional Dynamics, Physical Geography, Geography and Social Theory, Geographic Information Science, and Geographic Education. These areas are not construed as mutually exclusive but as overlapping and interactive. Many faculty members participate in more than one core area, and students are encouraged to do likewise. Students are permitted to combine courses from the Geography specialization with the Geosciences specialization. They are also encouraged to take courses in related disciplines — particularly those such as Anthropology, Environmental Psychology, and Women's Studies — that house faculty with connections to geography to round out their educational experience. Through the Interuniversity Doctoral Consortium, it is possible to take courses at other institutions such as Columbia, New York, New School, and Rutgers universities.

Faculty members associated with the Geography specialization, based primarily at Hunter and Lehman colleges and at the Graduate Center, pursue interests in their own areas utilizing a variety of methods. A primary objective of the Geography specialization as a whole, however, is to utilize the urban laboratory of the New York metropolitan region as a catalytic framework to bring diverse threads of geographic research together in a collective and interactive effort. An attempt has been made to remove some of the artificial barriers that have traditionally developed between areas within the discipline of Geography. While a focus on the relations between urbanization and environmental issues seems particularly appropriate, many other combinations of research are possible. For example a student is able to combine geographic information science with urban theory, coastal geomorphology with urban hazards, social theory with a critical approach to geographic knowledge, theories of uneven geographic development with urban studies, migration studies with regional development, or geographic education with a focus on children's geographies.

Helping to facilitate these cross-specializations are a number of research centers housed within the program including the Center for the Analysis and Research of Spatial Information, the Center for Urban Coastal Processes, and the Center for Geographic Education. The Center for Place, Culture, and Politics, the Center for Human Environments, and the Bildner Center for Western Hemisphere Studies at the Graduate Center also engage with themes of interest to students within the Geography specialization.

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While there is an emphasis on using the New York metropolitan area as a laboratory for training and research, faculty with considerable expertise are actively engaged in a wide range of regional and global issues (Africa, Asia, Latin America, Europe as well as North America). This permits local issues to be placed in a global perspective and facilitates cross-cultural and comparative work. Given the wide range of techniques and methods deployed by faculty, there is also an emphasis on maintaining the diversity of approaches and of methodologies that gives so much strength to the program. Our aim is to promote diversity and to ensure open conversation, communication, and collaboration across different traditions

Course requirements are kept to a minimum. Each student, in consultation with key faculty, can look forward to designing a tailor-made educational program to satisfy his or her own needs. We are committed to fostering a strong sense of Geography as a community of interests working over a wide range of topics armed with an equally wide range of methodologies.

### *Core Areas in the Geography Specialization*

#### *Urban and Regional Dynamics*

A focus on urban/regional geography flows naturally from the location of the CUNY Graduate Center in the heart of Manhattan. One aim of this concentration is to combine a general understanding of the role of cities in regional, national, and international developments with deep analysis of the elements that make the city what it is — from built environments and transport systems, to an understanding of migration flows, ethnic, and religious differentiations, to the cultural uses of space and the transformation of patterns of urban daily life. Theories of the urban process and of the political economy and political ecology of urbanization are emphasized. The overlap between the understanding of physical processes and of urbanization generates a strong interest in the issue of sustainable urban development and the environmental impacts of urbanization in relation to such issues as climate change and urban health. The other aim is to understand the dynamics of interregional and interurban relations in their global context. Within those settings, modeling of transportation systems, optimal locational arrangements, and studies in the optimal organization of governance and administration are brought into contact with detailed inquiries into migration flows, social differentiation, retail arrangements, gentrification, consumption patterns, urban and regional health, financial services, the role of philanthropic institutions and NGOs, practices of governance, urban and regional social movements, and the evolution of everyday life within the matrix of urban/regional economies and cultures. Many of the issues taken up in geography and social theory — such as the production of space and questions of race, gender, class, and ethnic differentiations — are appropriately examined in their urban and regional settings.

#### *Physical Geography*

Studies of the physical environment, at all spatial and temporal scales, have always been important. In the context of environmental problems facing humanity in the twenty-first century, an appreciation of the earth system, including all its components and their interactions, is even more critical. To understand, mitigate, and/or adapt to any significant environmental problem, from urban pollution to global climate change, an interdisciplinary approach including aspects of physical science working in conjunction with other disciplines is usually essential. Faculty members are conducting research in a diverse array of fields, including cli-

matology, geology, atmospheric sciences, oceanographic sciences, and remote sensing of the earth's environment. Research projects focus on subdisciplines such as geochemistry, paleoclimate, land-surface interactions, hydrology, climate change, and cryospheric studies. Students are encouraged to avail themselves of opportunities to work on research projects with CUNY faculty, as well as with experts from other institutions. Many students are currently working in one of our active laboratories, including a geochemistry laboratory, a computer-based environmental geosciences laboratory, and a climate laboratory. A program exists for students to work as paid interns with the U.S. Army Corp of Engineers, where they participate in research on problems involving coastal processes. In addition, our students have participated in the NOAA-CREST (National Oceanic and Atmospheric Administration's Cooperative Remote Sensing Science and Technology Center) program, of which CUNY is one of the lead institutions. NOAA-CREST is a partnership between government, academe, and industry to conduct research consistent with NOAA's missions of environmental assessment, prediction, and stewardship using a variety of modern techniques.

### ***Geography and Social Theory***

Studies in geography and social theory are designed to alert students to the overlaps between geography and other knowledge systems in the physical and social sciences as well as in the humanities. Students are encouraged to explore the intersections between geographical work and feminist theory, cultural studies, postcolonial theory, political economy, political ecology, and critical theory. Geographical approaches to fundamental concepts such as place, region, space, environment, and nature are highlighted. Critical geography seeks actively to reshape geographic concepts and geographic work in relation to general political, social, and environmental concerns. Issues of gender, class, race, and sexuality, particularly though not only in relation to geographically achieved identities (place, neighborhood, community, region, nation), are foci of concern. Critical and constructive reflection is encouraged on geographical modes of representation such as cartography and GIS as well as on technical and political issues such as the scale problem within geographic research. Applied work attempts to build on a general understanding of variegated processes of uneven geographic development at all scales — micro, local, urban, regional, and global — as a way to understand topics such as global/local relations, locational conflicts, environmental justice, production and reproduction, regionalism and nationalism, imperialism and neocolonialism, resource utilization, as well as ecological and environmental issues at a variety of scales. While regional specialization is encouraged it is not required.

### ***Geographic Information Science***

Geographic information science deals with the development and applications of the concepts, principles, models, methods, and technologies for gathering, processing, and analyzing geographically referenced data and effectively communicating the derived information to scientists, engineers, legislators, managers, and the general public for judicious and timely spatial decision-making. The Ph.D. Program in Earth and Environmental Sciences focuses on the three core geographic information technologies: Geographic Information Systems, Global Positioning Systems, and Remote Sensing. The program covers the theoretical aspects, technical issues, and a wide range of applications. Particular emphasis is placed on the representation, visualization, and communication of spatial information; models, algorithms, and methodologies for

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efficient extraction of spatial information from remotely sensed data; spatial statistics and analysis; collaborative spatial decision-making; and innovative applications of geographic information technologies in environmental and resource management, urban and regional planning, international development, public safety, human health, and policy analysis.

### ***Geographic Education***

Geographic education is becoming an increasingly important aspect of geographic training. The need for geographic education is provided by recent education reform. In 1994 the Educate America Act formalized the national education standards movement and identified geography as a key subject area. Subsequently, the New York State Education Department adopted virtually verbatim the National Geography Standards and revised the scope and sequence of its social studies and earth science curricula to ensure that geography is taught and tested at various points in the K–12 years. This program offers a critical perspective on the fields of children’s geographic and environmental learning and education. Together with course offerings from Environmental Psychology, Developmental Psychology, Urban Education, Anthropology, and Sociology, this area offers broad and critical coverage of the geographic learning and education of children and youth. Students in this area will have the opportunity to work with the faculty and staff of the Hunter College Center for Geographic Learning, whose functions include:

- Promoting interaction between schools, departments, and individuals involved in geographic education at Hunter College;

- Coordinating the scheduling and staffing of courses relevant to Hunter’s geographic education curricula;

- Partnering with the teachers’ union, school districts, and superintendencies to offer teacher training and staff development;

- Working with personnel from the Center for the Analysis and Research of Spatial Information (CARSI) to develop that facility’s resources for educational use;

- Facilitating grant writing aimed at promoting geographic education at all levels (K–University);

- Building working relationships with schools in the general vicinity of Hunter College; and Developing geographic materials for classroom use.

### ***Curriculum Requirements for the Geography Specialization***

Incoming students are expected to consult with their prospective adviser(s) and devise a personal program of study to acquire command over the skills and methods they need to work in their proposed area of research within their first semester. If courses for specific skills and methods are not available within the program, students will be encouraged to seek the necessary instruction elsewhere. The core course work includes the following requirements.

1. EES 71100 Introductory Workshop in Academic Resources (no credit) All students will take a noncredit intensive introductory workshop in the first weeks of the first semester introducing them to academic resources (libraries), IT facilities, and how to use the opportunities for research in the metropolitan area efficiently and well.

2. EES 70900 Geographical Thought and Theory (3 credits, first semester) This course explores the foundations of geographical knowledge. The course situates the history of geo-

graphical thought in its broad philosophical and historical context. Topics may include themes such as the concept of nature (incorporating scientific, anthropological, historical, and humanistic perspectives), questions of technology and society (with particular emphasis on technologies of geographical enquiry and representation — for example, cartography to geographic information science, remote sensing, statistics); how to think about basic geographical concepts such as space, place, region, and environment in historical perspective; and examination of the relations between geographical knowledge and political power.

3. EES 71200 Geographical Knowledge in Action (3 credits, second semester) This integrated course takes the form of an investigative workshop in which students and faculty collaborate in the examination of a specific geographic problem using the New York metropolitan region as a focus for study. Students with different research interests will here be encouraged to integrate their skills (along with those of participating faculty) in studying a general problem in an integrative way. Research seminars will bring in outside experts to look at different facets of a common problem.

4. EES 70400 The Nature of Scientific Research (3 credits, first year) This course is designed to introduce first-semester students in the Ph.D. Program in Earth and Environmental Sciences to the principles of scientific inquiry. Following a broad overview of the epistemological foundations of the sciences, we compare and contrast the nature of explanation in the historical sciences (biology and geology), experimental sciences (physics and chemistry) and social sciences. We will discuss in detail the mix of quantitative and qualitative methods that are appropriate to each of these fields of inquiry. Finally, we explore ethics in scientific research. We will go beyond the issues of fabrication, falsification and plagiarism to look at the broader responsibilities of the researcher to her (his) research subjects, co-authors, mentor / mentee, scientific community, and society at large.

5. EES 80200 Dissertation Proposal Workshop (3 credits). This seminar is designed to teach students how to write a dissertation proposal, prepare grant proposals, and present ideas in a seminar setting. The student is required to formulate a dissertation proposal under the supervision of the student's mentor and the instructor. Permission of the dissertation advisor and instructor is required.

### ***Requirements for the Geography Specialization***

From the first stages of matriculation, the students direct their program toward their desired research specialization. The major steps occur in the following order: First Examination, Second Examination, Oral Defense of the Dissertation Proposal, Oral Defense of the Dissertation.

*First Examination* A written and oral examination is administered by the Geography First Examination Committee, comprising members of the doctoral faculty in Geography, following the student's successful completion of between 18 and 24 course credits including the following requirements:

- A. The three first-year core courses
- B. A methods course directed to the student's specific needs
- C. At least one graduate-level course in each of the following areas: Geographic Education, Geographic Information Science, Geography and Social Theory, Physical Geography, Urban Regional Dynamics

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Note: A student who has taken any of the required courses in section A or B in a master's program or equivalent may test out of the course by taking the course final examination. The written component of the first exam will be an open-book, take-home exam. The questions will be prepared by members of the Geography First Examination Committee, based on selective sets of readings for each core course and area of specialization. Students will be expected to provide substantive responses to several essay questions, with citations and references to all the salient literature. The committee, following a 1-2 week period to review the written examination, will meet with the student and have the opportunity to provide feedback and ask follow up questions, based on the written responses. The grade (pass/fail) will be based on the student's performance on both the written and oral examinations. A student who fails all or part of the written or oral examinations will be given one opportunity to retake those parts of the examination, no more than 12 months after the original examination.

*Second Examination* The Second Examination involves the submission and defense of a proposal describing the dissertation research planned by the student. A dissertation committee, comprising a minimum of three members of the doctoral faculty, is appointed to assist the student in preparing for the Second Examination.

*Oral Defense of the Dissertation Proposal* The dissertation proposal must be written in an acceptable research-journal format, and presented to the student's Dissertation Committee for a critical review of content. The Dissertation Committee must receive the Proposal at least two weeks prior to the scheduled Second Examination. The Second Examination is an oral examination conducted by the Dissertation Committee during which the student describes and defends all aspects of his/her proposal. The student must be able to explain his/her research in the context of the historical development of the research discipline; relate his/her project to ongoing research in his/her field, and must demonstrate a thorough command of the literature relevant to the research. Normally, the Second Examination takes place upon completion of 60 credits, and requires approximately 2 hours.

The Dissertation Committee will require that the student rectify any errors in the research plan or address specific inadequacies in the literature review through a retake of all or a portion of the exam as specified by the Dissertation Committee no more than 12 months from the date of the first attempt.

*Oral Defense of the Dissertation*

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## Courses

Students will be permitted to register for courses appearing in either specialization providing they meet the necessary prerequisites of the course or receive permission from the faculty member teaching the course. These course names and numbers are subject to change based on recent revisions in the program; see the program's Web site above.

EES 70100\* Advanced Principles of Physical Geology

*3 hours lecture, 3 hours laboratory, field trips, 4 credits*

EES 70200\* Advanced Principles of Historical Geology

*3 hours lecture, 3 hours laboratory, field trips, 4 credits*

- EES 70300 Introduction to Mapping Science  
*1 hour lecture, 3 hours laboratory, 3 credits*
- EES 70400 The Nature of Scientific Research  
*2 hours, 2 credits*
- EES 70500 Earth's Internal Processes  
*2 hours lecture, 2 hours laboratory, 3 credits*
- EES 70600 Earth's Surface Processes  
*2 hours lecture, 2 hours laboratory, 3 credits*
- EES 70700 Human Geography  
*3 hours lecture, 3 credits*
- EES 70800 Time, Life and Global Change  
*2 hours lecture, 2 hours laboratory, 3 credits*
- EES 70900 Geographic Thought and Theory  
*30 hours lecture, 3 credits*
- EES 71000\* Structural Geology  
*75 hours, 4 credits*
- EES 71100 Introductory Workshop in Academic Resources  
*5 hours, 0 credits*
- EES 71200 Geographical Knowledge in Action  
*45 hours, 3 credits*
- EES 71400 Introduction to Geophysics  
*30 hours lecture and 45 hours laboratory or 15 hours recitation, 3 credits*
- EES 71500 Research Opportunities in Environmental and Geological Sciences  
*30 hours, 1 credit*
- EES 71600 Earth Systems I: Origin and Evolution of Earth and Life  
*45 hours, 3 credits*
- EES 71700 Earth Systems II: Earth's Energy Networks  
*45 hours, 3 credits*  
*Prerequisite: EES 71600*
- EES 72000 Mineralogy  
*30 hours lecture and either 15 hours recitation or 30 hours laboratory, 3 credits*  
Prerequisites: One year of college physics and calculus through differential equations or permission of instructor
- EES 72300\* The History and Philosophy of Geology  
*45 hours lecture, 3 credits*  
*Prerequisites: Matriculation to the EES Ph.D. Program or EES 70100 and 70200*
- EES 72400\* Igneous Petrology  
*30 hours lecture, 45 hours laboratory, 3 credits*
- EES 72600\* Metamorphic Petrology  
*30 hours lecture, 45 hours laboratory, 3 credits*
- EES 73000 Paleontology of the Invertebrates  
*75 hours, 4 credits*
- EES 73600\* Stratigraphic Palynology  
*60 hours (2 hours lecture, 2 hours laboratory), 3 credits*

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- EES 74000 Sedimentology  
*75 hours (30 hours lecture, 45 hours laboratory), 3 credits*
- EES 74200 Stratigraphy  
*60 hours (2 hours laboratory, 2 hours lecture), 3 credits*
- EES 74300\* Sedimentary Petrology  
*30 hours lecture, 45 hours laboratory, 3 credits*
- EES 74400\* Environmental Geology  
*75 hours, 3 credits*
- EES 74500 Hydrology  
*30 hours lecture, 30 hours problem sessions and recitation, 3 credits*
- EES 74600 Groundwater Hydrology  
*30 hours lecture, 30 hours problem sessions and recitation, 3 credits*
- EES 74700\* Coastal and Estuarine Geology  
*30 hours lecture, 30 hours laboratory, field trips, 3 credits*  
*Prerequisites: EES 70100 or permission of instructor*
- EES 74800 Environmental Geology of the Coastal Zone  
*30 hours lecture, 30 hours laboratory, field trips, 3 credits*  
*Prerequisites: EES 74700 or permission of instructor*
- EES 74900 Quantitative Methods in Earth and Environmental Sciences  
*45 hours lecture, 45 hours laboratory, 3 credits*
- EES 75000 Computer Applications in Earth and Environmental Sciences  
*2 hours lecture, 4 hours laboratory, 4 credits*  
*Prerequisites: An introductory college level course in computer programming (Basic, Fortran, Pascal, or C) or equivalent programming skill*
- EES 75100 Introduction to Geographic Information Systems  
*45 hours, 3 credits*
- EES 75200 Principles of Remote Sensing  
*45 hours, 5 credits*
- EES 75300\* Topographic Field Mapping  
*2-3 weeks, full time, 3 credits, offered during summer*
- EES 75400 Environmental Conservation  
*45 hours, 3 credits*
- EES 75500 Digital Image Processing  
*30 hours lecture, 60 hours laboratory, 4 credits*
- EES 75600 Coastal Dynamics  
*36 hours lecture, 8 hours laboratory, 3 credits, field trips*  
*Prerequisites: EES 70100 or permission of instructor*
- EES 75700 Environmental Problems of Urban and Metropolitan Coasts  
*45 hours lecture, 3 credits, field trips*  
*Prerequisites: EES 75600 or permission of instructor*
- EES 75800 Introduction to Environmental Modeling  
*30 hours, 3 credits*
- EES 75900: Multivariate Statistical Analysis in Geography  
*30 hours, 3 credits*

- EES 76000 Advanced Cartography  
*15 hours lecture, 90 hours laboratory, 4 credits*
- EES 76100 Automated Cartography  
*15 hours lecture, 90 hours laboratory, 4 credits*
- EES 76200\* Photogrammetry and Air Photo Interpretation  
*30 hours lecture, 60 hours laboratory, 4 credits*
- EES 76300\* Geological Applications of Remote Sensing  
*60 hours, 3 credits*
- EES 76400 Advanced Quantitative Methods in Earth and Environmental Sciences  
*45 hours, 4 credits*
- EES76500 Urban Application of GIS  
*30 hours, 3 credits*
- EES 77000 Principles of Geochemistry  
*45 hours, 3 credits*
- EES 77100 Geobiochemistry of Soils  
*30 hours lecture, 3 credits*  
*Prerequisites: EES 70100 or permission of instructor*
- EES 77300\* Low Temperature Geochemistry  
*3 hours (lecture), 3 credits*  
*Prerequisite: EES 77000 or permission of instructor*
- EES 77400\* Physical Geochemistry  
*45 hours, 3 credits*
- EES 77500\* Industrial Mineralogy  
*30 hours lecture, 3 credits*  
*Prerequisites: EES 70100 or permission of instructor*
- EES. 77600 Climate and Climate Change  
*3 hours lecture plus 2 hours laboratory, 4 credits*  
*Prerequisites: EES. 70100 or permission of instructor*
- EES 78000 Economic Geography  
*30 hours, 3 credits*
- EES 78100 Urban Geographic Theory  
*30 hours, 3 credits*
- EES 78200 Population Geography  
*30 hours, 3 credits*
- EES 78600 Latin Americanist Geography  
*30 hours, 3 credits*
- EES 79900 Special Topics in Earth and Environmental Sciences  
*15-60 hours, 1-4 credits*
- EES 80000 Geology Seminar  
*15 hours, 1 credit*
- EES 80100\* Environmental Science Seminar  
*15 hours, 1 credit*
- EES 80200 Advanced Research Seminar  
*15 hours, 1 credit*

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- EES 80500 Independent Study  
*Credits variable, 1 or more credits per semester*
- EES 81000 Research for the Doctoral Dissertation  
*Credits variable, 1 or more credits per semester*
- EES 82000\* Special Topics in Stratigraphy  
*45 hours, 3 credits*
- EES 82010\* Stratigraphic Dating and Correlation  
*45 hours, 3 credits*
- EES 82020 Facies Analysis  
*45 hours, 3 credits*
- EES 82100\* Special Topics in Paleoclimatology and Paleoceanography  
*45 hours, 3 credits*
- EES 82200\* The Cenozoic Oceanographic Record as a Predictive Base  
*30 hours lecture and 15 hours recitation or 45 hours laboratory, 3 credits*  
*Prerequisites: Graduate courses in marine geology and stratigraphy or permission of instructor*
- EES 82500\* Special Topics in Paleontology  
*45 hours, 3 credits*
- EES 82501\* Special Topics in Paleontology: Paleobiomechanics  
*45 hours, 3 credits*
- EES 83000 Special Topics in Geochemistry  
*45 hours, 3 credits*
- EES 83100 Special Topics in Environmental Geology  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 83200\* Seminar on Urban Coastal Management  
*3 hours, field trips, 3 credits*  
*Prerequisites: EES 74800 or permission of instructor*
- EES 84000\* Special Topics in Mineral Resources  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 84500 Special Topics in Hydrology  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 84900\* Special Topics in Quantitative Geology  
*45 hours lecture, 3 credits*
- EES 85100 Carbonates and Evaporites: Sedimentology  
*3 hours laboratory, 3 hours lecture, field trips, 4 credits*  
*Prerequisites: A course in sedimentology or stratigraphy or sedimentary petrology or permission of the instructor*
- EES 85200\* Carbonates and Evaporites: Petrology  
*3 hours laboratory, 3 hours lecture, field trips, 4 credits*  
*Prerequisites: EES 85100 and knowledge of the petrographic microscope*
- EES 86000\* Special Topics in Igneous and Metamorphic Petrology  
*45 hours, 3 credits*

- EES 86001\* Applications of Igneous and Metamorphic Petrology to Regional Tectonic Problems  
*45 hours, 3 credits*
- EES 86100\* Special Topics in Mineralogy  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 86500\* Special Topics in Sedimentology  
*30 or 45 hours, 2 or 3 credits*
- EES 87000\* Special Topics in Structural Geology  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 87100\* Special Topics in Tectonics  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 88500\* Special Topics in Remote Sensing  
*30 or 45 hours, 2 or 3 credits*  
*Prerequisite: Permission of instructor*
- EES 88600\* Seminar in Cartographic Research  
*45 hours plus conferences, 3 credits*  
*Prerequisites: Permission of instructor*
- EES 88700 Seminar in Remote Sensing  
*45 hours, 5 credits*
- EES 88800 Seminar in Geographic Information Systems  
*45 hours, 3 credits*
- EES 90000 Dissertation Supervision  
*1 credit*

\*offered infrequently