Proposed Change to an Existing Degree: Academic Component

Please answer all relevant questions below. Consultation with the appropriate Associate Provost on a draft of the proposal is recommended.

Using the relevant template, please submit a budget even if no additional resources are needed.

Title of Degree: Ph.D. in Earth & Environment

1. Please provide the name, title, email address, and phone number of the primary contact person for this academic program:

David Marchant  
Chair, Earth & Environment  
marchant@bu.edu  
617 353 3236

2. Please describe briefly the proposed change to the existing degree:

We propose to unify our two overlapping Ph.D. programs in Earth Sciences and Geography to form a single Ph.D. in Earth & Environment. Our revised Ph.D. would retain coursework in all disciplinary areas of the Department, and provide flexibility for pursuit of novel research at the interface of human-natural systems.

Background:

In 2012, the Earth Sciences Department (ES) and the Department of Geography & Environment (GE) merged to create the Department of Earth & Environment (EE). Prior to the merger, the two departments worked separately to provide BU and BU students with synergistic coursework and research opportunities centered on the study of planet earth. The Earth Sciences Department focused on surface processes, paleoclimate reconstructions, biogeochemistry, coastal/marine processes, and active tectonics. The Geography & Environment Department concentrated on climate change / climate assessment, remote sensing of global change, sustainability, and environmental policy & energy analysis.
At the time of the departmental merger, the unified department collectively administered six undergraduate degrees, two professional Master’s degrees, and two academic MA and Ph.D. degrees.

Our immediate efforts following the merger focused on curricular reform in our undergraduate and professional MA programs. We reduced our undergraduate degrees from six to two, and now offer distinct majors in (1) Earth & Environmental Sciences and (2) Environmental Analysis & Policy, both of which unite coursework in GE and ES. Our professional MA programs have also been modified and now include two highly focused, one-year programs in (1) Remote Sensing & Geospatial Sciences and (2) Energy & Environment.

At present, we seek to unify our overlapping Ph.D. programs in Earth Sciences and Geography, which are legacies of the merger, and form a unified Ph.D. in Earth & Environment. We envision the Ph.D. in Earth & Environment as a world-class program that builds upon our disciplinary strengths, bridges existing fields, and is fully aligned with emerging trends in Ph.D. programs and long-term, national research priorities.

3. Please provide a rationale for the proposed change to the existing degree:

An emerging global perspective challenges the academic community to observe and study the planet as a unified, highly-interactive system, and move past disciplinary approaches that view the chemical, biological, geological, and physical processes that operate across the Earth's surface as separate – and distinct from - human systems. Uniquely, our combined department includes faculty from both the natural and social sciences, which allows us to address the role human’s play in altering our environment and how changing environmental conditions affect society. Modeling and expanding off successful programs at Stanford University, UC-Irvine, and Arizona State University, among others, our Ph.D. is at the forefront of emerging programs nationwide that aim to combine natural and social science research in the pursuit of Earth systems science, sustainability, climate science, and coupled human-natural systems.

Following the merger, the core disciplinary strengths in the Department of Earth & Environment expanded to include: Earth, ocean, and atmospheric sciences; geographical sciences and remote sensing; and energy, resources, environment, and society. The intellectual glue that binds these subfields is the study of global environmental change, which we address from a variety of viewpoints including the geological (natural hazards, sea level rise, erosion), observational (remote sensing of the oceans, atmosphere, and land surface), historical (paleoclimate and climate reanalysis), oceanographic (marine science, marine biogeochemistry), numerical (physical and chemical modeling; climate modelling), and humanistic (climate adaptation and mitigation, energy alternatives, environmental policy, food resources, conservation, and sustainability). With these varied approaches, the Department produces new knowledge of earth
and environmental processes and human-environment interactions at all geographic and temporal scales, provides the scientific basis for environmental and climate policy, trains the next generation of experts in Earth and environmental sciences and sustainable practices, and disseminates knowledge for the benefit of society. Our wide range of research methods, which includes field, instrumental, survey-based, geochemical, and computational, is one of our major strengths. This variety allows for in-depth research within core disciplinary areas, as well across new and emerging subfields at the interface of coupled human-natural systems. Housed in a single department, the revised PhD program not only provides opportunity for interdisciplinary research, but provides *unparalleled incentive and flexibility* in the pursuit of novel research at the intersection of human-natural systems.

4. Please describe how the proposed change(s) advances the Strategic Plans of the department, of the school/college, and of the University:

The mission of the Department of Earth & Environment is to become the nexus at Boston University for research, education, and outreach related to Planet Earth. This vision includes the study of the physical and chemical processes that shape the earth surface; the ecology and biogeochemistry of terrestrial and marine ecosystems; and the dynamic interactions of people and society in regional and global environmental systems. A particularly important initiative in the Department is to expand our depth and breadth in the area of climate science, which recognizes climate change as the defining and unifying earth and environmental issue of the 21st century. A unified Ph.D. in Earth & Environment represents the logical and final step toward departmental unity, and creates a state-of-the-art platform for environmental research that draws from both the natural and social sciences. In essence, the revision of our Ph.D. program represents the culmination of our merger and helps frame our scholarly and academic profile and pursuits.

Beyond these immediate benefits for our own Department, the unified Ph.D. in Earth & Environment will complement existing global-change research initiatives and programs within the Departments of Biology and Sociology, the Pardee Center/ School of Global Studies, the School of Public Health, the Initiative on Cities, and the Institute for Sustainable Energy, as well as the proposed university-wide Climate Action Plan (CAP) recently announced by the Board of Trustees.

5. Please list all the program requirements for the current and revised programs so that review committees can easily see the changes: (expand the table as needed and denote new courses in bold print)
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<thead>
<tr>
<th>Ph.D. in Earth Sciences</th>
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<td><strong>COURSE REQUIREMENTS</strong></td>
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<tr>
<td>Students must complete 16 graduate-level courses (64 credits).</td>
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<tr>
<td>A maximum of 6 courses may be 900-level research courses.</td>
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<td>A maximum of 32 credits may be 900-level research courses.</td>
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<td>Two courses must be completed in the following sub-disciplines: geodynamics, geochemistry, earth history.</td>
<td>CAS GE 516 and two courses from an approved list of analytical-based courses.</td>
<td>Appropriate coursework will be determined in consultation with the student’s major advisor, and will be dependent upon the student’s background and interests.</td>
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<td><strong>PROFESSIONAL DEVELOPMENT</strong></td>
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| N/A | N/A | The professional development requirement ensures that students are well prepared for academic research at BU and for pursuing their ultimate careers. The requirement may be satisfied through coursework; co-curricular activities sponsored by the University; professional or community organizations; or through activities approved by the student’s dissertation committee. Possible co-curricular activities:  
• Teaching/learning workshops offered through CIRTL  
• Conference presentations  
• Proposal preparation and writing  
• Work with community organizations  
• RCR-Responsible Conduct of Research training  
• Career center professional development workshops |
| **LANGUAGE REQUIREMENT** | **LANGUAGE REQUIREMENT** | **LANGUAGE REQUIREMENT** |
| No language requirement | No language requirement | No language requirement |
| **QUALIFYING EXAM** | **QUALIFYING EXAM** | **QUALIFYING EXAM** |
| Students must pass a qualifying examination (written and oral components) in the fourth semester. | Students must pass a qualifying examination to be taken near the end of the last semester of coursework. | Students must pass a qualifying examination (written and oral components) by the end of the fifth semester.  
A Ph.D. student who has not been advanced to candidacy based on the Ph.D. qualifying examination may still receive a master’s degree. This student may receive a master’s degree in Earth & Environment if all members of the Ph.D. qualifying examination committee... |
committee vote that the student’s performance on the qualifying examination was of sufficiently high quality for a master’s degree. In addition, this student must have completed at least 32 credits of graduate-level coursework.

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<td>N/A</td>
<td>Students must prepare a substantial written research paper and give a departmental presentation on its content sometime after the completion of six courses and before completion of 16 courses. This paper and presentation are a separate requirement from the dissertation.</td>
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<td>• Candidates shall demonstrate their abilities for independent study in a dissertation representing original research or creative scholarship. A prospectus for the dissertation must be completed and approved by the readers, the director of graduate studies, and the department chair/program director. Ideally, the prospectus is completed in the first semester following the qualifying examination.</td>
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<td>• Students who choose not to continue the pursuit of the Ph.D. may elect to complete the degree requirements to receive an MA in Earth Sciences.</td>
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6. Is this change a result of program learning outcomes assessment and/or academic program review? If yes, please describe:

The proposed changes represent the outcome of more than two years of faculty discussion centered on the mission and goals of our new Department. The faculty considered retaining two separate Ph.D.’s in Earth Sciences and Geography, but opted against this approach due to: (1) broad overlap in core research areas of each Ph.D. program, now and especially so moving forward, and (2) because retaining two separate Ph.D.’s would hinder the pursuit of exciting
research opportunities and scholarly activities at the interface of the natural and social sciences. The Department also considered separate tracks within a single Ph.D. program, but this too created artificial distinctions among research clusters and tended to segregate the department into several disconnected groups, which is exactly the opposite of what we intend to build. A unified Ph.D. with the flexibility to pursue coursework in core disciplinary areas, as well as at the interface of natural and social science systems, provides our students with a highly stimulating research environment, one that not only retains the best elements of both separate Ph.D.’s but also highlights and supports emerging national trends in research that draw on the union of both natural and human systems in environmental research.

7. Please list learning outcomes for the revised program:
1. Demonstrate advanced knowledge of the fundamental concepts and topics in a specific sub-field of Earth & Environment.

2. Demonstrate understanding of key research questions, the research design process, and the quantitative and/or qualitative methods used in a specific sub-field of Earth & Environment.

3. Communicate research questions and results to the scientific community and communicate about problems in Earth & Environment to a broader audience.

4. Integrate, synthesize, and apply scientific knowledge to societal problems, such as the sustainable use of energy and water resources, the identification and mitigation of risks posed by climate change and natural hazards, and the consequences of human activities on the environment.

5. Produce and defend an original and substantial contribution to the field.

8. How does the change place your program in the context of programs at peer institutions?
As noted above, a global perspective has emerged over the last decade that challenges the academic community to observe and study the planet as a unified, highly-interactive system. This growing perspective emphasizes basic disciplinary research, but also encourages researchers to move past traditional disciplinary approaches and foster research at the interface of human-natural systems. Noteworthy Ph.D. programs at peer institutions (and aspirational peer institutions) include the cross-cutting Ph.D. initiative in Columbia University’s Earth Institute; Earth Systems Science at UC-Irvine; Environmental Science, Policy, and Management at UC-Berkeley; Geography at UC Santa Barbara; Earth and Ocean Sciences at Duke University; Environmental Systems and Processes at the University of Cambridge, UK; Geography at Penn State University; and Earth Systems Science at Stanford University. Of these comparisons, the latter
most closely matches our proposed revisions to the Ph.D. in Earth & Environment at BU. Stanford’s Ph.D. in Earth System Science centers on seven thematic areas, nearly identical to our own, and includes climate system dynamics, contaminant and nutrient cycling, geo-biology, human-environment interactions, land use change, ocean and ecosystem response, and sustainable food & water. Earth System Sciences at Stanford University was rated #1 in the most recent US News and World Report, followed by Penn State and UC Berkeley.

Historically, interdisciplinary research in earth systems science, environmental policy, climate change, and human-environment interactions at leading US universities was available through study in research centers and institutes, and indeed many universities still follow this model. Increasingly, however, the silo approach toward research in earth and environmental sciences – with students enrolled in a single department but with coursework and research at the interface of multiple departments – is giving way to research departments that focus on scientific questions and approaches, rather than single disciplinary foci. The success of Earth Systems Science at Stanford, and other similar programs represents the logical next step in the evolution of interdisciplinary research at the university level, and in its essence is, by definition, the merger of Earth Sciences and Geography at BU. In merging the two programs, we still retain excellence in each foundational area, but we also immediately open up new opportunities for novel research at their interface, and provide a framework for cutting-edge research in coupled human-natural systems.

The proposed Ph.D. in Earth & Environment will immediately place our program among elite universities nationwide, and set the department on track for considerable gains in stature and rankings worldwide.

9. How does the change affect other academic units and existing programs at the University?

The proposed revision to a single Ph.D. program in Earth & Environment will provide our students and colleagues with an identifiable program that centers fully on environmental issues of global significance. We found that offering two overlapping Ph.D.‘s (Earth Sciences and Geography) not only created confusion for our own students - especially those new students applying to our programs - but also raised questions for existing students and faculty within BU. The central question received is “what is the difference between Earth Sciences and Geography at BU?” Over the last decade, the distinction has diminished to a level where there is very little reason to retain two Ph.D.‘s.

More broadly, however, promoting a single, flagship Ph.D. in Earth & Environment at BU will help advertise and coordinate research ties with the Institute for Sustainable Energy, The Pardee Center and School, The School of Public Health, the Initiative on Cities, the Biogeosciences Program, and the BU Marine Science Program (BUMP), to name just a few.
10. How will you notify current students of the proposed changes and implement the requirements? How will you assure that current students are able to complete their programs under the requirements that were in place at the time of their matriculation?

Current students enrolled in our Ph.D. programs in Earth Sciences or Geography (and those matriculating in Fall 2017) will be able to continue their degrees, or switch into the new Ph.D. in Earth & Environment if they so choose. Assuming successful approval at the university level, students matriculating in 2018 and beyond will pursue the Ph.D. in Earth & Environment. Ph.D. programs in Earth Sciences and Geography will be phased out following graduation of the last enrolled students.

11. Please document any implications that the change has on professional accreditation or licensure at the program or school/college level:
N/A

12. If the change includes a new course or courses, please indicate who will teach the course and how the rest of that faculty member’s course load will be affected (courses(s) redistributed to other faculty, taught less frequently, no longer taught, etc.). Please be specific about affected courses. This information should be reflected in the budget form that accompanies the proposal, e.g. the cost for a new faculty member to teach the new course or a redistributed course:

No new courses are required as a part of this merger; moving forward, as our faculty numbers increase, however, we envision offering a sequence (two courses, 2 credits each) of courses for incoming Ph.D. students that will add to our developing program on professional development.

13. Please list other resources needed including new staff, IT, technology enhanced classrooms, office space, and other facilities. This information should be reflected in the budget:
N/A

14. Please describe the budgetary impact that the proposed change will have:
No budgetary impacts.

15. Please provide the bulletin copy (exactly as it should appear) related to the proposed change, including all text connected to the program (requirements, description, learning outcomes) [NOTE: this bulletin copy is in a final form and cannot be changed]:
**Ph.D. in Earth & Environment**

The Ph.D. in Earth & Environment provides students with extensive and cross-disciplinary research opportunities within the earth and environmental sciences, geography, remote sensing, sustainability, and energy, environment analysis, and policy. Students may specialize, for example, in - and at the interface of - climate dynamics; carbon & nutrient cycling; surface processes; hydrology; active tectonics and crustal evolution; sustainable food, water, and energy; land use/land cover change; environmental analysis and policy; paleoclimate and earth history; and coastal, marine, and ecosystem response to climate change. Upon completion of the Ph.D., students should be prepared for postgraduate training and to assume teaching and/or research positions in academia, industry, government, or nonprofit agencies.

**Course Requirements**

Students must complete 64 credits at the graduate-level (500-level or above); a maximum of 32 credits at the 900-level may be applied toward this requirement. Appropriate coursework will be determined in consultation with the student’s major advisor, and will be dependent upon the student’s background and interests. Students with prior graduate work may be able to transfer up to 32 credits toward completion of the Ph.D. requirements. See the GRS Transfer of Credits policy for more details.

**Language Requirement**

There is no foreign language requirement for this degree.

**Professional Development**

The professional development requirement ensures that students are well prepared for academic research at BU and for pursuing their ultimate careers. The requirement may be satisfied through coursework; co-curricular activities sponsored by the University; professional or community organizations; or through activities approved by the student’s dissertation committee.

**Qualifying Examination**

Students must pass a qualifying examination by the end of the fifth semester in order to be advanced to Ph.D. candidacy. The purpose of the Qualifying Exam is to determine whether students have the requisite background and intellectual curiosity needed for successful completion of the Ph.D. The exam consists of written and oral components. Recommendations to the department for advancement to PhD candidacy will depend on the results from the qualifying examination and on performance in coursework and research.
Dissertation and Final Oral Examination

Candidates shall demonstrate their abilities for independent study in a dissertation representing original research or creative scholarship. A prospectus for the dissertation must be completed and approved by the readers, the director of graduate studies, and the department chair/program director within a year after passing the qualifying exam. Candidates must undergo a final oral examination in which they defend their dissertation as a valuable contribution to knowledge in their field and demonstrate a mastery of their field of specialization in relation to their dissertation. All portions of the dissertation and final oral examination must be completed as outlined in the GRS General Requirements for the Doctor of Philosophy Degree.

A Ph.D. student who has not been advanced to candidacy based on the Ph.D. qualifying examination may still receive a master’s degree. This student may receive a master’s degree in Earth & Environment if all members of the Ph.D. qualifying examination committee vote that the student’s performance on the qualifying examination was of sufficiently high quality for a master’s degree. In addition, this student must have completed at least 32 credits of graduate-level coursework.