

**Proposal for a Ph.D. in Applied Earth Sciences**

**Office of the Dean  
Purdue School of Science, IUPUI**

INSTITUTION: Indiana University – Purdue University Indianapolis

SCHOOL: Science

DEGREE PROGRAM TITLE: Ph.D. in Applied Earth Sciences

FORM OF RECOGNITION TO BE AWARDED/DEGREE CODE: Doctor of Philosophy

SUGGESTED CIP CODE: TBD

LOCATION OF PROGRAM/CAMPUS CODE: IUPUI

PROJECTED DATE OF IMPLEMENTATION: August 2009

DATE PROPOSAL WAS APPROVED BY INSTITUTIONAL BOARD OF TRUSTEES:

SIGNATURE OF AUTHORIZING INSTITUTIONAL OFFICER:

DATE:

DATE RECEIVED BY COMMISSION FOR HIGHER EDUCATION:

COMMISSION ACTION (DATE)

#### A. ABSTRACT

This proposal outlines a new Doctor of Philosophy in Applied Earth Sciences on the IUPUI campus.

### **Objectives**

The program is designed to prepare future scientists in the applied study of the geology, biology, and chemistry of the environment. The major goal of the program is to explore the complex interactions that exist in the interface between the earth's surface and the organisms, including human, who occupy it. The Ph.D. will prepare students for academic positions as well as research and policy positions in a variety of environmentally related organizations and agencies. Students who complete the program will be in a unique position to contribute to the well-being of humans and the environment on local, national, and international scales.

### **Clientele to be Served**

The program is designed for students desiring advanced study to prepare them for teaching and research in the broad field of applied earth sciences. Because this is an interdisciplinary program, students from a wide range of backgrounds will be accommodated, and the program itself will draw on the past skills and experiences of students to explore the applied aspects of earth sciences.

### **Curriculum**

A total of 90 hours will be required for this degree. No more than 30 of those hours would be counted from a master's degree taken at Indiana University or a graduate work at IU or another university. The 90 credit hours will consist of:

- 18 hours in core courses
- 18 hours in specializations
- 54 hours of dissertation credit

Subject Area of Core Courses: The core courses cover the applied, theoretical, and interdisciplinary nature of the field of applied earth sciences. The Ph.D. is designed to develop in students the knowledge, values, and skills necessary to enable them to enhance the knowledge base of the field, to utilize interdisciplinary research methods to pursue the understandings of environmental sciences, and to contribute to the understanding of effective practice of integrated environmental research. The proposed curriculum is designed to achieve these goals. The common core courses will facilitate the broad needs of incoming students, bringing them up to speed on disciplines that they were not formally trained in but will need for effective interdisciplinary research. The specialization courses will build on the core by covering water resources research-related areas, including earth sciences, ecology, sedimentation, hydrology, geochemistry, toxicology, environmental engineering, and environmental remediation.

Each student is required to enroll in GEOL 6XX Seminar in Applied Earth Sciences (1 credit hour/semester) for four semesters during their degree program. This course is counted toward specialization hour requirements. Students enrolled in GEOL 6XX may either make a formal presentation or write a brief synopsis and critique of four presentations attended each semester. The goal of this course is to define the field of applied earth sciences through examples, thus enhancing the transdisciplinary inquiry. Students may enroll in GEOL 7XX Advanced Topics in Applied Earth Sciences, which may be taken multiple times as the topics will vary. Advanced topics and reading courses may be used to meet requirements, depending upon the topic and the

student's area of interest. The key with this course is to provide students with a fundamental understanding of the research tools and approaches that are current in the field.

Prerequisites: Before admission to the Ph.D. program, students must complete a Bachelors degree in some field of science. Students who have completed Masters degree coursework in an appropriate sub-discipline may substitute alternate coursework to avoid overlap, to be determined by the admissions committee.

Unique and Innovative Features: This degree is an interdisciplinary program, housed in the Department of Earth Sciences but involving representative faculty from many departments and several schools at IUPUI. The interdisciplinary nature of the program is further strengthened by the applied nature of the training and research to be conducted, with applications in the water, earth, life, and human health sciences. In addition, the program will be the academic branch of a new Signature Center in Water Resources Research, with support from the Center for Earth and Environmental Sciences and the Center for Environmental Health, thus effectively linking the research and training aspects of this new university initiative. Faculty advisors and dissertation committee members will consist of faculty across the various academic units at IUPUI and other appropriate members of the faculty across the IU system and external University approved members. This will be among a small handful of Ph.D. programs in Applied Earth Sciences in this country, a distinction that IUPUI is particularly well suited for given the wide range of programs offered, the past focus of the campus on improving the quality of life for individuals in central Indiana and the state, and aspiration to build top-quality research programs that are national and international in scope.

### **Employment Possibilities**

This program will prepare students for academic and research careers as well as for careers in the government and private sectors. Because of the solid grounding in applied sciences that the program offers, the interdisciplinary nature of the training will yield graduates who can make an immediate and substantial contribution in the extremely integrated field of environmental sciences.

## **B. PROGRAM DESCRIPTION**

### **1. Description of Proposed Program and Objectives**

This is a proposal to award the Ph.D. in Applied Earth Sciences (AES) at IUPUI. The proposed program has been developed by a committee of the Environmental Sciences faculty that represents faculty across several academic units. This proposed program follows the recommendations of our Graduate Program external review (Appendix 1), which highlight the appropriateness of a focused Ph.D. program in our departmental strengths that builds on the campus vision.

The field of AES is built upon an interdisciplinary examination of earth processes, particularly as they relate to interactions between humans and the environment. This field is based on several tenets: (1) natural systems behave in complex ways, (2) humans have a substantial impact on

natural systems, and (3) predicting responses of environmental systems, and their net impacts to social, political, and economic systems, requires an integrated framework spanning physical science, life science, spatial analysis, visualization, and policy. A firm basis in the quantitative physical and life sciences augmented by training in visualization, policy, and information sciences are required to adequately assess the complex milieu of human-environment interactions. Additionally, a focus on the built environment (i.e., the concept that most “natural” processes and responses have been significantly altered by the human built landscape) is important to enable the scientific outcomes of basic research to be applied for the benefit of society as a whole.

Several integrated graduate programs have arisen over the past five years to accommodate the increasingly interdisciplinary nature of research. At the heart of all these programs is the requirement that academic units shed their territoriality in the face of increasing demands by students and funding agencies. These integrated programs enhance rather than compete with standing programs on campuses, and will fail if an adequate level of administrative support is not available to encourage full cross-discipline ownership in the program. Again, perhaps this is where IUPUI has an edge, in that the youth of the university and the cross-disciplinary mindset engendered by need in the face of limited resources has primed faculty and administration in the benefits of interdisciplinary research and graduate training.

The closest IU or PU program to the proposed AES degree is the SPEA Ph.D. in Environmental Science, offered at the Bloomington campus. The SPEA program is quite broad, with the primary objectives to: (1) clarify and improve understanding of environmental problems and to identify solutions to these problems; and (2) foster collaborative, interdisciplinary research amongst scientists from various disciplines. The objectives of our proposed program are distinct from these, with a defined focus on the intersection between ecosystems, human health, and the built environment via water resources and environmental health sciences research. Our program will be pulling from broad range of disciplines on the IUPUI campus and embracing the mission of IUPUI as an urban research university to achieve these objectives. Purdue University has an Ecological Sciences and Engineering program through the Office of Interdisciplinary Graduate Programs, which is directed by the Center for the Environment. This program integrates science and engineering concepts, whereas our proposed program integrates science and social/health/urban concepts, and thus little overlap exists in the faculty specializations or degree objectives between these programs.

Letter of support, articulating the wide interest in the proposed program and the role that it will play with respect to current programs can be found in Appendix 2. These letters are from partner programs at IUPUI, IUB, and from local governmental and professional organizations.

Program Goals. The Ph.D. will prepare students either for academic positions or research and leadership positions in local, state, national, or private environmental organizations. The major goal of the program is to prepare future researchers and leaders who assess complex environmental systems and assist in providing quantitatively based options and solutions for optimizing human-environment interactions. The general goal of the Ph.D. program in AES is the development of individuals who, through their scholarly contributions and original research,

will contribute to the knowledge base of the applied aspects of complex environmental systems. The field of environmental sciences is appropriately interdisciplinary as it seeks to examine relationships between physico-chemical processes (e.g., geochemical interactions with contaminant elements, water transport in the surface and subsurface) and ecological-human processes (bioremediation of contaminants in wetlands, relationships between soil contamination and human health). The perceived weakness of many environmental programs is a lack of quantitative science background. This proposed Ph.D. program is taking the same philosophy as applied in our recently-approved interdisciplinary BS in Environmental Sciences program—a strong science base is required to provide information to decision-makers to enable them to make more informed decisions and to foster a greater understanding of the complexity of natural systems. This proposed Ph.D. program will encourage research in problems appropriate to central Indiana through internships and the extensive field research systems already developed by the Center for Earth and Environmental Sciences (housed in the Department of Earth Sciences), thus potentially acting to attract and retain broadly trained environmental scientists in the region. In addition, the new program will interact with the newly approved Center for Environmental Health, an inter-School effort at IUPUI to enhance the quantitative understanding of environmental parameters and human health factors by research and graduate training.

The Ph.D. program is designed to develop in students the knowledge, values and skills necessary to enable them to:

- ◆ enhance the knowledge base of the field from perspectives that cross traditional academic disciplines.
- ◆ utilize interdisciplinary research methods to pursue in-depth critical inquiry into the physical, chemical, biological, and social aspects of applied earth sciences.
- ◆ quantify and model complex human-earth interactions.
- ◆ utilize scientific methods to acquire, synthesize, and evaluate complex earth science data.
- ◆ engage in debate and discussion about the scientific and social interactions related to applied earth sciences.
- ◆ transmit knowledge in the field of applied earth sciences.
- ◆ appropriately integrate selected knowledge and skills derived from at least one other academic discipline or professional field of practice into the knowledge base of applied earth sciences.
- ◆ conduct independent research in at least one methodological area with a thorough understanding of different paradigmatic assumptions and how they influence the research process.
- ◆ demonstrate expertise in a particular substantive area of applied earth sciences.

The culmination of these goals is the presentation and defense of a doctoral dissertation that makes a significant contribution in the form of an original scholarly product.

## **2. Admission Requirements, Student Clientele, and Financial Support**

**a. Admission Requirements.** Admission into the Ph.D. will be based on the standard policies and procedures of the Indiana University Graduate School. This includes formal application to the Department of Earth Science for admission through the Graduate School to the Ph.D. program in Applied Earth Sciences; completion of prerequisites as specified in 2b below; three letters of recommendation; a cumulative GPA of 3.0 or higher, and the GRE. Individuals for whom English is a second language must demonstrate proficiency in English. This can be demonstrated through taking the TOEFL examination. Scores from the TOEFL exam should be submitted with the application for admission.

**b. Prerequisites.** Because of the science-based prerequisites of the core curriculum, a Bachelor's or Master's degree in the physical, biological, or health sciences is expected.

**c. Student Clientele.** The clientele for the Ph.D. would primarily consist of graduates seeking an advanced degree in applied earth sciences—at present, no degree above a Master's is available to those students at IUPUI.

**d. Enrollments.** The number of students in the Ph.D. program is expected to be small, five to eight students admitted annually with an upper limit of approximately twenty active full-time students. The admission committee will apply the following selection criteria:

- Research potential. Assessed by evaluation of vita and personal statement
- Ability for engaging in advanced graduate work. Assessed by evaluation of letters of reference and grade point average in prior graduate work
- Professional learning goals and objectives. Assessed by evaluation of personal statement

**e. Financial Support.** Students will be supported by the usual sources for graduate programs in the School of Science, including fellowships, research assistantships, and teaching assistantships. We anticipate no new State funds for this Ph.D. program. Private funding will be sought to fund full-time students in the form of graduate fellowships. Research grants received by affiliated faculty also could provide assistantship opportunities for Ph.D. students. At present about five research assistantships are available in the Department of Earth Science—we anticipate that this number will double via contributions and external grant opportunities by providing Ph.D. level research and training opportunities in AES.

## **3. Proposed Curriculum**

**a. Curriculum Requirements.** The Ph.D. in AES is based on a curriculum and faculty that are already largely in place at IUPUI. The AES program will involve specialization courses that reflect the individual research interests of the students and thus may span a range of disciplines. To integrate students and faculty, however, the program will be built around six common core

courses. All students will be required to take the core courses, unless they have already received credit for them. Because of the philosophy of this integrated graduate program, the coverage of materials provided by the core courses will enable students from diverse backgrounds to obtain the breadth of knowledge required to successfully complete this program.

#### *Core Courses*

Core courses will be offered annually, with three occurring in the fall and three in the spring:

Earth Sciences G585	Environmental Geochemistry (3 cr)
Earth Sciences G5xx	Aquatic Toxicology (3 cr)
Biology K5xx	Global Change Biology (3 cr)
Geography G538	Introduction to Geographic Information Systems (3 cr)
SPEA E519	Environmental Health (3 cr)
Earth Sciences G550	Surface-Water Hydrology (3 cr)

#### *Specialization courses*

After completing the core courses, Ph.D. students will identify the specialization area that they will pursue and take the additional courses in support of that specialization. A preliminary committee selected from the affiliated faculty will meet every semester to ensure progress. The courses within the tracks are mostly already offered by departments at IUPUI—significant coordination will be required to ensure compatibility of prerequisites and adequate rotation for curriculum completion.

Geography G538	Introduction to Geographic Information Systems (3 cr)
Geography G539	Advanced Geographic Information Systems (3 cr)
Geography G588	Applied Spatial Statistics (3 cr)
Geography G536	Remote Sensing (3 cr)
Geography G556	Advanced Remote Sensing (3 cr)
Chemistry C621	Sensors (3 cr)
Earth Sciences G536	Geologic Remote Sensing (3 cr)
Earth Sciences G635	Soil Geomorphology (3 cr)
Earth Sciences G595	Data Analysis and Environmental Statistics (3 cr)
Earth Sciences G5xx	Wetlands (3 cr)
Earth Sciences G551	Advanced Hydrogeology (3 cr)
Earth Sciences G502	Trace Element and Isotope Geochemistry (3 cr)
Earth Sciences G527	Geological Oceanography (3 cr)
Earth Sciences G6xx	Toxins in Natural Systems (3 cr)
Earth Sciences G6xx	Topics in Applied Earth Sciences (1 cr)
Earth Sciences G7xx	Advanced Topics in Applied Earth Sciences (3 cr)
SPEA E527	Applied Ecology (3 cr)
SPEA E536	Environmental Chemistry (3 cr)
SPEA E546	Stream Ecology (3 cr)
SPEA E515	Fundamental of Air Pollution (3 cr)
SPEA F817	Principles of Toxicology (3 cr)
SPEA E560	Environmental Risk Analysis (3 cr)



SPEA E552	Environmental Engineering (3 cr)
Biology BIOL 507	Principles of Molecular Biology (3cr)
Biology BIOL 516	Molecular Biology of Cancer (3cr)
Biology BIOL 566	Developmental Biology (3cr)
Biology BIOL 571	Developmental Neurobiology (3cr)
ME 542	Introduction to Renewable Energy (3 cr)
Public Health H517	Fundamentals of Epidemiology (3 cr)
Public Health P600	Epidemiological Research Methods (3 cr)
Public Health P601	Advanced Epidemiology (3 cr)
Public Health P609	Infectious Disease Epidemiology (3 cr)
Public Health P610	Chronic Disease Epidemiology (3 cr)

### Research

Our recent self-reflection and program review provided strong support for an interdisciplinary Ph.D. program. This program would also allow us more opportunities to continue developing a nationally recognized research program in a highly interdisciplinary field of earth sciences. The Earth Sciences Department is well placed to coordinate and deliver this program because of its extensive network of research collaborations across campus, as well as the research and outreach support provided by the Center for Earth and Environmental Sciences (CEES) housed within the department. Additionally, the new Signature Centers in Water Resource Research, a partnership of Earth Sciences, CEES, and the Center for Environmental Health (IUSOM), and at the Richard G. Lugar Center for Renewable Energy demonstrate the commitment of the department, school, and university to become a nationally recognized program in environmental, human, and engineering sustainability. Furthermore, with the recent launch of the BS in Environmental Sciences program, of which we are a partner, we foresee the need for graduate and research training opportunities growing in the future. The IUPUI campus is thus the ideal campus in Indiana to provide the research infrastructure to successfully develop this program and to achieve national and international stature for the program.

This AES research program could be supported by several vehicles, including start-up funds from RIF, Research Assistantships from grants, Graduate Fellowships funded by inter-school/system-wide pool of funds, support from external contract sources (e.g., NSF, NIH, Veolia Environnement, USGS), and potentially external support targeted toward novel and interdisciplinary graduate programs (e.g., NSF's IGERT program). An AES Colloquium Series would support common and integrated research themes within the program, and would be run by and required of graduate students in the program. The clientele for this program would include students from various parts of IUPUI who want an advanced degree that is flexible and capitalizes on breadth of programs at IUPUI, people returning to school from the workforce to gain new/deeper experiences, and external students. Several program faculty have been repeatedly approached by students from both within and outside the university enquiring about Ph.D. program options, indicating that interest in this research direction is strong.

### Coordination

The AES graduate program would have a Director, in charge of coordinating and promoting the program. The Director would meet annually with a small faculty advisory group to ensure that

curricular, research, and outreach efforts are complementary. AES program faculty will be selected initially from interested faculty at IUPUI and adjusted to suit the needs of a growing/changing program.

Upon admittance to the program, students would be assigned a preliminary committee from among the program faculty. Students would identify an appropriate sub-discipline after their first year, and the preliminary committee would be modified and transformed into a research committee to suit the research goals of the student. The Research Committee would ensure successful progress in coursework, coordinate oral qualifying exams for Ph.D. students, and advise the students in their progress to the Ph.D. as appropriate. This Research Committee could be chaired by any AES program faculty member (with the qualification that they are a Full Member of the IU Graduate Faculty for Ph.D. students). The Research Committee would be required to include AES program faculty from at least two academic units.

**b. Specialization.** Students will be required to enroll in at least 21 credits of advanced studies in a specialization area defined by the research committee. These specialization areas could also constitute Ph.D. Minors (e.g., Water Resource Research, Environmental Health Sciences), and courses will thus be available for students not enrolled in the Ph.D. program in AES as well. A student will select a specialization that meets their needs in consultation with their advisory committee and after their Oral Qualifying exam (typically occurring toward the end of their second year).

### **c. Dissertation, Qualifying exams, and Advisory Committee**

**Dissertation: AES 8XX.** Students may enroll in up to 51 credits of dissertation work. One of the primary reasons for doctoral education is the development of knowledge, which will help solve intellectual problems that have both theoretical and practical significance to the field. Students will be expected to utilize cross-disciplinary methods as they pursue original research in applied environmental sciences.

**Examination Structure.** The examination structure for students in the program will involve three benchmarks. The first is the preliminary examination, which is a test of basic knowledge, problem solving skills and intellectual rigor of the Ph.D. candidate. The preliminary exam has a written portion, with individual questions coming from each of the members of the Ph.D. examining committee. Questions are broad, but may focus on the student's specialization, and can be open or closed book. The student will have 4-8 hours to answer each set of questions from individual committee members, thus the exam takes about a week. Lastly, the student has an oral portion of the preliminary exam where he/she defends and /or discusses the written answers, with all committee members present. The student must pass both the written and oral components of the examination to advance on to the qualifying exam. The second exam is the qualifying exam, which assess how prepared the student is to undertake Ph.D. level research. The student writes a research proposal (no more than 15 pages, excluding figures and references) which he/she defends in front of the committee of faculty members. The third exam is the defense of the Ph.D. which is initially introduced as an open talk to the Department, but a closed question and answering session with the committee.

**Research Committee.** All doctoral students will have a Research Committee comprised of at least four individuals, two of which must be from the major area and one from the sub-discipline area. The chair must have full graduate status and be authorized to supervise AES doctoral dissertations. If special expertise is held by a scholar external to IU, one such member may be added to the committee with the approval of the departmental chairperson and the associate dean of the graduate school. All other members of the committee must be members of the graduate school. At least half of the members must have full status, others may be associate or affiliate members. The Research Committee will approve the student's program of study and counsel the student until the passing of the qualifying examination.

#### **4. FORM OF RECOGNITION**

**a. Degree.** The Doctor of Philosophy will be awarded after completing the requirements of the Ph.D. This is the appropriate terminal degree for recognition in this field.

**b. CIP Code.**

**c. Diploma Information.** The Ph.D. diploma will read: Doctor of Philosophy, Applied Earth Sciences, Indiana University, with a subheading denoting which focus area was completed.

#### **5. AES FACULTY AND ADMINISTRATION**

**a. Listing of faculty.** Ultimate authority for the Ph.D. in AES will be with the Indiana University Graduate School. The degree will be awarded by the faculty of the interdisciplinary AES program, with the Department of Earth Sciences (see Appendix 3 for a listing of faculty expertise and background, as well as the complete list at [http://www.earthsciences.iupui.edu/Faculty\\_Staff/index.htm](http://www.earthsciences.iupui.edu/Faculty_Staff/index.htm)) serving as the central administrative structure to oversee the awarding of the degree. Listing of potential participating faculty is in Appendix 4.

**b. New Faculty Positions.** The prescribed coursework will utilize the new hire in Aquatic Toxicology (funded by the successful Signature Center in Water Resources Research) but would not require additional new faculty lines at this time.

#### **6. LEARNING RESOURCES**

**a. Library and Publication Resources**

The IUPUI library includes the University Library at IUPUI, the Ruth Lilly Law Library, and the Ruth Lilly Medical Library. Total holding at the IUPUI library amounts to 1.4 million documents making it the fourth largest among Indiana's academic libraries. The library maintains subscriptions to 14,386 periodicals and journals, many of them are also available on-line. The library is also part of a Statewide Academic Library system allowing a rapid turnaround on requests by IUPUI students and faculty for materials not available on campus. The

library also maintains a wide range of electronic resources, including catalog systems of regional academic libraries, indexing and abstracting services (e.g. Web of Science Citation Index, GeoRef, Geographical Abstracts), electronic journals and e-books. Specialized search engines operated either as stand-alone or as integrated portal (e.g. Meta-Search) providing simultaneous access to these various electronic resources, either on campus or off campus via the internet. The Library collection includes periodicals related to traditional Earth Science disciplines, as well as to fundamental sciences such as Chemistry and Biology. The diversity of journal holdings will meet the need of Earth Science faculty and students in efforts to expand their research beyond traditional Geosciences boundaries.

Through the U.S. Government depository program, the University Library subscribes to and collects 85 U.S. Geological Survey (USGS) publication series. The Government Publication collection includes numerous technical reports on the geology of various US regions, mineral and water resources, and on management of real-world environmental issues. These documents - prepared in large part by the USGS and Environmental Protection Agency (EPA) field technicians - are particularly suited for graduate student training.

These various collections provide an articulated resource of primary and secondary materials to students and scholars—whether formally involved in the academic world or self-driven as lifelong learners.

### **University Research Centers**

*Center for Earth and Environmental Science (CEES)* - CEES is a research center working to solve complex environmental problems. The program seeks to translate environmental issues and solutions to legislators, environmental professionals, students, and citizens. Research and educational initiatives cross traditional science boundaries and facilitate science-based decision making in the areas of drinking water quality, ecosystem restoration and environmental data management. CEES sponsors such activities as the Lilly ARBOR Project where volunteers planted approximately 1,400 trees in an eight-acre strip of land between 10th and New York streets along the White River in downtown Indianapolis. This project is part of an experimental floodplain restoration program that will test the best way to restore riverbanks with native forests.

*The Polis Center* is an academic research center that builds the capacity of communities to develop knowledge about themselves, to build collaborations, and to create and apply information innovatively and effectively. POLIS concentrates on issues related to metropolitan Indianapolis and other mid-sized American cities and excels in creative uses of information technology, especially geographic information systems.

*The Center of Environmental Health* is a research and training center capitalizing on the strengths in health and environmental sciences at IU. The center, led by Director J. Klaunig in the School of Medicine and Associate Director G. Filippelli in Earth Sciences has five objectives: 1) Promote state-of-the-art research on environmental health that will help reduce the burden of environmentally related disease. 2) Enhance basic research on mechanisms of toxicity of hazardous chemicals. 3) Improve our understanding of the environmental and genetic determinants of disease in populations. 4) Foster inter-disciplinary collaborations and creative uses of the expertise and facilities within the campus, university, and state. And 5) Provide a resource to the State of Indiana on environmental health.

*Center for Urban Policy and the Environment (CUPE)* - The Center's mission is to work with state and local governments and their associations, neighborhood and community

organizations, community leaders, and business and civic organizations in Indiana to identify issues, analyze options, and develop the capacity to respond to challenges.

*Center for Research and Learning (CRL)* – The CRL exists to develop, expand, and promote research-based learning in all disciplines across the IUPUI campus. The center promotes and supports all varieties of research and scholarship. It promotes the principle that active engagement in research and scholarship promotes learning through inquiry and experience.

*Richard G. Lugar Center for Renewable Energy* - Established to address the societal needs for clean, affordable and renewable energy sources, improve the nation's energy security, and reduce global warming. Its primary mission is to promote research excellence in the area of renewable energy through collaborative efforts among faculty in the disciplines of engineering, chemistry, physics, biology, and environmental affairs. It will promote renewable energy applications through teaching, learning, civic engagement, and synergistic partnerships with industry, government labs and local communities.

*Visualization and Interactive Spaces Lab (VIS)* - The Visualization and Interactive Spaces Lab explores the use of computer-generated graphics, advanced user interaction strategies, and smart room technologies to build compelling applications and spaces for data exploration and learning. VIS supports the PercepTable, which is a display station where small groups of people can get together to view and interact with computer-generated graphics on a table top. Users interact with the imagery by manipulating small tools on the table.

### **Established Laboratories and Field Sites**

IUPUI faculty maintain state-of-the-art research laboratory facilities across campus. In the home school (Science) for this proposed program, these include Aquatic Toxicology, Biogeochemistry, Clay Mineralogy, Environmental Geology, Graphics, Hydrology, Microscopy, Sedimentology, Sediment Analysis, Water Resources and Soil Biogeochemistry, and Environmental Remote Sensing.

A number of established field research sites are also available, and include:

*Lilly Arbor Project* - the Lilly ARBOR Project utilizes an 8-acre strip of land located on the west side of the IUPUI campus along the White River. This floodplain restoration project is the last key component of a conservation corridor through Marion County and will help to improve the ecological function of the White River floodplain.

*Scott Starling Nature Sanctuary Wetland Restoration* – a mosaic of relatively rare and biologically diverse groundwater-fed wetland systems in the Scott Starling Nature Sanctuary portion of Eagle Creek Park are being restored

*Ritchey Woods Natural Area* - 130 acres of former agricultural land in Hamilton County that is being restored to natural prairie, flatwoods and wetland ecological communities in a rapidly urbanizing area of Indiana

*Urban Reservoirs* – The Central Indiana Water Resources Partnership (CIWRP) facilitates water resources research in a number of watershed in the region, with a focus on water quality impactors for Eagle Creek, Geist, and Morse reservoirs.

### **City, State and Federal Agencies**

*U.S. Geologic Survey in Indiana (USGS)* – The USGS Division of Water Resources of Indiana maintains historical and real-time data on surface water conditions across the state.

*Indiana Department of Environmental Management (IDEM)* – This agency is dedicated to conserving, protecting, enhancing, restoring and managing Indiana’s environment, including air, land and water. The mission includes promulgation and enforcement of laws as well as the promotion of conservation, pollution prevention and a healthy and sustainable ecosystem.

*Indiana Department of Natural Resources (IDNR)* - The mission of the IDNR is to protect, enhance, preserve, and wisely use natural, cultural, and recreational resources for the benefit of Indiana's citizens through professional leadership, management, and education. The IDNR identifies, protects, and manages an assortment of natural areas in order to maintain viable examples of all of Indiana's natural communities, including endangered, threatened, or rare species. The Division of Water within IDNR is a regulatory and public information agency, having diverse responsibilities associated with the evaluation of Indiana's water resources, and development near Indiana's waterways and lakes.

*Indiana State Department of Health* - The Indiana State Department of Health is committed to facilitating efforts that will enhance the health of the people in Indiana. To achieve a healthier Indiana, the State Department of Health will actively work to: promote integration of public health and health care policy; strengthen partnerships with local health departments, collaborate with hospitals, providers, governmental agencies, businesses, insurance, industry, and other health care entities; and support locally-based responsibility for the health of the community.

### **Student Support:**

Students being recruited into the Ph.D. program would be expected to be competitive for University Fellowships, which are awarded to outstanding incoming students. Each program selects up to three nominees for these fellowships and final awards are made after a ranking of the applications by the Fellowship Subcommittee of the Graduate Affairs Committee. The University Fellowships for Ph.D. students currently carry a \$22,000 stipend. In addition, current policy is for each student to have his or her insurance premium paid for the fellowship year, and may qualify for travel awards up to \$800.

Support is also available at the department level to support Ph.D. students. The Department of Earth Sciences offers 2-3 teaching and research assistantships to either incoming or continuing graduate students. The amount of these awards is similar to the campus-wide awards described above. Two Mirsky Fellowship awards are also available to incoming out-of-State graduate students. Currently this Fellowship provides \$18,000 for stipend, tuition and fees. Through the Central Indiana Water Resources Partnership (CIWRP), support is available for 2 graduate students engaged in research related to management of water resources in Central Indiana. In addition to these scholarships, several Ph.D. students will be supported through grants and contracts from external sources. As a frame of reference, faculty in the Department of Earth Science currently have external support for seven full-time graduate students beyond that listed above—we anticipate that a PhD program will allow this external support of graduate students to double. Campus-wide and department-level efforts are underway to enhance the overall department performance in attracting external funding.

A number of program support mechanisms are also available. These include

Program Development RIF Block grants from the IUPUI Graduate School  
NSF IGERT Program for Interdisciplinary PhD programs  
Stipend support from the Water Resources Research Signature Center

#### **b. Need for Additional Learning Resources**

Ph.D. students will occupy office space in the appropriate home department. As the program grows, some departments may require additional space for graduate student offices.

No new library materials will be required to support this program besides the normal yearly allocation.

### **7. OTHER PROGRAM STRENGTHS**

#### **a. Special Features**

The Ph.D. in AES is a research-centered degree program that will prepare students to pursue research projects that cross traditional disciplinary boundaries and extends the knowledge base in water resources research and environmental health sciences. The Ph.D. degree in AES integrates these existing programmatic strengths at IUPUI and will be the only one of its kind in the nation. The proposed program will allow students to explore the complex spatial and temporal linkages between environmental quality and human health in a synergistic fashion. To accommodate the breadth of students enrolling in the program, a core curriculum will be required, that will introduce students to the diverse, but interrelated disciplines involved. This strategy will ensure that all students are aware of the resources, datasets, and expertise to support their developing research interests. The program will also sponsor a regular seminar series, which will serve as another mechanism for students and faculty to exchange ideas and to promote cross-disciplinary communication.

The AES faculty will consist of Indiana University and Purdue University faculty at IUPUI who have demonstrated a commitment to the academic affairs of this interdisciplinary program. To obtain full faculty status, a faculty member must provide evidence of substantial intellectual contribution in research, teaching or service to one or more of the three program subfields. The program faculty will come from at least five different Schools and twelve different Departments.

#### **b. Anticipated Collaborative Arrangements**

CEES and the Department of Earth Sciences currently have a strong working relationship with Veolia Environment, the manager of the Indianapolis Water Company, which is the foundation for the Central Indiana Water Resources Partnership (CIWRP, formed by CEES and Veolia). CIWRP is a long-term research and development partnership to create a center of excellence in water quality and watershed research and development. Through this partnership, IUPUI faculty, staff and students are researching local and regional environmental impacts on drinking water quality in central Indiana. The existing research infrastructure and easy site

accessibility provide extensive opportunities for interdisciplinary research for students and faculty.

No formal relationships with other universities are planned at this time. We are open to the possibility of future collaboration with faculty from other IU campuses and from Purdue University, West Lafayette.

## **C. PROGRAM RATIONALE**

Many of the major research problems facing scientists today require an interdisciplinary approach. Although there are still ample opportunities for individual researchers to make profound contributions while working on individual systems or processes, interdisciplinary is increasingly valued by national funding agencies because of its ability to tackle larger-scale problems. Nowhere is that asset so valued as in human-environment interactions, where the theoretical bridges with the practical in a very direct way. But the intersection between basic earth sciences and applied aspects of earth interactions with ecosystems and humans is a critical and under-studied junction. The fields of human health, ecosystem quality, and information technology have largely independently and significantly advanced in their own disciplines. This independent advancement has taken important issues outside the realm of the broader earth sciences. For example, the quantification of human disease patterns and genetic/behavior/disease interactions has come a long way. However, even though environmental triggers are often implicated with human disease, little credible work has been done on integrating the environmental factors with the human factors. Additionally, a number of health, environmental, and human landscape modification patterns have been determined in the context of geographically referenced data, but these data are often determined and planned in ways that are discipline-specific, and thus often do not integrate adequately with each other.

The importance of greater quantitative integration of fields and enhancing the bridge between basic and applied sciences is seen in funding patterns. The National Science Foundation has developed a number of new programs to enhance interdisciplinary work in the earth sciences, including Environmental Geochemistry, Informatics, and Complex Biogeochemical Cycles. Meanwhile, the National Institutes for Health have substantively funded a number of NIEHS Centers of Excellence to quantitatively explore the environmental parameters affecting human health.

### **1. Institutional Factors**

#### **a. Compatibility with the Institution's Mission.**

The mission of IUPUI seeks to raise educational achievement and intellectual aspiration in Indianapolis, the state, and beyond through leadership and success, and to create and apply knowledge in health, environmental and information sciences through teaching, research and service. IUPUI also seeks to serve as a model for collaboration and interdisciplinary work through partnerships with Indiana University and Purdue University and the community. Finally, the Life Sciences Initiative has clearly prioritized Life and Health Sciences on our urban research campus. The IUPUI campus houses Indiana University (IU) Medical School, IU School of Liberal Arts, IU School of Informatics, IU School of Public and Environmental Affairs



(SPEA) and Purdue School of Science. Each of them facilitates the training of graduate students, but no cross-disciplinary program exists to maximize individual resources. The proposed Ph.D. fits well with the mission of IUPUI. As a department, ES has several distinct advantages over other geology departments with larger faculty numbers. First, many of the ES faculty were hired specifically to satisfy medium-term goals of developing excellence in Applied Earth Science research. Second, ES faculty have maximized our utilization of campus and local resources. For example, we have active, ongoing research collaborations with other departments in the School of Science (including Biology, Chemistry, and Computer Sciences), with other Schools in the university (School of Medicine, Dental School, School of Public and Environmental Affairs, School of Liberal Arts, the new School of Informatics), as well as other university centers and organizations like the US Geological Survey, Indiana Department of Environmental Management, Department of Natural Resources, Public Health Department, Indianapolis Parks Department, the City of Indianapolis, and the Indianapolis Water Company. The foregoing is by no means comprehensive, and honestly reflects our regular research interactions.

**b. Planning Process.** Describe here the development of external review in light of future direction of department, integration with long-range plan, hiring of suitable faculty.

A goal of the Department of Earth Science is to expand its research and graduate training programs. One of the only ways to maximize this potential is to have the ability to train graduate students at the Ph.D. level, for several reasons: Ph.D. students are a good long-term investment in research training from the perspective of faculty, the lack of Ph.D.-level training classifies our department as a second-tier program in the eyes of colleagues and funding agencies (both NSF and ACS-PRF have different programs for non-Ph.D.-granting departments), and Ph.D.s go on to post-doctoral and faculty positions directly from a given program, and thus bring the name of that program to their new research environments. In pursuit of this goal, the Department of Earth Science has systematically hired research-focused faculty over the past decade to establish the intellectual capital required to offer an excellent Ph.D. program in earth sciences. In addition, the Department instigated an external review of the current graduate program and faculty in 2002 to assess the capabilities of developing a Ph.D. program in earth sciences at IUPUI. The self-study that was the basis of this review can be found at <http://www.planning.iupui.edu/programreview/geocont.html>. The review committee report and the department response are in Appendix 5. The outcome of that review was very positive, with the consensus of the committee that “The review team concluded that there is great potential to build a nationally recognized, high quality program of this type at IUPUI - a new graduate program that is innovative, builds on campus strengths, is beneficial to the University and the State of Indiana, and is therefore worthy of support.”

One area that the ES Department has focused on since the review is in the area of new faculty hires. A need of the department was to establish research strengths on the borders of its disciplines, and in response the department advertised for and hired four new research faculty in a direction directly aimed to enhancing our capabilities in interdisciplinary research and in offering a strong PhD program in the direction recommended by the review. The four new faculty members use cutting-edge techniques to examine complex environmental questions, and include expertise in the focus areas presented in this proposal:

*Applied Biogeochemistry*--Dr. Pierre-Andre Jacinthe with expertise in isotopic biogeochemical analysis of soils and carbon.

*Water Resources*--Dr. Philippe Vidon with expertise in surface water hydrology and nutrient transport.

*GeoInformatics*--Dr. Lin Li with expertise in remote sensing, geochemical spatial analysis, and environmental quality.

*Modeling of Hydrologic Systems*—Dr. Meghna Babbar-Sebens with expertise in hydrogeology and development and application of numerical models for water quality assessment.

Over the past decade we have built a strong MS program in Geology, have hired faculty in the focused area of interdisciplinary earth sciences, and have developed research and training collaborations across a number of schools at IUPUI. These efforts ultimately are steps to our departmental goal—to be a research and training program of regional and national scale in the area of interdisciplinary earth sciences. The final paver in this path is the ability to offer a PhD program in Applied Earth Sciences.

**c. Impact on Other Academic Programs.** The proposed Ph.D. is the outgrowth of the currently existing Masters Degree in Geology. The interdisciplinary nature of the program will attract students not only from geoscience fields but also from other science majors. The program will provide students as a resource for faculty in their research efforts. It also will provide an opportunity for the Department faculty members to further explore the field and new research directions through the development of the new courses proposed in this proposal. Thus, this degree program has the potential to bring new resources to the University rather than drain current resources.

**d. Utilization of Existing Resources.** Because this is an interdisciplinary program, Ph.D. students in Applied Earth Sciences will come from a variety of academic disciplines and enroll in courses currently offered at IUPUI, thereby increasing effective use of resources. The proposed Ph.D. program is composed initially of two tracks, each of which stands alone as a Ph.D. minor. Students matriculating into the Ph.D. will choose a minor area of study. The designed tracks will serve to increase the enrollments of the existing Ph.D. minors currently offered at Indiana University-Purdue University Indianapolis. Research conducted by Ph.D. students will likely constitute an expansion of current research areas of program faculty, and thus no specialized equipment will be required. As the program grows such that the Masters and Ph.D. Students combined exceed the current number of Master's students in the department, we may anticipate greater space needs for graduate student offices. This is not expected for the first several years of the program, given a need to scale up the Ph.D. program in a planned manner consistent with fiscal and human resources.

## **2. Student Demand.**

**a. Enrollment Projections.** As of Fall 2008, the Department has 16 full-time graduate students pursuing master degrees, and many of them are expected to be interested in enrolling in the proposed Ph.D. program based on informal discussions with them during graduate committee meetings. Based on the present numbers of Master students, we estimate the first-year enrollment

in the Ph.D. in Applied Earth Sciences is likely to be four to six students. In light of the availability of financial resources, we would expect the program to include around 15-20 students at full implementation.

**b. Enrollment and Completion Data.** We estimate that these students will be wholly new to IUPUI given that no such program currently exists on campus. A potential exists for some current M.S. students, with advanced research career objectives, to apply to and enroll in the Ph.D. program without completing the M.S., and thus our M.S. student population might decline somewhat with this new opportunity.

### **3. Transferability**

### **4. Access to Graduate and Professional Programs**

Not Applicable

### **5. Demand and Employment Factors**

With increasing human population growth, the effects of human activity on Earth are increasingly extensive as reflected by increased severity in many existing environmental problems and new arising problems. Our society has placed environmental issues to a high priority, and environmental problems have captured so much public attention. As environmental problems become more serious, career opportunities continue to increase in environmentally-related fields. Government agencies, private companies, consulting firms, non-profit organizations and universities hire qualified graduates to work in research, policy-setting and educational capacities. This promising employment outlook is one reason so many of today's students seek to prepare themselves for jobs in the environmental sector through both extra-curricular activities (such as campus service programs) and increasingly, formal courses of study in environmental sciences or related fields. This interest is evidenced in enrollment of our recently approved B.S. in Environmental Studies major—the Water and Earth Resources concentration of this major, housed in the ES Department, already has over 20 majors after 1.5 years of establishment.

To accommodate this demand Environmental programs have been introduced in many universities. According to the database maintained by Brown University, over 80 U.S. colleges and universities now have graduate and undergraduate interdisciplinary programs in environmental studies, and this number will continue to grow in the next several decades based on projections of employment demand.

The growth of environmental programs will provide much of the demand for graduates with a Ph. D. in applied environmental sciences, and educators are needed to fill positions in these programs. We expect graduates enrolled into the proposed Ph.D. program will be broadly trained by taking core courses. In addition to broadly based training, the proposed program allows students to acquire depth of knowledge in one of sub-disciplines through the minor option. This area of emphasis is typically the area in which graduates will pursue careers. Many of the courses taken by the students entering the program will be met by current graduate

offerings. Students who earn the Ph.D. in applied environmental sciences should be prepared to offer courses and conduct research on environmentally related subject-areas.

As for students, we expect demand for the proposed Ph.D. will come primarily from current and former students who are working in academic institutions, government employees as well as other environmental scientists who are working in consultant companies.

### Test of Demand

- Job market indicators for 2000 show that the market for recent PhDs in the geosciences is stronger than each of the previous four years. Starting salaries are up in almost every employment sector, including postdoctoral appointments.
- Time spent looking for work is down for the third year in a row. In 1998, graduates spent an average of 5.5 months looking for a job. In 1999, the average was 4.7 months; by 2000, it was only 3.4 months.
- Of the PhD class of 2000, 82% found work within the Earth and Space sciences and 97% were employed in science or engineering.
- Ten percent of new PhDs over the past three years had been employed for more than one year by the time they received their doctorates. Their age, work experience, and salaries differ substantially from those finding initial employment after graduation.

As noted in our support letters from two environmental consulting firms, our focused program provides much-needed expertise for local, state, and national needs in environmental assessment and solution-driven science.

## **6. Regional, State, and National Factors**

**a. Comparable Programs.** There are currently no Ph.D. Programs in Applied Earth Sciences joining together human health, geoscience and geoinformatics in the State of Indiana and across the country. Many campuses have only one of these three components in their geoscience/geological Ph.D. program such as Purdue University at West Lafayette, IUB and Indiana State University. One external Ph.D. program in Interdisciplinary Program in Environment and Resources is offered at Stanford University, CA. As indicated in the support letter from the IU School of Public and Environmental Affairs, there is no duplication of this proposed program and their Ph.D. program in Environmental Sciences. Also, as indicated in our support letter from the Department of Geological Sciences at IUB, our program has a clear and distinctively different focus than their PhD. This degree emphasizes biological and earth sciences without having human health and informatics components.

**b. External Agencies.** Graduate programs in Applied Earth Sciences, as well as traditional Earth Sciences or Geology, are not licensed or accredited. Graduate program quality is assured by the quality of the Applied Earth Sciences faculty at IUPUI and the admission and graduate standards of the Graduate School.

**Appendix 1. Ph.D. Proposal Committee Members:**

Gabriel **Filippelli**, Committee Chair and Professor and Chair, Earth Sciences

Lenore **Tedesco**, Associate Professor, Earth Sciences; Director, Center for Earth and Environmental Sciences

Andrew **Barth**, Professor, Earth Sciences

Doug **Lees**, Professor and Chair, Biology

Joseph F. **Pachut, Jr.**, Associate Professor and Graduate Program Chair, Earth Sciences

Mathew **Palakal**, Associate Dean for Research and Graduate Studies, Informatics

Pamela **Crowell**, Associate Dean for Research and Graduate Studies, Science (now at Idaho State Univ.)

James **Klaunig**, Professor of Toxicology and Director of the Center for Environmental Health, Medicine

Jeff **Wilson**, Associate Professor and Chair, Geography, Liberal Arts

Greg **Wilson**, Professor and Chair of Public Health, School of Medicine

Greg **Lindsey**, Professor and Associate Dean SPEA, IUPUI (now at Univ. Minnesota)

Ingrid **Ritchie**, Associate Professor, SPEA, IUPUI

William **Blomquist**, Professor of Political Sciences, Liberal Arts (now Dean, Liberal Arts)

**Appendix 2. Letters of support**

The following electronic copies of letters of support were obtained based on this proposal.



# INDIANA UNIVERSITY

SCHOOL OF PUBLIC AND  
ENVIRONMENTAL AFFAIRS

September 2, 2008

Professor Gabriel Filippelli, Chair  
Department of Earth Sciences  
Indiana University - Purdue University Indianapolis  
723 W. Michigan Street  
Indianapolis, IN 46202

Dear Professor Filippelli:

I would like to write in support of your proposal for a new Ph.D. program in Applied Earth Sciences at IUPUI. I believe this degree program will enhance research and teaching in the Earth Sciences at IUPUI, and will complement our Ph.D. program in Environmental Science here on the Bloomington Campus. At a recent meeting of the School of Public and Environmental Affairs (SPEA) Environmental Science faculty, your proposal received unanimous support of the Bloomington faculty.

As you know, the Environmental Science Ph.D. program is administered by SPEA, and is a campus-wide degree program with a broad focus in environmental science research, reflecting the research of the faculty on the Bloomington campus. As noted in the proposal, the Ph.D. program in Applied Earth Sciences at IUPUI would be more focused on research problems at the intersection between ecosystem and human health with the built environment, reflecting the research interests of the IUPUI faculty in water resources and environmental health. These areas compliment the research expertise of the Bloomington campus while supporting the mission of IUPUI as an urban campus.

Together with the new Center for Research in Environmental Science (CRES) in Bloomington and the Center for Earth and Environmental Science (CEES) in Indianapolis, the establishment of this degree program will likely enhance collaborative research opportunities between faculty on the Bloomington and Indianapolis campuses. I look forward to working with you as these programs flourish in the future.

Very truly yours,

A handwritten signature in black ink that reads "Philip S. Stevens". The signature is written in a cursive, flowing style.

Philip S. Stevens, Professor  
Director, Ph.D. program in Environmental Science



**INDIANA  
UNIVERSITY  
DEPARTMENT OF  
GEOLOGICAL  
SCIENCES**

SIMON C. BRASSELL  
PROFESSOR & CHAIR  
OF GEOLOGICAL  
SCIENCES  
(812) 855-5581  
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1001 E. 10<sup>TH</sup> STREET  
GEOLOGY BUILDING  
INDIANA UNIVERSITY  
BLOOMINGTON  
IN 47405-1403

Professor Gabriel Filippelli, Chair  
Department of Earth Sciences  
Indiana University - Purdue University Indianapolis  
723 W. Michigan Street  
Indianapolis, IN 46202

November 25 2008

Dear Professor Filippelli,

PH.D. PROGRAM IN APPLIED EARTH SCIENCES AT IUPUI

I am pleased to write a letter on behalf of the Department of Geological Sciences in support of the proposal for development of a Ph.D. Program in Applied Earth Sciences at IUPUI.

The research emphasis of the Ph.D. program in Geology on the Bloomington campus adheres to the objectives expressed in our departmental mission statement "to advance fundamental understanding in the geosciences and its interdisciplinary interfaces, to propagate the application of this knowledge to address issues of societal importance, and to provide effective, innovative, and marketable training for graduate students in the geosciences and interrelated disciplines." Hence, there are overlaps between our aims of those of the proposed Ph.D. degree program at IUPUI, but these represent inevitable similarities among geoscience programs rather than any substantive duplication in emphasis. Moreover, the targeted linkages of Applied Earth Sciences at IUPUI to aspects of toxicology and public health, coupled with its focus on the human built environments, is wholly distinct from many of the synergies with the Indiana Geological Survey and other College Departments that characterize our geology program.

Establishment of a Ph.D. program in Applied Earth Sciences at IUPUI promises to strengthen interactions and facilitate development of collaborative enterprise at the interface of our common interests and through the new initiatives of the Center for Research in Environmental Sciences (CRES) and the Center for Research on Energy and the Environments (CREE). Undoubtedly, the availability of diverse opportunities for graduate study will provide further advantageous in attracting national and international talent to Indiana.

I believe that the new Ph.D. program also affords the possibility to foster further sharing of expertise between our Departments through cooperative faculty service on Ph.D. research committees. I also hope that it will enhance recognition of the critical societal role of geosciences leading to increased institutional support and funding for all such programs, that enable our State's ability to tackle current and future challenges, especially in environmental sciences.

Yours sincerely,

*Simon Brasell*





# INDIANA UNIVERSITY

SCHOOL OF MEDICINE

Graduate Division

September 5, 2008

Professor Gabriel Filippelli, Chair  
Department of Earth Sciences  
Indiana University - Purdue University Indianapolis  
723 W. Michigan Street  
Indianapolis, IN 46202

Dear Professor Filippelli,

On behalf of the Indiana University School of Medicine (IUSM), I write in support of your unique and impressive proposal for a new Ph.D. program in Applied Earth Sciences here at IUPUI. I have read your proposal and I think that the degree program will well complement the other graduate offerings on campus and will enhance the research and work of both the Center for Earth and Environmental Science that is administered by your Department, the Center for Environmental Health that is lead by Dr. J. Klaunig of Pharmacology & Toxicology at the IUSM, and other units on campus.

The IUSM and the School of Science have many productive interactions and we are proud of the collaborative spirit here at IUPUI. As an example, I think that some future students in this proposed Ph.D. program might be supported by the NSF-funded “*GK-12 Urban Educators Program at IUPUI*”. As you know, this program is lead by Dr. Kathy Marrs of the Biology Department in the School of Science and is a partnership between the IUPUI School of Science, the IUSM, and the Indianapolis Public Schools. GK-12 Fellows are research graduate students who dedicate 10 hours per week in nearby grade 6-12 school classrooms (plus 5 hours prep time) working with a science teacher partner to bring excitement of research into the science classroom or outdoor laboratory. GK-12 Fellows benefit by improving their leadership, communication, and teaching skills, and become more aware of the need for high-quality science education at all levels. The Co-PIs on the grant include Dr. Tedesco of Earth Sciences and me. Several M.S. students from your Department already are supported as GK-12 fellows.

We give your program our full support. Please let me know if I can help in any way.

Yours sincerely,

Simon J. Rhodes, Ph.D.  
Associate Dean for Graduate Studies

September 15, 2008

Prof. Gabriel Filippelli, Chair  
Department of Earth Sciences  
Indiana University - Purdue University Indianapolis  
723 W. Michigan Street  
Indianapolis, IN 46202

Professor Filippelli:

INDIANA UNIVERSITY  
SCHOOL OF  
LIBERAL ARTS



Please accept this letter of strong support for the Applied Earth Sciences Ph.D. program proposed at IUPUI. The concentrations and curriculum described in the proposal indicate a unique and important focus that integrates environmental science and human health, drawing on the strength of scientists from multiple disciplines and schools on the IUPUI campus. The proposal is strongly supported by the IUPUI Department of Geography.

As noted, after completing core courses, students in the Applied Earth Sciences Ph.D. program would have options to take specialized courses in geographic information science and environmental remote sensing through the Geography Department. The Geography faculty teaching these graduate courses have active research agendas integrating environmental science and health themes that are well matched with the focus on the Ph.D. program.

The interdisciplinary nature of the Applied Earth Sciences Ph.D. program leverages synergies in environmental and health sciences that are already quite active and well established at IUPUI. The curriculum and focus complement rather than replicate other Ph.D. programs in environmental science in the IU system.

The proposed research focus of the program is also aligned with major funding initiatives from external sources such as the National Science Foundation, National Institutes of Health, and the Environmental Protection Agency, as well as foundations that support research in environment and health. Faculty and graduate students in the Applied Earth Science Ph.D. program will be well positioned to support their research through such sources and contribute to further enhancing the research profile of our University.

The research faculty of the Geography Department are excited about the potential to participate in the proposed program. We anticipate that many of the graduates from our Master of Science in Geographic Information Science (MS GIS) program will view the Applied Earth Science Ph.D. as a potential way to continue on for an advanced degree that build upon themes and research agendas that we focus on in the MS GIS. We look forward to the collaboration.

Sincerely,

A handwritten signature in black ink, appearing to read "J. Wilson".

Jeffrey S. Wilson, Ph.D.  
Associate Professor and Chair

DEPARTMENT OF GEOGRAPHY

Cavanaugh Hall 213  
425 University Boulevard  
Indianapolis, Indiana  
46202-5140

317-274-8877  
Fax: 317-278-5220



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Indiana Water Science Center  
5957 Lakeside Blvd.  
Indianapolis, IN. 46278-1996  
317-290-3333

November 18, 2008

Professor Gabriel Filippelli, Chair  
Department of Earth Sciences  
Indiana University – Purdue University Indianapolis  
723 W. Michigan Street  
Indianapolis, IN 46202

Dear Professor Filippelli:

I am writing in support of the proposed Ph.D. program in Applied Earth Science at Indiana University – Purdue University Indianapolis (IUPUI). The U.S. Geological Survey (USGS) Indiana Water Science Center has worked with staff at the Center for Earth and Environmental Science for a number of years and we are always looking for opportunities for additional collaboration.

The USGS Science Strategy outlines areas where natural science can make substantial contributions to the well-being of the Nation and the world. The proposed program which focuses on research concerning the interaction between ecosystems and human health fits perfectly with one of the USGS strategic directions. The USGS is looking for opportunities to work collaboratively with others to understand the distribution, interactions, conditions, and conservation requirements of organisms in ecosystem context, and to predict changes to biodiversity resulting from land-cover changes, climate change, and other impacts to the ecosystem. This new program should provide opportunities for the University and the USGS Indiana Water Science Center to work on projects that would help advance the understanding of ecosystem structure, function, patterns, and process in the State of Indiana and the Nation.

We look forward to enhancing our collaborative efforts with the University.

Sincerely,

William R. Guertal, Ph.D  
Director, USGS IN & KY Water Science Centers

# MUNDELL & ASSOCIATES, INC.

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110 South Downey Avenue, Indianapolis, Indiana 46219

Phone: 317-630-9060, Fax: 317-630-9065, email: [info@MundellAssociates.com](mailto:info@MundellAssociates.com)

November 20, 2008

Dr. Gabriel M. Filippelli  
Professor and Chair  
Department of Earth Sciences  
Indiana University Purdue University (IUPUI)  
723 W. Michigan Street  
Indianapolis, IN 46202

RE: **Recommendation for Ph.D. Program**  
Department of Earth Sciences, IUPUI

Dear Dr. Filippelli:

I write in strong support of your proposed PhD program in Applied Earth Sciences at IUPUI. I have been fortunate enough to have interacted with the Department of Earth Sciences for some time now, and have been impressed by your growth in terms of faculty, graduate students, and research. This focused growth has been in a very important area—namely, the intersection between environmental processes and people, both through your work in water resources and in human health. You have singled yourselves out by utilizing new technologies grounded in basic research principles to address environmental questions from an interdisciplinary standpoint. An important next step is to expand research dimensions further—a PhD program is essential for developing highly trained graduate students and maximizing your potential to land large NSF, EPA, and NIH research grants. You will be providing unique opportunities for students to capitalize on the exciting research in applied earth sciences going on at IUPUI. As the world is beset by environmental challenges in all directions, this type of program is more important now than ever. You will be training a new breed of interdisciplinary researchers to improve the environmental and economic health in Indiana and beyond.

As a working professional with nearly 30 years of experience in the environmental and geological sciences consulting field, I am well aware of the interdisciplinary approach necessary to solve complex environmental issues. In addition, as the President and Senior Environmental Consultant for a small 20-person Indianapolis-based earth and environmental services firm, and I am also constantly faced with the task of locating, recruiting and retaining high-level professionals with graduate degrees. This is an absolute necessity in order to compete for significant geological, hydrogeological, geochemical, and geophysical science and engineering projects throughout the United States and beyond. Having made our niche in all quantitative aspects of the earth sciences and engineering, we appreciate more than most what a new Ph.D. program

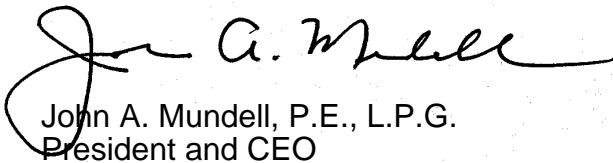
could do to increase the available pool of potential graduates in central Indiana who could offer our firm the expertise needed to continue to expand our capabilities. With so many challenging areas facing us (e.g., sustainable drinking water quality, soil and groundwater impact remediation, global warming's impacts on water availability, and human-health risk assessment to name a few), your Ph.D. program will allow us the benefit of drawing from these additional resources, and continuing to growth our high-tech earth science consulting firm.

Based on my own knowledge of your program and faculty, as well as the excellent approach outlined in your proposal, I predict that, once implemented, your program will be a national player in applied earth sciences. Such a program will draw top-quality student researchers to Indiana from across the nation, and indeed the world. Your focused approach on water quality issues and the intersection between human and environmental health will allow you to uniquely identify your program, maximizing the potential of IUPUI as the Life Sciences campus of IU and providing additional academic resources in an area not currently covered in Indiana. By attracting top talent to Indiana, you also have the potential to reverse the brain drain, thus improving both economic and environmental quality in our state.

You have spent the last decade building your intellectual base with high-quality faculty, and building top-level research facilities. The only ingredient missing now is a PhD program to capitalize on these research resources and vault your program into the top echelon of environmental quality/human health programs. I wish you best success in implementing your PhD program, and look forward to working with you and your PhD students in the decades to come.

Sincerely,

**MUNDELL & ASSOCIATES, INC.**



John A. Mundell, P.E., L.P.G.  
President and CEO

/jam



September 29, 2008

Gabriel Filippelli, Ph.D.  
Professor and Chair  
Department of Earth Sciences  
Indiana University-Purdue University Indianapolis (IUPUI)

Dear Gabe:

I write in strong support of your proposed PhD program in Applied Earth Sciences at IUPUI. I have interacted with the Department of Earth Sciences for decades, and have been impressed by their extraordinary growth in terms of faculty, graduate students, and research. That growth has been in a much focused direction—using cutting-edge technologies and firmly grounded research principles to address environmental questions from an interdisciplinary standpoint. The next step in this growth is to expand research dimensions further, providing opportunities for students to capitalize on the exciting research in applied earth sciences going on at IUPUI. Doing so will develop intellectual capital in this critical field, and will train the next set of interdisciplinary researchers to improve the environmental quality and economic assets in central Indiana and beyond.

I am well aware of the interdisciplinary approach necessary to solve the complex environmental problems of today, be they as broad as global climate change or as focused as protecting the quality of water in urban watersheds. As the President and Managing Principal for Quality Environmental Professionals, Inc., "Qepi" 80 percent of our project work is based on soil and groundwater investigation and remediation services where having interdisciplinary staff is crucial to our high tech field. Qepi and the local consulting field would greatly benefit from having the opportunity to hire and/or work with the highly trained experts at IUPUI.

Based on your proposal, my knowledge of your program and faculty, and the research needs in environmental issues in Indiana and globally, I foresee this program becoming a national leader in interdisciplinary applied earth sciences, particularly because of the unique and timely focus on water resources research and human health-related topics. The program is likely to recruit students nationally and internationally, bringing top talent to central Indiana. I also foresee some of your graduates staying here in Indiana to influence the course of earth sciences research, thus reversing the brain drain and enhancing the economy of Indiana.

You have built the intellectual resources and research infrastructure to be a national player in this field. All you need now is simply the opportunity to work with top-level PhD students to achieve that goal. I wish you great success in implementing your PhD program, and will capitalize on this resource myself in the decades to come.

Sincerely,

Deborah E. Peters.  
President & CEO

### **Appendix 3. Earth Sciences Faculty research**

A summary of Earth Sciences faculty research interests, three recent publications, recent/current funding, and graduate student mentoring experience is listed below. A complete listing of faculty backgrounds and scholarship is at [http://www.earthsciences.iupui.edu/Faculty\\_Staff/index.htm](http://www.earthsciences.iupui.edu/Faculty_Staff/index.htm). Additionally, a complete list of thesis titles for our 52 M.S. since 1992 is available at [http://www.earthsciences.iupui.edu/Degree\\_Programs/Graduate\\_Studies/past\\_thesis.htm](http://www.earthsciences.iupui.edu/Degree_Programs/Graduate_Studies/past_thesis.htm)

#### **Dr. Meghna Babbar-Sebens, Assistant Professor**

*Ph.D., University of Illinois at Urbana-Champaign, 2006*

Research is focused on the modeling of water-borne contaminants, and decision support systems for management of water quality and associated ecological and human health risks. Dr. Babbar-Sebens research focuses on a) analysis of uncertainty when models are used to conduct spatially referenced systems-scale environmental assessments, b) incorporation of uncertainty analysis within decision support systems used for risk assessment and management, and c) optimization of water resources planning and management strategies for emergency response and water-borne disease prevention.

#### Publications

- Babbar-Sebens, M., and R. Karthikeyan, *in review*, Consideration of sample size for estimating contaminant load reductions using load duration curves, *Journal of Hydrology*.
- Babbar-Sebens, M., and B. S. Minsker, *in press*, Standard interactive genetic algorithm (SIGA): A comprehensive optimization framework for long-term ground water monitoring design. *J. of Water Resources Planning and Management*.
- Babbar, M., and B. S. Minsker, 2006. Groundwater remediation design using multiscale genetic algorithms, *J. of Water Resources Planning and Management*, 132: 341-350.

#### Graduate Mentoring (thesis students)

##### *Current student*

Andrew Gamble, M.S. candidate

#### **Dr. Andrew Barth, Professor**

*Ph.D., University of Southern California, 1989*

Research focuses on the tectonic evolution of Western North America during the last 3 billion years. Previous work emphasized the evolution of Mesozoic granitic rocks, both as windows into the evolution of magma systems and as indicators of later rock exhumation. Currently studying Proterozoic metamorphic rocks and their implications for the origin of continental crust, and the tectonics within the dying Mesozoic continental margin arc system in southern California and western Arizona.

#### Publications

- Barth, A.P., Wooden, J.L., Howard, K.A., and Richards, J.L., 2008, Late Jurassic plutonism in the southwest U.S. Cordillera, in Wright, J.E., and Shervais, J.W. (eds.), *Arcs, Ophiolites and*

Batholiths: A Tribute to Cliff Hopson: Geological Society of America Special Paper, 438: 379-396.

Barth, A.P., and Wooden, J.L., 2006, Timing of magmatism following initial convergence at a passive margin, southwestern U.S. Cordillera, and ages of lower crustal magma sources: *Journal of Geology*, 114: 231-245.

Barth, A.P., Wooden, J.L., Jacobson, C.E., and Probst, K., 2004, U-Pb geochronology and geochemistry of the McCoy Mountains Formation, southeastern California: A Cretaceous retroarc foreland basin: *Geological Society of America Bulletin*, 116: 142-153.

### Funding

Timing and geodynamic significance of Mesozoic basement tectonism and basin evolution in the southwestern North American Cordillera. National Science Foundation

Secular variation in the Cordilleran continental arc: Implications for arc geodynamics. National Science Foundation

Volcanic material in Triassic sedimentary units of southwestern North America: understanding the initiation of arc magmatism. National Science Foundation

### Graduate Mentoring (thesis students)

#### *Current students*

Sarah Needy, M.S. candidate

Jennifer Roell, M.S. candidate

#### *Past students*

Kristen Hellem Hughes, M.S. 2007. *The heterogeneity of southern California mantle as determined by the petrologic classification, geochemical analysis, and geothermometry of mantle xenoliths from Joshua Tree National Park, USA*. Indiana University.

Nicole Fohey, M.S. 2006. *A comparison of ignimbrites from the Sidewinder volcanic series to exposed plutons, southern California*. Indiana University.

### **Dr. Gabriel Filippelli, Professor and Chair**

*Ph.D., University of California, Santa Cruz, 1994*

Studies the chemistry and geologic history of nutrient cycling in the ocean and on land. Current research projects involve determining the controls on nutrient cycling on land during glaciation, examining the timing and driving forces of biological productivity in the ocean, assessing the content and distribution of the potentially harmful element mercury in coal resources of Indiana and examining the links between lead distribution and children's blood lead levels in urban areas.

### Publications

Filippelli, G.M., 2008. The global phosphorus cycle: Past, present and Future. *Elements*, 4(2): 89-95. *Highlighted as an Editor's Choice in Science, May, 2008.*

Laidlaw, M.A. and Filippelli, G.M., 2008. Resuspension of urban soils as a persistent source of lead poisoning in children: A review and new directions. *Applied Geochemistry*, 23: 2021-2039.

Filippelli, G.M., Latimer, J.C., Murray, R.W., and Flores, J.A., 2007. Productivity records from the Southern Ocean and the equatorial Pacific Ocean: Testing the Glacial Shelf-Nutrient



Hypothesis. *Deep Sea Research II*, 54/21-22: 2443-2452. *Highlighted as an Editor's Choice in Science, October, 2007.*

### Funding

Testing the shelf-nutrient hypothesis by examining the oceanic phosphorus cycle on glacial timescales. National Science Foundation

Phosphorus and carbon sedimentation on precessional timescales: A Pleistocene-Miocene comparison. American Chemical Society-Petroleum Research Fund

SMOGEE: Students as Mentors and Owners of Geoscience and Environmental Education: The Global Warming Road Show. National Science Foundation

### Graduate Mentoring (thesis students)

#### *Current students*

D. Lani Pascual, Ph.D. candidate, University of Michigan (co-advisor)

Carrie Hatcher, M.S. candidate

Angela Robertson, M.S. candidate

J. Brice Mabry, M.S. candidate

Alexavier Rowan, M.S. candidate

Deborah Morrison, M.S. candidate

#### *Past students*

Sarah Hale, M.S. 2008. *Paleoproductivity variations in the eastern central equatorial Pacific Ocean on glacial timescales*. Indiana University.

Cheryl Nazareth, M.S. 2008. *Invasive species and panne ecosystems: The effects of atmospheric pollution*. Indiana University.

Robyn Raftis, M.S. 2007. *Internal cycling of phosphorus in an urban drinking water reservoir*. Indiana University.

Kimberly Null, M.S. 2005. *Sediment Geochemistry across six sediment facies from ODP Site 893, Santa Barbara Basin, California*. Indiana University.

Jennifer Latimer, Ph.D., 2004. *Paleo-export production and terrigenous sedimentation in the Southern Ocean*. Indiana University.

Sara Slater-Atwater, M.S. 2004. *The effects of climate and weathering on terrestrial phosphorus cycling in an alpine system: Coast Mountains, British Columbia*. Indiana University.

Rosalice Haberman Buehrer, M.S. 2003. *Sulfur and carbon in granitic rocks: Analytical techniques for quantitative analysis and implications for the volatile content of magmas*. Indiana University (co-advised with Andrew Barth).

Mark Laidlaw, M.S. 2001. *Distribution and sources of metals in soils of Marion County, Indiana*. Indiana University.

Nancy Dollar, M.S. 2000. *Chemical fractionation of metals in wetland sediments: Indiana Dunes National Lakeshore*. Indiana University.

Lynette de Silva, M.S. 2000. *Is there strong evidence supporting natural attenuation of chlorinated solvents at the Uniontown Landfill?* Indiana University.

Jennifer Latimer, M.S. 1998. *Dust inputs and biogeochemical cycling in the Southern Ocean on glacial/interglacial time scales*. Indiana University.

- Jeffrey Carnahan, M.S. 1998. *Determination of germanium/silicon in freshwater diatoms: Separation, cleaning, dissolution and analysis of biogenic opal from an alpine lake sediment core*. Indiana University.
- Steven Perkins, M.S. 1998. *Trace metal contamination of wetland sediments at Indiana Dunes National Lakeshore, Indiana*. Indiana University.
- Michael Yarling, M.S. 1996. *The occurrence and origin of sulfates in a sand gravel aquifer system near Fort Wayne, Indiana*. Indiana University.
- Stephen Zins, M.S. 1995. *Phosphorus accumulations rates in a midwestern lake from the last glacial maximum*. Indiana University.

**Dr. Lin Li, Assistant Professor**

*Ph.D., Brown University, 2002*

Publications

- Li, L., 2008. Retrieval of vegetation equivalent water thickness from reflectance using genetic algorithm (GA)-partial least squares (PLS) regression, *Advances in Space Research*, 41:1755-1763, 2008.
- Li, L., S. L. Ustin, and D. Riaño, 2007. Retrieval of fresh leaf fuel moisture content using genetic algorithm – partial least squares modeling (GA-PLS), *IEEE Transaction on Geoscience and Remote Sensing Letters*, 4: 216-220.
- Li, L., 2006. Partial least squares modeling to quantify lunar soil composition with hyperspectral reflectance measurements, *Journal of Geophysical Research-Planets*, 111, E04002, doi:10.1029/2005JE002598, 2006

Funding

Quantitative mineral abundance maps of the Moon. NASA.

Testing Bio-Optical Algorithms for Remote Sensing of Inland Water Quality. NASA.

Developing a survey tool for the rapid assessment of blue-green algae in Central Indiana's reservoirs. Lake and River Enhancement Program, Indiana State Department of Natural Resources.

Graduate Mentoring (thesis students)

*Current students*

Anthony Robertson, M.S. candidate

Tingting Zhang, Ph.D. candidate, China (supported by Chinese National Science Foundation)

*Past students*

Baojuan Zheng, M.S. 2008. *Remote sensing applications for monitoring and assessing environmental problems*. Indiana University.

Rebecca Sengpiel, M.S. 2007. *Using airborne hyperspectral imagery to estimate chlorophyll A and phycocyanin in three central Indiana mesotrophic to eutrophic reservoirs*. Indiana University.

**Dr. Kathy Licht, Associate Professor**

*Ph.D., University of Colorado, 1999*

Previous work has utilized sedimentology and stratigraphy to reconstruct ice extent, as well as <sup>14</sup>C dating to constrain the timing of ice advance and retreat. A recently funded Antarctic project linked the mineralogical, geochemical, and isotopic characteristics of the sediments from Ross seafloor sites that were once covered by glacial ice to sediments collected from the source areas of ice in East and West Antarctica to determine past ice flow paths. This type of study contributes to the understanding of changes in ice sheet dynamics through time. Reliable predictions of the West Antarctic ice sheet's future response to changing climate and rising sea level depend, to a large extent, on improving our knowledge and understanding of its ice dynamics during the last glacial maximum (~18,000 yrs ago). Sediments from the Ross Sea, Antarctica contain a detailed physical record that can be used to reconstruct the glacial history of the region. Although significant progress has been made in constraining the extent of ice and the timing of its maximum extent, details of ice flow paths, chronology, and ocean conditions remain unresolved.

Publications

- Emslie, S., Coats, L., and Licht, K., 2007. A 45,000 yr record of Adélie penguins and climate change in the Ross Sea, Antarctica. *Geology*, 35: 61-64.
- Farmer, G.L., Licht, K., Swope, R.J., and Andrews, J.T., 2006. Isotopic constraints on the provenance of fine-grained sediment in LGM till from the Ross Embayment, Antarctica. *Earth and Planetary Science Letters*, 249: 90-107.
- Licht, K.J., Lederer, J.R., and Swope, R.J., 2005. Provenance of LGM Glacial Till (sand fraction) across the Ross Embayment, Antarctica. *Quaternary Science Reviews*, 24: 1499-1520.

Funding

- Collaborative Research: Integrated Study of East Antarctic Tills (ISET): Tracers of ice flow and proxies of the ice-covered continental shield. National Science Foundation.
- Analysis of Detrital Zircon from Antarctic Glacial Sediments as a Tool to Constrain Past Ice Flow Dynamics. IUPUI Office of Professional Development, Research Support Funds Grant.
- Collaborative Research: Paleo ice flow paths from till provenance in the Ross Embayment, Antarctica. National Science Foundation.

Graduate Mentoring (thesis students)

*Current student*

Andrea Schilling, M.S. candidate.

*Past students*

- Kate Kremer, M.S. 2008. *Provenance of sediment from Reedy Glacier, Antarctica*. Indiana University.
- Emerson Palmer, M.S. 2007. *Provenance of sediment of the Ross Sea, Antarctica*. Indiana University.
- Jennifer Nelson, M.S. 2006. *Cyclic deposition of carbonate and organic matter in Holocene lacustrine sediment, Lower Michigan, USA*. Indiana University.

Jason Lederer, M.S. 2003. *Provenance of last glacial maximum till from the Ross Embayment, Antarctica*. Indiana University.

**Dr. Joseph Pachut, Associate Professor**

*Ph.D., Michigan State University, 1977*

Research interests involve understanding the patterns of evolution in fossil organisms using quantitative data analysis techniques. Included are analyses of the paleoecology of ancient ecosystems, of patterns of growth and development in colonial animals that lived under different paleoenvironmental conditions, statistical evaluations of the "genetics" of fossil colonial organisms, fossil biodiversity biogeographic patterns and changes in the tempo and mode of evolutionary changes throughout geologic time.

Publications

Pachut, J. F. and R. L. Anstey, *in press*. Inferring evolutionary modes in a fossil lineage (Bryozoa: *Peronopora*) from the Middle and Late Ordovician. *Paleobiology*.

Powers, C. M. and J. F. Pachut. 2008. The fate of Triassic bryozoans in the wake of the Permo-Triassic extinction. *Journal of Paleontology*, 82: 393-402.

Pachut, J. F. and R. L. Anstey. 2007. Inferring Evolutionary Order and Durations Using Both Stratigraphy and Cladistics in a Fossil Lineage (Bryozoa: *Peronopora*). *Palaios*, 22: 476-488.

Funding

Microevolution in Two Lineages of Upper Ordovician (Cincinnatian) Bryozoans. National Science Foundation.

Graduate Mentoring (thesis students)

*Current student*

Amber Adamczyk, M.S. candidate.

*Past students*

Margaret McGinnis, M.S. 1999. *Larval development of Ordovician bryozoans from the Dillsboro Formation, southeastern Indiana*. Indiana University.

Catherine Jamet, M.S. 2002. *The fate of Triassic bryozoans in the wake of the Permo-Triassic extinction*. Indiana University.

**Dr. Lenore Tedesco, Associate Professor**

*Ph.D., University of Miami, 1991*

Research focuses on wetland restoration including evaluation of restoration strategies and wetland function. This includes studies of urban riparian reforestation, fen wetland restoration, and on the distribution of anthropogenic pollutants. Additional research interests address regional watershed and water quality issues. Working with the Pervasive Technology Labs and CEES staff to develop an autonomous environmental monitoring network measuring water quality

throughout central Indiana. Environmental education based on restoration research and environmental monitoring is an important part of her research interest.

### Publications

- Vidon, P., L.P. Tedesco, J. Wilson, M.A. Campbell, L.R. Casey, and Mark Gray. 2008, Direct and indirect hydrological controls on E.coli concentration and loading in Midwestern streams. *Journal of Environmental Quality*, 37(5):1761-1768.
- Randolph, K., Wilson, J., Tedesco, L.P., Li, L., and Soyeux, E., *in press*. Hyperspectral Remote Sensing of Cyanobacteria in Turbid Inland Waters Using Optically Active Pigments, Chlorophyll a and Phycocyanin. *Remote Sensing of Environment, Special Issue – Application of Remote Sensing to Monitoring Freshwater and Estuarine Systems*.
- Tedesco, L.P., and Salazar, K.A., 2006, Using Environmental Service Learning in an Urban Environment to Address Water Quality. *Journal of Geoscience Education*, 54: 123-132.

### Funding

- Mitigation of Contaminants in Rural and Semi-Rural Environments to Protect Surface and Groundwater (Aquisafe 07). KompetenzZentrum Wasser Berlin.
- Watershed-Scale Evaluation of BMP Effectiveness and Acceptability: Eagle Creek Watershed, Indiana. US Department of Agriculture.
- The GK-12 Urban Educators Program at IUPUI: Teaching and Learning Science through Research. National Science Foundation.

### Graduate Mentoring (thesis students)

#### *Current students*

- Michael Stouder, M.S. candidate.
- Angela Cowan, M.S. candidate.

#### *Past students*

- Leda Casey, M.S. 2007. *The influence of season, flow regime, and watershed land use and land cover on nutrient delivery to two rapidly urbanizing watersheds in central Indiana, USA*. Indiana University.
- Dustin Graves, M.S. 2007. *Geologic setting, hydrology, and geochemistry of fens in the Midwest area*. Indiana University.
- Karen Koy, M.S. 2005. *Changes in late Holocene coastal paleoenvironments in Southwest Florida as reflected in reef-associated macrofauna*. Indiana University.
- Lora Shrake, M.S. 2002. *Groundwater, surface water, and estuarine interactions in the Blackwater River Estuary, Ten Thousand Islands, Florida, USA*. Indiana University
- Jody Arthur, M.S. 2001. *The pollen record of recent hurricane events in a nearshore sedimentary environment: Oyster Bay, South Florida*. Indiana University.
- Adam Boettner, M.S. 2000. *Vertical profiles of trace elements concentrations and sediment accumulation in four marginal marine environments, Southwest Florida*. Indiana University.
- Michael O'Neal, M.S., 1999. *The sediment record as a proxy of late Holocene sea level rise, southwestern Florida*. Indiana University.
- Toby Rickabaugh, M.S. 1999. *The distribution of trace elements in superficial sediments of Rookery Bay National Estuarine Research Reserve: Implications for anthropogenic impacts*. Indiana University.

## **Dr. Philippe Vidon, Assistant Professor**

*Ph.D., York University, 2004*

Current research focuses on watershed hydrology and biogeochemistry with a special focus on nitrogen (N) and carbon (C) cycling at the watershed scale. Research includes riparian zone hydrology and biogeochemistry, watershed hydrology, and E.coli dynamics and N and C cycling in riparian soils and small watersheds, with an aim of better understanding the hydrological and biogeochemical processes controlling water quality at the watershed scale and nutrient removal in riparian zones and wetlands.

### Publications

- Vidon, P., L.P. Tedesco, J. Wilson, M.A. Campbell, L.R. Casey, and Mark Gray. 2008, Direct and indirect hydrological controls on E.coli concentration and loading in Midwestern streams. *Journal of Environmental Quality*, 37(5):1761-1768.
- Vidon, P., L.E. Wagner, E. Soyeux, 2008. Changes in the character of DOC in streams during storms in two Midwestern watersheds with contrasting land uses. *Biogeochemistry*, 88: 257-270, DOI 10.1007/s10533-008-9207-6.
- Vidon, P., M.G. Dosskey, 2008. Testing a simple field method for assessing nitrate removal in riparian zones. *Journal of the American Water Resources Association* 44(2):523-534. DOI: 10.1111/j.1752-1688.2007.00155.

### Funding

Nutrient and carbon delivery to streams in artificially drained landscapes of the Midwest: matrix flow, overland flow or macropore flow? USGS-NIWR National Competitive Grant Program.

Generalizing riparian zone function at the landscape scale: new tools, new approaches, gaps in knowledge and future research directions. National Science Foundation.

Greenhouse gas emissions from riparian zones across a regional hydrogeomorphic gradient. USDA (w/ P. Jacinthe)

### Graduate Mentoring (thesis students)

#### *Current students*

Matt Hennessy, M.S. candidate.  
Joseph Johnstone, M.S. candidate.  
Pilar Cuadra, M.S. candidate.

#### *Past students*

Laura Wagner, M.S. 2007. *Variations in nitrate, soluble reactive phosphorus, and dissolved organic carbon concentration in streams during storms in glaciated landscapes of the Midwest*. Indiana University.

Andrew Smith, M.S. 2007. *Riparian hydrology and geomorphologic setting of a glaciated valley in central Indiana*. Indiana University.

**Dr. Pierre-André Jacinthe, Assistant Professor**

*Ph.D., Ohio State University, 1995*

Nitrogen dynamics and water quality; soil-atmosphere exchange of trace gases (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O); biogeochemistry of restored wetlands; soil erosion and the global carbon cycle; carbon sequestration; conservation tillage and soil processes. Programs include (1) trace gas dynamics in managed and natural ecosystems, (2) nutrient cycling and water quality, (3) carbon biogeochemistry, dynamics and assessment methods, and (4) biogeochemistry of restored ecosystems.

Publications

Jacinthe, P.A., and R. Lal. 2006. Spatial variability of soil properties and trace gas fluxes in reclaimed mineland. *Geoderma* 136: 598-608.

Jacinthe, P.A., and R. Lal. 2006. Methane oxidation potential of reclaimed grassland soils as affected by management. *Soil Science* 171: 772-783.

Jacinthe, P.A., and P.M. Groffman. 2006. Microbial nitrogen cycling processes in a sulfidic coastal marsh. *Wetlands Ecology and Management* 14:123-131.

Funding

Greenhouse gas emissions from riparian zones across a regional hydrogeomorphic gradient. USDA-CSREES – Air Quality Program (w/ P. Vidon)

Greenhouse gas budget and methane dynamics in a no-tillage chronosequence. USDA-CSREES – Air Quality Program

Trace gas fluxes in riparian buffers along an urban-rural gradient. Indiana Water Resources Research Center.

Graduate Mentoring (thesis students)

*Current students*

Allyson Smith, M.S. candidate.

*Past students*

Jonathan Bills, M.S. 2009. *Carbon Sequestration in Wetlands affected by Invasive Non-native Vegetation*. Indiana University.

**Dr. Gary Rosenberg, Associate Professor**

*Ph.D., University of California, Los Angeles, 1972*

Research interests include mapping the distribution of trace elements in shells, teeth, and bone with digital electron microscopy to determine how both physiology and environment influence skeletal form, crystallography, growth, and composition. These studies, in combination with studies of the metabolism of bivalves, will help us develop proxies for the metabolism of fossil molluscs. Additional interests in studying art history for clues to help us understand the origin of modern geologic thought in Western Europe. I have compared the geometric representation of spatial relationships that European Renaissance artists developed, with the meditative images that eastern cultures produced. I believe these different ways of viewing nature help to explain why the Scientific Revolution took place first in Europe and not in the East.

### Publications

- Rosenberg, G.D., Hughes, W.W., Parker, D.L. and Ray, B.D. 2001. The geometry of bivalve shell chemistry and mantle metabolism, *Bulletin of the American Malacological Society*, 16: 251-261.
- Rosenberg, G. D. 2001. An artistic perspective on the continuity of space and the origin of modern geologic thought, *Earth Sciences History*, 20: 127-155.
- Rosenberg, Gary D. 2006. Nicholas Steno's *Chaos* and the shaping of evolutionary thought in the Scientific Revolution, *Geology*, 34: 793-796.

### **Dr. R. Jeffrey Swope, Senior Lecturer**

*Ph.D., University of Colorado, 1997*

My research involves the determination of mineral structures using x-ray diffraction data in order to address a wide variety of Earth-related problems including: the crystal chemical behavior of mantle minerals, the effects of chlorine in biotite and amphibole, the shape of atoms in minerals as related to bond type, and the effects of cation ordering in micas. Additional applied studies include: study of natural analog minerals to evaluate potential nuclear waste forms, structure determination of organo-metallic molecules, and evaluation of the structural state of semi- and super-conducting materials.

### Publications

- Swope, R.J., and Gieré, R., 2004. A strategy for teaching an effective undergraduate mineralogy course. *Journal of Geoscience Education*, 52: 15-22.
- Jacobsen, S.D., Smyth, J.R., and Swope, R.J., 2003. Thermal expansion of hydrated six-coordinate silicon in thaumasite,  $\text{Ca}_3\text{Si}(\text{OH})_6(\text{CO}_3)(\text{SO}_4)\cdot 12\text{H}_2\text{O}$ . *Physics and Chemistry of Minerals*, 30: 321-329.
- Jakubowski, R.T., Fournelle, J., Welch, S, Swope, R.J., and Camus, P., 2002. A study of anhydrite phenocrysts from the 1991 climactic eruption of Mount Pinatubo: evidence for magmatic vapor deposition of anhydrite. *American Mineralogist*, 87: 1029-1045.

### **Ms Jennifer Nelson, Lecturer**

*M.S., Indiana University (IUPUI), 2006*

Jennifer has collaborated on several course development projects, including the reorganization of the intro level environmental geology laboratory course and the development of an online field experience course in Indiana Geology. Research interests include paleoclimatology (study of past climate), paleolimnology (study of history of lakes) and oceanography.

### Publications

- Thomas, Christopher W, Nelson, Jennifer A., 2006, Designing an Online Science Lab Around Self-Paced Field Trips, *Geological Society of America Abstracts with Programs*, Vol. 38, No. 7, p. 80
- Nelson, J.A., and Licht, K.J., 2006, Deposition of Carbonate and Organic Matter in Holocene Lacustrine Sediment, Lower Michigan, USA. 10<sup>th</sup> International Paleolimnology Symposium, Duluth, Michigan.



Yansa, C., Rawling III, J.E., Nelson, J.A. Licht, K.J. and Young, A., 2006, Climate Changes in Southern Lower Michigan Over the Last 2000 Years: Differentiating Between “Lake Effect” and Regional Climate Patterns. American Quaternary Association (AMQUA) 2006 Biennial Meeting, Bozeman, Montana.

#### Appendix 4. Listing of Potential participating faculty

Faculty listed below reside in the following Schools and Departments listed and will play a role in the Ph.D. in G3.

<u>School</u>	<u>Department(s)</u>
Engineering and Technology Informatics	Richard G. Lugar Center for Renewable Energy Bioinformatics, Health Informatics
Liberal Arts	Geography, Political Science
Medicine	Public Health, Pharmacology & Toxicology, Pediatrics
Nursing	Nursing; Environments for Health
Public and Environmental Affairs	Environmental Science & Health, Public Affairs
Science	Biology, Chemistry and Chemical Biology (Forensics)

Pauline Baker, Ph.D., (University of Illinois), Associate Professor of Informatics (IUPUI) – Visual Information Sensing and Computing

Aniruddha (Rudy) Banerjee, Ph.D., (Univ. Iowa, 2004), Assistant Professor of Geography -- Environmental epidemiology/medical geography

Richard Bein, Ph.D., (Univ. Florida, 1984), Professor of Geography – Third world agriculture and environmental conservation.

Anne Belcher, D.N.S., (Indiana University), Associate Professor, and Chair, Department of Environments for Health, IU School of Nursing – Community Health.

William Blomquist, Ph.D., (Indiana University-Bloomington, 1987), Professor of Political Science (IUPUI); Dean, School of Liberal Arts – Surface and groundwater policies and problems

Timothy Brothers, Ph.D., (UCLA, 1985), Associate Professor of Geography (IUPUI) – Human alteration of vegetation and the environment.

Sapna Deo, Ph.D., (University of Kentucky, 2000), Assistant Professor of Chemistry and Chemical Biology – Analytical chemistry, environmental sensors.

Stephen Downs, M.D., M.S., (Stanford University), Director of Children's Health Services Research Program at Indiana University School of Medicine -- Computer-based decision effectiveness analysis.

Dominique Galli, Ph.D., (Ludwig Maximilians-Universität, Munich, Germany), Associate Professor of Oral Biology, IU School of Dentistry – Environmental microbiology.

John Goodpaster, Ph.D., (Michigan State University, 2000), Assistant Professor of Chemistry and Chemical Biology – Analytical chemistry and forensic science.

Andrew Hsu, Ph.D., (Georgia Tech, 1986), Professor of Mechanical Engineering—Fuel cells and reformers, renewable hydrogen.

Daniel Johnson, Ph.D., (Indiana State University, 2007), Assistant Professor of Geography -- Urban health, urban climatology

James Klaunig, Ph.D., (University of Maryland, 1980), Professor of Toxicology (IUPUI) – natural and synthetic chemical carcinogens

Gilbert Liu, M.D., (University of Mississippi, 1996), Assistant Professor of Pediatrics, Indiana Children's Health Services Research, Indiana University School of Medicine – Environmental health and spatial analysis.

David McSwane, H.S.D., (Indiana University), Professor and Interim Associate Dean, School of Public and Environmental Affairs – Environmental safety, food safety.

Richard Nass, Ph.D., (The Johns Hopkins University School of Medicine, 1998), Associate Professor of Environmental Toxicology – Environmental toxicology, metal toxicity

Matthew Palakal, Ph.D., (Concordia University, 1987), Professor and Associate Dean, School of Informatics – Intelligent Information Management Systems

Ingrid Ritchie, Ph.D., (University of Minnesota), Associate Professor of Environmental Science and Health (IUPUI) – Environmental Management and Assessment

Jay Siegel, Ph.D., (George Washington University, 1975), Professor and Chair, Chemistry and Chemical Biology – Forensic analytical chemistry.

Greg Steele, D.P.H., (University of Alabama, Birmingham), Associate Professor of Public Health, Indiana University School of Medicine – Epidemiology, environmental contamination and human health.

Sarah Wiehe, M.D., (University of Chicago, 1998), Assistant Professor of Pediatrics, Indiana Children's Health Services Research, Indiana University School of Medicine – Poverty and health.

Jeff Wilson, Ph.D., (Indiana State University, 1998), Associate Professor and Chair, Geography – Remote sensing and Geographic Information Science.

Xianzhong Wang, Ph.D., (Ohio State University, 1997), Associate Professor of Biology – Ecology and Environmental Change.

Jian Xie, Ph.D., (Miami University, Ohio, 1999) Assistant Professor of Mechanical Engineering – Renewable energy.

11/21/2008

## Appendix 5. External Graduate Program Review Response

28 April, 2003

To: T. Banta, D. Stocum  
From: A. Barth  
Re: Department of Geology Academic Program Review

The Department of Geology completed the initial phase of an external academic program review with the visit of a review team to IUPUI on 19 and 20 September, 2002. The review team included faculty from high quality geoscience programs at other universities in the Midwest, local community representatives, and IUPUI faculty, and was comprised of

- S.L. Forman, University of Illinois at Chicago
- W.B. Lyons, Ohio State University
- T.C. Moore, University of Michigan
- L. Kaplan, Indiana Department of Environmental Management
- J. Mundell, Mundell and Associates, Indianapolis, IN
- R. Larter, Department of Chemistry, IUPUI
- C. Souch, Department of Geography, IUPUI

The primary focus of this external review was the graduate program, because a thorough external review of the Geology undergraduate program was completed in 1998. A copy of the self-study for that prior review is available at <http://www.planning.iupui.edu/programreview/geocont.html>.

The review team concluded that the department provides a high quality, personalized education at both the undergraduate and graduate levels. The team recognized a very strong operational synergy between the undergraduate and graduate programs. This recognition is a reflection of the success of the faculty's efforts to develop the graduate program in geology since 1995 while maintaining the quality of the undergraduate program and ensuring the continued success of undergraduate students. We intend to maintain this course into the future, as we attempt to attract new, talented freshman undergraduate majors through targeted program development in environmental geoscience.

The review team concluded that the school has built a department faculty that is a real asset to IUPUI, in that it is relatively youthful, remarkably diverse, and very talented at both research and teaching. The geology faculty have developed a united vision for the continued growth of the department focusing on environmental geoscience research and education. The review team sensed this vision and recognized that, when coupled with a strong faculty and the enhanced intellectual capital derived from growing collaborations across the campus, the momentum for continued growth and future excellence is very real.

The review team concluded that, in general, the intellectual climate and vision for further development of the graduate program in environmental geosciences is in place. Specifically, the review team was asked to evaluate the state of readiness and the potential of the department to expand graduate education and to undertake a Ph.D. program. We proposed to develop a truly interdisciplinary and innovative graduate program in biogeosciences, defined as the intersection between geology, biology, and the health sciences, and focusing on the impact of the natural environment on human health. This graduate program would include M.S. and Ph.D. degrees, and may have either research tracks or Ph.D. minors in Environmental Microbiology, Ecosystem

Dynamics, Public Health, GeoInformatics, and Environmental Forensics. Full partners in this program would include other departments in the School of Science, and the Schools of Informatics, Liberal Arts, Public and Environmental Affairs, and Public Health. Such a program would take advantage of our central Indiana location and existing campus strengths, and would align program development in geology with the campus goals of expanding graduate education and life science programs. The review team concluded that there is great potential to build a nationally recognized, high quality program of this type at IUPUI - a new graduate program that is innovative, builds on campus strengths, is beneficial to the University and the State of Indiana, and is therefore worthy of support.

The challenges that we face in further development, in graduate education generally and in biogeosciences in particular, are well known to you, and were clearly articulated by the review team.

- *The department must articulate a mission and goals for the new program:* the faculty are drafting a revised mission and set of strategic objectives in response to these comments.
- *The review team centered on a number of full-time faculty (ca. 15) necessary to adequately deliver graduate education:* the faculty are refining and focusing the Ph.D. program proposal for graduate education in biogeosciences that will allow us to take advantage of the strengths of our most research-active faculty and faculty in affiliated departments (Geography, Public Health, Public and Environmental Affairs, Informatics) to constitute a core faculty of 15-20 for the proposed program; if the life sciences and informatics aspects of the program are well developed, new faculty may be added in these emerging interdisciplinary areas.
- *The review team rightly emphasized the low level of support for graduate students:* this program must be supported by growth in external funding, continuing the trajectory of external funding growth in the department over the last 6 years and tapping new sources (e.g., USFilter, U.S. Geological Survey; NSF's IGERT program); in addition, if the proposed program is well aligned with campus goals, start-up funds from the Research Investment Fund for research infrastructure and/or program support would be appropriate.
- *The review team also rightly emphasized space constraints:* this issue is central to campaign plans of the school.
- *An improved relationship with our 'peer' department at Bloomington would be beneficial for further growth:* attempts so far have been unsuccessful, and the likelihood of operational collaboration as peers with the Bloomington geological sciences faculty in the near future is low, and if pursued would divert scarce IUPUI resources and delay program growth.

In summary, the Department of Geology graduate program review confirmed that we have developed an effective M.S. degree program over the last seven years, with an overall positive impact on a high quality undergraduate program offering B.A. and B.S. degrees. The review team recognized a high quality faculty with a focus on biogeosciences, an area of local and national need, and with a vision and great potential for further developments at the intersection of earth and life sciences that will serve the needs of the university and the state. The Department of Geology appreciates the valuable input from the review team, and proposes to pursue continued growth in this direction at both the undergraduate and graduate levels.