Environmental Engineering and Science

MS and PhD degree Studies

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Admission and Application details at www.civil.northwestern.edu
... Program Overview

Sustainable Communities

The goals of our program are to ensure that modern civilizations coexist in synergy with nature and to promote sustainable communities where critical activities are ecologically sound, socially just, and economically viable now and far into the future.

Environmental engineers and scientists are the technical professionals who identify and design solutions for environmental problems. They seek to mediate and mitigate human impacts on the environment, protect human populations from adverse environmental events such as floods and disease, and restore environmental quality for ecological and human well-being.

Northwestern University’s Environmental Engineering and Science (EES) program is organized to both provide a common core for all environmental engineers and to allow individual students to tailor the program to their interests. The core program features a mixture of fundamental classes and distinct integrative classes, which reflect our commitment to interdisciplinary approaches to environmental problems. The chosen specialization will allow you to develop a depth of expertise in a particular area within your interests. There is also the opportunity to take additional electives in a wide range of subjects, drawing on Northwestern’s broad strength in science, engineering, and management.

We feel that our program will ensure that all of our graduate students gain a good general knowledge of environmental processes and also develop very strong skills that will enable them to make major contributions through the course of their careers.

The Northwestern University Approach

To meet today’s demands, undergraduate and graduate education at Northwestern University begins by building a strong foundation in fundamental and applied environmental sciences. This foundation expands students’ capabilities, providing state-of-the-art knowledge needed for finding and managing both natural and engineered solutions to environmental challenges. These two components—
and technology—prepare students for entering professional practice and performing independent research.

Research at Northwestern stresses the integration of applied science and engineering methods. It addresses current problems and generates new knowledge for dealing with the problems of the future. Although the scope of projects is large, the research is characterized by developing a fundamental scientific understanding in parallel with engineering solutions for prevention, restoration or management of natural and human systems.

Collaboration with faculty and students in other departments and centers augments the research resources available to students in environmental engineering. Examples of such collaborators include the Departments of Chemical and Biological Engineering (biotechnology, catalytic processes, and green manufacturing), Biochemistry, Molecular Biology, and Cell Biology (molecular biology and heavy-metal resistance), Chemistry (photocatalysis and surface science), Earth and Planetary Science (organic biogeochemistry), and Geological Sciences (stable isotope analysis and the global climate); the Center for Advanced Cement-based Materials (radionuclide immobilization and CO₂ fixation); the Institutes for Policy Research (environmental impact assessment and urban sustainability) and Environmental Catalysis (molecular chemistry and biology); the Medical School (environmental toxicology and pathogens); the J.L. Kellogg Graduate School of Management (environmental management); and Geotechnics (groundwater transport and geoenvironmental engineering).

**EES Program Objectives**

Environmental engineers and scientists take the technical lead for environmental assessment, protection, remediation, and scientific research. Traditionally, environmental engineers assumed responsibility for providing a safe water supply, treating wastewaters, mitigating air pollution, ensuring industrial hygiene and disposing of solid waste. While those traditional responsibilities grow more important every day, environmental engineers and scientist are being called upon increasingly to expand the scope of their efforts to include the protection, restoration and management of natural systems such as lakes, rivers, wetlands, the development of renewable energy, the characterization of physical, chemical and biological complexity in natural and engineered systems, the development of novel technologies to identify, monitor and remediate emerging contaminants, and the reduction of society’s carbon and ecological footprints.

Although many people are concerned about the state of our environment, environmental engineers understand how complex environmental systems work. They develop molecular tools to measure contaminants at very low levels in complex mixtures and genomic tools to characterize microbial diversity in unknown communities. They devise sensitive techniques to track chemicals and particles under dynamic fluid flow conditions. They are not only involved in developing nanomaterials and nanotechnologies for new environmental applications, they also address the unintended ecological and toxicological consequences of nanomaterial use.

Environmental engineers are the vital link between scientific discovery, technological development and the societal need for protecting human health and ecological integrity. More and more the emphasis of their work is shifting from managing wastes after they are generated, to altering production processes so to recover, recycle and reuse resources.
The field of environmental engineering, as well as environmental engineering education, is highly interdisciplinary. It involves traditional components such as mathematics, physics, chemistry, and engineering design. But, environmental engineering education also includes a range of other disciplines, including biology, microbiology, ecology, public health, material science, geology, meteorology, economics, political science, and computer science. To address the spectrum of issues facing the environment, environmental engineers are broadly educated, as well as technically trained.

**Eligibility and Background**

The program looks for students whose academic preparation and work experience support their development in the environmental area. Superior students who hold a bachelor’s or master’s degree in Environmental Engineering, Civil Engineering, or Chemical Engineering normally are eligible for admission to the graduate program without remedial course work. Superior students with degrees in other engineering disciplines or Chemistry, Biological Sciences, Geology, and other scientific disciplines also are eligible for admission, but they may be required to take remedial courses that do not confer graduate credit.

The minimum course work background required for all students is:

- Full sequence in differential and integral calculus (Math 220, 224, and 230)
- Differential equations (Math 250)
- Classical physics (Physics 235-1 and 2)
- One year of chemistry (Chemistry 101, 102, and 103)
- Computer programming (Computer Science 101)
- Fluid mechanics (Mechanical Engineering 241)

The courses in parentheses are given at Northwestern University; they can be used to assess equivalency or can be taken on a remedial basis, thus not for credit.
The Master of Science (MS) degree in Environmental Engineering and Science (EES) is highly valuable as preparation for professional practice and serves as a foundation for advancement to doctoral study. Listed here are the MS Degree Requirements in EES.

- **Satisfy the university’s residency requirement of 3 quarters** *(a minimum of three units and a maximum of four units constitutes full-time residency for any quarter).*
- **Complete at least 12 graduate-level units in this manner:** *(9 units for a letter grade, and no more than 2 research units can be used for the 12 units):*
  
  - Completing EES Master’s Degree Core Program courses (6 units) plus the CIV_ENV 516 seminar each quarter — students who have already completed equivalent course work will not be required to repeat courses at Northwestern.
  - Completing Specialization courses (3 units) — to be approved by EES faculty
  - Completing Graduate-level Elective courses (3 units) — to be approved by EES faculty

### Required EES Master’s Degree Core Program

<table>
<thead>
<tr>
<th>Units</th>
<th>Course#</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>1</td>
<td>CIV_ENV 361-1</td>
<td>Environmental Microbiology</td>
</tr>
<tr>
<td>1</td>
<td>CIV_ENV 365</td>
<td>Environmental Laboratory</td>
</tr>
<tr>
<td>1</td>
<td>CIV_ENV 367</td>
<td>Aquatic Chemistry</td>
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<tr>
<td>1</td>
<td>CIV_ENV 440</td>
<td>Environmental Transport Processes</td>
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<tr>
<td>1</td>
<td>CIV_ENV 444</td>
<td>Physical/Chemical Processes in Environmental Control</td>
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<tr>
<td>1</td>
<td>CIV_ENV 448</td>
<td>Biophysicochemical Processes in Environmental Systems</td>
</tr>
<tr>
<td>0</td>
<td>CIV_ENV 516-1,2,3</td>
<td>Seminar in Environmental Engineering and Science</td>
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6 units  I-unit courses are for letter grade; 0-unit courses are for S/U (satisfactory/unsatisfactory)

### Specialization Themes

Student-designed three-course thematic specialization in some aspect of environmental engineering and science. EES faculty approval required.

### Specialization Programs (Examples)

#### Environmental Chemistry
- CIV_ENV 447 Biogeochemistry
- CIV_ENV 468 Chemical Speciation in Environmental Systems
- MAT_SCI 360 Introduction to Electron Microscopy

#### Environmental Microbiology
- CIV_ENV 441 Methods in Microbial Complexity
- CIV_ENV 442 Processes in Environmental Biotechnology
- CIV_ENV 443 Microbial Ecology
Suggested Electives

Three graduate-level courses in Engineering, Science, Policy, Public Health, Kellogg Graduate School of Management, Research, or the environmental courses listed here (EES faculty approval required).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CIV_ENV 303</td>
<td>Environmental Law and Policy</td>
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<tr>
<td>CIV_ENV 355</td>
<td>Engineering Aspects of Groundwater Flow</td>
</tr>
<tr>
<td>CIV_ENV 356</td>
<td>Transport Processes in Porous Media</td>
</tr>
<tr>
<td>EARTH 314</td>
<td>Organic Geochemistry</td>
</tr>
<tr>
<td>CIV_ENV 395</td>
<td>Environmental Justice: Environmental Protection and Social Equity</td>
</tr>
<tr>
<td>CIV_ENV 441</td>
<td>Methods in Microbial Complexity</td>
</tr>
<tr>
<td>CIV_ENV 442</td>
<td>Processes in Environmental Biotechnology</td>
</tr>
<tr>
<td>CIV_ENV 443</td>
<td>Microbial Ecology</td>
</tr>
<tr>
<td>CIV_ENV 468</td>
<td>Chemical Speciation in Environmental Systems</td>
</tr>
</tbody>
</table>

Full-time students who do not need remedial courses are able to complete the MS degree course work in three academic quarters, or nine months. The necessity for remedial courses may extend the program's duration beyond nine months. In addition, an independent research project (CIV_ENV 499) may also extend the program's duration beyond nine months.

The typical MS program does not require an MS thesis, although an independent study project can be arranged at the discretion of the student and a faculty adviser and may produce a written report. At the invitation of faculty, MS students may prepare an MS thesis and receive thesis-research credit. Normally, thesis research is reserved for the PhD student.
Doctor of Philosophy (PhD) — Environmental Engineering and Science

The doctor of philosophy (Ph.D.) degree prepares students for advanced, independent research and teaching in academic, industrial, governmental, or other settings. Candidates for the Ph.D. degree may enter the program with a BS or an MS degree. Candidates for the Ph.D. must complete the following requirements:

- Satisfy The Graduate School’s residency requirement of eight quarters of full-time registration (defined as registration for a minimum of three units or a maximum of four units during each of the eight quarters).
- Meet The Graduate School’s requirement for a minimum of nine graduate-level courses for a letter grade even if entering with an MS degree. Students continuing for the Ph.D. degree after obtaining the MS degree at Northwestern generally are not required to take further courses for a grade, although most do take additional courses because further course work may be required by your advisor.
- Complete course work necessary to prepare for independent research in the student’s research area; the course work is determined by the student and his/her adviser with advice from the student’s preliminary examination committee.
- Demonstrate competency in the program’s core courses and an appropriate research area by passing a preliminary qualifying examination (PQE); students normally take the PQE within one year after entering the graduate program.
- Pass an oral qualifying exam (QE) based on a defense of a written research proposal. Ideally, the QE is taken in the 6th quarter (end of the 2nd Academic Year) after the student passes the PQE. The QE must be completed by end of the 7th quarter (or Fall Quarter of the 3rd Academic Year). The student enters official Ph.D. candidacy after passing the qualifying examination.
- Committees: The PQE committee must be comprised of three EES faculty; The QE committee must have a minimum of four members, three of whom must be EES faculty. We encourage at least one member outside the department and students may have additional members beyond the minimum. Students will provide a yearly update of their progress to their committee in the form of a meeting, a two-page summary of progress and short presentation.
- Complete a program that provides a mentored teaching experience.
- All Ph.D. students must give at least one EES seminar prior to their formal defense (typically in 4th year).
- Successfully present, defend, and submit a Ph.D. dissertation that constitutes a significant and original research contribution.
Full-time students typically complete the Ph.D. requirements three to four years after completing the preliminary examination. Since many research fields are interdisciplinary, students usually take a significant number of their courses from areas outside the environmental engineering and science program, such as chemistry, biochemistry, applied mathematics, geology, geotechnics, and chemical engineering. Dissertation research is carried out under the supervision of the student’s faculty adviser. Selection of faculty advisers takes place during the student’s first year in the Ph.D. program. In some cases, having co-advisers is desirable to facilitate interdisciplinary research.

... Fields of Study and Research

Research areas at Northwestern University are diverse and reflect the wide ranging interests of the faculty and students. The following summaries describe the major research areas:

- Environmental Biotechnology
- Physical/Chemical Processes
- Natural Systems

Environmental Biotechnology

Environmental biotechnology at Northwestern combines the traditional tools of environmental engineering—kinetic modeling, reactor design, and lab- and pilot-scale experimentation—with approaches of modern biotechnology, such as molecular genetics, microbial ecology, and biochemistry. Research based on this combination is providing the next generation of biological treatment processes for contaminated waters, wastewaters, soils, and air. It also is creating the foundation for understanding the fate of biodegradable pollutants in the environment. Although individual projects might emphasize experimentation, modeling, or microbiological aspects, all research involves quantification, the key to making the research results useful in practice. Examples of current and recent environmental biotechnology projects are:
• Molecular and modeling techniques for studying mixed cultures including nitrifying bacteria
• Mechanisms of adaptation of anaerobic communities to chlorinated organic compounds
• Biofilm community structure and function in reaction to H2 exchange
• Kinetic fundamentals of biofilm treatment of gas stream VOCs
• Biological reduction of perchlorate using a membrane-biofilm reactor
• Microbially driven water quality changes in drinking water distribution networks
• Modeling of complex biogeochemical systems involving metals
• Mechanisms of microbial resistance to metals
• Cell-to-cell signaling in biofilms

Physical/Chemical Processes

Physical and chemical phenomena can be used to separate or destroy contaminants in waters, wastewaters, sludges, soils, and sediments. The traditional physical/chemical processes—such as sedimentation, coagulation, filtration, and adsorption—remain critically important, and exciting new technologies are emerging. These include advanced oxidation, flotation, and membrane separations. Our research improves fundamental understanding of the governing mechanisms, which leads to more broadly useful bases for design, scale-up and operation. Examples of projects in physical/chemical processes are:

• Photocatalytic destruction of hazardous organic pollutants using TiO2 with UV and visible light (reaction pathways, mechanistic and kinetic modeling)
• Identification of precursors to disinfection byproducts
• Characterization of natural organic matter in water and wastewater treatment by pyrolysis GC-MS
• Electrokinetic soil decontamination

Natural Systems

Research in this area at Northwestern focuses on interactions of natural system components—such as soils, sediments, water, and living organisms—with environmental contaminants and waste materials. Specific emphases range from the biophysical chemistry occurring at interfaces to cycling of elements to overall macrosystem fate and effects. Examples of natural systems projects are:

• Bacterially produced manganese oxide catalyst solids
• The role of particles in scavenging trace metals at the oxic/anoxic interface in aquatic systems
• The fate of PCBs in a perphytic bio-layer of an artificial stream system
• The fate of trace metals in freshwater sediments
• The fate of metals in artificial wetlands
• Studies in a reconstructed wetland: plant transpiration, phosphate fractionation in sediments, and modeling water flow
• Microbial ecology of Lake Michigan sediments
• The transport of particles and water at the groundwater/surface-water interface
... Facilities

The Environmental Engineering and Science Program occupies approximately 7,000 square feet of state-of-the-art laboratories in the A-wing of the Robert R. McCormick School of Engineering and Applied Science. Major instrumentation and facilities include:

**MAJOR INSTRUMENTATION**

| Gas chromatographs (GC’s) with FID and ECD | Electrophoresis systems |
| Pyrolysis GC-MS | DGGE system |
| Reduced-gas chromatograph | DNA sequencers |
| High-performance liquid chromatograph (HPLC) | General molecular biology instrumentation |
| Ion chromatograph | Incubators and refrigerators |
| Total organic carbon (TOC) analyzer | -80°C Freezers |
| Graphite furnace atomic absorption spectroscope | Walk-in temperature control chamber |
| UV/VIS spectrophotometer | Anaerobic glove box |
| Fluorescence spectrophotometer | Autoclave |
| Phase-contrast microscope with fluorescence and photographic capabilities | Muffle furnace |
| High quality CCD camera for microscopy | Drying ovens |
| Scanning laser confocal microscope | Analytical balances |
| Mercury intrusion porosimter | Water still |
| Sub-micron particle sizers and zeta-potential analyzer | Ultrapure water system |
| Laser Doppler velocimeters | Flume laboratories |
| Microtitre plate fluorimeter | Clean room for trace metal analysis |
| Microtitre plate absorbance reader | Radioactivity counting room |
| Biofilm flow cell apparatus | Scintillation counter |
| PCR thermocycler | Biosafety Level 2 laboratory |
| Sorvall centrifuge | Teaching laboratory |
| Ultracentrifuges and mini centrifuges | Access to shared facilities @ Facilities |
| Computerized titrator |

These laboratories also are fully equipped for routine wet chemistry and have advanced safety features. The CEE Department has a full-time laboratory coordinator for the environmental engineering and science laboratories.

Northwestern University is connected to CIC Net and the worldwide Internet, allowing researchers to make full use of all Internet-connected resources, such as program archive sites and supercomputer centers. Furthermore, recent modifications to the network infrastructure within the Department of Civil and Environmental Engineering have brought this connection not only to a central location on campus but also to almost every room in the department, including faculty and student offices and research laboratories.
The department maintains a network of computer workstations for research use. These stations include Macintosh, IBM, Sun, Hewlett-Packard, and other microcomputers. The department also maintains its own graphics workstation laboratories used for research and instructional purposes. Fully networked, these computing systems have a wide variety of software installed, including source code compilers (C, C++, Fortran, and Pascal), Scientific Visualization Software (SGI Explorer and MovieSTAR.BYU), and Geographical Information Systems software (GRASS 4.1). The department has a full-time computer-network manager.
Education

- B.A., Northwestern University, Biology
- M.S., University of Miami, Civil Engineering (Environmental)
- Ph.D., Johns Hopkins University, Environmental Engineering

Research

My areas of research are environmental catalysis and physicochemical processes in natural and engineered environmental systems. We are studying the synthesis, characterization, and performance of photocatalytic materials, principally TiO₂. Currently, we are collaborating with materials scientists at Northwestern to prepare highly active nano-structured mixed phase titania catalysts using a variety of techniques and with chemists at Argonne National Laboratory to detail charge transfer behavior in these materials using EPR. This fundamental understanding of structure and function is guiding the use of these photoactive materials for applications in renewable energy (CO₂ reduction, water splitting), water recycling (reactive membranes for chemical oxidation and disinfection, photoactive carbon nanotubes for reactions and separation) and air quality control (cabin air, building air handling). Work in my group also involves the investigation of chemical fate in natural systems. We are probing the role of periphyton (algal biofilms) in contaminant accumulation in stream sediments and in denitrification in wetlands. We are also studying the ways in which detailed understanding of ecological relationships (periphyton structure, dynamic food web descriptions) improves our ability to predict chemical transfer (bioaccumulation) in aquatic systems and ultimately human health risks. Application of this research is important in efforts to restore critical ecosystems (Great Lakes) and to employ ecosystem function for environmental protection (treatment wetlands).
Teaching

- ENVR-SCI 203  Energy and the Environment: The Automobile
- CIV_ENV 368  Sustainability: Issues and Actions, Near and Far
- CIV_ENV 398-1,2  Community-based Design
- CIV_ENV 444  Physical/Chemical Processes in Environmental Control

Professional Activities and Honors

- Sigma Xi Distinguished Lecturer, 2008-2010
- Aldo Leopold Leadership Fellow, 2008
- Board of Directors, Chicagoland Redevelopment Initiative (REDI), 2002-2006.
- National Research Council Water Science and Technology Board, Member of Committee on USGS Water Resources Research, 1996-1999.
- Presidential Young Investigator, National Science Foundation, 1991-1996

Selected Publications


Education

- B.S. (Chemistry) University of Maryland
- Ph.D. (Organic Chemistry) Stanford University

Research

The cycling of the element carbon is fundamentally important to the functioning of our planet. My research has focused on the biogeochemical transformations of carbon with an emphasis on process-oriented studies of the evolution and fate of organic matter in surficial environments. Methanogenesis, methane oxidation, and the influence of macrofauna on organic carbon turnover are some of the processes that have been investigated in field areas ranging from the North Carolina slope to the Amazon shelf.

Delineating the transformations of carbon from source (mountains) to sink (marine sediments) in small watershed systems ranging from Northern California to Papua New Guinea and New Zealand is a recent focus of research. Understanding what controls the persistence and/or breakdown of organic species in the environment is the major impetus for this work.

My group has specialized in the development of novel stable isotope and radiocarbon tools to study carbon-cycling processes.

Teaching

- CIV_ENV 395, 20  Organic Geochemistry (offered jointly with EARTH 314)
- CIV_ENV 447  Biogeochemistry (offered jointly with EARTH 317)

Professional Awards and Activities

- National Ocean Sciences Accelerator Mass Spectrometry Advisory Board (10/05-06, chair 2007)
- NASA "Landscapes to Coast" panelist (2006)
- Biocomplexity Workshop on Animal-Sediment Interactions (2002, invited speaker)
- Carbon Erosion Workshop (2002), Palmerston North, New Zealand (invited international reviewer and speaker)

Selected Publications

Education

- B.S., Civil Engineering, University of Missouri – Columbia
- M.S., Environmental Engineering, University of Missouri – Columbia
- Ph.D., Environmental Engineering, Johns Hopkins University
- Post-doc, École Nationale Supérieure des Industries Chimiques (Nancy, France)

Research

My research in drinking water treatment has focused in two primary areas, mechanics of coagulation/flocculation, and membranes. In the coagulation area we have developed new approaches to (1) directly measure floc size distributions, (2) characterize relative velocity fields and secondary flows in impeller-driven mixers, and (3) predict floc growth using new kinetic models that incorporate floc breakup, flow inhomogeneity and flow periodicity, and which are sensitive to process scale. In the membrane area we have developed new methods of characterizing (and minimizing) membrane fouling by natural organic matter. Recent work includes (1) molecular dynamics simulation of the interaction of humic materials with membrane surfaces, (2) development of a low-cost laser-scanning cytometer to monitor low concentrations of particulate foulants in fresh and saline waters, (3) development of a nanostructured polysulfone adsorbent for organic fouling control, and (4) development of an aquaporin-impregnated polymer membrane.

Teaching

- CIV_ENV 444 Physical/Chemical Processes in Environmental Control
- CIV_ENV 306 Uncertainty Analysis in Civil Engineering
- CIV_ENV 340 Fluid Mechanics II

Professional Awards and Activities

- Organized Committee of 20 University of Illinois researchers and local nursing
home administrators to discuss remediation of nursing home odors (2006 -2007).

- Developed student and faculty exchange between University of Illinois Engineering College and the French CNRS (2000)
- Chair, Membrane Technology Research Committee, American Waterworks Association (1995-1998)
- Associate, Center for Advanced Study, University of Illinois, 1999-2000.
- Presidential Young Investigator, National Science Foundation, 1991-1996
- Xerox Award for Faculty Research, University of Illinois, 1990.

Selected Publications

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fax: (847) 491-4011

Education

- B.S., University of Savoie, Environmental Engineering
- M.S., University Pierre et Marie Curie (Paris VI), Water Sciences
- Dr., University Pierre et Marie Curie, Water Sciences
- D.Sc., University Denis Diderot (Paris 7), Docteur És Sciences Physiques -Géochimie

Research

Professor Gaillard's current research focuses on the study of the chemical forms (speciation) and the biogeochemical cycles of elements in aquatic systems. The chemical speciation of elements determine their toxicity and availability to microorganisms. Conversely, microbes mediate changes in oxidation state and coordination, controlling therefore the speciation of elements in natural systems. The primary objective of his research group is to determine the analytical speciation of metals to better understand their fate in the environment and define appropriate remediation actions. To that end, he and his group are using a multi-method approach combining electrochemical, microscopic, and molecular tools.

Teaching

- ENVR_SCI 201 Earth: A Habitable Planet
- CIV_ENV 365 Environmental Laboratory
- CIV_ENV 367 Aquatic Chemistry
- CIV_ENV 468 Chemical Speciation in Aquatic Systems

Professional Activities and Honors

- Associate Editor: Journal of Hydrology
- Chief Scientist of the oceanographic cruise: ANTARES 1, France-JGOFS (1993)
- Northwestern University, Fulbright Fellowship Committee member (2006-present)
- IUPAC Fellow. (2006)
**Selected Publications**

(Please note: bold names are those of my graduate students or postdoctoral fellows, underlined names are of graduate students or Postdoctoral fellows under the supervision of collaborators)


Education

- BS./MS., University of Lisbon, Portugal, (Plant Biotechnology and Molecular Biology)
- Ph.D., University of Lisbon, Portugal, degree in absentia through Massachusetts Institute of Technology, Cambridge, MA (Molecular Biology/Genetics)

Research

Our group works on developing and applying optical and genetic methods to study fundamental aspects of reef-forming corals and their associated algae. We are currently investigating why some reef-forming coral species are resistant to bleaching and/or recover quickly from bleaching while others suffer high mortality after a bleaching episode.

Toward this goal, we are developing a two-level approach. First, we are studying specific optical properties of the stony corals to understand the role that the coral’s tissue and skeleton play during bleaching. We are collaborating with biomedical engineers at Northwestern to characterize the light transport properties of coral skeleton and tissue for coral species showing resistance and susceptibility to bleaching. Second, we are collaborating with Field Museum scientists to characterize the coral-algae association at the cellular and genetic level to establish indicators of susceptibility to bleaching.

Teaching

- CIV_ENV 361-1 Environmental Microbiology
- CIV_ENV 361-2 Public and Environmental Health
Selected Publications

Education

- B.S., Washington University, Mechanical Engineering
- M.S., California Institute of Technology, Environmental Engineering Science
- Ph.D., California Institute of Technology, Environmental Engineering Science

Research

My research focuses on environmental and microbial transport processes, with particular emphasis on understanding the basic processes that control interfacial transport in aquatic systems and the coupling of physical transport processes with biological and biogeochemical processes. I seek to define critical structure-transport-transformation relationships in dynamic natural environments such as rivers and surface-attached microbial communities (biofilms). My work is highly collaborative and encompasses basic fluid mechanics, particle transport and morphodynamics, microbiology, and aquatic and surface chemistry. Important applications include contaminant transport and water quality, microbial habitat conditions and benthic microbial ecology, nutrient and carbon cycling, ecosystem degradation and restoration, control of biofilm-based infections, and the transmission of waterborne disease.

Teaching

- CIV_ENV 260  Fundamentals of Environmental Engineering
- CIV_ENV 440  Environmental Transport Processes

Professional Activities and Awards

- Northwestern Murphy Institute Faculty Fellow (2007-2008)
- NIH Career Award (2006)
- McCormick Excellence Award, Northwestern University (2006)
- Searle Junior Teaching Fellow (2001-2002)
- NSF CAREER Award (1999)
- Associate Editor, Water Resources Research (1999 – present)
- Board of Directors, International Association for Sediment Water Science (2005-present)
- UNESCO International Hydrological Programme, Groundwater-Surface Water
Interactions and Nutrient Behavior in River Corridors, Invited Panelist (2005)

Selected Publications


Yun Wang  
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Environmental Engineering  

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**Education**

- Postdoctoral Scholar, MIT/HHMI & Caltech/HHMI: Molecular Geobiology  
- Ph.D., Johns Hopkins University: Aquatic Chemistry  
- M.S., Nankai University  
- B.S., Nankai University  

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**Research**

Our research is at the interface of the medical/environmental microbiology and geochemistry. We apply an interdisciplinary approach to studying the link between reactions of bioactive small molecules (e.g., antibiotics) with environmental constituents and their mode of action on microbial biofilm architecture and physiology. Current research directions include:

- Investigating the roles of redox-active “antibiotics” (phenazine- and quinone-based molecules) in iron acquisition and microbial physiology. We use two opportunistic pathogens, *Pseudomonas aeruginosa* and *Burkholderia cepacia*, as our model organisms.  
- Optimizing small molecule-facilitated electron transfer in biofilm processes, with emphasis on improving bioenergy generation and bioremediation efficiency.  
- Determining the fate and transformation of (bio)molecules and environmental pollutants at mineral-water interfaces.  
- Developing imaging techniques for studying (bio)molecules and organic pollutants *in vivo* and *in situ*.  

These studies will not only help us predict the chemical and biological impact of bioactive molecules in natural aqueous environments but also highlight strategies for manipulating clinical and environmental biofilms.
Selected Publications

### Affiliated Faculty

- **Nicholas P. Cianciotto**  
  NU-Department of Microbiology-Immunology  
  *Microbial pathogenesis*

- **Richard J. Finn**  
  NU-Department of Civil and Environmental Engineering  
  *Environmental geotechnology*

- **Franz M. Geiger**  
  NU-Department of Chemistry  
  *Geochemistry, aquatic chemistry, and atmospheric chemistry*

- **Michael E. Graham**  
  NU-Department of Materials Science and Engineering  
  *Photoactive materials*

- **Keith I. Harley**  
  Chicago Environmental Law Clinic  
  *Environmental law and ethics*

- **John Hudson**  
  NU-Department of Anthropology  
  *Cultural/physical/settlement geography*

- **Andrew D. Jacobson**  
  NU-Department of Earth & Planetary Sciences  
  *Cycling of elements between Earth’s lithosphere, hydrosphere, atmosphere, and biosphere*

- **Richard M. Lueptow**  
  NU-Department of Mechanical Engineering  
  *Fluid mechanics, membrane processes*

- **Margaret M. MacDonell**  
  Argonne National Laboratory  
  *Environmental impact assessment*

- **Lance Peterson, M.D.**  
  NU-Feinberg School of Medicine, Department of Pathology  
  *Biodefense, antimicrobial resistance*

- **Kenneth Poeppelmeier**  
  NU-Department of Chemistry  
  *Inorganic environmental materials and inorganic synthetic chemistry*

- **Bradley B. Sageman**  
  NU-Department of Earth & Planetary Sciences  
  *Paleontology, sedimentology*

- **Peter C. Stair**  
  NU-Department of Chemistry and Catalysis Center  
  *Catalysis, spectroscopy*

- **Richard B. Thomson**  
  NU-Feinberg School of Medicine, Department of Pathology  
  *Microbiology, virology*

- **Joseph B. Walsh**  
  NU-Program in Biological Sciences  
  *Restoration ecology, biogeography*

- **Eric Weitz**  
  NU-Department of Chemistry  
  *Emissions treatment, photocatalysis, spectroscopy*