

RISK AND UNCERTAINTY QUANTIFICATION IN EARTH SYSTEMS GRADUATE MINOR

Marine and coastal scientific and management issues are technically and socially complex, involving many forms of science, interests, perspectives, and stakeholders. There is much uncertainty in modeling forecast and policy outcomes associated with climate change and global markets. This interdisciplinary graduate minor will provide students with knowledge and skills to quantify and communicate risk and uncertainty derived from the analyses of large data in earth system science.

The graduate minor focuses on marine science and resource management, yet will be relevant to students from a variety of fields. Students will extend their ability to perceive and solve problems in a transdisciplinary context related to statistical inference, uncertainty quantification, risk analyses, earth system science, and social systems. Students will also acquire professional skills in communication and collaboration. The world is changing. Join us in becoming more resilient. The graduate minor is open to all OSU graduate students.

Learning Goals

Social Systems

The “social or human system” component is one of the key elements of a coupled natural human system. Specifically, it encompasses the social, cultural, economic, management, and policy aspects of the system, and how they interact with each other and with their environment. Disciplinary approaches to the human system include anthropology, sociology, policy, economics, etc. The goal of the “social systems” training component of the graduate R&U minor is to learn about social science methods, theory and/or applications as they relate to a marine, coupled natural human system. Risk and Uncertainty graduate minor students are expected to complete the requirements by taking at least one course in this area. The course must allow students to: (1) Recognize the perspective of the particular discipline or area of study, (2) Understand and respect the various methodological approaches used in the social sciences (qualitative and/or quantitative), their possibilities and limitations, and how these may be best integrated to the earth systems, big data or R&U component of the minor, (3) Explain and extract the scalar nature of the course material, whether it is related to cultural, social, institutional, management, or policy aspects of a system, (4) Critically assess gaps or opportunities for inclusion of social, cultural, or economic elements of a natural system, and vice versa.

Risk and Uncertainty

The goal of the risk and uncertainty quantification training component of the graduate R&U minor is to understand and acquire mastery of some of the fundamental mathematical/computational and statistical methods for quantifying uncertainty and analyzing risk for decision making. NRT (National Research Traineeship) students seeking the graduate minor are expected to acquire (mathematical/computational/statistical) tools that can be used to describe and assess risk and uncertainty in problems related to the marine, coupled natural human system. Students have options to choose from a variety of courses dealing with the mathematical foundations of risk and uncertainty involving mathematical techniques in (i) decision making under uncertainty, (ii) ruin probabilities, (iii) measures of variability, (iv) probabilities of rare events and large deviations, (v) Monte Carlo simulation, (vi) optimization

and dynamic programming, (vii) stochastic models in biology pertaining to spread of disease and related phenomena. Students are expected to acquire experience in a combination of computational, simulation and/or theoretical approaches. NRT students with a social science or human dimension component will be expected to understand and become literate and conversant in the quantitative aspects of risk and uncertainty quantification.

Earth Systems

Students will develop an integrated understanding of the Earth System, including biological, physical and geological mechanisms that affect Earth climate, species dynamics and interactions, elemental cycles and ecosystem services. The emphasis will be on understanding the linkages between physics, biology, geology, and chemistry from a system theory perspective, and on how these linkages affect Earth's biogeochemical processes. Disciplinary components of the Earth System module include biological, chemical and physical oceanography, biogeochemistry, geology, climate and atmospheric sciences, and ecology.

Big Data

Issues surrounding massive data sets (“big” data) are intertwined with data-enabled science and engineering. The goals of the big data training component are for students

1. to acquire computational and data-management skills necessary for handling and processing large data sets, and
2. to assess the value of information obtained from big data with respect to such issues as observation bias, signal versus noise, spurious relationships, and incidental endogeneity.

Much of the training in big data management and processes is acquired through hands-on experiences. Specific components of the big data module include handling and processing massive datasets; being able to identify and articulate the limitations of big data sets; implementing classification, clustering and/or network analyses as appropriate.

Graduate PhD students are required to complete at least 18 credits, MS students complete 15 credits.

All students complete the professional development requirement (6 credits).

Additional credits are taken from these four following specializations:

1. Big Data and Uncertainty Quantification
2. Risk Analyses
3. Earth Systems
4. Social Systems

Mentoring Requirements

There must be a minor professor in the student's committee. The minor professor is in any of the fields where course designators fall but must not be from the student's major.

Classes for Minor

Graduate PhD students are required to complete at least 18 credits, MS students are required to complete at least 15 credits for the minor.

PhD students take one course from each of the four remaining areas: Big data and Uncertainty Quantification, Risk Analyses, Earth Systems, and Social Systems.

MS students take one course in Social Systems and one in Earth Systems and choose one course from either Big Data and Uncertainty Quantification or Risk Analysis.

Code	Title	Hours
Professional Development		
MRM 525	SPECIAL TOPICS IN MARINE RESOURCE MANAGEMENT ¹	6
Big Data and Uncertainty Quantification Specialization		
CS 515	ALGORITHMS AND DATA STRUCTURES ²	4
CS 534	MACHINE LEARNING ²	4
GEOG 565	SPATIO-TEMPORAL VARIATION IN ECOLOGY AND EARTH SCIENCE	4
ST 538	MODERN STATISTICAL METHODS FOR LARGE AND COMPLEX DATA SETS	3
ST 599	SPECIAL TOPICS (Big Data and Uncertainty Quantification)	1-4
Risk Analysis Specialization		
FW 544	QUANTITATIVE DECISION ANALYSIS FOR FISH AND WILDLIFE MANAGEMENT	4
ME 515	RISK AND RELIABILITY ANALYSIS IN ENGINEERING DESIGN	4
MTH 527	INTRODUCTION TO MATHEMATICAL BIOLOGY	3
MTH 563	PROBABILITY I	3
MTH 567	ACTUARIAL MATHEMATICS	3
MTH 599	SPECIAL TOPICS (Risk Analysis)	3
Earth Systems Specialization		
Select at least one of the following:		3-4
ATS 520	PRINCIPLES OF CLIMATE: PHYSICS OF CLIMATE AND CLIMATE CHANGE	
GEO 550	COASTAL HAZARDS: PROCESSES, RESPONSE, AND ADAPTATION	
GEO 684 or SOIL 684	GLOBAL BIOGEOCHEMICAL CYCLES	
OC 523	OCEAN ECOLOGICAL DYNAMICS	
OC 533	COASTAL AND ESTUARINE OCEANOGRAPHY	
OC 534 or FW 534	ESTUARINE ECOLOGY	
OC 599	SPECIAL TOPICS IN OCEANOGRAPHY	
OEAS 520	THE SOLID EARTH ²	
OEAS 530	THE FLUID EARTH ²	
OEAS 540	THE BIOGEOCHEMICAL EARTH ²	
Social Systems Specialization		
Select at least one of the following:		3-4
AEC 552 or MRM 552	MARINE ECONOMICS	
ANTH 581	NATURAL RESOURCES AND COMMUNITY VALUES	
COMM 599	SPECIAL TOPICS (Policy Conflict and Public Participation, 3)	
MRM 530	PRINCIPLES AND PRACTICE OF MARINE RESOURCE MANAGEMENT	
PPOL 545	INTERNATIONAL MARINE POLICY	
PPOL 546	THE POLICY AND LAW OF UNITED STATES COASTAL GOVERNANCE	
PPOL 548	MARINE POLICY IN THE UNITED STATES	

SOC 581 SOCIETY AND NATURAL RESOURCES

Total Hours

48-53

¹ 2 credits each fall, winter, and spring term in sequence:

1. *Marine and Earth Systems Science: Foundations in Risk and Uncertainty (2)*
2. *Marine and Earth Systems Science: Collaborative Working Structures in Risk and Uncertainty (2)*
3. *Marine and Earth Systems Science: Communication of Risk and Uncertainty (2)*

² Classes where a more advanced listing can be substituted.**Minor Code: 5050**