Indiana University - O'Neill School of Public and Environmental Affairs

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E560: Environmental Risk Analysis

Course Description and Objectives:

Risk analysis is a set of techniques which are widely used in business, scientific, environmental and public policy analyses. It can be used to address a wide variety of problems ranging from business risk of financial loss, the risks of disease, climate change and its implications, cybersecurity, the effects of pollutants on human health and the environment. Risk analysis can be broken down into two components: risk assessment and risk management. In this course these two areas are examined both in general from a theoretical perspective, and in particular as they are applied to the outcomes for human health and the environment. We examine these topics from three perspectives. First, we take a straightforward, though abstract approach to the topic: examining the concept of risk and uncertainty, their effects in systems and how they can be managed. This involves choosing one or two of many frameworks that have been developed. Our second perspective examines the way that risk analysis is used by the EPA in its guidelines for CERCLA funded projects. As we go through their standard procedure (RAGS) we will augment it with theory and models from both exposure assessment and toxicology. We'll extend this perspective to regulatory types of analysis.

While the central thrust of the course will be on the assessment of human health risks, we will also consider other environmental health and safety applications including ecological risk assessment, technological risk assessment, risks associated with non-chemical types of toxicant (e.g., biological or radiation) the management of risks, communication of risks and the regulatory issues surrounding their use. The objective of this course is to provide students with the skills necessary to understand conduct, evaluate and critique modern environmental risk analyses, as they are currently practiced, and to identify trends in the methodology, describing how they are likely to be practiced in the future.

It is common for a risk analysis course to take on the flavor of the instructor. If taught by a toxicologist, the course becomes one in toxicology. If taught by an ecologist, it is one in ecology. My perspective will be a systems course. In other words, risk analysis involves the interaction between several key systems: technical and economic systems that involve the creation of hazards (for example the release of pollutants), physical systems that involve its fate and transport in the environment, behavioral systems that lead to human actions of exposure, biological systems that lead to consequences to the individual exposed, and psychological, economic and political systems that attempt to mitigate the consequences of the rest of the system. As a result, the course does not put an emphasis on any of the particular components.

As a capstone replacement for people in the MSES and the dual MSES/MPA degrees, additional objectives include:

- Identifying problems that are worth pursuing
- Organizing and prioritizing the key features of a problem
- Working with others who are different than you
- Forcing you to work outside your comfort zone (doing things that you have not been trained to do)
- Managing time and scope when there are no clearly defined stopping rules

Course Texts and Course Materials:

There are several sources of material for the course. While the list may appear long, most are freely available on line as pdf documents. Specific chapters of others will be available on canvas.

> Covello, F. and M. Merkhofer. *Risk Assessment Methods: Approaches for Assessing Health and Environmental Risks* (Plenum Press: New York, 1994)
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> US EPA *Risk Analysis Guidelines for Superfund Part A* (annotated version online at EPA with links to revised and updated material) and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments - Interim Final* (1997) annotated online
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> Morgan and Henrion, *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis* 6th ed. (Cambridge University Press: 1998)
>
> *Science and Decisions: Advancing Risk Assessment*. National Academies of Science, Engineering and Medicine consensus report (2009)

Risk Assessment Guidelines for Superfund (RAGS), while well organized, is narrow in scope. Even after 25 years, additions and updates for RAGS in specific types of applications continue to be published. The ecological risk version is one such update. These are dealing with the mechanics of the process. Covello is an excellent and sophisticated roadmap to a much broader range of risk analyses than is handled in RAGS, yet it lacks depth in several key areas, particularly exposure assessment; is a little dated in discussing toxicological/ecological models; and unfortunately no longer in print. Fortunately, there are several additional volumes associated with RAGS to fill in the gaps. Morgan and Henrion is a more directed set of useful tools for dealing with messy situations. If you were to buy one text, this would be it. Paperback from Amazon is about $45. The National Academies consensus report from 2009 provides a much more sophisticated critique of risk analysis as it is practiced. A free pdf is downloadable. These will be augmented with other readings that will be available on the Canvas website for the course.

At this stage in your careers, you should also be looking at the literature. The journal *Risk Analysis*, and the European journal *Journal of Risk Research*, presents a wide variety substantive issues in conducting risk analyses and how they can fit into the overall policy/risk governance framework.

Prerequisites:

The only specific course requirements for Risk Analysis is some prior experience with statistics and chemistry. This is an integrating course that ties together other things you have may learned in SPEA such as environmental engineering, ecology, environmental law and economics, benefit cost analysis or program evaluation (for considering epidemiological analysis of human health risks) toxicology.... It's a long list. Every students preparation for the course is expected to be different, some bringing primarily mathematics, some ecology, some toxicology, etc. Like other capstone courses, these different skill sets will be integrated with other in group work. This course is not self contained. While not specific requirements, you need things to integrate. ***First year students would be well advised to wait until later in their training to take this course.***

Student Evaluation:

Homework (Approximately 4)	30%
Low stakes quizzes (approximately 2)	5%
Course Project	
Preliminary reports	10%
Presentation	15%
Written report	30%
Class Participation	10%

Dealing with the details in homework can be time consuming and is best done in small groups (two or three people). I expect that these group meetings will be done in zoom. There are no exams in this class. The low stakes quizzes are opportunities to force you to keep up to date with terminology and concepts.

The course project will be a real risk analysis and will be done in groups of up to four. While the topic is a matter of individual/group choice, it should be on a topic related to environmental health and safety or to a technological risk assessment. *Both the topic and the overall scope of the project must be approved.* In order to insure that projects remain on schedule two preliminary reports are due (10% of your course grade). The first is a set of initial project proposals, about one paragraph in length. These are designed to identify that the project(s) you propose are worth doing. The second is an outline which should be sufficiently detailed to demonstrate that the project can be completed by the end of the semester. This report is designed to show that your project is feasible withing the course of the semester. The course project will be presented (15% of the course grade) at the end of the semester. A final project report is due on the last day of final exam period (30% of the course grade).

Three things to note:

- Since modern risk assessments are typically conducted by multi-disciplinary teams, individuals will be assigned to groups to insure that they have the required diverse sets of skills in statistics, project management, mathematical modeling, toxicology, etc.
- Your future careers are driven by how your peers evaluate your work in addition to how your work is work is evaluated by your employers. The project portion of the course will include a peer evaluation component.
- It is essential that you stay reasonably up to date on the readings. The material in the course has many more branching off directions than are typical. You have to think about the material in a structured way. As a result, we may implement some quick quizzes to help you validate that you are up to date on key elements in the material.

Readings and assignments are/will be posted on the course Canvas site.

Important Dates:

Jan 27. Project Groups formed.
Feb. 5 (Friday) First Project Report due!
Feb. 15 (Monday) Second Project Report due
Friday, April 30 (Time TBD), Project Presentation Marathon
May 7, (Last day of finals week) Project Final Reports Due

Coping with COVID

The academic calendar this semester is unusual. The course has nominally been identified as one which is scheduled for hybrid delivery, using face-to-face and online meeting. Face to face meetings do not start until February 8. In addition, there are holidays (MLK day on January 18) and wellness days (February 16, March 24 and April 22) which serve as a pale substitute for a spring break. It is my intention that we will meet in person on April 30 to conduct the project presentations. We should be prepared to be flexible. The schedule is designed with some resilience in mind (ability to recover quickly from unforseen events). We may switch to an all online format if necessary.

Ethical and Civil Conduct

Academic dishonesty will not be tolerated. On quizzes you are expected to present your own work. On homework, working in very small groups is permitted as specified on the individual assignment. But the contributions should be

limited to only those in your group. You should clearly identify the team you are working with in order to avoid possible misconduct. You not only cheat your classmates by using the work of others, but you cheat yourself out of learning the material by doing it. This will show up on later by your doing poorly on exams. Please refer to the University's guidelines for the process and sanctions associated with academic misconduct at http://studentcode.iu.edu/procedures/bloomington/discipline/academic-misconduct/index.html

At O'Neill, you deserved to be treated with respect and civility. Obviously, that requires that you treat others with respect and civility. You are encouraged to read O'Neill's code of civil and professional conduct for both graduate and undergraduate students at https://myspea.indiana.edu/doc/ugrad-doc/ugrd-student-honor-code.pdf

Student and Community Wellbeing

I care about the well-being of all students in my classes. If you need assistance, please ask me. I will help to the best of my ability. The University also has many resources available for students, such as:

Counseling and Psychological Services: for information about services offered to students by CAPS, please visit http://healthcenter.indiana.edu/counseling/index.shtml

Disability Services for Students: for information about support services or accommodations available to students with disabilities, and for the procedures to be followed by students and instructors, please visit https://studentaffairs.indiana.edu/disability-services-students

Food: Did you know that the Crimson Cupboard is available to all in the IU community? http://crimsoncupboard.indiana.edu/home.php

Sexual Harassment: As your instructor, one of my responsibilities is to create a positive learning environment for all students. Title IX and IU's Sexual Misconduct Policy prohibit sexual misconduct in any form, including sexual harassment, sexual assault, stalking, and dating and domestic violence. If you have experienced sexual misconduct, or know someone who has, the University can help. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with:

- The Sexual Assault Crisis Services (SACS) at (812) 855-8900 (counseling services)
- Confidential Victim Advocates (CVA) at (812) 856-2469 (advocacy and advice services)
- IU Health Center at (812) 855-4011 (health and medical services)

It is also important that you know that Title IX and University policy require me to share any information brought to my attention about potential sexual misconduct with the campus Deputy Title IX Coordinator or IU's Title IX Coordinator. In that event, those individuals will work to ensure that appropriate measures are taken and resources are made available. Protecting student privacy is of utmost concern, and information will only be shared with those that need to know to ensure the University can respond and assist. I encourage you to visit http://stopsexualviolence.iu.edu/index.html to learn more.