University of Guelph

School of Engineering

ENGG*4510 Assessment and Management of Risk

Course Proposal

1. Introduction

The world seems a very hazardous place. Every day, the newspapers announce that some chemical has been found to be carcinogenic, or some catastrophic accident has occurred. Humans have always sought to eliminate unwanted risks to health and safety. However, there is acknowledgement by scientists, engineers, and others who have thought carefully about risk, that the real problem is not the unachievable task of making technologies and lifestyles risk-free, but the more subtle problem of determining how to make the many causative features of risk appropriately safe.

Engineers and scientists frequently become disturbed when they discover that the question "how safe is safe enough?" has no simple answer. In response, this course will develop the bases by which we can assess risk to human health and the environment. The emphasis in the course will be on the application of principles of risk, in the making of decisions. In this respect, risk assessment has become an increasingly important tool as risk assessments are being performed in application to the spectrum of issues including such concerns as

- hazardous waste cleanups,
- permitting activities for water and air discharges,
- input to land and water management decisions related to open land, forests, watersheds and estuaries,
- food safety,
- non-chemical risks,
- flood protection, and,
- establishing environmental quality standards and guidelines.

From the assessment of the magnitude of risks, the course will then examine how decisions are made to manage the risks to acceptable levels for health, safety and the environment. It will be demonstrated that risk assessment and management are inherently interdisciplinary, and evolving rapidly, despite the associated uncertainties in assessment methodologies and data limitations. Elements of applications in both developed and developing countries will be presented.

2. Objectives of the Course:

Students who successfully complete the course will be able to:

- use the knowledge of everyday risks in society, to establish the context of risk management for human health and the environment;
- assemble, interpret, and analyze environmental data as a basis from which risk assessments can be developed for protection of human health and the environment;
- identify strategies which can be used to determine if the collection of additional data are warranted;
- develop concepts, and then build the concepts/techniques in risk assessment, for application to simple and complex environmental issues;
- understand how to access various data sources from epidemiology and toxicology; and,
- develop plans for appropriate risk management, reflecting legal, economic, and socioeconomic considerations

3. Material to be Covered in the Course:

The course will progress through the following material:

- introduce the concepts of risk as understood by the general public through their perceptions, and understand how risk assessments conducted in a scientific way, can give the correct picture to the general public and help the taking of appropriate decisions in the public interest;
- cover basic statistical concepts which are essential for understanding data, determining which data might still be needed for decision-making, examine distributional assumptions of data and how these are used to characterize inputs to risk assessment methodologies;
- describe exposure assessments to human health and the environment, considering bio-accumulation, biomagnification, ecological modeling, and dose-response methodologies;
- quantitatively characterize risk to human health and the environment;
- the students will be exposed to a variety of examples that demonstrate concepts which have gone into building risk assessment methodologies
- develop understanding of risk communication and management strategies including acceptable risk, legislation on risk assessment, and deficiencies in risk assessment processes.

4. Method of Presentation

The course material will be presented in three hours of lectures per week. Experience with dealing with data and the development of risk assessments will be gained through a tutorial hour each week. Computer applications for the completion of risk assessments and management will be relied upon throughout the course.

Tutorials/Computer Laboratory Assignments

- Excel spreadsheet analyses for derivation of summary statistics;
- Testing of distribution assumptions for extreme values;

- Simple experiments to develop exposure risk assessments;
- Risk assessment strategies for application to developing world concerns; and,
- Interactive, inclass experiments to develop risk communication strategies that can demonstrate how public communication is needed and can be accomplished.

Project
A term project will be required from groups of three to four students, to provide experience in developing a risk assessment application.

5. Method of Evaluation

- Assignments 15%
- Project 25%
- Midterm 25%
- Final 35%

6. Reason for Course Offering:

Strategies and needs for risk assessment are pervasive throughout society as we learn more about human health and environmental risks. While it is desired to drive the risk to zero, this is infeasible as no activity or technology can be absolutely safe; instead, we make tradeoffs. As we gain more information and knowledge (e.g. about the carcinogenicity of specific food additives and/or water treatment alternatives), decision-making reflecting risk assessment will become even more complex. It is essential that students learn how to address these issues, and how to interact and communicate with the public.

Students currently must learn how variability and uncertainty can be incorporated into human health and ecological risk assessment, using available statistical and simulation tools to comprehend the basis for decisions. The ability to understand, analyze, and design such data assembly and interpretation has become an indispensable skill that engineers and scientists increasingly need.

The expected enrollment in the course is from 30 to 70 students in the senior undergraduate years. The degree programs expected to be served include: BSc(Eng) (from Biological Engineering, Environmental Engineering, and Water Resources Engineering), BSc(Environmental Science), and BSc(Land Resource Science).

Status: The course will be offered as a restricted elective in that first courses in (a) statistics and probability and (b) calculus, will be assumed.

7. Resource Needs:

A: Access to spreadsheet programs such as Excel

8. Consultation with other units:

This course will provide a technical elective to Biological Engineering, Environmental Engineering, Water Resources Engineering, Environmental Science, and Land Resource Science. The addition of this course will also be beneficial to the graduate students who require additional background in the statistical interpretation of data and the elementary concepts of risk assessment and management.

It is noted that Environmental Risk Analysis Stats 3510 is offered in Statistics. While both courses (the proposed course and Stats 3510) address risk assessment issues, there is a very significant difference in the focus. The emphasis in Stats 3510 is predominantly from the statistics side as it is applied to risk assessment, as opposed to this proposed course which is very predominantly from the risk assessment, engineering application, public interface component.

In terms of CEAB, the breakdown of the course is projected to be:

Basic Mathematics	0
Basic Science	0
Engineering Science	.50
Engineering Design	.50
Complementary Studies	.0

9. Library Assessment

The following library material is essential, as it will be the textbook:

McBean, E., and Rovers, F., 1998, Statistical Procedures for Analysis of Environmental Monitoring Data and Risk Assessment, Prentice-Hall Publishing Co. Inc., Englewood Cliffs, New Jersey

The text will be supplemented with focused materials from the technical literature for purposes of enhancing background information available to the students.

Supplementary material includes:

- Asante-Duah, Kofi, Risk Assessment in Environmental Management, John Wiley and Sons, New York, 1998
- Hubert, J.J., Environmental Risk Assessment, Dept of Mathematics and Statistics, University of Guelph, 2004
- Neely, Brock, Introduction to Chemical Exposure and Risk Assessment, Lewis Publishers, Ann Arbor, 1994
- Linkov, I., and Palma-Oliveriera, J., 2001, Assessment and Management of Risks Cost-Efficient Methods and Applications, Kluwer Academic Publishers, London
- Louvar, J. F., and Louvar, B.D., Health and Environmental Risk Analysis - Fundamentals with Applications, Prentice Hall PTR, 1997

10. Contributions to Learning Objectives

I. Literacy

In-class discussions will stimulate students to consider alternative magnitudes of risk which are faced on a regular basis, and how to extend that knowledgebase to communication with the public and to get public liaison committees to build consensus on decision-making.

II. Numeracy

The students will undertake detailed calculations for purposes of risk assessment and their associated costs, to demonstrate tradeoffs which we must necessarily make, in risk management.

III. Historical Development

The evolution of risk aspects associated with human and ecological disasters will be used to demonstrate how we have reached the present situation in terms of our understanding of human health and ecological risks. This will include some brief discussions of plagues, and water supply incidents, including public and private responses to risk.

IV. Global Understanding

The future scenarios include significant efforts to utilize risk assessment and management as strategies throughout the globe, to address tradeoffs. There are significant differences between approaches adopted in developed and developing countries that will be developed.

V. Moral Maturity

The development of risk assessment and risk management methodologies is a multi-stage process of information assembly, analysis and inference development. It is typical that the process will be challenged by conflicting criteria (e.g. cost versus risk), and hence, for students to develop and understand the procedures, they will be required to exercise effective knowledge assimilation and maturity.

VI. Aesthetic Maturity

Students will be encouraged to strive for demonstrative tradeoffs and effective responses to risk assessment and management. They will learn that mathematical elegance is not necessarily going to be the most effective but how to hedge against the implicit uncertainty in risk assessments. In this course, students will experience how to work together in several assignments.

VII. Depth and Breadth of Understanding

Topics to be covered in the course are interdisciplinary and application domains, drawing from engineering, science, epidemiology/toxicology, and lifestyle. All elements must be appreciated in identifying strategies that influence exposure risks, and potential risk management actions. Further, the development of the term papers will involve collective group efforts, and the communication between group members will be important in improving their team participation.

VIII. Independence of Thought

During class discussion, students will be stimulated to express their views regarding alternative methodologies for risk assessment, and potential communication strategies with the public. They will also be motivated to exercise independence of thought in approaching the course assignments and their term papers.

IX. Love of Learning

The students in this course will observe how their everyday decisions involve risk, and improve their understanding of the external features (e.g. the food they eat, the water they drink, and the air they breathe) influence their exposure risk. As well, they will better understand the processes by which the development of collective public response to many projects can be enhanced. These activities will provide them with an excellent environment to enjoy learning through assessment and tradeoff decision-making.

Week No.	Topics to be Covered
1	Background to exposure risks to human health, safety and to the environment
2	Fundamentals of statistics and probability
3	Contaminant source types and fate and transport of chemicals
4	Receptor impacts - ecological and human
5	Exposure assessments and dose response information
6	Databases and information sources
7	Risk assessment methodologies for human health
8	Risk assessment methodologies for the environment
9	Monte Carlo analytical procedures
10	Risk communication and management
11	Case studies
12	Larger views of risk including developing world considerations.

Additional Items:

(i) Currently, there is only one faculty member who is in a position to teach the course. However, as part of the School of Engineering's aggressive growth pursuit, one of the considerations in the hiring of a new faculty member will be that the individual would be positioned well to teach the course.

(ii) The course will be taught once per year. The expectation is that there will be 30 to 70 students taking the course in a single offering.