

# SYLLABUS

Spring 2018

## ENVR 470: Environmental Risk Assessment

**Time and location:** Wednesdays, 8:00-10:45 a.m., McGavran-Greenberg 1305

**Instructor:** Jackie MacDonald Gibson (MHRC 0032)

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**Homework help:** Thursdays, 3:00-5:00 (except Jan. 18 or if otherwise notified), MHRC 0032

### **Course Description and Goals**

Risk assessment involves estimating the probability of harm to humans or ecosystems from chemicals, pathogenic microorganisms, radiation, technology, or any other factor that can influence health and well-being. Although risk assessment can cover a number of domains, in keeping with our placement at a School of Public Health, we focus exclusively on quantifying the risks to human health of exposure to chemicals and pathogenic microorganisms. However, many of the techniques and concepts we will discuss can be applied in other areas.

Risk assessment fundamentally involves the integration of knowledge across numerous disciplines. Epidemiology and toxicology are used to understand what types of illness may be caused by exposure to harmful chemicals or microorganisms. Exposure levels can be estimated through field measurements or mathematical models of pollutant fate and transport and can sometimes include information about human physiology to better understand the actual dose delivered to an organ. A formal risk assessment mathematically combines these and other pieces of information with a careful consideration of the relevant uncertainties to arrive at estimates of risk useful for decision-making.

In this course, we aim to explore all of the major components of risk assessment, learning how to make the critical calculations but also exploring the underlying assumptions and considering the implications for policy and public health.

### **Prerequisites**

One previous college-level course in probability and statistics is required.

### **Course Requirements and Evaluation**

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| Class participation (completion of in-class response sheets, participation in discussions) | 15%   |
| Quizzes  | 25%   |
| Homework assignments   | 40%   |
| Final presentation   | 10%   |
| Final exam   | 10%   |
|  | <hr/> |
|  | 100%  |

## Class Participation

Your class participation grade will be based on your completion of in-class exercises and discussions. Participation in each class session is worth 1% of your grade.

## Grading Scheme

90-100% = H (A for undergraduates)

80-89% = P (B for undergraduates)

70-79% = L (C for undergraduates)

60-69% = F (D for undergraduates)

<60% = F (graduate students and undergraduates)

## Homework Policy and Expectations

Each student is responsible for turning in his or her **own** homework results. You may consult other students for assistance, **but you must acknowledge their assistance on your homework. An automatic zero will be assigned as the grade for any homework that is a copy of another student's work.**

In your homework, **please show all of the key steps** in your analysis. If you do not show your work, you will receive a score of zero.

**You must submit your homework on time.** Late assignment grades will be dropped by 20% for each day late, unless the permission of the instructor is obtained in advance.

## Textbooks

Two books are required:

1. *Should We Risk It?*, by Daniel M. Kammen and David M. Hassenzahl, Princeton University Press, 2001.
2. *Quantitative Microbial Risk Assessment*, by Charles N. Haas, Joan B. Rose, and Charles P. Gerba, John Wiley & Sons, 2014.

## Software

We will use *RStudio* for some statistical analyses in class. Please download *Rstudio* before the second week of class from <https://www.rstudio.com/products/rstudio/download/>.

We will make extensive use of *Analytica* software for Monte Carlo simulation. Please download the free educational version from <http://www.lumina.com/products/free101>. If you are a Mac user, you will also need to install a Windows emulator, such as the free Boot Camp (<https://support.apple.com/en-us/HT201468>) or Parallels Desktop (\$79.99, download from [www.parallels.com](http://www.parallels.com)). You will also need Windows, which you can obtain from UNC's Software Acquisition Office (see <http://software.sites.unc.edu/how-to-order/>).

### Course Schedule (subject to updates)

| Date                            | Topics  | Assignments (Due the Following Week Unless Otherwise Specified)  |
|---------------------------------|---|--|
| 10-Jan                          | Course overview and logistics<br>Introduction to risk analysis<br>Ranking risks   | Download <i>Analytica</i> software, and be sure it is working on your lap-top<br>Download <i>R Studio</i> , and be sure it is working<br><b>Required reading:</b> <i>Judgment under Uncertainty: Heuristics and Biases</i> , A. Tversky and D. Kahneman, Science, 1974 |
| 17-Jan                          | Risk perception<br>Probability and statistics review; using <i>R Studio</i> to generate histograms and summary statistics                     | Optional reading: SWRI, Chapter 3<br>Optional additional probability and statistics review materials will be posted on Sakai under "Resources"→"Probability and Statistics Review"<br><b>Homework 1</b> (probability and statistics review)—due January 26, 5:00 PM    |
| 24-Jan                          | Risk calculations with random variables via Monte Carlo simulation using <i>Analytica</i> software  | Optional reading: SWRI, Ch. 4<br><b>Homework 2</b> (Monte Carlo simulation)—due February 2, 5:00 PM  |
| 31-Jan                          | Monte Carlo simulation and <i>Analytica</i> (continued)   | Optional reading: SWRI, Ch. 1; QMRA, Ch. 3, pp. 63-67<br><b>Homework 3</b> (Monte Carlo simulation, continued)—due February 9, 5:00 PM   |
| 7-Feb                           | Four-step risk assessment paradigm; introduction to risk modeling; additional practice with <i>Analytica</i>                                  | Optional reading: SWRI, Ch. 2  |
| <b>CHEMICAL RISK ASSESSMENT</b> |   |  |
| 14-Feb                          | <b>Quiz 1:</b> Cognitive heuristics; probability and statistics; Monte Carlo simulation<br>Lecture: Exposure assessment—mass-balance modeling | Optional reading: SWRI, Ch. 4, pp. 134-143<br><b>Homework 4</b> (mass-balance modeling)—due February 23, 5:00 PM   |
| 21-Feb                          | Exposure assessment: monitoring; analysis of monitoring data with <i>R Studio</i> ; Bayesian updating of monitoring data                      | Optional reading: SWRI, Chapters 5, 7  |

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|        |  | <b>Homework 5</b> (working with and updating monitoring data)—due March 2, 5:00 PM   |
| 28-Feb | Dose-response assessment for chemicals in the environment: introduction; dose calculation; dose-response assessment from toxicological studies   | Optional reading: SWRA, Chapter 6<br><b>Homework 6</b> (dose-response assessment using toxicological data)—due March 9, 5:00 PM  |
| 7-Mar  | <b>Quiz 2:</b> Mass-balance modeling; using monitoring data<br>Lecture: Limitations of toxicology studies for dose-response assessment; dose-response estimation from epidemiologic studies; limitations of epidemiologic studies  | <b>Required reading (due March 21—there will be a quiz):</b> Arsenic Regulatory Impact Analysis, Chapters 1-3, Chapter 5 (focus on Chapter 5)<br><b>Homework 7</b> (dose-response assessment using epidemiologic data)—due March 23, 5:00 PM |
| 21-Mar | <b>Quiz 3:</b> Dose-response assessment; risk characterization; arsenic regulatory impact analysis<br>In-class exercises: reproducing calculations in arsenic regulatory impact analysis   | Optional reading: QMRA, Chs. 1-4 (skim), Ch. 6<br><b>Homework 8</b> (arsenic regulatory impact analysis calculations)—due March 30, 5:00 PM  |
|        | <b>MICROBIAL RISK ASSESSMENT</b>   |  |
| 28-Mar | Introduction to quantitative microbial risk assessment; hazard identification; exposure assessment   | Optional reading: QMRA, Chs. 7-8<br><b>Homework 9</b> (microbial exposure assessment)—due April 6, 5:00 PM   |
| 4-Apr  | Microbial growth and decay; microbial dose-response assessment   | Optional reading: QMRA Chs. 9-10<br><b>Homework 10</b> (microbial dose-response assessment and risk characterization)—due April 13, 5:00 PM  |
| 11-Apr | <b>Quiz 4:</b> Microbial exposure assessment; microbial growth and decay<br>Lecture: Population disease transmission   | <b>Required reading (due April 18—for quiz):</b> Enhanced Surface Water Treatment Rule regulatory impact analysis, Chapters 1-3, Chapter 5 pp. 1-34 (focus on Chapter 5)   |
| 18-Apr | <b>Quiz 5:</b> Microbial dose-response assessment; microbial risk characterization; Enhanced Surface Water Treatment Rule regulatory impact analysis<br>In-class exercises: Reproducing calculations in regulatory impact analysis | <b>Final project presentations</b>   |

|        | <b>COURSE CONCLUSION</b>    |  |
|--------|-----------------------------|--|
| 25-Apr | Final project presentations |  |
| 4-May  | FINAL EXAM (4:00-7:00 PM)   |  |