SYLLABUS

Fall

ENVR 570-001:

Environmental Decision Analysis

Time and location: M, W, F, 10:10 – 11:00 a.m., McGavran-Greenberg 2305

Instructor: Jackie MacDonald Gibson (MHRC 0032)

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Office hours: Mondays, 11:00-12:00, or by appointment

Course Goals

This course will introduce students to tools for balancing conflicting priorities (such as costs versus human health protection) and evaluating uncertainties when making environmental decisions, either in government agencies or private industry. **The goal of the course is to learn how to provide structure to "messy" environmental decision problems, in order to help decision-makers arrive at the decision that best reflects their values or the values of the constituency they represent**. By the end of the course, students will have learned new methods and tools for structuring such problems and providing advice on alternative choices. Students will learn to build decision models using spreadsheet add-on tools and stand-alone software.

Scope and General Organization

The course will begin with an overview of the field of decision analysis. The first several classes will involve understanding why decisions sciences emerged as a field of inquiry and the use of decision analysis methods in the federal government. The remainder of the course will cover nine different operational methods for helping people make better-informed decisions under conditions in which future outcomes are uncertain. These methods are

1. Economic discounting
2. Decision trees
3. Value of information analysis
4. Multi-criteria decision analysis
5. Monte Carlo simulation
6. Expert elicitation
7. Bayesian belief networks
8. Optimization
9. Disability- and quality-adjusted life year calculations

Learning Objectives

Content learning objectives	*Skill* learning objectives
• Structuring complex decisions • Understanding situations in which decision support tools may be useful and which types of tools are applicable to these situations. • Understanding the differences between facts and values and the legitimacy of alternative value systems • Demonstrate awareness of and sensitivity to the varied perspectives, norms and values of others. • Understanding the success of environmental interventions and assessing the uncertainty involved. • Obtaining broad exposure to contemporary issues in environmental sciences, environmental health, and environmental engineering. • Explaining the relationships between scientific knowledge, exposure, risk assessment, environmental management, and environmental policies. • Applying evidence-based concepts in public health decision-making. • Identifying needed resources for public health programs or research (for example, through value-of-information analysis).	• Structuring complex decisions by understanding the characteristics of systems relevant to the decision • Identifying objectives and values in the context of environmental decisions. • Applying nine decision-making methods (including use of available software and other tools): 1. Economic discounting 2. Decision trees 3. Value of information analysis 4. Multi-criteria decision analysis 5. Monte Carlo simulation 6. Expert elicitation 7. Bayesian belief networks 8. Optimization 9. Disability- and quality-adjusted life year calculations • Learning how to analyze, interpret, and explain the results of original research through weekly readings and discussion of peer-reviewed journal articles.

Course Materials

One textbook is required: *Making Hard Decisions (With DecisionTools)*, by Robert T. Clemen and Terence Reilly, Duxbury, 2014 edition. The textbook comes with software that we will use for the class. Unfortunately, the software expires after one year of use, so used textbooks will not be sufficient, unless you have a way to procure the software.

Most Fridays will be dedicated to discussing decision analysis case studies and other articles that you will read. These readings will be posted on Sakai at least one week before the date they are to be discussed. ***Please make sure you complete all of the readings before arriving in class on Friday.*** A short quiz will be given at the beginning of each Friday class to test your preparedness. You will be asked to participate in in-class exercises and small-group discussions based on the reading, and you will be graded based on your quiz results along with your participation in the discussion. **Policies for assigning a class participation grade are described in the attached appendix.**

Prerequisites

One previous course in probability and statistics is required. There are no exceptions to this pre-requisite.

Student Evaluation

Class participation and Friday quizzes	15%
Mid-term exam	15%
Homework assignments	50%
Final exam	20%
	100%

The appendices provide details on course grading, including grading of Friday discussion sessions.

Homework Plagiarism Policy

Each student is responsible for turning in his or her **own** homework results, although you may consult other students for assistance. You may work in groups, but please give credit to your other group members. In addition, each member of the group should turn in their own write-up for each assigned problem. **Copying solutions developed by another student will result in an automatic zero for the entire assignment**.

Course Schedule (subject to updates)

Please complete the readings *before* each class.

Date	Day	Topic	Assigned Readings	Homework
		Course overview; motivation for studying decision analysis		
		Friday reading: cognitive heuristics; brief probability and statistics review	Judgment under Uncertainty: Heuristics and Biases (Tversky and Kahneman, 1974)	
		Cognitive heuristics; introduction to the rational decision-maker model; probability review problems	C&R, Chapters 1-2	Assignment 1 distributed
		How environmental decisions are made in the US government; probability review problems		
		Friday reading: and in-class debate Precautionary Principle	The Precautionary Principle: Risk, Regulation, and Politics (Lofstedt, 2003); Beyond the Precautionary Principle (Sunstein, 2003)	
		Regulatory Impact Analysis; probability review problems		Assignment 1 due; assignment 2 distributed
		Friday reading: Impact of Regulatory Impact Analysis	Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone (EPA, 2014); Obama Administration Abandons Stricter Air-Quality Rules (NYT 2011); New Regulations on Smog Remain as Divisive as Ever (NYT 2015)	
		Tool 1: Economic discounting	Re-read relevant sections of C&R Ch. 2; Hand-out: Have We Caught Your Interest?	

Date	Day	Topic	Assigned Readings	Homework
		Discounting (continued)		Assignment 2 due; assignment 3 distributed
		Friday reading: discounting in U.S. government agencies	Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis (Morrison, 1998)	
		Issues in discounting: non-market goods (e.g., a clean environment, a human life)		
		Issues in discounting (continued): intergenerational discounting	C&R, Chapter 7	Assignment 3 due; assignment 4 distributed
		Friday reading: discounting preferences in less-developed countries	Time Preferences for Life-Saving Programs: Evidence from Six Less Developed Counties (Poulos and Whittington, 2000)	
		Tool 2: Decision trees	C&R, Chapters 3-4	
		Decision trees, continued		Assignment 4 due; assignment 5 distributed
		Tool 3: Value of information	Clemen & Reilly, Ch. 12	
		Friday reading moved to Monday: decision tree example	Using Decision Analysis to Include Climate Change in Water Resources Decision Making (Hobbs et al., 1997)	
		Value of information, continued		Assignment 5 due; assignment 6 distributed
		Friday reading: value of information examples	Information Value of the Rodent Bioassay (Lave et al., 1998); Buying Greenhouse Gas Insurance (Manne and Richels, 1991)	
		Tool 4: Multi-criteria decision analysis; risk aversion	C&R, Chapters 14-16	

Date	Day	Topic	Assigned Readings	Homework
		Multi-criteria decision analysis (continued): limitations, paradoxes		
		Friday reading: multi-criteria decision analysis case study	Prioritizing environmental health risks in the UAE (Willis, MacDonald Gibson et al. 2010)	
		Review session		Assignment 6 due; assignment 7 distributed
		MID-TERM EXAM		
		Tool 5: Monte Carlo simulation and uncertainty analysis	C&R, Chapters 9-11	
		Monte Carlo simulation and uncertainty analysis (continued)		Assignment 7 due; assignment 8 distributed
		Friday reading: Monte Carlo simulation case study	Burden of disease attributable to environmental pollution in the United Arab Emirates (MacDonald Gibson et al., 2013)	
		Monte Carlo simulation (continued)		
		Tool 6: Subjective probability and expert elicitation	C&R, Chapter 8	Assignment 8 due; assignment 9 distributed
		Friday reading: expert elicitation case study	Explosion probability of unexploded ordnance: expert beliefs (MacDonald et al., 2008)	
		Tool 7: Bayesian belief networks (BBNs)	Download Netica from http://www.norsys.com/download.html; supplemental readings (optional): Bayesian Networks and Bayesia Lab, pp. 13-14, 21-30; Bayesian networks without tears (Charniak, 1991)	
		BBNs (continued)		Assignment 9 due; assignment 10 distributed

Date	Day	Topic	Assigned Readings	Homework
		Reading: BBN case study	A Bayesian network for assessing the collision induced risk of an oil accident in the Gulf of Finland (Lehikoinen et al., 2015)	
		Tool 8: Linear programming		
		Linear programming (continued)		Assignment 10 due; assignment 11 distributed
		Friday reading: linear programming case study	Economic and Environmental Costs of Regulatory Uncertainty for Coal-Fired Power Plants (Patino-Echeverri et al., 2009)	
		Tool 9: Disability- and quality-adjusted life year analysis (DALYs and QALYs)		
		DALYs and QALY's, continued		Assignment 11 due; assignment 12 distributed
		Friday reading: DALY, QALY case study	Balancing risks and benefits of drinking water disinfection: disability-adjusted life-years on the scale	
		Decision analysis example: policies to protect wastewater and sewer workers during Ebola outbreak, Dr. Joe Zabinski, ESE	TBA	**Assignment 12 due**
		Decision analysis example: ozone regulatory impact analysis, Dr. Zach Pekar, EPA Office of Air Quality Planning and Standards	TBA	
		Semester review		
		FINAL EXAM, 8:00 a.m.		

Appendix 1: Grading of Student Participation in Friday Reading Discussions

Each student will be graded according to their quiz result and the *quality* of their contribution to discussion. The quiz will consist of two short questions, worth a total of 2 points. The quality of participation in the discussion will be graded as follows:

- No participation/question, or participation that hinders overall development of discussion without benefit to understanding or clarification*: 0
- Comment made that is not focused on scope of assigned readings, or new information provided that does not contribute to developing overall (group) understanding of readings: 1
- Comment/question made that contributes to enhancing overall understanding of assigned reading theme (includes placing theme in wider context relevant to course, succinct presentation of assigned reading main theme and/or new relevant information): 2

*Includes demonstrated lack of understanding of issues that would reasonably be expected to have been clear from the reading.

One score will be generated per student per applicable class session, i.e., scoring is driven by quality, not quantity of participation in any given session. The maximum total participation grade for each class is 4 points, which will be assigned a grade of 100%. The average score across all discussion days will serve as the class participation grade.

Appendix 2: Overall Grading

Each homework assignment and exam, and the final presentation, will receive a grade between 0 and 100%. The average homework grade across all homework at the end of the semester will be computed in order to determine the overall homework grade. The final grade will be determined as a weighted average of the class participation, homework, mid-term exam, presentation, and final exam grades using the weights shown on p. 3. Final grades will be assigned as follows:

Final Course Score	Undergraduate Grade	Graduate Student Grade
90-100%	A	H
80-89%	B	P
70-79%	C	L
60-69%	D	F
<60%	F	F