Princeton University
Woodrow Wilson School of Public and International Affairs
Science, Technology and Environmental Policy (STEP) Program
Fall, 2002

WWS-584
The Use of Science in Environmental Policy
Room 012 Robertson Hall
Mondays 7:00 – 10:00 PM
(first class meets Monday September 13, 2004)

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Overview: Science and technology are having an increasing influence on modern society and the natural environment is increasingly stressed by human activities. How scientific information is framed can have a large influence on technical and environmental policy development and implementation. This course presents a set of basic methods and tools for analyzing technical policy issues with an emphasis on environmental issues. Topics include: order-of-magnitude estimation; modeling for policy evaluation; risk assessment and risk communication; and analysis of science assessments for policy makers on stratospheric ozone depletion, climate change and long-range transport of air pollution.

The goal of this course is to improve the students' ability, confidence and judgment in the use of science in policy applications. The course is intended both for students with significant technical training as well as for those with primarily a policy focus but with an interest in better understanding how science can be effectively used to inform policy making. Students should leave the course with an increased understanding of how technical information can be used to inform the policy process, an ability to ask questions necessary to differentiate between legitimate and illegitimate claims, and the confidence to do so.

Course format: There will be one three-hour meeting per week divided, very roughly, between a lecture, discussion and practical application. The discussion will be based on the weeks reading. There will also be a precept each week to prepare for and go over homework.

Homework: There will be homework assignments approximately every other week which will include back-of-the-envelope calculations, computer modeling exercises, and technical policy memos.

Final Project: The course will culminate in a final project that makes use of the techniques taught in the course. The project will involve a technical analysis in support of specific policy recommendations. Depending on the diversity of student interest, this project will be part of a larger course project or will be an independent paper.

Grading: Grades will be based on class participation, homework and the final project. The following percentages will be used:
Class participation 20%
Homework: 40%
Final Project - written report 30%; oral presentation 10%

SCHEDULE OF CLASSES

Week 1: Friday September 13. Introduction and Overview.

Class:
Course overview. The role of science, technology and environmental issues in modern society. How is science used (and misused) in policy making?

Precept:
Review of basic science and math topics.

Recommended Reading:
E.O. Wilson, The Future of Life (2002)
Chapter 2 "The Bottleneck", pp.22-41;
Chapter 7 "The Solution", pp. 149-189.

MODELING MODULE:

Computer models are becoming increasingly pervasive tools for analyzing complex phenomenon to inform policy decisions. However, it is often difficult to determine the accuracy of their predictions. In this module we will construct and evaluate simple models in order to demystify the modeling process and learn how to evaluate their results. We will start with "back-of-the-envelope" and order-of–magnitude estimation, and from there developing steady-state, computer-spreadsheet, and stock and flow models. The culmination will be the use of the integrated assessment RAINS-EUROPE model which was used by the European community in their negotiations to control acid rain. Emphasis will be placed both on constructing and evaluating models, and on their use and misuse in the policy process. Modeling exercises will be oriented around environmental problems with background on air and water pollution and risk assessment provided in lectures.

Week 2. Monday September 20.

Class:
Use and misuse of basic quantitative methods. Back-of-the envelope estimates. Introduction to simple modeling techniques: box, steady-state and non- steady-state models, stocks and flows.

Precept:
STELLA introduction, tutorial and modeling session.

Required Readings:
Koomey, JG et al., Sorry, Wrong Number: The Use and Misuses of Numerical Facts in Analysis and Media Reporting of Energy Issues, Annual Review of Energy and Environment, 27:119-58, 2002.

Frank von Hippel, Citizen Scientist (1991)
"Peer Review of Public Policy", pp. 16-29;
"The Advisors Dilemma", pp. 30-39.

Harte, J. (1985) Consider a spherical cow: a course in environmental problem solving, Chapter 1, p. 1-44.

Reference Reading:
Soltzberg, L., The Dynamic Environment, computer models to accompany Consider a spherical cow, pp. 1-22, 52-67.
High Performance Systems (1992), STELLA II: Introduction to Systems Thinking (High Performance Systems, Hanover, NH, chapters 1-6 (pp. 1 – 102)

Week 3. Monday September 27.

Class:
Complex models are becoming commonplace in a diverse range of technical and non-technical policy areas. To what extent are these models useful, and to what degree do they obscure important components of the situation? How can we evaluate them? How much can we rely on the answers they provide?

Precept:
Testing the stability and utility of a simple global change forecast model. Introduction to the World3 model.

Required Readings:
Meadows, D. H., Meadows, D.L. and Randers, J. (2004) *Limits to Growth - the 30 Year Update.*.

Nordhaus, William D. Lethal Model 2: The Limits to Growth Revisited, Brookings Papers on Economic Activity, 2:1992.

Week 4. Monday October 4.

Class:
Air pollution resulting from fossil fuel combustion - aerosols, acid rain, smog. Inter-connections between energy, air pollution, and climate change.

Precept:

Overview of links between energy use, climate change and air pollution, particularly acid rain formation. Introduction to the RAINS (Regional Air Pollution Information and Simulation) model.

Required Readings:
Graedel, T. E., Crutzen, P.J. (1997) Atmosphere, Climate and Change,
Chapter 3 "Chemistry in the Air", pp.34-57.
Chapter 5 "Changing Chemistry", pp. 89-111
Chapter 6 "Predicting the Near Future", pp.113-140.

Supplementary Reading:
Graedel, Thomas E. and Paul J. Crutzen. *Atmospheric Change: an Earth Systems Perspective*. New York: W. H. Freeman and Company. 1993.

Week 5. October 11.

Class:
Description of local and long-range transport of air pollution. Introduction to the integrated assessment model RAINS for analyzing alternative strategies to reduce acidification, eutrophication and ground-level ozone in Europe. RAINS combines a variety of information on energy technologies, sulfur dioxide emissions, transport, impacts and economics that are relevant to the development of cost-effective emission control strategies in Europe. It was used as a tool in the international negotiations of the Long Range Transboundary Air Pollution (LRTAP) agreement.

Precept:
Tutorial on RAINS model.

Required Readings:
Skim information at: http://www.iiasa.ac.at/~rains/index.html

RISK ASSESSMENT MODULE:

Science and technology decision making routinely involves uncertainty and the evaluation of hazards. This module introduces a set of risk assessment tools commonly employed in public health, environmental, military and industrial applications. We will examine probabilistic and exposure assessment methods. We will also explore the critical step of risk prioritization and communication, both as a tool for 'public interest science' and as it is utilized to legitimize/evaluate/inform political decisions.

Week 6. October 18.

Class:
Methods for estimating and prioritizing risks.

Readings:
Articles are in:

Glickman, T. S., Gough, M. (eds.) Readings in Risk,

Morgan, Granger *Probing the Question of Technology-Induced Risk*, p.5-16.

Morgan, Granger, *Choosing and Managing Technology-Induced Risk*, p. 17-29.

Fischhoff, B., C. Hope, S. R. Watson, *Defining Risk*, p. 30-41.

Kelman, S. *Cost-benefit analysis: an ethical critique*, pp. 129-137.

Precept:
Preliminary discussion of course project

FALL BREAK

Week 7. November 1.

Class:
Risk/benefit analysis and cost/benefit analysis. Estimating exposure, dose and response to toxins.

Required Reading:

Vose, D. *Monte Carlo Risk Analysis Modeling*, in Fundamentals of Risk Analysis and Risk Management, Lewis Publishers, 1996.

Cifuentes, L., et al. Hidden Health Benefits of Greenhouse Gas Mitigation, *Science*, 293, 1257-1258, 2001.

Hall, J. V., et al. *Valuing the Health Benefits of Clean Air*, Science, vol. 255, pp. 812-816, 1992.

Supplementary Reading:

Rabl, Ari, and Spadaro, J. Public Health Impact of Air Pollution and Implications for the Energy System, *Ann. Rev. Energy Environ*. 25:601:627, 2000.

Pope, C.A., et al., Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution., *JAMA*, 287, 1132:1141, 2002.

Kammen and Hassenzhal, Should We Risk It? pp. 122-152.

Precept:
Crystal Ball and Monte Carlo laboratory Session

Week 8. Monday November 8.

Class:
Risk communication and risk policy

Case study: Biotechnology -- evaluating risks and benefits. Guest Speaker: Prof. Lee Silver, "Risk assessment of organic plants, natural dietary supplements, and genetically modified food."

Required Readings:

Article in:
Glickman, T. S., Gough, M. (eds.) Readings in Risk,

Plough, A., Krimsky, S. *The emergence of risk communication studies: social and political context,* pp. 223-231.

Additional readings will be provided.

SCIENCE ASSESSMENTS FOR POLICY MAKING MODULE

The scientific community is increasingly being asked to prepare state-of-the-science summaries to inform policy-makers of the current understanding of technical issues. How influential are these assessments? What is the best way to make use of them? How can they best inform policy decisions?

Week 9. November 15

Class:
What are the role of science assessments? How can they be used effectively in the policy process? Overview of major mechanisms for obtaining science assessments.

Precept:
Description of effective design of a technical policy memo.

Required Readings:
Morgan MG, Houghton A, Gibbons JH. Science and government - Improving science and technology advice for Congress, *Science*, 293 1999-2000, 2001.

Politics and Science in the Bush Administration. U.S. House of Representatives, Committee on Government Reform - Minority Staff Special Investigations Division, August 2003.

Cash, David and Clark, William. From Science to Policy: Assessing the Assessment Process. Kennedy School of Government, Harvard University, Faculty Research Working Papers Series, RWP01-045, November 2001.

Sarewitz, Daniel. Frontiers of Illusion: Science, Technology and the Politics of Progress, chapter 5: The Myth of Authoritativeness, 1996, p. 71-96.

Week 10. November 22, U.S. Air Quality Management and the National Academy of Science /National Research Council Assessment of the Clean Air Act

Class: How does the National Academy of Science and the National Research Council provide policy-makers with objective analyses of technical material?

Guest speaker: NAS/NRC Program Manager

Required Reading:

Anderson, Fredrick R., Improving Scientific Advice to Government, Issues in Science and Technology, Spring 2003.

NRC, U.S. Air Quality Management, 2004.

Week 11. November 29, Stratospheric Ozone Depletion and the Montreal Protocol

Class: International panels of experts on the science of ozone depletion, technology options to replace CFCs, effects of stratospheric ozone loss and the economics of substitutes were used to evaluate the impacts of stratospheric ozone depletion, and the feasibility and costs of phasing out the production of CFCs. The Montreal Protocol is one of the few international environmental success stories. Why did it work so well? What can we learn from this of relevance to other international environmental treaties?

Reading:

Scientific Assessment of Ozone Depletion: 1998, World Meteorological Organization, Executive Summary and Frequently Asked Questions.

Stephen O Andersen & K Madhava Sarma, Protecting the Ozone Layer: The United Nations History, United Nations Environment Program, 2002. Chapters 5-10.

Week 12. December 6, Climate Change and the Intergovernmental Panel on Climate Change (IPCC)

Class: What is the IPCC? How is it different than other science advisory panels? How much of decisions regarding climate are based on science and how much on politics? How certain are we climate change is occurring relative to our certainty regarding stratospheric ozone loss?

Precept: Presentation/discussion with staff of the writing center regarding final class projects and term papers.

Reading:

Parson, Edward. The Technology Assessment Approach to Climate Change, Issues in Science and Technology, National Academy of Sciences, XVIII,4, 65-72, 2002.

Summary for Policymakers. Climate Change 2001: The Scientific Basis, Intergovernmental Panel on Climate Change, 2001. pp. 1-18. Also, skim the next chapter: Technical Summary, pp. 21-79. *Choose one area with which to be sufficiently familiar that you can summarize the issue for the class.*

Summary for Policymakers. Climate Change 2001: Synthesis Report, Intergovernmental Panel on Climate Change, pp. 1-34, 2001.

READING PERIOD

Reading: Packet on Public Speaking techniques.

Final presentations will be made during reading period.

Required Texts:

Von Hippel, Frank. Citizen Scientist, Simon and Schuster, 1991.

Harte, John. Consider a Spherical Cow: A Course in Environmental Problem Solving, University Science Books, 1988.

Meadows, D. H., Meadows, D.L. and Randers, J. (2004) Limits to Growth - the 30 Year Update

Graedel, T. E., Crutzen, P.J. Atmosphere, Climate and Change, Scientific American Library, New York, 1997.

Glickman, T.S., Gough, M. (eds.) Readings in Risk, Resources for the Future, Baltimore, MD, 1990.

Additional material will be distributed through e-reserve.

Material on reserve in Stokes Library:

Soltzberg, Leonard, The Dynamic Environment: Computer models to accompany Consider a Spherical Cow, University Science Books, 1996.

Kammen, D. M., Hassenzahl, D. M. Should We Risk It? Exploring Environmental, Health, and Technological Problem Solving, Princeton University Press, 1999.

Andersen, Stephen O and Sarma, K Madhava, Protecting the Ozone Layer: The United Nations History, Earthscan, 2002.

High Performance Systems, STELLA II: Introduction to Systems Thinking, High Performance Systems, Hanover, NH, 1992.

Climate Change 2001, The Scientific Basis, Contribution of Working Group I to the third assessment report of the Intergovernmental Panel on Climate Change, Edited by J.T. Houghton, et al., Cambridge University Press, 2001.

Climate Change 2001 : Impacts, Adaptations, and Vulnerability, Contribution of WGII to the third assessment report of the Intergovernmental Panel on Climate Change, edited by McCarthy. et al., Cambridge University Press, 2001.

Climate Change 2001: Mitigation, Contribution of Working Group III to the third assessment report of the Intergovernmental Panel on Climate Change, Edited by Metz, et al., Cambridge University Press, 2001.

Climate Change 2001: Synthesis Report, Contribution of Working Groups I, II, and III to the third assessment report of the Intergovernmental Panel on Climate Change, edited by Robert Watson, Cambridge University Press, 2001.