Princeton University
Woodrow Wilson School of Public and International Affairs
Science, Technology and Environmental Policy (STEP) Program
Spring 2006

WWS-584
The Use of Science in Environmental Policy
Room 015 Robertson Hall
Wednesdays 1-4 PM

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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 long-range transport of air pollution, stratospheric ozone depletion and climate change.

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 lecture and discussion. The discussion will be based on the weeks reading. There will also be a precept most weeks 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: Tuesday February 7, 2006. 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?

Readings for class:
E.O. Wilson, The Future of Life (2002) Chapter 2 "The Bottleneck", pp.22-41.

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.

Week 2. Tuesday February 14, 2006.

Class: The Use of Scientific Advice in Making Environmental Policy

Readings to Discuss in Class:

Frank von Hippel, Citizen Scientist (1991)
"Scientists as Citizens", pp. 3-15
"Peer Review of Public Policy", pp. 16-29;
"The Advisors Dilemma", pp. 30-39.

Goodstein, Eban and Hodges, Hart, "Polluted Data: Overestimating Environmental Costs", The American Prospect, November-December 1997

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

U.S. House of Representatives, Special Investigations Division, Minority Staff, Politics and Science in the Bush Administration, November 2003.

"Copenhagen Consensus: The Results", plus additional material available at http://www.copenhagenconsensus.com

Sachs, Jeffrey. "Seeking a Global Solution: The Copenhagen consensus neglects the need to tackle climate change", *Nature*, August 2004.

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 is 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 3. Tuesday February 21, 2006.

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:

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 4. Tuesday February 28, 2006.

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 5. Tuesday March 7, 2006

Class:
Air pollution resulting from fossil fuel combustion - aerosols, acid rain, smog. Inter-connections between energy, air pollution, and climate change. Integrated assessments of the impacts of air pollution on health and agriculture.

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

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

Mauzerall, D. L.**,** Sultan, B., Kim, J, Bradford, D., "NOx Emissions: Variability in Ozone Production, Resulting Health Damages and Economic Costs," *Atmospheric Environment*, 39, pp. 2851-2866, 2005.

Wang, X. and Mauzerall, D. L.**,** "Characterizing Distributions of Surface Ozone and its Impact on Grain Production in China, Japan and South Korea: 1990 and 2020," *Atmospheric Environment*, 38, pp. 4383-4402, 2004.

Week 6. Tuesday March 14, 2006

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
Focus on the information on the RAINS model (accessible by clicking on the side-bar).

SPRING BREAK

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 7. Tuesday March 28, 2006.

Class:
Methods for estimating and prioritizing risks. Risk communication.

Readings:

Morgan, Granger, "Risk Analysis and Management", *Scientific American*, July 1993.

National academy of Sciences, Understanding Risk: Informing Decisions in a Democratic Society, Summary, 1996.

Additional 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.

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

Week 8. April 4, 2006.

Class:
Raw materials for conducting risk assessments; model choice; introduction to exposure assessment and dose-response analysis. Estimating exposure, dose and response to toxins.

Guest Speaker: Dr. Adam Finkel

Reading:

Excerpts (pages 1-13, 29-41, 53-83, and 139-152) from Lorenz Rhomberg (1996). "A Survey of Methods for Chemical Health Risk Assessment among Federal Regulatory Agencies" (report for the National Commission on Risk Assessment and Management).

Martha Crawford and Richard Wilson (1996). "Low-Dose Linearity: The Rule or the Exception?" *Human and Ecological Risk Assessment,* **2,** pp. 305-330.

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

Finkel, Adam. Toward Less Misleading Comparisons of Uncertain Risks: The Example of Aflatoxin and Alar, Environmental Health Perspectives, 1995.

Supplementary Reading:

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

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 most effective way for them to be written? How can they best inform policy decisions?

Week 9. April 11, 2006

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. The Role of the National Academy of Sciences /National Research Council in providing policy-makers with objective analyses of technical material.

Guest speaker: National Academy of Science/ National Research Council Program Manager, Dr. Kevin Crowley

Readings:

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

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

Cash, David; Clark, William; Alcock, Frank; Dickson, Nancy; Eckley, Noelle; Jager, Jill. Salience, Credibility, Legitimacy and Boundaries: Linking Research, Assessment and Decision Making. Kennedy School of Government, Harvard University, Faculty Research Working Papers Series, RWP02-046, November 2002.

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

Week 10. April 18, 2006. Use of science in the development of the Montreal Protocol on Substances which Deplete the Ozone Layer

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 11. April 25, 2006. 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 effective is science in influencing decisions regarding climate change? What is the role of politics?

Reading:

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

See http://www.ipcc.ch/pub/reports.htm for all the IPCC assessments.

In particular, look at:

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

Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons, 2005.

Morgan, Granger, et al. Learning from the U.S. National Assessment of Climate Change Impacts. Environmental Science & Technology, 39, 9023-9032, 2005.

Revkin, Andrew. "Climate Expert Says NASA Tried to Silence Him", New York Times, January 29, 2005.

Week 12. May 2, 2006

Student presentations.

Required Texts:

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

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

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.