RMES-520: Climate Change: Science, Technology and Sustainable Development

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Winter Session 2013 (Term 1), Thurs. 1:00 PM to 4:00 PM
Aquatic Ecosystems Research Laboratory (AERL) 107/108
Enrolment: Graduate Students (or advanced undergraduates with instructor approval)
Course Site: http://blogs.ubc.ca/rmes520

Course Description:

Over the past few decades, climate change has emerged as one of the most complex challenges faced by both social and ecological systems globally. On the one hand, changes in global climate are likely to have significant impacts in many parts of the world, and while a small number of regions / sectors may benefit many others could be devastated. On the other hand, reducing greenhouse gas emissions poses significant technological, economic and political challenges. Reductions of greenhouse gas gases will be made in the presence of incomplete information and continued scientific and economic uncertainty. The mismatches between the spatial and temporal scales of both emissions and impacts means that incentives to take action are very different globally, making effective action difficult. Changes in human behaviour and technological innovations of the magnitude needed to significantly reduce greenhouse gas emissions may be difficult to achieve. Adapting to climate change will require long-term planning and will pose differential burdens to countries in the developed and developing world. While the challenges are immense, the possibility for radically transforming human energy systems exists and options for adapting to a climate change can be implemented. This course focuses primarily on these two potential responses to climate change: mitigation and adaption. In the course students will engage in the major debates around options for dealing with the climate problem with an emphasis on both behavioural and technological aspects of the climate change problem.

The course will consist of five modules:

- **Module 1** provides a **general overview of climate science and impacts**, highlighting the current state of knowledge and remaining uncertainties.
- **Module 2** focuses on **carbon management options**: mitigation and energy system changes and efficiency options.
- **Module 3** will examine **geo-engineering management options** that may be considered if carbon management is not timely or sufficient enough to avoid major climate impacts with a focus on carbon capture and sequestration. Technology options, risk management issues and policy responses will be discussed.
- **Module 4** on **vulnerability and adaptation** will look at how different populations are at risk of climate change impacts and the options available and requirements for successful adaptation.
- **Module 5** related to **carbon politics and carbon economics** will cover the role of politics (at various scales) and the role of economics in addressing the climate change problem. Included will be discussion of international negotiations, equity, the role of local action, and economic versus other instruments to control carbon emissions.

Each module will consist of a mix of lectures, in-class activities and student led discussions. Students are expected to come to each class having done the readings and prepared to discuss them.

Course Evaluation

Grading for this course will be based on a series of short assignments (often tied to in-class activities), student led discussion sections, in-class and online participation, and a final paper. Grading is divided as follows:

Final Paper	40%
Short Assignments	15%
Student Led Discussion	15%
Viewpoints	10%
Discussion Questions	10%
Participation in Classes	10%

Final Paper:

The final paper will allow students to explore a climate change related topic in more depth over the course of the term. The topic is entirely up to you to decide.

Paper Requirement: The paper is not intended to be simply a review of a topic. As graduate students I expect you to produce a paper with original content. This does not mean you necessarily have to generate new data. It means you must at least use existing data or literature to make a new argument. In other words, using existing literature is fine but the framing around that literature should result in something that is more than the sum of its parts. The paper can be related to your thesis and can be used as an opportunity to explore a topic that is related but not directly core to your thesis.

Paper Format: Students will have the option to write an individual paper or a group paper with up to two other students. However, requirements for the group paper will be higher. Students writing individual papers are expected to hand in a journal-style article of 3-5,000 words. Group papers are expected to be 6-8,000 words.

Interim Products: In order to ensure students are on-track to timely completion of the paper, an abstract and an annotated paper outline will have to be handed in during the term (deadlines indicated below).

Short Assignments:

Science, Policy and Activism: While the majority of scientists are in agreement that anthropogenic climate change is happening and could have significant consequences (see IPCC), there remains debate in the general public, among policy-makers and in some corners of the scientific community about these conclusions. At the same time, decisions on actions about climate change involve more than just the scientific evidence, they involve trade-offs (monetary and non-monetary) and value judgements. Given this what is the role of scientists (broadly defined) in the public debate around climate change and

in the policy formulation process? We will debate and discuss this in class. Prior to class you will write a 1-2 page position statement on this question. I strongly suggest you ground this position statement not only in your own views on the matter but also in the literature on the subject of science and activism. Subsequent to the in-class discussion, you will write a 1-2 page response.

Wedges Game: One of the in-class activities will be the "wedges game," based on the paper by Pacala and Socolow (see readings). In this game, each group will have to decide upon a package of options, each of which provides 1 GT of carbon reductions for a total of 7 GT of reductions. Prior to the in-class exercise, each student will do some background reading on the wedges and derive their own package of wedges, which will be the starting point of their discussions with their other group members. Students will write up a 2-3 page justification of their wedges strategy prior to the in-class session and then a 2 page post-class discussion of the group decision.

Country Energy/Climate Situation and Negotiating Position: One of the challenges in solving global environmental problems is that responsibilities, impacts and capacity to affect both (i.e. mitigation and adaptation options) vary widely between countries and this impacts the negotiation of global commitments. For this short assignment you will research and write up a summary of a particular country's energy system and resources, their historic, current and projected emissions and climate impacts and their negotiating position at the UNFCCC meetings. This should be about 5-10 pages long.

Student-Led Discussion

In groups of ~3 you will be responsible for leading the class in a discussion on a relevant topic. Your group will decide on readings (in consultation with the instructor) and decide on the format for the in-class section (lecture, debate/discussion, activity, combination of those, etc.). Plan on 60-80 minutes of in-class time. Students will sign up for a particular time-slot using a doodle poll that the instructor will circulate shortly after the first class. There are multiple slots for each module (except the first on science). The readings you select and the in-class time should be related to the module but this will be an opportunity for the class to explore a particular topic not covered by the instructor. The more successful in-class discussions will generally be those where the group has selected a topic and readings around which there remains uncertainty and disagreement (either technical, political, economic, social, etc.).

Student Engagement:

This is a graduate level seminar and so students are expected to come to class prepared for discussion and engagement with the instructor and their fellow students. In addition, students are expected to engage with their peer students on-line. Each student will be assigned a discussion group of approximately 4-5 students for the term. At times you will be divided into these groups during class for discussion but each group will also have

a blog on the course website for posting Viewpoints and responding to Discussion Questions.

Viewpoints: Please be aware of the course's themes throughout the semester, as you read the newspaper, watch television or browse the Internet.

- Approximately every two weeks, you will post a link to a news article, blog post or similar online item regarding current events relevant to the coursework. Tag each post with your group's assigned identification tag as well as relevant themes.
- You will then comment on the articles posted by other members of your Discussion Group.
- You need not write at length (a link with a paragraph will do with each of your original posts, and a quick reply to those of others), but you should demonstrate an understanding of the core issues and how they relate to topics covered in the lectures and readings.
- Tag each post with VP1, VP2, VP3 or VP4 so that I can search and find each viewpoint.

Discussion Questions: Approximately every third week, the instructor will pose a discussion question, related to the course materials, to which you must provide a short response on the course website (1-2 pages). You should then comment on at least one response posted by another member of your Discussion Group. Similar to the viewpoints, tag your responses DQ1, DQ2 or DQ3.

Class Participation: In addition to the viewpoints and the discussion questions, student engagement will also be judged by participation in discussions during class time.

Grading for student engagement will be assessed on the combination of each student's in-class and online participation to accommodate the different ways in which students may engage with the course materials. Students will be evaluated on the frequency and depth of their participation:

- Frequency: Demonstrated willingness to engage in critical discussion, either online or in-class.
- Depth: Demonstrated awareness of climate change themes in current events, and the ability to identify the real-world implications of course concepts.

Late written assignments without prior approval of the instructor will be docked by 5% for each day late.

Course Readings

There is no single text for this course. Readings will come from a variety of articles, books and reports including the latest report of the Inter-Governmental Panel on Climate Change.

Deadlines

Date	Assignment
16/09/2013	Viewpoint 1
19/09/2013	Science Policy 1
20/09/2013	Paper Abstract
23/09/2013	Discussion Question 1
30/09/2013	Science Policy 2
10/10/2013	Viewpoint 2
14/10/2013	Discussion Question 2
24/10/2013	Wedges 1
31/10/2013	Viewpoint 3
31/10/2013	Wedges 2
11/11/2013	Discussion Question 3
15/11/2013	Annotated Outline
21/11/2013	Viewpoint 4
28/11/2013	Country Summary
07/12/2013	Final Paper

Course Schedule

Introduction to the Course

Sept. 5: Course Overview and Introduction to Complex Environmental Problems

Class Objective: Review of the syllabus, introductions, short discussion of human society and environmental problems

Suggested Readings
Surowiecki, "Better and Better: The Myth of Inevitable Progress."

Waggoner and Ausubel, "A Framework for Sustainability Science: A Renovated IPAT Identity."

Module 1: Climate Science

Recommended Reading for the Module:
1. Schneider, "What Is 'Dangerous' Climate Change?".
2. Kolbert, "The Curse of Akkad."

Recommended Viewing for the Module:

1. An Inconvenient Truth, David Guggenheim (Director). Website: www.climatecrisis.net. For a scientific review of the movie see: http://www.realclimate.org/index.php/archives/2006/05/al-gores-movie/

Sept. 12: Biogeochemistry and Greenhouse Gas Cycles

Class Objective: To provide a basic understanding of the global cycles of greenhouse gases.

Required Readings

Archer, "The Perturbed Carbon Cycle."

Additional Readings:

Forster et al., "Changes in Atmospheric Constituents and in Radiative Forcing."

Sept. 19: The Climate System / Climate Policy Discussion

Class Objective: To provide a basic understanding of the workings of the global climate system. To develop an understanding of the complexity surrounding the public debate on climate change and the role of science therein.

Required Reading:

Skim IPCC, "Climate Change 2007: Synthesis Report."

Meyer et al., "Above the Din but in the Fray: Environmental Scientists as Effective Advocates."

Lackey, "Science, Scientists, and Policy Advocacy."

Fischhoff, "Nonpersuasive Communication About Matters of Greatest Urgency: Climate Change."

Additional Readings:

Rubin, "Global Warming and the Greenhouse Effect."
Pew, "The Causes of Global Climate Change."

Module 2: Carbon Management

Required Reading for the Module:

Pacala and Socolow, "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies."

Sept. 26: Technological Change and Understanding Technology Options

Class Objective: Learning the fundamentals of technological change and an overview of the technical options for GHG reduction.

Required Reading:

Grübler, *Technology and Global Change*. Chapter on Technology Concepts and Definitions

Enkvist, Nauclér, and Rosander, "A Cost Curve for Greenhouse Gas Reduction."

Additional Readings:

Jacobson and Delucchi, "Providing All Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials."

Delucchi and Jacobson, "Providing All Global Energy with Wind, Water, and Solar Power, Part II: Reliability, System and Transmission Costs, and Policies."

Trainer, "A Critique of Jacobson and Delucchi's Proposals for a World Renewable Energy Supply."

Delucchi and Jacobson, "Response to 'A Critique of Jacobson and Delucchi's Proposals for a World Renewable Energy Supply' by Ted Trainer."

Oct. 3: Modelling Energy Futures

Class Objective: To provide an overview of long-term energy modeling and its limitations.

Required Readings:

International Energy Agency, *WORLD ENERGY OUTLOOK 2012*. Skim the Summary

Craig, Gadgil, and Koomey, "WHAT CAN HISTORY TEACH US? A Retrospective Examination of Long-Term Energy Forecasts for the United States*."

GEA, *Global Energy Assessment - Toward a Sustainable Future*. Read the technical summary, focusing on the scenarios. For more information you can read the chapter on transitions.

Module 3: Geoengineering

Required Reading for the Module:

Benson et al., "Chapter 13 - Carbon Capture and Storage."
Vaughan and Lenton, "A Review of Climate Geoengineering Proposals."

Optional Reading for the Module:
IPCC Special Report on CCS

Oct. 10: The Science, Engineering and Economics of Geo-Engineering

Class Objective: Providing an overview of the technical options for Geo-Engineering and Carbon Capture and Storage/Sequestration

Required Readings:

Haszeldine, "Carbon Capture and Storage: How Green Can Black Be?".

Oct. 17: Risk, Regulation and Institutional Challenges to CCS

Class Objective: Providing an overview of the regulatory and institutional challenges to CCS and issues around risk management and risk perception.

Guest Lecturer: Prof. Hadi Dowlatabadi, Institute for Resources, Environment and Sustainability and Liu Institute for Global Issues, UBC (TBC)

Required Readings:

Wilson, Johnson, and Keith, "Regulating the Ultimate Sink: Managing the Risks of Geologic CO2 Storage."

Victor, "On the Regulation of Geoengineering."

Additional Readings:

Palmgren et al., "Policy Analysis: Initial Public Perceptions of Deep Geological and Oceanic Disposal of Carbon Dioxide."

Blackstock and Long, "The Politics of Geoengineering."

Schneider, "Geoengineering: Could—or Should—we Do It?".

Oct. 24: Wedges Game

Guest Lecturer: Prof. Milind Kandlikar, Institute for Resources, Environment and Sustainability and Liu Institute for Global Issues, UBC

Module 4: Impacts, Vulnerability and Adaptation

Required Reading for the Module:

Schneider et al., "Assessing Key Vulnerabilities and the Risk from Climate Change."

Morgan et al., "Why Conventional Tools for Policy Analysis Are Often Inadequate for Problems of Global Change."

Oct. 31: Overview of Climate Change Impacts and Vulnerability

Class Objective: To review the evidence regarding the types of impacts expected under different climate change scenarios and to understand vulnerability as a conceptual framework for discussing and measuring climate change impacts.

Required Reading:

Eakin and Luers, "Assessing the Vulnerability of Social-Environmental Systems."

Füssel and Klein, "Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking."

Ford, Smit, and Wandel, "Vulnerability to Climate Change in the Arctic: A Case Study from Arctic Bay, Canada."

Optional Reading:

Walker et al., "British Columbia."

Nov. 7: From Vulnerability to Adaptation

Class Objective: To understand the concepts relating vulnerability to adaptation, the determinants of adaptive capacity, and planning for adaptation.

Guest Speaker: Prof. John Robinson, Associate Provost, Sustainability, UBC

Required Reading:

Adger, Arnell, and Tompkins, "Successful Adaptation to Climate Change Across Scales."

Dessai, Lu, and Risbey, "On the Role of Climate Scenarios for Adaptation Planning."

Module 5: Carbon Economics and Politics

Required Reading for the Module:

Gupta et al., "Policies, Instruments and Co-operative Agreements."

Nov. 14: The Economics of Carbon Mitigation

Class Objective: To review the evidence regarding the costs and benefits of carbon mitigation and the methodological issues surrounding models and cost estimates, as well as, issues around pricing carbon.

Required Reading:

Stern, "The Economics of Climate Change."

Nordhaus, "ECONOMICS: Critical Assumptions in the Stern Review on Climate Change."

Pindyck, *Climate Change Policy: What Do the Models Tell Us?*.

Optional Reading:

Hepburn, "Regulation by Prices, Quantities, or Both: A Review of Instrument Choice."

Rivers and Jaccard, "Canada's Efforts Towards Greenhouse Gas Emission Reduction: a Case Study on the Limits of Voluntary Action and Subsidies."

Nov. 21: Political Economy of Carbon Policies

Class Objective: To review some of the political issues (at various scales) that impact the ability of societies to take action on climate change.

Required Reading:

Pan, "Meeting Human Development Goals with Low Emissions : An Alternative to Emissions Caps for post-Kyoto from a Developing Country Perspective."

Additional Readings:

Chakravarty et al., "Sharing Global CO2 Emission Reductions Among One Billion High Emitters."

Ellerman and Joskow, "The European Union's Emissions Trading System in Perspective."

Ellis et al., "CDM: Taking Stock and Looking Forward."

Wrap-Up

Nov. 28: Discussion and Course Evaluation

Class Objective: To discuss policy options and political realities with guest speaker and overall discussion of course.

Guest Speaker: Prof. Mark Jaccard, Resource and Environmental Management, SFU

Summary of Readings:

Adger, W Neil, Nigel W Arnell, and Emma L Tompkins. "Successful Adaptation to Climate Change Across Scales." *Global Environmental Change* no. 15 (2005): 77–86.

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Enkvist, Per-Anders, Tomas Nauclér, and Jerker Rosander. "A Cost Curve for Greenhouse Gas Reduction," 2007. http://www.berc.berkeley.edu/flyers/McKinseyQ.pdf.

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Füssel, Hans-Martin, and Richard Klein. "Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking." *Climatic Change* 75, no. 3 (2006): 301–329. http://dx.doi.org/10.1007/s10584-006-0329-3 .

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Wilson, Elizabeth J, Timothy L Johnson, and David W Keith. "Regulating the Ultimate Sink: Managing the Risks of Geologic CO2 Storage." *Environmental Science & Technology* 37, no. 16 (August 15, 2003): 3476–83. http://www.ncbi.nlm.nih.gov/pubmed/12953855.