POSC 333-00:
Sustainability Science

Syllabus

Mondays and Wednesdays 1:50p.m – 3:35p.m
Spring 2009: March 30 – June 3

Willis 211
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Preface

> "Just providing knowledge, even if communicated well, without offering spaces to discuss the implications, will no longer suffice. If sustainability were something we could achieve by holding hands and singing "kumbaya" despite all our differences, we'd already be there!"
>
> Susanne C. Moser, in IHDP Update, Special Edition, 2008, International Human Dimensions Program (www.ihdp.org)

> "The big question in the end is not whether science can help. Plainly it could. Rather, it is whether scientific evidence can successfully overcome social, economic and political resistance."
>
> Donald Kennedy, *Science Magazine's State of the Planet 2006-2007*

The continual existence and betterment of humankind depends on the ability and intellect of human beings to make educated choices (rightly understood) in living with nature and to govern themselves. At the center of this challenge for human beings in the age of Anthropocene is the need for systematic and scientific understanding of how the dynamic relationship between societal changes and environmental changes influence change, adaptation, and evolution of coupled human-environment systems. This seminar will introduce students to theories, concepts, analytical frameworks, and research designs that will help us advance in understanding the dynamic relationship between societal changes and environmental changes. In so doing, we will study empirical cases and experimental results of real world sustainability problems.

As the two quotes above indicate, understanding dynamics of human-environment interactions is only half way to achieving sustainability of social ecological systems. The additional and more intriguing challenge is in analyzing, explaining, and understanding the circumstances under which these scientific understandings are translated into public policy and governance of human

interactions. Therefore, achieving sustainability of human societies is a dual challenge. This course is conceived within the dual challenge of the need to understand how societal dynamics and environmental dynamics interact over time *and* how they help induce or inhibit sustainability of social ecological systems. For the lack of a better term, scholars who engage in the field of analyzing and explaining these challenges generally call their intellectual endeavor "Sustainability Science."

There are three learning goals in this seminar. First, students will learn key trends of literature that addresses the challenge of the field amplifying the pivotal role of social dimensions in sustainable societies. Second, students will gain knowledge of key concepts and theories in sustainability science that are developed and redeveloped by scholars from multiple academic disciplines. Third, students will gain practical experience and skills of linking theories to practices of sustainability challenges by conducting team projects.

In order to achieve these goals, we will actively read and engage our class discussions on the literature on sustainability science from multiple academic disciplines; study cases that illustrate the dual challenge of understanding and developing theories in the field of sustainability science; and conduct team projects that will allow students to analyze, challenge, and develop theories and research methods by linking theories to practices. The seminar is organized with the following outline.

Course Outline

Week One: Ontological Foundations

Week Two: Epistemic Foundations

Week Three: A New Kind of Science

Week Four: Dynamics and Diversity of Ecosystems

Week Five: Dynamics and Diversity of Human Institutions

Week Six: Understanding Social Ecological Transformations

Week Seven: Collapses and Survival of Social Ecological Systems

Week Eight: Vulnerability, Adaptation, and Resilience

Week Nine: Crossing Boundaries and Building Bridges

Week Ten: Sustainability Science (aka) Social Ecological Sciences

Required Texts:

Fritjof Capra, *The Hidden Connection: A Science for Sustainability Living*, Anchor Books, 2002. ISBN 0-385-49472-6 (paperback)

Simon Levin, *Fragile Dominion: Complexity and Commons*, Perseus Publishing, 1999. ISBN: 0-7382-0319-X (paperback)

Brian Walker and David Salt, *Resilience Thinking: Sustaining Ecosystems and People in Chaining World*, Island Press, 2006, ISBN: 1-59726-093-2 (paperback)

Lance H. Gunderson and C. S. Holling, *Panarchy: Understanding Transformations in Human and Natural Systems*, Island Press, 2002, ISBN: 1-55963-857-5 (paperback)

Donald Kennedy (ed), *State of the Planet 2006-2007*, Island Press, 2006.

In addition to reading chapters from these texts, we will also read articles from various peer-reviewed academic journals and also watch documentaries and videos illustrating the concepts we struggle to understand in this course. In addition to readings listed in this syllabus, I have placed additional relevant readings on E-Reserve at the Gould Library. Feel free to browse and read as relevant. Team project related readings will be provided for the teams separately.

Expectations, Assignments, and Grading Procedures

The following four components of assignments will be used to evaluate your performance in this seminar. Percentage worth of each assignment is in parentheses. The details of each assignment are below.

1. **Active Reading and Participation (20%)**: Reading assigned materials is crucial for understanding class discussion and cases we will unpack in this seminar. Readings are assigned to be complementary to the class discussion and interactive lectures. In this sense, readings are not substitutable for class discussion and interactive lectures. For each week, active reading questions will be provided which will serve as a guide to active reading. I will send out active reading questions on Fridays. A group of three students will self-identify to lead class discussion for each week. A student must lead at least two classes, preferably one before mid-term and one after mid-term. Students will sign up for the date on April 1 when I will have signup sheet. This component will be worth 10 points out of 20 for this part of seminar. Remaining 10 points will be assigned based on your performance as a responsible citizen of this seminar. To be a good standing citizen of this course, you are required to:(1) have good attendance; (2) read assigned materials before the class; (3) have timely notification and communication with me when you have to be absent or if you need to request extension for personal reasons; and (4) exercise self-respect and responsibility of a student for success of the learning mission of this

seminar and Carleton College as a whole; and (5) exercise your intellectual freedom in discussions and the assignments.

2. **Quantitative and Critical Review of an Article (15%)**: Each student will review one of five chapters from *Resilience Thinking* by Brian Walker and David Salt. The objective is to review the selected chapter with the focus on quantitative reasoning of the chapter. For example, on p. 3 of *Resilience Thinking* claims that "Global grain production, currently 1.84 million tons annually, will need to increase by around 40 percent to meet the demand in 2020." This statement contains quantitative reasoning and assertion. Your task is to identify statements like this one in the selected article and provide a critical review of the article. In this critical and quantitative review, you are required to: (1) identify the authors' key quantitative statements and their validity; (2) interpret the meaning of such statements and evaluate them; (3) provide critical reviews of the use, misuse, and miss-use of numbers in the arguments; (4) access the effectiveness or the weakness of using numbers in reasoning, arguments, and assertions made in the chapter; and (5) to suggest how to remedy the misuse and miss-use of numbers in reasoning and making assertions . Your review should be 5 to 6 pages. The due date for this review is to be self-assigned. However, **all review essays are due by April 30 at 5:00p.m.**

3. **Critical Review of a Documentary Video (10%)**: This assignment requires writing an essay on nature and society interactions. This essay is to critically reflect on complexity of social ecological systems based on class discussion, lectures, and documentary videos we watched over the course of the term. Students will pick one of three movies and documentary we watch and write a critical and reflective essay on human-environment interactions. In so doing, you are encouraged to draw upon concrete examples or cases that shed light on the concepts you attempt to formulate in your essay. This essay should be 4 to 5 pages. Students will sign up for the documentary they plan to review and the review essay is due within five days after the designated viewing day in this syllabus. For instance, if you select to review *Life after People* video to be shown on April 7, your review essay is due by no later than April 12 at 5:00p.m. All review essays are due by **April 27 at 5:00p.m**.

4. **Livelihood Systems Analysis (25%)**: Each student will recollect items brought to Carleton College in their freshman year and put in a log sheet. Students then will select five items that were deemed necessary (frequently used) and five items that were considered unnecessary (rarely used) after the fact. After selection of these ten items, student will draw a livelihood map of a freshman student life at Carleton College during their respective freshmen years. Key activities that were directly related to the ten items must be described, discussed, and analyzed to write about the relationships between an individual livelihood system and the nature. Along with study of their own livelihood

systems, students will interview a parent, a relative, a teacher, or a person who went to a college at least 20 years ago and find out what items they brought to their respective college freshman years and what they did with them. If you have parents who did not go to college, ask your uncles or aunts. If none of your relatives went to college in the United States, then conduct an interview with one of your professors, staff members at Carleton or a resident in Northfield. This paper requires a light research yet in-depth investigation of your own livelihood systems and that of one other individual. This paper should be 8 to 10 pages excluding diagram, tables, and references. More details will be provided in a separate handout on April 1. This analysis is due on **May 7 at 5:p.m**.

5. **Collaborative Project (30%):** A team of five students will select a project out of four projects. The **first** project asks: how many trees does the Eastside Neighborhood in Northfield, MN need to absorb all carbon dioxide emitted by human activities of the residents. In answering this question, students will investigate physical science of carbon sequestration, the validity of the question in regard to the purpose of the answer, and legal and policy science aspects of urban trees, city codes, state laws, and federal laws that govern the answer to this question. The **second** project asks: How do we identify boundaries of social systems and ecosystems? This question is concerned with the problem of scale in addressing global environmental changes. Can local activities be confined under local political, judicial, and human drawn boundaries? How do we identify the boundaries of these activities and their consequences to the environment and climate? Students will analyze time series data of social change and climate change in Northfield, MN. The **third** project requires students to answer a key question that will be asked to UNFCC conferences leading to the post-2012 (or post-Kyoto Protocol) global climate change treaty. Which scientific findings should be a guiding force and what is the role of that guiding science in the next global climate change treaty? In answering this question, a group of students will answer the question from the perspective of one of the top five GHG emitting countries and its political, economic, and social conditions. For the **fourth** project, students will investigate the interplay of factors that influence science, politics, and human decision makings in the case of *Mystery in Alaska* featured in PBS Nature program. Final report should be 20 to 25 pages excluding maps, pictures, tables, figures, diagrams, and references. More details about these four projects and project guidelines will be provided on Wednesday April 8 in a separate handout.

IMPORTANT NOTE: All assignments should be written with 12 point Times New Roman font on double-spaced pages with page numbers inserted on 1 inch page margin of A4 size. It is highly encouraged that students use the Write Place or available writing services on campus to achieve high quality product. Electronic copy is acceptable in pdf or rtf format or other read only format. You do not need to submit a hard copy when you send me electronic copy.

Schedule of Assignments and Due Dates

4/1 - Sign up due dates for quantitative and critical review and documentary review
4/8 - Distribute assignments and guidelines for team project
4/17 - Meeting with teams
4/27 - Review of documentary film is due by this date (self-assigned)
4/28 - Meetings with teams
4/30 - Quantitative Critical Review is due by this date (self-assigned)

MIDTERM BREAK 5/2 – 5/4

5/7 - Livelihood System Analysis paper is due
5/23 - The final draft of team paper is due
5/25 - Meeting with teams and distribute comments on final drafts
5/27 - Team presentations
6/1 - Team presentations …
6/3 - Team presentations and conclusion
6/6 - final team paper is due

No final exam for the course.

Course Conduct

a. Attendance: Attendance is required for this course. If you need to be absent from the class, it is your responsibility to notify me in advance. When you are absent, it is in your benefit to borrow notes from your classmate or ask your classmates to learn what you missed. If you wish, I will be available during office hours or by appointment at your request to meet with you and go over what you missed while you were absent.

b. Plagiarism: There is zero tolerance for plagiarism. A summary of the College's policy on plagiarism states: *"At Carleton College, an act of academic dishonesty is therefore regarded as conflicting with the work and purpose of the entire College and not merely as a private matter between the student and an instructor; all cases involving such dishonesty are referred for appropriate action to the Academic Standing Committee (ASC) via the Associate Dean of Students or the Associate Dean of the College."* For more information on Carleton's policy on academic honesty, please consult http://apps.carleton.edu/campus/dos/handbook/academic_regs/?policy_id=21359

c. Late assignments: Assignments are due on the dates specified in this syllabus or in the assignment sheet. Late work **will receive half point reduction per late day.** If you are unable to complete an assignment on time due to illness or personal emergency, you can request an extension with the supporting documents such as a medical note from a doctor or the Wellness Center.

d. Special needs: If you require special accommodation due to a documented physical or medically classified different learning strategy, please come see me during the first week of class or any time throughout the semester to discuss how I might best assist you in meeting the objectives and requirements of this course.

NOTE: This is a provisional syllabus and subject to change.

Schedule of the Course and Readings

WEEK ONE: ONTOLOGICAL FOUNDATIONS

March 30: Introduction to the Seminar

Essential readings:

This syllabus. Overview and the roadmap of seminar.

April 1: Nature of Life

Essential readings:

Fritjof Capra, 2002, *The Hidden Connections: A Science for Sustainable Living*, Anchor Books.
Chapter 1: The Nature of Life, p. 3-32.
Chapter 3: Social Reality, p. 70 - 96.

James Fowler and Darren Schreiber, 2008, "Biology, Politics, and Emerging Science of Human Nature," *Science*, 322 (November): 912-914.

Daniel Koshland Jr., "The Seven Pillars of Life," 2002, *Science* 295 (March): 2215-2216.

Donald Kennedy, "Life on Human Dominated Planet," Chapter 1 in *State of the Planet 2006-2007*, AAAS, p. 5-12.

WEEK TWO: EPISTEMIC FOUNDATION

April 6: Science and Sustainable Societies

Essential readings:

Fritjof Capra, 2002, *The Hidden Connections: A Science for Sustainable Living*, Anchor Books.
Chapter 4: Life and Leadership in Organizations, p. 97 -128.

Chapter 5: The Networks of Global Capitalism, p. 129 - 157
Chapter 6: Biotechnology at a Turning Point, p. 158 - 185.

Peter H. Raven, "Science, Sustainability, and the Human Prospect" *Science*, Vol. 297, No. 5583 (Aug. 9, 2002), pp. 954-958, **Online:** http://www.sciencemag.org/cgi/reprint/297/5583/954.pdf

April 7 – Movie screening – Life after People

April 8: Struggle with Concepts, Theories, and Paradigms

Essential readings:

Partha Dasgupta, "The idea of sustainable development," *Sustainability Science,* 2 (1): 5-11. April 2007.

Frank E. Egler, "Vegetation as an Object of Study," *Philosophy of Science,* 9 (3): 245 – 260, July, 1942.

Dyson, Freeman. 1998. A Science as a Craft Industry. *Science* 280 (May 15): 1,014-15. **Online:** http://www.sciencemag.org/cgi/content/full/280/5366/1014

Robert W. Kates, William C. Clark,* Robert Corell, J. Michael Hall, Carlo C. Jaeger, Ian Lowe, James J. McCarthy, Hans Joachim Schellnhuber, Bert Bolin, Nancy M. Dickson, Sylvie Faucheux, Gilberto C. Gallopin, Arnulf Grübler, Brian Huntley, Jill Jäger, Narpat S. Jodha, Roger E. Kasperson, Akin Mabogunje, Pamela Matson, Harold Mooney, Berrien Moore III, Timothy O'Riordan, Uno Svedin, "Environment and Development: Sustainability Science, *Science,* Vol. 292. no. 5517, pp. 641 – 642, 27 April 2001.

WEEK THREE: SOCIAL ECOLOGICAL COMPLEXITY

April 13: Fundamental Questions

Essential readings:

Simon Levin, *Fragile Dominion: Complexity and Commons*, Perseus Publishing, 1999.
Chapter 1: Biodiversity and Our Lives, p. 1 – 15.
Chapter 2: The Nature of Environment, p. 17 – 38.
Chapter 3: Six Fundamental Questions, p. 39 – 55.

Ottino, J. M. 2004. "Engineering Complex Systems." *Nature* 427 (January): 399.

 **April 14: Documentary screening – Mystery in Alaska**

April 15: A Mystery or Complexity

Essential readings:

Simon Levin, *Fragile Dominion: Complexity and Commons*, Perseus Publishing, 1999.
Chapter 4: Patterns in Nature, p. 57 – 80.
Chapter 5: Ecological Assembly, p. 81 – 115.
Chapter 6: The Evolution of Biodiversity, p. 117 – 156.

WEEK FOUR: DYNAMICS AND DIVERSITY OF ECOSYSTEMS

April 20: Ecosystem Rules as Sources of Dynamics and Complexity

Essential readings:

Wilson, James. 2002. "Scientific Uncertainty, Complex Systems, and the Design of Common-Pool Institutions," in National Research Council, *The Drama of the Commons.* Washington, D.C.: National Academy Press. pp. 327-60.

Lance H. Gunderson and C. S. Holling, *Panarchy: Understanding Transformations in Human and Natural Systems*, Island Press, 2002, ISBN: 1-55963-857-5 (paperback)
Chapter 5: "Back to the Future: Ecosystem Dynamics and Local Knowledge" by Fikret Berkes and Carl Folke, p. 121-146.

 **April 21: Documentary screening – Queen of Tree**

April 22: Foraging Experiment in the Lab at CMC 109

Essential readings:

Hardin, Garrett, "The Tragedy of the Commons," *Science*, 163: 1243-1248.
url: http://www.sciencemag.org/sciext/sotp/pdfs/162-3859-1243.pdf
[Optional Readings: Extensions of "The Tragedy of the Commons," by Hardin at http://www.sciencemag.org/cgi/content/full/280/5364/682]

WEEK FIVE: DYNAMICS AND DIVERSITY OF HUMAN INSTITUTIONS

April 27: Understanding Evolution of Human-crafted Rules

Essential readings:

Dietz, Thomas, Elinor Ostrom, and Paul Stern. 2003. "The Struggle to Govern the Commons." *Science* 302(5652) (December 12): 1907-12. **Online:** http://www.sciencemag.org/cgi/content/full/302/5652/1907 **Supplemental Online Material at**: http://www.sciencemag.org/cgi/content/full/302/5652/1907/DC1

Ostrom, Elinor. 2005. *Understanding Institutional Diversity*, Princeton: Princeton University Press.

Chapter 1: Understanding the Diversity of Structured Human Interactions, p. 3-31.
Chapter 4: Animating Institutional Analysis, p. 99-133.

April 29: The Role of Human Values and Knowledge Systems

Essential readings:

Tim W. Clark, *The Policy Process: A Practical Guide for Natural Resource Professional,* Yale University Press, 2002.

Chapter 1: Professional Challenge, p. 1-16.
Chapter 2: A View of Individuals and Society, p. 17-31.
Chapter 3: Social Process - Mapping the Context, p. 32-55.

Hong, Lu, and Scott E. Page. 2004. "Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers." *PNAS* 101(46):16385-389. **Online:** http://www.pnas.org/cgi/content/full/101/46/16385

MIDTERM BREAK MAY 2 – 4

WEEK SIX: ECOLOGY, ECONOMICS AND INSTITUTIONAL CHANGES

May 6: Economic Values of Ecology and Institutions

Essential readings:

Mark Sagoff, *Price, Principle, and the Environment,* Cambridge University Press, 2004.

Chapter 1: Zukerman's Dilemma, p. 1-28.
Chapter 4: Values in Use and in Exchange or What Does Willingness to Pay Measure?
Chapter 6: On the Value of Wild Ecosystems, p. 126-153.

WEEK SEVEN: COLLAPSES AND SURVIVAL OF SOCIAL ECOLOGICAL SYSTEMS

May 11: Why some social ecological systems collapse and some don't

Essential readings:

Lance H. Gunderson and C. S. Holling, *Panarchy: Understanding Transformations in Human and Natural Systems*, Island Press, 2002, ISBN: 1-55963-857-5 (paperback)

Chapter 3: "Sustainability and Panarchies" by C. S. Holling, Lance H. Gunderson, and Gary d. Peterson, p. 63-102.

Chapter 8: "Dynamic Interaction of Societies and Ecosystems – Linking Theories from Ecology, Economy, and Sociology" by Marten Scheffer, Frances Westley, William A. Brock, and Milena Holmgren, p. 195-239.

Robert Costanza, Lisa Graumlich, Will Steffen, Carole Crumley, John Dearing, Kathy Hibbard, Rik Leemans, Charles Redman, and David Schimel, "Sustainability or Collapse: What can we learn from integrating the history of humans and the rest of nature," *Ambio,* 36(7): 522-527, November 2007.

May 13: Empirical Evidences

Essential readings:

Weiss, H. and Bradley, R.S. 2001. 'What drives societal collapse?' *Science*, 291(5504):609–10.

Hodell, D.A., Curtis, J.H. and Brunner, M., 1995. 'Possible role of climate in the collapse of the Classic Maya civilization', *Nature*, 375:391–4.

Haug, G.H., Günther, D., Peterson, L.C., Sigman, D.M., Hughen, K.A. and Aeschlimann, B., 2003. 'Climate and the collapse of Maya civilization', *Science*, 299:1,731–5.

Will Steffen, Paul J. Crutzen and John R. McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature? *Ambio*, 36(8): 614-621, December, 2007.

WEEK EIGHT: ADAPTATION, VULNERABILITY, AND RESILIENCE

May 18: Adaptation and Resilience

Essential readings:

Carlson, Jean M., and John Doyle. 2002. "Complexity and Robustness." *Proceedings of the National Academy of Sciences* 9 (suppl. 1) (February 19): 2499–545.

Kates, Robert W., and Thomas M. Parris. 2003. "Long-Term Trends and a Sustainability Transition. *Proceedings of the National Academy of Sciences* 14 (July 8): 8062-8067.

Turner, B. L., et al., 2003. "A Framework for Vulnerability Analysis in Sustainability Science." *Proceedings of the National Academy of Sciences* 100(14) (July 8): 8074-8079.

May 20: Vulnerability and Shocks

Essential readings:

Brian Walker and David Salt, *Resilience Thinking: Sustaining Ecosystems and People in Chaining World*, Island Press, 2006, ISBN: 1-59726-093-2 (paperback)

Chapter 1: Living in a Complex World
Chapter 3: Crossing the Threshold
Chapter 4: In the Loop: Phases, Cycles, and Scales

WEEK NINE: CROSSING BOUNDARIES AND BUILDING BRIDGES

May 25: Multi-disciplinary challenges

Essential readings:

Stern, Paul C., Thomas Dietz, Nives Dolšak, Elinor Ostrom, and Susan Stonich. 2002. "Knowledge and Questions After 15 Years of Research." In *The Drama of the Commons*, Chapter 13. Washington, DC: National Academy Press.

Lance H. Gunderson and C. S. Holling, *Panarchy: Understanding Transformations in Human and Natural Systems*, Island Press, 2002, ISBN: 1-55963-857-5 (paperback)

Chapter 16: Toward an Integrative Synthesis

May 27: Team Presentations

WEEK TEN: YOUR INTERPRETATIONS

June 1: Team Presentations

June 3: Team Presentations