Fall 2016

Course Number and Title
ESS_411 Earth Systems Ecology

Time and Place
Tuesday and Thursday 12:30 to 1:45pm
Wagar 231

Instructors
Dennis Ojima
Natural and Environmental Sciences Building (NESB) – B 231
(970) 491-1976
http://www.nrel.colostate.edu/ojima-lab/
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Office hours:

John Moore
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(970) 491-1967
http://www.nrel.colostate.edu/moore-lab/
John.Moore@ColoState.edu
Office hours:

Credits
3 Credits

Prerequisites
- GR210 Physical Geography
- ESS 311

Instructor(s)
Dennis Ojima and John Moore

Course Description
Ecosystem science has been incorporated into a number of critical societal areas where the science-policy interface has fundamental linkages between human actions and ecosystem dynamics. Knowledge shared between components is critical to enhanced management of the earth system and the ecosystem processes associated controlling changes in the surrounding environment.

This course will explore the interactions between physical, biological and social systems in controlling the cycles of energy, water and nutrients that underpin linkage between ecosystem processes and the earth system. The course will provide students with a solid basis for understanding the ecosystem interactions and feedback to earth system dynamics through an exploration of several topics associated with global environmental challenges society is faced with. Through these example issues, the course

material and instruction will build a foundation of ecosystem science theory, earth system dynamics, science-policy interface, and management approaches to deal with global environmental challenges. We will use these example topics to highlight the critical thinking on the science, a framework in addressing management applications dealing with solutions to the challenges raised in each topic, and the relevance of these issues to society.

Topics to be covered include reduced emissions from deforestation and degradation (REDD), biodiversity linkages to ecosystem services (BES), water system management, and managing reactive nitrogen. These 4 topics provide various perspectives on the role ecosystem play in controlling earth system dynamics, the manner in which human activities have affected the earth system through alterations in ecosystem properties and processes, and challenges being faced in developing policy and management strategies to manage the challenges being presented by global environmental challenges.

Through lectures, discussions and participatory working group exercises students will be challenged to understand the complexity of the earth system and gain confidence in interpreting issues relating to ecological sustainability in our changing world.

A series of required and suggested readings will be provided for each lecture.

Course evaluation materials will include in-class exercises and quizzes; in class and working group participation; short written assignments, poster presentation, and oral presentation to the class.

Learning Objectives

- Students will understand the effects of ecosystems on surface energy balance, gaseous and liquid water fluxes, and biogeochemistry
- Students will understand the Earth as a system of interactions, know what those are, and know the role of the biosphere in regulating/moderating climate
- Students will understand how human activities influence land cover, energy and water fluxes, and biogeochemical fluxes and how that affects climate
- Students will be able to trace the cause and effect pathways from human activities to climate change
- Students will understand how models are used to investigate biophysical and ecological interactions at multiple scales

Course Website:

Canvas

Readings:

Selected readings for each set of topics to cover scientific and policy areas. Will be posted to Canvas prior to meeting on the topics

Instructional Methodology

This course will have both lecture and small group projects. The lectures will be two 75 minute sessions in a mixture of lectures, group discussions, and student presentations. Instructional methods for these

class periods will include traditional lectures, problem based learning exercises requiring group discussions, and occasional discussions of current journal articles.

CLICKR required

Mode of Delivery

Classroom instruction

Methods of Evaluation

30% Homework assignments and quizes
30% Project exercises
30% Exams
10% Class participation – class discussions and hands-on activities

Letter Grade	Percentage
A+	98-100
A	94-97
A-	90-93
B+	88-89
B	84-87
B-	80-83
C+	78-79
C	70-77
D	60-69
F	Below 60

Lecture Schedule

Class meeting	Date	Class content
1	23-Aug	intro & basics
2	25-Aug	Ecosystem-Earth Interconnection
3	30-Aug	weather and climate
4	1-Sep	Global Environmental Change
5	6-Sep	Science Policy Considerations
6	8-Sep	T1.1 REDD: Ecosystem Science Perspective
7	13-Sep	T1.2 REDD: Challenges and Approaches
8	15-Sep	T1.3 REDD: Group project on Research agenda proposal
9	20-Sep	T1.4 REDD: Group project on Management study
10	22-Sep	REVIEW DISCUSSION
11	27-Sep	EXAM 1
12	29-Sep	T1.5 REDD Summary Discussion
13	4-Oct	T2.1 BIODIVERSITY: Ecosystem Science Perspective
14	6-Oct	T2.2 BIODIVERSITY: Biodiversity and Ecosystem Services
15	11-Oct	T2.3 BIODIVERSITY: Science Policy Interface
16	13-Oct	T2.4 BIODIVERSITY: Challenges and Approaches
17	18-Oct	T2.5 BIODIVERSITY: Group project on Research agenda proposal
18	20-Oct	T2.6 BIODIVERSITY: Group project on Management study
19	25-Oct	REVIEW DISCUSSION
20	27-Oct	EXAM 2
21	1-Nov	T4.1 REACTIVE N: Ecosystem Science Perspective
22	3-Nov	T4.2 REACTIVE N: Science-Policy Perspective
23	8-Nov	T4.3 REACTIVE N: Challenges and Approaches
24	10-Nov	T4.4 REACTIVE N: Group project on Research agenda proposal
25	15-Nov	T4.5 REACTIVE N: Group project on Research agenda proposal
26	17-Nov	T4.6 REACTIVE N: Group project on Management study
	22-Nov	Fall Break
	24-Nov	Fall Break
27	29-Nov	Work on Posters and projects
28	1-Dec	Student presentations (1-20)
29	6-Dec	Student presentations (21-40)
30	8-Dec	Student presentations (41-60)

Readings for Lecture Schedule

Class meeting	Date	Class content
1	23-Aug	intro & basics

Readings:

Chapter 9. Revisiting the Ecosystem Concept: Important Features that Promote Generality and Understanding. Michael L. Pace. In "Fundamentals of Ecosystem Science" eds. K. C. Weathers, D. L. Strayer, and G.E. Likens. Elsevier Press. 2013.

Chapter 11. Controls on Ecosystem Structure and Function. K.C. Weathers, H.A. Ewing, C.G. Jones, D.L. Strayer. In "Fundamentals of Ecosystem Science" eds. K. C. Weathers, D. L. Strayer, and G.E. Likens. Elsevier Press. 2013.

Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment (2009) Stephen R. Carpenter et al., Proceeding of the National Academy of Sciences of the United States of America (PNAS) 1305–1312, doi: 10.1073/pnas.0808772106

2	25-Aug	Ecosystem-Earth Interconnection

Readings:

Global Change and the Earth System. Executive Summary (2004). Steffen, W. et al. http://www.igbp.net/publications/igbpbookseries/igbpbookseries/globalchangeandtheearthsystem2004.5.1b8ae20512db692f2a680007462.html

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries:exploring the safe operating space for humanity. *Ecology and Society* **14**(2): 32.
[online] URL: http://www.ecologyandsociety.org/vol14/iss2/art32/

3	30-Aug	weather and climate

Readings:

Chapter 3. Understanding climate as a system. In "Climate Change 2009: Faster change and more serious risks". Will Steffen. Commonwealth of Australia 2009 ISBN: 978-1-921298-58-5

NRC booklet: Climate Change: Evidence, Impacts, and Choices. https://nas-sites.org/americasclimatechoices/more-resources-on-climate-change/climate-change-lines-of-evidence-booklet/

IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

4	1-Sep	Global Environmental Change

Readings:

Rockstrom et al 2009. A safe operating space for humanity. Nature 461: 472-475.

Steffen, W., et al 2015. Planetary boundaries: Guiding human development on a changing planet. Science: 347(6223):1259855. February 13, 2015

5	6-Sep	Science Policy Considerations

Readings:
Brundtland Report: Our Common Future Part 1. http://www.un-documents.net/our-common-future.pdf

NRC Report on "Climate and Social Stress: Implications for Security Analysis". (2013). Read pages 1 – 52, Summary, plus Chapters 1 and 2.

6	8-Sep	T1.1 REDD: Ecosystem Science Perspective

Readings:
Angelsen, A. (ed.) 2008 Moving ahead with REDD: Issues, options and implications. CIFOR, Bogor, Indonesia.

Baker, D.J., Richards, G., Grainger, A., Gonzalez, P., Brown, S., DeFries, R., Held, A., Kellndorfer, J., Ndunda, P., Ojima, D. and Skrovseth, P.E., 2010. Achieving forest carbon information with higher certainty: A five-part plan. environmental science & policy, 13(3), pp.249-260.

Canadell, P., et al (2007). Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. PNAS 104: 18866 –18870. http://www.pnas.org/content/104/47/18866.full.pdf

Fynn, A.J., P. Alvarez, J.R. Brown, M.R. George, C. Kustin. E.A. Laca, J.T. Oldfield, T. Schohr, C.L. Neely, and C.P. Wong. 2009. Soil carbon sequestration in U.S. rangelands: Issues paper for protocol development. Environmental Defense Fund, New York, NY, US

Corinne le Quéré, Michael R. Raupach, Josep G. Canadell, Gregg Marland et al.* 2009. Trends in the sources and sinks of carbon dioxide. Nature Geoscience 2, 831 - 836 (2009). http://www.nature.com/ngeo/journal/v2/n12/pdf/ngeo689.pdf

7	13-Sep	T1.2 REDD: Challenges and Approaches
8	15-Sep	T1.3 REDD: Group project on Research agenda proposal
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Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment (2009) Stephen R. Carpenter et al., Proceeding of the National Academy of Sciences of the United States of America (PNAS) 1305–1312, doi: 10.1073/pnas.0808772106

Daily G. C., et al., 2009. Ecosystem Services in decision making: time to deliver. Front. Ecol. Environ 7:21-28. doi:10.1890/080025

Shahid Naeem, et al. 1999. Biodiversity and ecosystem functioning: Maintaining Natural Life Support Processes. Issues in Ecology 4

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

14	6-Oct	T2.2 BIODIVERSITY: Biodiversity and Ecosystem Services
15	11-Oct	T2.3 BIODIVERSITY: Science Policy Interface
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19	25-Oct	REVIEW DISCUSSION
20	27-Oct	EXAM 2
21	1-Nov	T4.1 REACTIVE N: Ecosystem Science Perspective

James N. Galloway, John D. Aber, Jan Willem Erisman, Sybil P. Seitzinger, Robert W. Howarth, Ellis B. Cowling, and B. Jack Cosby. 2003. The Nitrogen Cascade. BioScience: 53: 341-356.

Galloway, James N., et al. 2004. Nitrogen cycles: past, present, and future. Biogeochemistry 70: 153–226, 2004.

Matson, P.M. 2013. Chapter 13. From Global Environmental Change to Sustainability Science: Ecosystem Studies in the Yaqui Valley, Mexico. In “Fundamentals of Ecosystem Science” eds. K. C. Weathers, D. L. Strayer, and G.E. Likens. Elsevier Press. 2013.

Mosier, A.R., et al. 1998. Closing the global N2O budget: nitrous oxide emissions through the agricultural nitrogen cycle. Nutrient Cycling in Agroecosystems 52: 225–248, 1998.

UNEP and WHRC. Reactive Nitrogen in the Environment: Too Much or Too Little of a Good Thing. United Nations Environment Programme, Paris, 2007.

22	3-Nov	T4.2 REACTIVE N: Science-Policy Perspective
23	8-Nov	T4.3 REACTIVE N: Challenges and Approaches
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