Spring Term 2018
Environmental Studies 80.01/ Biology 148

Arctic Environmental Change
10: M, W, and F 10:10 – 11:15, Xhr- Th 12:15 – 1:05
Class location- Fairchild 405
Office Hours: M and W 11:15 – 12:15 or by appointment

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ORC Description: ***Arctic Environmental Change*** This course examines the connections between science and the human dimensions of rapid environmental change. Environmental responses to climate change and resource development will be introduced from a scientific perspective. In addition, we will explore how this science is framed in policy documents such as reports from the Intergovernmental Panel on Climate Change. The course will emphasize the importance of science communication and will culminate with a collaborative project that integrates climate change, resource development, and social issues. (TAS)

Guiding Principles
Climate change is happening twice as fast in the Arctic. The resulting loss of sea ice and glacier ice is expanding opportunities for the development of shipping, extractive, and other industries. These and other human-induced changes are disrupting ecosystems that support culturally-important subsistence hunting and fishing. Scientists and engineers are tasked with understanding the causes and consequences of these environmental changes, information which ultimately will influence management recommendations and policy.

In the Arctic, Traditional Ecological Knowledge (TEK) also informs understanding of changes in ecosystems. TEK is deeply embedded in indigenous communities and in turn, western science is conducted within its own institutions, which often makes the "synthesis" of these approaches difficult. Furthermore, integration across scientific disciplines can be challenging but is often necessary for solving complex problems. Effective communication and trust between scientists and all stakeholders are essential for solving complex environmental issues in the Arctic.

General structure and organization
The course will include a mix of lectures, analytical exercises, small work groups, structured discussions, and unstructured time for work on independent or group projects. In the first part of the course, we will review the science of Arctic environmental issues related to climate change and resource development (climate variability, albedo, thermal physiology, environmental contaminants etc.). Students will complete assignments that will broaden our inference on these topics and stimulate class discussion. The second part of the course will examine how scientific knowledge merges with other types of knowledge to broaden our understanding of Arctic environmental change. Students will gain familiarity with the methodology of TEK research and will judge the advantages and limitations of this and other approaches. Last, we will examine the role of western science and traditional knowledge in decision-making processes. The culminating poster project will involve developing practical skills in communicating Arctic environmental change. Students will develop a poster that integrates climate change, resource development, and social issues to communicate a message about Arctic change.

Learning targets

Students will gain facility with theories, models, data, and inferences regarding the responses of Arctic systems to environmental change. Students will learn generalities regarding system response that extend across polar science disciplines (e.g., positive and negative feedback systems; directional change; coupled human-natural systems). Students will improve skills for reading scientific papers and using spreadsheets for data exploration. Students will gain capacity to communicate theories, models, and data in a way that is accessible to the general public.

Assignments

Assignments are designed to give students practical experience in researching and communicating the science of Arctic environmental change. The first assignment is designed to improve skills for accessing and reading scientific papers and writing succinctly. The second assignment involves accessing publicly-available climate data and analytical exercises using spreadsheets. This assignment will facilitate class discussions about variability in Arctic warming and thermal effects on ecological dynamics. More details about each of these assignments will be distributed in class.

Final Poster Project: Communicating about Arctic Environmental Change

Scientific discoveries from the polar regions are relevant to the entire world. For example, polar glaciers melt and cause sea levels to rise, ice cores allow us to understand and anticipate global climatic changes, and Arctic residents have deep ecological knowledge based on thousands of years of adaptation to change. This information can shape perceptions and local, regional, and international policies if it is communicated effectively. It can also appeal to people's emotions, a powerful resource to make audiences care.

This final assignment is designed to give you practical skills for developing a visual product that communicates science-centered content to a target audience; in this case, the Dartmouth and Hanover community. You will create a 3' x 4' poster (in power point) that communicates an aspect of Arctic environmental change, drawing on information, concepts, ideas, or theories from multiple perspectives. The poster will be displayed in the Russo Gallery at the end of spring term. It must include a strong visual component. Resources include the *Thin Ice* exhibition from the Hood Museum or resources in the Stefansson Collection at Rauner Library. Along with the poster, you'll produce a 1-page handout and will have 5-8 minutes to elaborate on your poster's content during presentations in the last class period. Faculty and staff from around campus will be invited to attend and see your work.

Some class time will be devoted to the poster project. More information will be provided about accessing campus resources and how to make a poster in power point, and we will go through a peer-review process on a draft version.

Academic Honor Principle: Students are expected to be fully aware of The Academic Honor Principle, that is, "all academic activities will be based on student honor. Each Dartmouth student accepts the responsibility to be honorable in the student's own academic affairs as well as to support the Principle as it applies to others." You should consult with the instructor if you are not clear about your responsibilities or expected conduct during any assignment or activity in this course. Visit the Dartmouth web site to be sure that you understand the proper use of Sources in preparing your work http://www.dartmouth.edu/~sources/

Students with Disabilities: I encourage students with disabilities, including "invisible" disabilities like chronic diseases, learning disabilities and psychiatric disabilities to discuss with me after class or during office hours appropriate accommodations that might be helpful to you. If you have a

documented disability needing academic adjustments or accommodations please see me by the end of the second week of the term. All discussions will remain confidential.

Religious Observances: Some students may wish to take part in religious observances that fall during this academic term. Should you have a religious observance that conflicts with your participation in the course, please come speak with me before the end of the second week of the term to discuss appropriate accommodations.

The Dickey Center Institute of Arctic Studies (147 Haldeman Center) has a reading library that you are welcome to use. If you want to be added to the Arctic Studies mailing list please let me know. Monitor the Arctic Studies blitz bulletin for announcements about campus speakers, news, and job and internship opportunities related to northern and polar locations.

Class Participation: This course relies on the full participation of each student through attendance and being prepared to engage in discussion. Staying up with the reading is essential.

Grading: The grading in the course will reflect class participation and individual and team work on assignments and a final project. The point breakdown is as follows:

Class Participation	30	
Assignments		
Abstract	10	Due 4/13
Weather Analysis	25	Due 4/27
Poster Project		
Draft	5	Due 5/11
Peer-review	5	Due 5/14
Poster	20	Due 5/30
Presentation	5	Due 6/1
TOTAL	100	

Tentative schedule and readings (subject to revision)

Week 1		**Readings and Assignments**
3/26	Course Introduction	
3/28	Defining the Arctic and other key background	Banerjee Ch. 1
3/30	Discussion: what's happening in the Arctic?	2017 Arctic Report Card http://arctic.noaa.gov/Report-Card/Report-Card-2017 Bring relevant 2018 news stories to class
Week 2		
4/2	Reading scientific papers, Intro to Assignment 1	Pagano et al. 2018; Wauchope et al. 2017
4/4	Positive Feedbacks	Serreze et al. 2007; Schuur et al. 2015
4/6	Temperature and biology	Post et al. 2009; Post et al. 2013
Week 3		
4/9	Marine ecosystems and resources	Laidre et al. 2015; Fossheim et al. 2017
4/11	Hunting and fishing	Laidler et al. 2009; Ford et al.2008
4/13	Changing climate, changing communities, Intro Assignment 2	Banerjee pp. 39-52 **Assignment 1 Due**
Week 4		
4/16 4/18 4/20	Weather data and report workshop	Bring computers to class
Week 5		
4/23	Change in Local Communities	Turner and Clifton 2009
4/25	Change in Local Communities Intro Assignment 3	Huntington 2000
4/27	Student Presentations	**Assignment 2 Due**
Week 6		
4/30	Student Presentations	No readings assigned, research poster topics
5/2	Poster workshop in class	Bring computers and **poster ideas** to class
5/4	What happens in the Arctic doesn't stay in the Arctic- sea level rise	Gardner et al. 2013; Bamber and Aspinall 2013
Week 7		
5/7	Sea level rise policy simulation	News stories posted on Canvas
5/9	What happens in the Arctic doesn't stay in the Arctic- weather patterns	Cohen, Pfeiffer and Francis 2018
5/11	Peer-reviews in class	**Poster draft Due in class**
Week 8		
5/14	Arctic science, TEK, and international policy	IPCC sections assigned **Peer-reviews Due**
5/16	Communicating Arctic Change in Policy	Ekwurzel et al. 2011, Hassol 2008, Somerville and Hassol 2011
5/18	Geopolitics of Arctic natural resources	Banerjee 107-121; Banerjee part 3, Forbes et al. 2009
Week 9		

5/21	Arctic Policy and Indigenous Perspectives…	Banerjee part 4, part 7, Institute for Arctic Policy, Reports on Canvas
5/23	…continued	
5/25	Policy and Stakeholder exercise	News stories posted on canvas
Week 10		
5/28	Memorial Day- no class	
5/30	Class wrap-up, meet in Russo Gallery	**Hang posters in Russo Gallery**
6/1 **exact time TBD**	Final presentations in the Russo Gallery in Haldeman	**Poster presentations**

* Readings will be assigned during the course. Monitor Canvas for updates.

Reading List. Additional Readings may be placed on Reserve during the course.

Alley RB (2000) The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future. Princeton University Press, Princeton, NJ
Note: This is a great reference, but not required reading.

Bamber JL, Aspinall WP (2013) An expert judgment assessment of future sea level rise from ice sheets. Nature Climate Change 3:242-427

Banerjee S (2012) Arctic Voices: Resistance at the Tipping Point. Seven Stories Press, New York, NY

Cohen J, Pfeiffer K, Francis JA (2018) Warm Arctic episodes linked with increased frequency of extreme winter weather in the United States. Nature Communications doi: 10.1038/s41467-018-02992-9

Ekwurzel B, Frumhoff PC, McCarthy JJ (2011) Climate uncertainties and their discontents: increasing the impact of assessments on public understanding of climate risks and choices. Climatic Change 108:791-802

Forbes BC, Stammler F, Kumpula T, Meschtyb N, Pajunen A, Kaarlejärvi E (2009) High resilience in the Yamal-Nenets social-ecological system, West Siberian Arctic, Russia. Proceedings of the National Academy of Sciences 106: 22041-22048

Ford JD, Smit B, Wandel J et al. (2008) Climate Change in the Arctic: Current and Future Vulnerability in Two Inuit Communities in Canada. The Geographical Journal 174: 45-62.

Fossheim M, Primicerio R, Johannesen E et al. (2017) Recent warming leads to a rapid borealization of fish communities in the Arctic. Nature Climate Change 5: 673-678.

Gardner AS, Moholdt G, Graham Cogley J et al. (2013) A reconciled estimate of glacier contributions to sea level rise: 2003 to 2009. Science 340:852-857

Hassol SJ (2008) Improving how scientists communicate about climate change. Eos 89:106-107

Huntington HP (2000) Using traditional ecological knowledge in science: methods and applications. Ecological Applications 10: 1270-1274

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.

Laidler GJ, Ford JD, Gough WA et al. (2009) Travelling and hunting in a changing Arctic: assessing Inuit vulnerability to sea ice change in Igloolik, Nunavut. Climatic Change 94: 363-397.

Laidre KL, Stern H, Kovacs KM et al. (2015) Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. Conservation Biology 29: 724-737.

Pagano AM, Durner GM, Rode KD et al. (2018) High-energy, high-fat lifestyle challenges an Arctic apex predator, the polar bear. Science 359:568-572.

Post E, Forchhammer MC, Bret-Harte MS, Callaghan TV, Christensen TR, Elberling B, et al. (2009) Ecological dynamics across the arctic associated with recent climate change. Science 325:1355-1358

Post E, Bhatt US, Bitz CM, Brodie JF, Fulton TL, Hebblewhite M, Kerby J, Kutz SJ, Stirling I, Walker DA (2013) Ecological consequences of sea ice decline. Science 341:519-524

Schuur EAG et al. (2015) Climate change and the permafrost carbon feedback. Nature 520:171-179.

Serreze MC, Holland MM, Stroeve J (2007) Perspectives on the Arctic's shrinking sea-ice cover. 2007. Science 315 (5818), 1533

Somerville RCJ, Hassol SJ (2011) Communicating the science of climate change. Physics Today. October 2011:48-53

Turner N J, Clifton H (2009) “It’s so different today”: Climate change and indigenous lifeways in British Columbia, Canada. Global Environmental Change 19:180-190

Wauchope HS, Shaw JD, Varpe Ø et al. (2017) Rapid climate-driven loss of breeding habitat for Arctic migratory birds. Global Change Biology 23:1085-1094.