Climate Change *vs.* Everything Else Causing Ecosystem Impairments: *What is driving global change?*

Syllabus of Aug 8, 2020

Fall - EAS 501.040 (2 credit hrs)
Th 5:30 – 7:10 pm Zoom Discussions and Lectures pre-recorded
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Rationale

This course tackles the oft' ignored reality that while ecosystems are being subjected to climate change-related impacts (e.g., increases in droughts, wildfires, flooding, heat), there remain a plethora of co-occurring physical, chemical and biological stressors. *How is climate change affecting these unknown and well-known stressors? What role do 1) land uses, 2) societal and political norms and media biases, 3) economic constraints, 4) the sensitivity and resilience of local/regional ecosystems, and ecosystem context have in this issue?*

These components vary across geographies and vary as system drivers. As environmental managers, assessors, educators and stewards it is critical to have an understanding how these issues are intertwined in the face of climate change. Many corporations and governmental agencies are now mandating that any plans to manage or restore sites have climate change contingencies included, in the event of flooding, drought, wildfires, etc.

Examples of common-place stressors in human-dominated systems include: Excess nutrients; harmful algal blooms; Habitat alteration (e.g., erosion and turbidity, siltation, loss of riparian vegetation and trees, flows, channelization), Metals, methyl mercury, and synthetic organics (e.g., pesticides, PFOS, PCBs, 1,4 dioxane, pharmaceuticals and personal care products); Macro- and microplastics; Water withdrawals for irrigation and fracking; Untreated sewage and viral, bacterial and fungal pathogens; Parasites; and invasive species.

Climate change is exacerbating the effects of all these stressors on ecosystems, including altering biodiversity, yet environmental managers and assessors have been remiss in considering the role climate change is having on these well-known environmental issues. These stressors tend to be addressed in a piece-meal, "silo" approach due to our regulatory frameworks and the challenge of implementing interdisciplinary frameworks.

This class will not focus on the sources of greenhouse gases or approaches to reduce their output.

Class Learning Objectives

Class learning objectives are for students to develop and understanding of the relative importance of stressors in the face of climate change, across a range of ecoregions and hydrology types. Students will generally consider the role of land uses, societal and political

norms, economic constraints and disease outbreaks, such as COVID-19 and how these can affect priority setting on ecosystem restoration actions and the ranking of stressors. An important focus will be understanding how ecosystems vary in their sensitivity to stress and subsequent resilience to resist impairments. These considerations will drive the development of pragmatic approaches for ranking and managing the most important stressors in the face of climate change. This will then allow for science-based decision making addressing appropriate restoration and remediation strategies.

Students should achieve the following learning outcomes from taking this course:

- An understanding of the likely aquatic ecosystem stressors in a range of ecoregions, land uses and hydrologic systems, while considering a range of societal and economic conditions (developed to undeveloped countries).
- An understanding of how these stressors may interact with each other.
- An understanding of the role climate change may have on human-dominated ecosystems, in the face of co-occurring stressors.
- An understanding of how to make science-based decisions for improved restoration and remediation strategies that prioritize stressor management.

Student Skill Requirements

This course is open to any SEAS, CEE, ClaSP, SPH, EES or EEB graduate student. No specific course background needed other than being in the above graduate programs.

Class Format and Pedagogical Tools

The class will consist of pre-recorded lectures with follow-up Zoom online discussions during the scheduled class time. There will be assigned readings and videos in addition to the lectures. The recorded lectures will be limited to 20 minutes in length. Three lecture videos and the Zoom discussion period equate to one class period, as a point of comparison. Each student will prepare a Powerpoint presentation (which may or may not be shared with the class) addressing the class problem assignment. It is not required this be a video recording or that you are speaking (optional). This Powerpoint will address an assigned class problem (explained under Grading below).

Class Topics

Each class topic will consist of a few pre-recorded lectures and videos, supported by assigned readings. Questions will be posed to facilitate the follow-up Zoom discussion period (0.5 – 1 hr in length) and to provide written answers for possible submission. Students may also ask questions via Chat or Email (perhaps via Canvas). All assigned readings, pre-recorded lectures and videos, and class materials will be posted on Canvas, which each enrolled student will have access to.

The first class will meet on Zoom at the scheduled class time (5:30 pm Tues, September 1). The first class will consist of reviewing the Syllabus and an overview of common ecosystem

stressors in human-dominated systems. We'll also discuss the class problem assignment – *A Decision-making Framework for Ranking Environmental Stressors*; and assign some readings.

We have the flexibility to discuss a wide variety of climate-related issues and their interaction with common physical, chemical and biological stressors; many of which are listed below:

- Overview of common aquatic stressors in human-dominated systems, such as: human-dominated land uses, habitat, flow, nutrients, dissolved oxygen, invasives/introduced species, temperature, pesticides, metals, synthetic organics, pharmaceuticals and personal care products.
- How do aquatic stressors vary by ecoregion, hydrologic type, and socio-economic status?
- Overview of known climate change impacts in freshwater and coastal systems, such as heat, extreme events (e.g., wildfires, drought, flooding, severe storms), food-web collapse, glacier and polar ice melt, pathogens, pests, invasives/introduced species, seasonal changes affecting reproduction and behavior, species loss and biodiversity declines
- Where are the climate-change hot spots? What are the indirect effects of climate-change on human populations, environmental justice, pandemics, and economies and how might these affect regional ecosystems?
- How will aquatic ecosystem stressors likely be influenced by climate change? How will this vary across ecoregions?
- How can local to regional ecosystems be better managed and restored in the face of climate change and other stressors? Which stressors should be targeted first in a restoration or protection program?

Grading

1. At the end of each video there will be one short answer question. So, by the end of the semester there will be 30-40 questions each student will have answered. During the **final scheduled class period** (via Zoom), each student will submit the answers to 6 videos from 2 lectures, randomly selected by Dr. Burton. Answers will be checked for plagiarism. **60 points**
2. Powerpoint and optional video on *Decision-making Framework on Ranking Multiple Site Stressors* (see details below) **30 points**
3. Participation (Zoom discussions, Chat, Email, Canvas) **10 points**
4. **BONUS POINTS**: Up to five half-page summaries of course-related journal papers and/or related UM environmental seminars. 4 points each - **20 points max**

Project assignment description: Decision-making Framework on Ranking Multiple Site Stressors for Restoration (30 points). Powerpoint format (30 slides maximum) and option to present as a video (20 mins maximum). Show how you would rank (worst to least harmful) stressors, based on their likely degree of ecosystem impairments in the context of climate change stressors. Also show how you would decide which stressors to target for restoration,

considering cost effectiveness at your project site. Examples of stressors: Climate change related extreme events, toxic chemicals, habitat degradation, excess nutrients, etc. Show how climate change affects your restoration. An example will be provided and the assignment discussed via Zoom.