Syllabus: ESM293  Advanced Special Topics in Climate and Energy - Globalized Biochar Production as a CO2 Sequestration and Climate Change Mitigation Strategy: What's the Potential?

Code: 78113

Patricia (Trish) Holden (Professor)  
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Office Hours: Holden BH 3508: Tuesdays 3 – 5, or by Zoom appointment 
https://ucsb.zoom.us/j/3067575343

Fall, 2021  
W: 8 – 9:15 am  
BH 1510 (Sycamore)

Course Description
Owing to fossil fuel overuse, consequences in the form of climate change impacts are being experienced globally. Although the recognition of the problems is longstanding, solutions have been slow to manifest. Among the solutions discussed are CO$_2$ sequestration. The purpose of this seminar is to critically evaluate a single strategy: household to industrialized plant cultivation coupled with biochar production, followed by biochar storage subsurface or otherwise to permanently sequester C. What is biochar? How is it produced? What is its net C sequestration footprint? What is the potential for biochar production and its storage to permanently sequester C, such that impacts of climate change might be slowed or mitigated? Students would read literature provided, and work in small groups to discuss the facts and address knowledge gaps. Where possible, analyses would be undertaken to quantitatively address key questions such that critical evaluations can be performed, and syntheses written. Visitors knowledgeable of related issues will provide additional perspectives and engagement.

About Your Instructor
Trish is an engineer and environmental microbiologist who researches origins and fates of pollutants in soil, water and sediments to inform management including pollution prevention and remediation. My teaching style is organized, attentive to individuals, focusing on principles, and reinforces with quantitative content. I encourage classroom questions and discussion. I use writing and presentation assignments so that students employ the subject matter while pursuing topics of interest and building professional communication skills. As for “me”: I love students, and simple pleasures: good friends, cooking, exercising, writing, working, collaborating, nature, art, music, films, and my dog.

Student Learning Outcomes and Assessments

1. Explain biochar: what it is, how it is produced and potential uses  
   a. In class discussion, synthesis

2. Critically evaluate the use of biochar as a C sequestration device  
   a. Distinguish between various uses of biochar  
   b. Explain potential, constraints, and unknowns for the use of biochar as a C sequestration device.
c. Examine questions that are actionable.
3. Discover how to find information and resources, for this course and the future.
   a. Selection of topic for paper and presentation
   b. Sourcing for lab reports.
4. Collaborate to reach a conclusion
   a. Achievement of synthesis in a team setting.
5. Communicate the material; write, and present, using your knowledge gained in this course
   a. Quality of written and oral assignment, based on rubric.

Recommended materials
Readings on GauchoSpace, and those that you discover relevant to this topic and issue.

How to succeed in this course
Attend class. Read the materials. Engage during class discussions. Work effectively in small groups to achieve goals of addressing key questions. Work consistently throughout the quarter. Ask questions.

Grading Criteria
Class participation 30%; Group work and synthesis 70%.

Course assignments
The aim of this course is to get somewhere. Biochar is a known entity. It has been explored as a soil amendment. It can be made in small batches using simple approaches. It is a fossilized form of fixed C whose permanent removal from the biosphere could effect C sequestration. Why are we in this class? What we’d like to do is determine, if it hasn’t been done already, if making and permanently disposing of biochar can assist with reversing global warming to any significant extent, over what time frame, and the social and governance structures that would have to support. I’d like for us to divide and conquer, then come to conclusions about these things:
1. Technical feasibility of massively distributed biochar production on Earth. Can it be done, and how? This is about the technical approach.
2. Utility of scaling up biochar production to essentially industrialize C sequestration. Will it have the effects in the time frame we need? This is about the outcomes.
3. Social and governance structures that would need to be in place. How could this be done? This is about the social engineering.

The proposal is that the class structure into 3 groups to work together throughout the quarter, meeting some outside of class, with individuals reading and thinking and bringing briefs and thoughts to class from individual and group deliberations. At the end of the quarter, some presentation of the findings from each group would occur. We’d end up with a conclusion that is informed by the three key issues, and let all pieces serve as a final report.
University and Course Policies

1. compliance with the UC COVID-19 Vaccination Policy, including completing the daily symptom survey and weekly testing for non-vaccinated students;
2. classroom masking: required
3. classroom eating/drinking—not allowed owing to COVID-19 masking requirement
4. ill students must not to attend class (lecture or lab). Consult with the TA or professor on how to keep up and/or catch up.
5. course materials, including recordings, may not be distributed or sold
6. notify instructor if you do not want to be included in classroom recordings

- The schedule is subject to change depending on the progress of the course.
- Lab assignments turned in late will be penalized 10% per 24 hours after the deadline. If extenuating circumstances arise, coordinate with the teaching assistant before the assignment deadline to agree on alternative arrangements.
- In this course we’ll work and learn together. That means that you need to be in class for the learning to happen. We understand that you may encounter situations where you can’t attend; for this reason, you may miss two meetings without penalty. For each class you miss thereafter, your participation grade will decline by 5%. If you miss more than five classes, you will have missed the majority of the learning experiences in the course and will be unable to pass.

Plagiarism and Academic Integrity

Universities are places dedicated to the production of knowledge by people. This happens when people (like you!) bring your ideas together with others. It’s important, though, to observe the conventions (formal and informal rules) associated with knowledge production in this process. This is especially true when it comes to creating the kind of written work we’ll produce in this class. It’s critical to use sources honestly, to indicate when you are drawing on materials from others. There are two concepts important to understand in conjunction with this idea.

First is plagiarism, which is a violation of academic integrity and UCSB policies. Plagiarism occurs when a writer deliberately passes off another’s words or ideas without acknowledging their source. For example, turning another’s work as your own is plagiarism. Plagiarized assignments (including copying of a friend’s homework) will receive a grade of 0 and may result in additional disciplinary action. You can view the university’s policy on student conduct at http://www.sa.ucsb.edu/Regulations/student_conduct.aspx.

Second is misuse of sources, occasions when a writer does not properly cite a source, misuses quotations, includes too much of an original source in a paraphrase or summary, or commits similar unintentional violations of academic protocol. If you misuse sources, we will work together on appropriately incorporating and/or citing the sources. Note that some audiences/instructors will consider misuse of sources to be plagiarism; for this reason, it is extremely important for you to identify the conventions associated with source use and citations in any class.

Student Resources

- Information and links for applicable student resources
- Links to wellbeing and mental health resources
- Library resources: UCSB Library

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## Calendar

Course Outline (approximate): See GauchoSpace (GS) for updates

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<thead>
<tr>
<th>Wk</th>
<th>Lecture Topic</th>
<th>Lab Exercise**</th>
<th>Due</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>E0: Introduction to the Lab (safety, and review of experiments)</td>
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<tr>
<td>2</td>
<td>Environmental compartments, habitats, function</td>
<td>E1: Culture microbes (part a)</td>
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<td>3</td>
<td>Diversity: discovery, quantification</td>
<td>E1: Describe, count, subculture (part b);</td>
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<tr>
<td>4</td>
<td>Energetics, growth, metabolism</td>
<td>E1: Characterize cultures (part c);</td>
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<td>5</td>
<td>Carbon cycle: greenhouse gas production and consumption; climate feedbacks</td>
<td>E2: DNA-based diversity (demo); E3: C mineralization setup</td>
<td>E1</td>
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<tr>
<td>6</td>
<td>Biotransformation of inorganic and organic pollutants</td>
<td>E3: Final measurements (TA) E4: Toluene biodegradation, biostimulation, and bioaugmentation</td>
<td>E2</td>
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<tr>
<td>7</td>
<td>Nitrogen cycle: N₂ fixation, ammonification, nitrification, denitrification</td>
<td>E5: N₂ fixation study</td>
<td>paper title / outline E3;</td>
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<td>8</td>
<td>Microbiological water quality</td>
<td>E6: Culture-based &amp; molecular analysis of water quality (IDEXX / qPCR)</td>
<td>E4</td>
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<td>9</td>
<td>Waste treatment</td>
<td>E6: Analysis of IDEXX data / DNA results overview <em>No class Thanksgiving Holiday</em></td>
<td>E5</td>
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<tr>
<td>10</td>
<td>Energy, Biotechnology and bioproducts; review</td>
<td><em>Lab meeting as per TA</em></td>
<td>E6</td>
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**Final Paper Presentations: Monday Dec. 6th, (12 – 3 pm; BH 1424)**

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