

Human Impacts on Global Biogeochemical Cycles

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Office hours: We will be together a lot – if you need to meet with me outside of class time please consult my [online office hour sign up](#) – if none of these times works, please email me or speak to me in class, I am happy to meet with you at another time.

In this course we will explore the large biogeochemical cycles of our planet, focusing on nitrogen, carbon, and water. By the end of the block you should know how they work (i.e. the chemical, biological, and geological mechanisms that drive them) and how humans have altered them. We will explore this intersection primarily through several case studies via multiple methods, using peer reviewed literature and modeling approaches.

Course Format. Class will begin every morning at **9 AM** unless otherwise noted. Morning sessions will usually last until about noon and will rely on you doing the reading so that class discussions are not completely boring. There will be a lab or a scheduled help session (with Nick and/or myself) on many days, starting at **1:30 PM** unless otherwise noted, so please check the schedule, you should always be done with class by 3:30 PM.

Attendance. We will be covering a lot of material in this course, with every day building on the previous day. In order to learn from and with each other and include all voices, attendance at all class meetings is expected. It is your responsibility to contact me directly if you are unable to attend class due to an emergency. Please note that if you get sick during the block I will do everything I can to help you catch up on the material – but you need to have a note from Boettcher or another doctor for your absence to be considered *excused*.

If you need to miss class for any justifiable reason during the block (e.g., athletic team travel, religious observance), please notify me **on the first day of class** so we can make arrangements on how you will receive the material for that day.

Note about assignment deadlines and student-teacher-human well-being. I am dedicated to providing you thorough and specific feedback to help you improve your work; this means I have dedicated time in my own schedule for reviewing assignments. Sometimes life gets in the way, and we have to submit something we know isn't completely edited or as well developed as we would like. I would much rather have you turn in something that is a work in progress than delay and become overwhelmed with too many overdue assignments at the end of the block. I am not a huge fan of taking "points off" for lateness, as it contradicts the developmental and human-focused commitments I have made as an educator. I have set deadlines in a way that I hope provides you the maximum flexibility in completing assignments yet keeps you on pace to not get behind in the necessary "practice" of working with scientific concepts. I am usually able to accommodate a day or two extension, but please keep in mind that the pace of the block is fairly unforgiving and things WILL build up. I highly encourage you to schedule time off on the weekends to spend with your friends or family, engaging in creative and activist endeavors, going outside for a hike, or to the movies, or to simply relax. Whenever possible the course schedule was created to encourage said "mental breaks."

Commitment to Diversity, Equity, & Inclusion. I am committed to making my classroom a place that enhances all students' learning, a place where students are both respected and challenged. I make pedagogical choices that I hope advance this goal. Outside of class, I run [mentoring programs](#) aimed at increasing the retention of women in earth and environmental sciences and conduct [bystander intervention trainings for faculty](#) to improve workplace climate. My commitment to diversity, equity, and inclusion does not mean I think I am perfect, I know I make mistakes. I will do my best to acknowledge these, along with my privilege and biases; I ask that you do the same. This is not easy. It is uncomfortable. We all make mistakes. I recommend using "ouch and educate" as a way to let your peers know that you are hurt and why. Colorado College is our community and it is up to each of us to make it a safe and welcoming place for all to learn and succeed.

Canvas, Readings, & Online Questions. I will use Canvas extensively throughout the course. I will do my best to have everything posted multiple days in advance but always by 4 PM for the following day. **All readings are posted on Canvas.** It is your responsibility to do the readings BEFORE class. You will be held accountable for the readings, so come to class prepared. Being prepared goes beyond reading, however. You should allow for adequate time to *think* about the readings as well. Sometimes there will be **questions posted on Canvas** or short **exercises in class** (5 min) - the goals of these questions are to (1) assess your comprehension of the reading material, and (2) to get you to start thinking about the material prior to classroom discussions.

Exams & Assignments.

You will have two exams this block. The first *in class, closed book* exam will be on the first Friday of week 1 and will test your knowledge of the chemistry basics that we learn in the first week. The second exam will be on Tuesday of week 4 – this exam will also be *in class, closed book, and comprehensive*.

There will be *three STELLA models* that you will complete: Population, Water, Carbon Cycling. STELLA is a visual modeling program and is available in multiple computer labs on campus (Barnes Lab, Palmer 2, computer terminals on the first floor of the library). This program enables you to model a system without writing code (and translates your model into differential equations); as such it is a great way to get introduced to modeling. You will have the option of incorporating STELLA into your final project.

There will be 4 homework assignments. These assignments are to provide you additional practice at applying the scientific concepts we discuss in class in a quantitative way. Nick and I are available to help (see course schedule for "optional help sessions" and/or sign up for my office hours).

You will all **create one Wikipedia entry of a female scientist** related to the field of biogeochemistry. I have worked with Wikiedu to create the module you will use and learn from. Did you know that less than 18% of the biographies on Wikipedia are on women? This assignment is an exciting opportunity for us to make a small contribution to expanding the image of "what a scientist looks like" and to "pay it forward" to those who do not have the privilege of a college education. Please choose one of the scientists listed in the [google doc](#). I strongly recommend working at the pace suggested within the Wiki-module (links provided on Canvas page with a suggested schedule). Note: you will be assessed on what you *produce* not what *sticks* on Wikipedia. You will also present a short synopsis & share the Wikipedia entry of your scientist on the 4th Monday of class.

You will all **present one peer reviewed article**, written by “your” Wikipedia scientist to the class. This serves three roles: 1) you learn how to digest a paper quickly and present the relevant facts, 2) increases the breadth of material covered in the course, and 3) will provide you information you can use in your Wikipedia entry. How it works: everyone will sign up for a day and find a peer reviewed article that examines a human impact on a biogeochemical cycle. By **7 AM** of the **day you are presenting** you must **send me the article** and designate **one or two figures** that you will focus on. In class, all students will receive these figures (I will make the handouts) and you will lead a brief (~5 min) discussion.

There will be *one group project*, the **Day in a Student’s LIFE CYCLE ANALYSIS**. This project will explore the full environmental impacts of *one aspect* of your day to day life at CC. You will work in groups of 2 or 3 to complete the LCA (life cycle analysis) for two elements (e.g. N and C or C and Fe). As a group you will reflect on your results and then think about how this information could be made into educational materials (e.g. signage near Rastall, posters in dorms, campus competitions) to improve our collective footprint on the planet. Results will be presented to representatives from the Office of Sustainability at the end of the block.

Grading.

Wikipedia Project	10%
Homeworks & Labs	25%
Exams (1 st exam: 10%, final: 20%)	30%
LCA Project	25%
Participation & In-class Activities	10%

Grading Assignments.

95 – 100 = A	77 – 79 = C+
90 – 94 = A-	73 – 76 = C
87 – 89 = B+	70 – 72 = C-
83 – 86 = B	69 – 66 = D (CR)
80 – 82 = B-	65 and below = NC

D, CR do not fulfill EV Major requirements

Failing grades (NC, WF) do not fulfill any college requirements

Honor Code. Failure to properly document sources in papers, plagiarism, copying from other student’s work, or turning in assignments that have already been submitted for credit in other courses are among some of the actions considered intellectual theft under the Colorado College Honor System. I encourage you to work together and talk through issues, but your final written work must be your own. I will give you further information on how the honor code applies to specific assignments as we go. If you are uncertain about the Honor Code’s application to a particular project, please ask me. If you have questions or to read further details of the Honor Code see: <http://www.coloradocollege.edu/other/honorcouncil/constitution-bylaws/constitution.dot>

Campus Resources. Collectively the resources listed below (as well as countless others) are in place to help you succeed at Colorado College. We all face challenges at some point in our lives and often a new environment (college) or difficult and stressful situations (college) mean that we need a bit more help from time to time. I encourage you to look into the various

resources available at CC and if you are needing assistance and cannot find said resource please reach out to me, your academic advisor, RA, clergy person, or other trusted person.

The Butler Center. [The Butler Center](#) works to foster an equitable intellectual and social climate at CC that is inclusive to all. The Butler Center Staff organizes significant amounts of programming throughout the year that I encourage you to check out.

The Colket Center for Academic Excellence houses both the [Quantitative Reasoning Center](#) and the [Writing Center](#). Both of which I strongly encourage you to use throughout your time at CC. If you need additional help or my explanations seem nonsensical to you, reach out to the tutors at the QRC and Writing Center!

Accessibility Resources. If you have a disability and require accommodations for this course, please speak with me privately as soon as possible so that your needs may be appropriately met. If you have not already done so, you will need to register with [Accessibility Resources](#) (227-8285), the office responsible for coordinating accommodations and services for students with disabilities. Accessibility Resources is also available for accommodations outside the classroom (e.g. housing, dining), I encourage you to seek assistance if needed.

Student Health Center. Health services are provided at Boettcher Health Center Building and their offices can be reached at 389-6384. They post updates to their clinic hours as well as alerts on their [website](#). The CC Counseling and Psychological Services (also in Boettcher) work in supporting and addressing the mental health needs of our students. [Counseling and Psychological Services](#) can be reached at 389-6093.

Student Life. Dean Edmonds and his team within Student Life are available to discuss and provide resources to assist you in a myriad of non-classroom related aspects of life. Please do not hesitate to get in touch with someone in [Student Life](#) if you need assistance.

Course Schedule. Each day's lectures, labs, and discussions will be based upon a question that we will try and answer. By the end of the course, you should be able to have a meaningful discussion about these questions.

As a note, the syllabus is also available on Canvas. The course Canvas site is also organized by weekly modules + modules for the Wikipedia project and LCA project. For each week, the syllabus (with hyperlinks) is available and readings are ordered chronologically, followed by assignments for the week.

The syllabus and schedule are subject to change depending on the progress of the course.

WEEK 1 | CHEMISTRY BASICS AND SYSTEMS THINKING

Day 1 – August 27

Opening Convocation 9 AM, class starts at 10:30 AM

- Course introduction
- Causal loops & feedbacks
- Check out list of [Wikipedia biography list](#) and set up your Wikipedia account [see Canvas *Women in STEM Wikipedia Project* module]
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Day 2 – August 28

- Chemistry basics – what is matter, atoms & periodicity, chemical reaction, ideal gas law
 - C&C pgs 15-27, 53-57, 115-119
- **Homework #1 due 1:30 PM** [hand in hard copy]
- 1:30 PM Lab | Palmer 2, *Population Growth with STELLA*
 - Cohen 1995 *Science*

Day 3 – August 29

- Chemistry basics – formal charges, Lewis structures, chemical bonding
 - C&C pgs 57-62, 104-112
- 1:30 PM Lab | Tutt 105, Introduction to Wikipedia Women in STEM Assignment (<1 hr)
 - Bring your laptop
- Optional Help Session 2 PM | Tutt 105 or Palmer 2
- **STELLA population lab due 4 PM** [upload to Canvas or hand in hard copy]

Day 4 – August 30

- Introduction to cycling
 - Weathers et al. Chapter 5
- The Water Cycle
 - One of the following: Gordon et al. 2005 PNAS or Sterling et al 2013 Nature Climate Change [see Canvas for assignment]
 - If you need to review the water cycle the USGS has some great [online resources](#)
- **Homework #2 due 1:30 PM** [hand in hard copy]
- 1:30 PM Lab | Palmer 2, *Modeling the Water Cycle*
 - Review and have access to Oki et al. 2006 *Science*
- Exam Review: Location and time TBA

Day 5 – August 31

- **Exam 1 starts at 9 AM** closed book, in-class

WEEK 2 | CARBON & NITROGEN CYCLES

Day 6 – September 3

- **Water STELLA Lab due at 9 AM** [upload to Canvas]
- Introduction to the C cycle
- Chemistry Basics – oxidation states
 - Weathers et al. Chapter 6
 - Falkowski et al 2000 *Science*
- 2:00 PM Lab | Tutt 105, Women in STEM Wikipedia Project
 - *Guest Speakers Dr. Jess Wade and Dr. Maryam Zaringhalam*
 - SO 302: Qualitative Research Methods (Professor Emily Schneider)

Day 7 – September 4

- Agriculture & the C cycle
 - Foley et al. 2011 *Nature*
 - West & Marland 2003 *Biogeochemistry* or Post & Kwon 2000 *Global Change Biology*
- 1:30 PM Lab | Barnes Computer Lab, STELLA C lab
 - Schultz 2000

Day 8 – September 5

- Introduction to the N cycle
- Chemistry basics – redox reactions
 - Weathers et al Chapter 7
 - Redox Primer (Findlay)
- 1:30 PM Optional Help Session, Tutt 105 or Barnes Computer Lab
- **STELLA C Lab due 4 PM** [upload to Canvas]

Day 9 – September 6

- Nitrogen Cascade, Acid Rain & Eutrophication
 - C&C 234-251
 - Galloway et al 2003 *Bioscience*
 - Elser et al. 2009 *PNAS*
- 1:30 PM Optional Help Session – Tutt 105

Day 10 – September 7

- **Homework #3 due 9 AM** [hand in hard copy]
- Calcium: Hubbard Brook as a case study
 - Likens et al. 2008 *Biogeochemistry*
 - Rosi-Marshall et al. 2016 *PNAS*
- *Over the weekend, catch up on Wikipedia trainings and milestones. At this point you should have started writing your biography*

WEEK 3: OTHER ELEMENTS MATTER TOO!

Day 11– September 10

- Elemental Footprints & Life Cycle Analysis
 - Introduction of final project
 - Hoekstra 2009 *Ecological Economics*
- Calculate your elemental footprints
 - Online footprint tools (C, N, water)
- 1:30 PM Optional Help Session | Tutt 105
 - Footprint calculation

Day 12 – September 11

- Phosphorus cycle – agriculture & downstream impacts
 - Weathers et al Chapter 8
 - Schindler et al 2008 *PNAS*
 - Michalek et al. 2013 *PNAS*
- 1:30 PM Lab | Tutt 105, LCA Project work day
- **Footprint Memo due 4 PM** [upload to Canvas]

Day 13 – September 12

- Sulfur Cycling – agriculture & atmospheric deposition
 - Schlesinger & Bernhardt pgs 471-482
 - Hinckley & Mason 2011 *PNAS*
 - Likens et al. 1996 *Science*
- 1:30 PM Lab | Palmer 2, Using STELLA for your LCA

Day 14 – September 13

- **Guest Lecture: Dr. Weslyne Ashton**
 - Chance et al. 2017 *Environmental Progress & Sustainable Energy*
- Review
- 1:30 PM Optional Help Session | Palmer 2, LCA Project work day
- **Homework #4 due 4 PM** [hand in hard copy]

Day 15 – September 14

- **LCA Project & Wikipedia Project Work Day**
- *Peer Review* Wikipedia article (must have **draft on Wikipedia by 9 AM**)

WEEK 4: CELEBRATION OF LEARNING!

Day 16 – September 17

- **Share your Wikipedia Entry (informal presentation)**
- Project work day & Review Session TBA

Day 17 – September 18

- **Comprehensive Final, 9 AM** in class, closed book

Day 18 – September 19

- **Day in a Student Life Cycle Presentations**
- **Wikipedia entry (final everything) due by 12 PM**