

**San José State University**  
**Department of Urban and Regional Planning**  
**Geog01-80: Geography of the Natural Environment**

**Fall 2023**



*January 13, 2020*

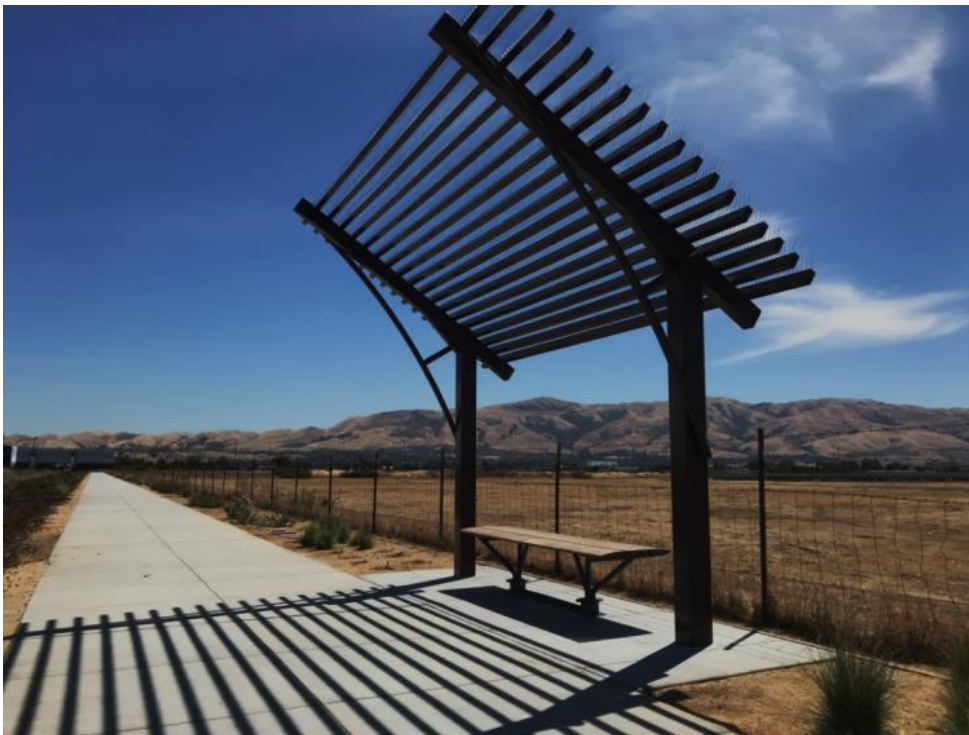
**Course and Contact Information**

**Instructor:** Gary Pereira  
**Office Location:** Online only.  
**Telephone:** (510) 825-3506 (**text** please, at least initially)  
**Email:** (**Canvas messaging preferred**, or text 510-825-3506 in emergency)  
gary.manuel.pereira@gmail.com  
**Office Hours:** Please message me if you need to set up an appointment.  
**Class Days/Time:** Weekly homework and announcements as scheduled.

## Course Format

This is an online-only course. Internet connectivity and computer are required. Many of the resources that we will use are from safe, reliable sources on the Internet. The course itself can be accessed through the Canvas Learning Management System course login website, primarily through the **Announcements** and **Assignments** for this class. Additional course materials (including this syllabus) can be found and uploaded from **Files**, as prompted by the schedule. Students are required submit one homework assignment each week, as well as a final evaluation paper. Study material and assignments are listed and described under **Assignments**, but additional requirements or suggestions may be described within the **Announcements**. Please check the Announcements at least once a week, particularly before submitting homework. Your grades may reflect repeated failure to address additional questions or concerns that I may post there. All homework must be submitted, even if late. Any work that has not been submitted by the end of the semester will receive a zero grade. Repeated lateness should be explained in an independent Canvas message or with a message pinned to the assignment itself. Messages may be pinned to each assignment by both the instructor and student. I will try to get to each submission within a week after its due date, although I may sometimes run late. Check in a week for any remarks or instructions that may have been pinned to that assignment, regardless of whether you have received a grade. Please address any requests for revision and resubmission I may have made. If you want to respond to a pinned message after a grade was issued, please do so by sending me an independent message within Canvas. I am unlikely to return to any particular submission once it has been graded, unless I've been prompted to do so by you.

The photo below represents (hopefully with a little humor) my impression of some of the systems and applications that have become commonplace in education. You might notice something a little strange. The structure looming over the bench looks it might provide some shade or shelter from the rain, but in fact it does neither, at any time. You can take this photo as my commentary on contemporary decision-making. Several of these structures were built, and it wasn't easy. Spikes had to be installed to keep birds from perching and messing up the bench, which would have been left undisturbed, had these remarkable structures not been there.



The bench is intended here to represent the parts of Canvas that we will be using: **Announcements, Assignments, Files,** and messaging. The stylish, attractive, but useless structure looming above it might be taken to represent what I consider some of the less helpful facets of Canvas, as well as most of the published resources that students are often required to buy. For this course, I have found that freely available readings are sufficient to supplement some carefully chosen Internet sources, as well as some of my own material. This strategy I believe results in a more substantive, robust, personal, and direct understanding of the topics described here than even the most expensive textbooks and their associated resources offer.

What makes a course engaging should be its subject matter, not the structure of the course or the personalities of the instructor or participants. Let's try a simple metaphor. If you're looking for the moon in the night sky, it would certainly be foolish to confuse the finger that someone might be using to point out the moon for you, with the moon itself. The characteristics of the finger are completely unimportant. It just points the way. For the most part, that is what I will be doing for you: pointing the way. As best I can, of course, given what I find to be true and meaningful thus far in my understanding of things. I've kept the structure of this course simple so that we will have more flexibility to follow relevant current events, discoveries, or connections in real time. Therefore, despite the structural simplicity of this course, it is important that you follow the **Announcements** by checking them at least once a week, and **respond in subsequent homework assignments to specific questions that may be posted there.**

Remaining within our metaphor, the tendency to confuse some pointing 'finger' with some external object of study can have another unfortunate association. Because we can manipulate our fingers any way we want, we might start to believe that by doing so we can magically affect the object being pointed at. Consider that the opposite might be true. Possibly, at least for educational purposes, I would like you to try to set aside the implications of your own personal or collective identities and just do your best to learn about what exists well beyond (or invisibly within) yourselves. I have found that, by taking this approach, we can learn to more realistically evaluate and adapt to whatever the unknown forces of nature (and of the human heart) might throw our way.

Within **Announcements**, I might try to be helpful by making some observations or offer general advice regarding earlier and future homework responses, but I will never identify students by name without prior permission. I further promise to keep any information we exchange via either messages or homework completely private. You of course may share any such exchanges or documents with anyone at all, at any time.

We can communicate as much or as little as you'd like, within Canvas messaging. I've had some long conversations with some students, and none (outside of homework comments) with others. I leave that up to you; it has no effect on your grade. With messaging, conversations cannot be ignored, misplaced, manipulated, forged, modified, or inappropriately shared with others. There are no such assurances with email (including the one assigned by the university, and is run by Google) or with other social media platforms, which are as a result often used as tools of manipulation, power, confusion, and disrespect, particularly by people in positions of authority. I prefer not to use email in my role as educator. The gmail address listed on page one here is a good way to get in touch with me down the line, but during the semester, **Canvas messaging is sufficient.** Text my private number, which is also listed on page one, if you have a time critical emergency, and I'll call you back. Being late with homework is not an emergency. If any of your work is late, submit it anyway and pin an explanatory message to the homework itself, or message me separately regarding more serious issues.

Given the current state of America's universities, I will not require you to share your work, your opinions, or even your image with others in the class, or with anyone else that happens to be looking in. Unfortunately, every moment of screen time can be inappropriately saved, shared, and broadcast publically, and it can live forever. I do not want anyone to suffer retaliation for anything expressed in any of my classes. This is not an idle concern. I know what it's like. It has happened to me repeatedly, and it is likely to happen again, and again. For the foreseeable future, I will not be asking students to use zoom or skype or whatever the latest thing happens to be to gather around a screen at some particular time. Nor will I

organize or participate in any sort of online discussions, so long as innocent people like you and me remain under threat for expressing or exploring ideas that someone somewhere now or at some future time happens to find problematic. Instead, I encourage you to refine and edit the work that you do for my courses and for others, and to post it online: **in your own time, at your own discretion, in a way that is fully under your own control** (e.g., via Portfolio).

Please carefully read and view the material that I have provided at the beginning of each **Assignment**, as well as any new **Announcements** at least once a week. These locations are where the material or pointers to the material that would otherwise be covered in lectures will be located. If you do not read over this material and view the videos, I will know through your homework responses. Homework questions are posed within each **Assignment**. Additional questions issued in an **Announcement** should be addressed within a week or two. If you do not address these additional questions, I will assume that you are not reading the **Announcements**, and this will be reflected in your grade.

I am not obsessive about the quality of your writing, since you have a limited amount of time each week to proofread, but I do appreciate good organization, reasoning, and grammar. **I am looking mostly to see that you have actually accessed and examined the material in question, and that you have put in the time.** If you are uncertain, make adjustments based on the grades and pinned comments you receive from me. You might want to ask someone to independently read and edit your homework before submission. However, your words and thoughts should be your own. You may quote extensively from material in the assigned or suggested texts or videos, but please provide attribution, by means of notes or references. A URL alone is not enough; provide proper references. The style is unimportant; just be consistent.

Copying and pasting text without attribution, or using an AI service to generate homework responses, is very likely to:

1. get me (your instructor and grader) extremely annoyed;
2. prompt me to investigate how much of your response has been synthesized or plagiarized (this isn't difficult);
3. generate a zero grade for each synthesized or plagiarized response, and possibly for the entire assignment;
4. prompt me to investigate all previous and subsequent submissions from you very carefully, and repeat steps 1, 2, and 3.

So plagiarism on assignment 1, even if it is only discovered at the end of semester, can still lead to a reevaluation of its original grade. Most of my questions are intended to elicit your impressions, rather than just regurgitate facts, so plagiarism would be pointless anyway. It should be easier for you to ask yourself for such impressions, than for you to ask the Internet. Try writing the way that you talk. If you have no clear impression or opinion on a topic, try the following strategy: on the one hand..., on the other hand....

The university expects that each student put at least **nine hours of work per week into each three-credit course** (University Policy S12-3 at <http://www.sjsu.edu/senate/docs/S12-3.pdf>). Your homework assignments and final paper will be evaluated and graded primarily on the degree to which this expectation has been met, based on my impression of your work. The more detailed, organized, and thoughtful your responses are, relative to your classmates, the better your grades will be. You are not graded on the basis of any opinions or conclusions you may express on any issue, even when I might ask you to express one. I am more interested in whether you understand and appreciate the issues themselves. Further details are discussed below under **Course Requirements** and Assignments, in the **Course Schedule**, and in my introductory video.

## Course Description

This course covers the basic sciences that describe the Earth's atmosphere, hydrosphere, biosphere, and lithosphere, and the human relationship to each of these.

## Textbook

The **Fundamentals of Physical Geography** (2<sup>nd</sup> edition) is a free online textbook with over 300 pages and 400 illustrations, photos and animated graphics. It is the work of two professors from the University of British Columbia Okanagan – Dr. Michael Pidwirny & Scott Jones. Important terms are hyperlinked to a glossary. There are links to study guide pages and additional reading within each chapter. Most importantly, ‘weblinks’ are provided for each chapter that provide a wealth of well-respected sources of additional data and social media. The textbook is accessible at the following site. **Do not download or use the pdf version suggested on the website or in popup windows.**

<http://www.physicalgeography.net/>

## Readings

Readings are required for certain assignments. All of the readings listed in the schedule are preceded by one of the following:

**Read:** take the time to read all or most of the text, keeping in mind any associated homework questions.

**Reference:** contains information that may help to fill out your understanding of key terms and relationships. You may use this information to inform your homework responses.

**Recommended reading:** read this if the topic interests you, and if you intend to study or write about the topic in greater detail (for example, for the final paper).

## Videos

Videos are a big part of this course, and much of the homework will be judged on the basis of how closely you consider them in your discussions. If you are accessing each assignment directly through CANVAS **Assignments**, you can watch the videos coming from YouTube embedded directly within CANVAS, but you also have the choice of running each video in a separate browser. Watching videos within separate browsers often provides you with additional textual information, as well as access to the author’s channel. You might want to watch videos on a tablet or TV as you write on a laptop. Use whatever method feels comfortable, but make sure you have a large enough screen to clearly see the details (including text) in the videos. You also obviously need sufficient bandwidth, which may change for you over the course of a typical day, particularly if you use public portals.

Videos are indicated by a short description, followed by the channel name in brackets. If a particular video interests you, you might want to check out other channel offerings. All of the videos listed in the schedule are preceded by one of the following instructions:

**Watch:** take the time to watch all or most of this video. You may find it helpful to ‘pause’ and watch key portions repeatedly, taking notes as you watch.

**Examine:** You may watch the video in its entirety if you like it, but there is no immediate need to do so. You might want to scrub through segments and watch only those portions that look particularly interesting or connect to the questions you need to address. Many of these videos have no narration, although they do convey a great deal of information. Some just provide a deeper sense of context. In any case, do NOT just skip over these videos, since they nearly always connect with the homework questions.

**Recommended:** You are not required to either watch or examine this video, but I have found it to be of exceptional value or interest with regard to the topic at hand, so you might want to check it out.

It is important that you have clear audio with easily adjustable volume. The sound processing on some of the videos is binaural, meaning that it simulates the geometry of human hearing. This provides a more realistic, 3D experience than normal stereo processing, particularly if you use earphones.

Most of the videos that I require or recommend embed within Canvas. If you click on the video, it should play. However, it is possible that the channel supplying the video has prohibited embedding, in which case you will get a screen indicating that it must be opened in a separate browser. If you do open any video in a separate browser, you will find that many of them contain or are preceded by ads. Some of these ads are part of the video. But often, ads can be cut short by clicking on the Skip Ad button that might appear, or by clicking on the **X** within the ad itself if it's a popup. YouTube reserves the right to place ads in front of, including my own videos, although I get no monetary benefit. By the way, I do not generally provide tags on my videos, and I sometimes disable comments. Views of my videos embedded within Canvas are not counted as views by YouTube. These are some of the reasons why most of my videos get few officially counted views, which is fine with me. Feel free to subscribe to any channel that interests you, including my channel, and to share these videos with others. If any of the videos for the course become unavailable over the course of the semester, don't panic. Check the Announcements to see whether I have recognized the issue yet and have provided alternatives. If I have not addressed it yet, please let me know about it. Otherwise, if time is short, do your best with the resources at hand, and if you're feeling resourceful you may searching for alternatives. In any case, videos disappear from YouTube only rarely.

## Course Requirements and Assignments

### Homework

Fourteen homework assignments should be completed on or before the due dates, as described in the course schedule below. They must all be submitted, even if late. Please submit all files via Canvas; never email them to me or as attachments to messages. If you are having difficulties, message me through Canvas. If personal life intrudes or if Canvas or the Internet are giving you problems, just be patient, try again later or the next day, and let me know about it in general terms. There is no penalty, obviously, if you let me know. For each homework assignment, I would prefer that you use 10 (or 12) point font with 1½ line spacing. Put your name, the Assignment number, 'envs121-80' or 'geog121-80', and 'Fall 2022', arranged at the upper right of the first page.

Text, figures, and images copied from documents or screenshots may be embedded within your homework, but these should include full attribution (not just the URL). In other words, just be honest about which words, figures and images are yours, and which are from other sources. You will need to be especially careful about this if you decide to publish or post your work in an online portfolio. Most of the text in each homework submission should be your own. If you do upload anything to a platform like Portfolio, you immediately get basic copyright protection under Creative Commons. That is evidence that you published it, and when. So make sure that it's all really yours.

Regarding the length in pages or word count expected for each assignment: this depends on the topic, and also on your writing style. **I'm looking for evidence of understanding, substance, and a willingness to sufficiently pursue each point you are making until you've made it properly.** I understand that you only have a few days for each one. It is also perfectly reasonable to be unsure about topics that you are just beginning to understand. The ability and willingness to openly express one's own doubts and uncertainties is a virtue, since it often leads to further understanding. If your writing

style is average, if you avoid redundancy, and you put in the time expected of you, each homework assignment should probably run at least three pages. The time and effort you spend on each question may vary, depending on your interest. **If you cannot find much to say about one topic, make sure you compensate for that with another one in the same assignment.** Each of your submissions is graded relative to those of your classmates in the current and former semesters. I often look through each week's submissions repeatedly before deciding on grades. I may offer comments or advice in Canvas for each assignment. Check back on each assignment a week or more after the deadline for any comments that I may have tagged to it, even if it hasn't been graded. If you would like to begin or continue a conversation about an assignment, please do so with an independent Canvas message. I encourage you all to go back and expand and polish up some of your most interesting essays and **publish them online**, in Portfolium at a minimum. In my opinion, the work you are doing for this class and others should be used in support of your professional career. Please read 'About your instructor', below.

## Final Evaluation

Instead of a comprehensive exam, I want you to write a thoughtful essay as described below in the Course Schedule.

## Grading Information

Fourteen homework assignments and the Final Exam should be completed on or before the due dates, as described in the Course Schedule below. They must all be completed by the end of semester. Please submit these responses as either Word or pdf files via Canvas.

Homework assignments (6.5% each) x 14	91%
Final Evaluation	9%
<b>Total</b>	<b>100%</b>

98% and above	A+
94% - 97.9%	A
90% - 93.9%	A-
87% - 89.9%	B+
84% - 86.9%	B
81% - 83.9%	B-
77% - 79.9%	C+
74% - 76.9%	C
70% - 73.9%	C-
67% - 69.9%	D+
64% - 66.9%	D
60% - 63.9%	D-
<b>below 60%</b>	<b>F</b>

## About the instructor



I grew up in a semi-industrial town in New Jersey, near New York City. Refinery flares lit the night sky. I went to public schools and held several untrained jobs in various settings, from our single-screen downtown movie theater to the reactor building of an active nuclear power plant. I began working professionally with a two-year degree in electronics engineering, on a team of about a dozen technicians that built and maintained the data acquisition and instrument control system for Princeton University's tokamak reactor 'TFTR', the largest nuclear fusion experiment in the world at the time. After six years at Princeton and the reactor's successful completion, I worked as an electronics technician for the science departments of Brooklyn College in NYC, where I took evening courses and earned a master's degree in computer science. While in Brooklyn, I met Cheri, we married and had a child. We moved to Bethlehem, PA, where I worked as a technician for the Physics Department at Lehigh University, later as a geographic information systems engineer for Lockheed Martin. After a few years we moved to Minnesota, where I worked at a NOAA facility called NOHRSC, which processes remote sensing, GIS, and hydrological models to produce online data products. I earned a PhD in Geography at the University of Minnesota, where I did tropical fire research, taught physical geography, and met and worked with some of the most well-known and highly respected scholars in geography and related fields. We finally moved to the Bay Area, and I've been at SJSU for over 20 years.

I encourage all students to participate in professional organizations or guilds and to make use of any truly meaningful learning opportunities or certifications that are being offered, at least until you are settled into a career path. Learn a few extra skills. Even if you don't end up using them all, you will have demonstrated to yourself and to others that you remain capable of learning. I've worked for business, government, and education, and everywhere the intentions and capabilities of individual people are the key to the success or failure of any given project. Before anyone serious hires you or decides to collaborate with you, they will probably want to know more about you than what your degree and GPA or even an interview or two may provide. I encourage you to revise and publish your best work (in whatever medium you use, but certainly including your most engaging text), within a setting that potential employers or collaborators can easily access, like Portfolium. Here's a little story to show what might happen if you just let people know what you're capable of doing. I worked for a few years as a technician for Lehigh University, where I also took the classes that I needed for a PhD in Computer Science. We moved away before I could make much progress on a dissertation, but I'd been working independently on something. Based largely on what I'd learned on my own and at Brooklyn and Lehigh, I developed a system in software that performed some novel analyses and visualizations (at the time) in remote sensing and GIS. I presented a paper explaining its function at an international conference in Vancouver. I paid for the membership, registration, flights, hotel, and everything myself. A couple of weeks later, I got a call from someone at Lockheed Martin Corporation who'd been to the conference and had read my paper. He described a position at a cutting edge GIS project within commuting distance of my home. They interviewed me and offered me a job as a systems engineer, which I accepted.

<https://portfolium.com/garympereira/portfolio>



# Geog01-80, Geography of the Natural Environment, Fall 2023

Please submit your homework responses as either Word or pdf files. Use 10 point font, with ~1 ½ line spacing and normal margins. At the top of the first page of each assignment, arrange your name, my name, the homework #, geog1-80, Fall 2023.

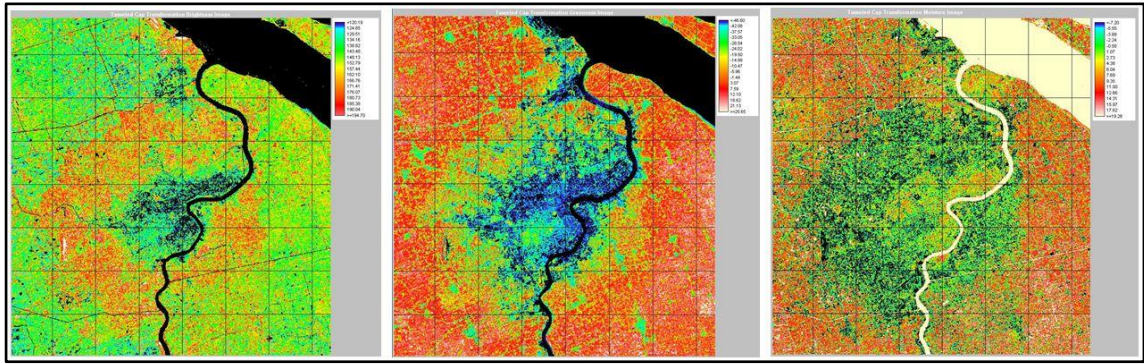
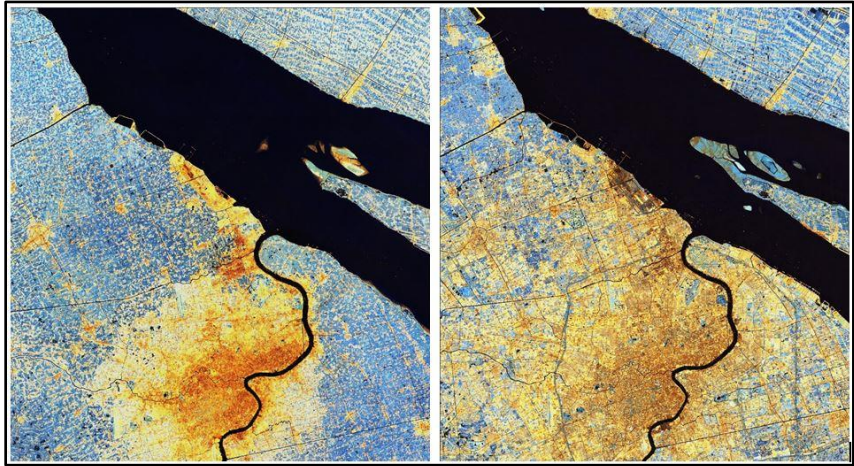
## Course Schedule

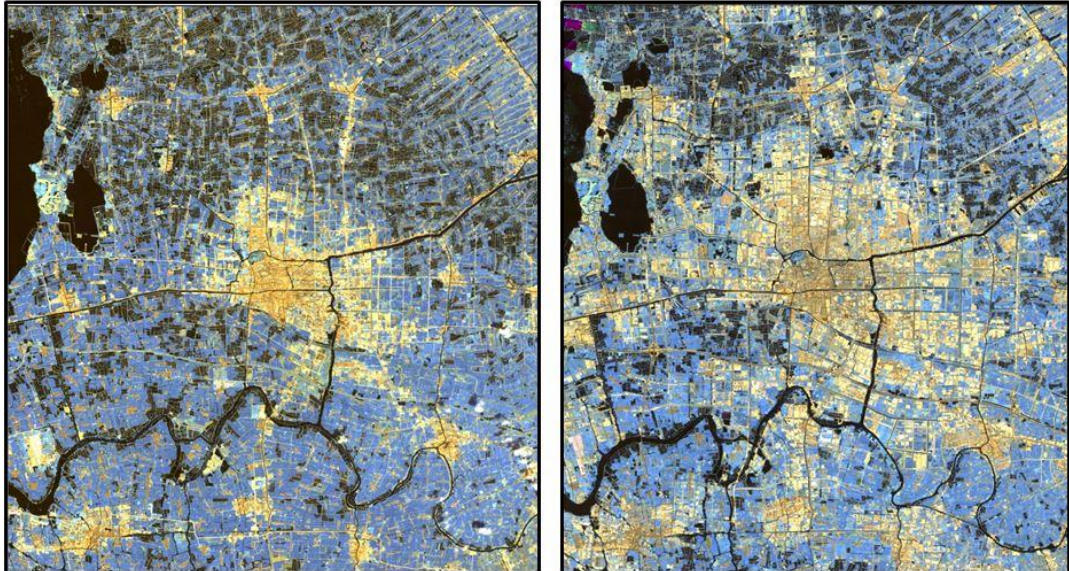
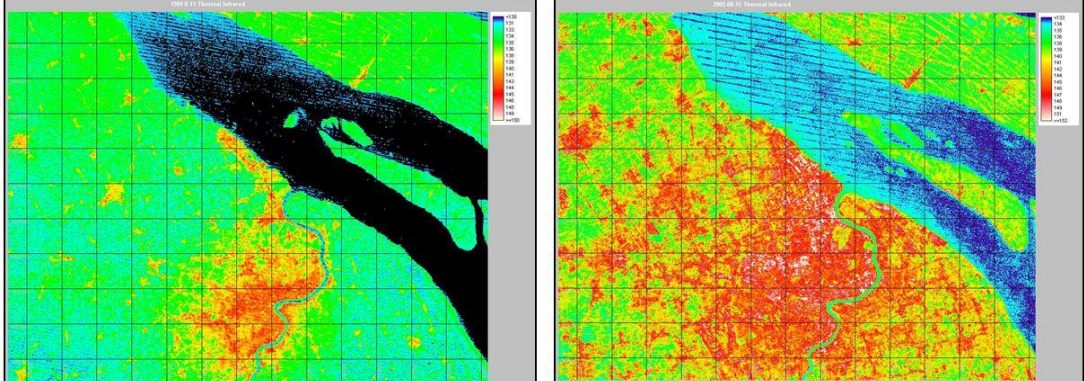
Week	Due Date	Topics, Videos, Readings, Assignments
1		<p>If you haven't already done so, please  <b>Watch:</b> General notes for my online classes [Gary Pereira]  <a href="https://youtu.be/AN8k0OgwI0">https://youtu.be/AN8k0OgwI0</a></p> <p><b>Topic 1: Understanding the world</b></p> <p>Unfortunately, given the events of the past three years, I feel compelled to discuss the nature of science. Let's start with a metaphor. Suppose a group of people walking through an unfamiliar dense forest without a map, phone, or access to GPS, and the group gets lost. If they need to rely on their own wits, what might happen? Depending on who makes up the group, someone might claim that they should follow him, in one particular direction, but he can't explain his reasoning to everyone's satisfaction. Someone else might make the same claim for a different direction. Even if most are unsure, everyone begins to feel pressured to accept one course of action or the other. What should the members of the group do? Should they stick together and follow the majority, or should they split up? I would argue that they should probably get down to basics and form a coherent picture of the situation before deciding upon a particular course of action. If they don't know something that they should know, they should admit it and try to find out. Where is the sun? Could someone scout out higher ground, local terrain and possible pathways, and report back? Which way does water flow, into what? Becoming aware of the precise circumstances within which a challenge presents itself is the first step toward meeting it.</p> <p>But observation is an inherently discriminatory, subjective act. If we as biological creatures couldn't filter out most of the information presented to our senses, even in everyday life, we might become overloaded and even lose our minds. Observation of complex systems like the Earth and, embedded within it, human societies, requires from the start that we have the ability to transform raw data into useful information. This week, we briefly look at some of the tools we used in previous years to provide precisely that sort of education. First, however, we need to look at the practice of science in the past and in recent years.</p> <p><b>1.1: On science</b></p> <p>Science as an <b>approach</b> to understanding reality must always include a willingness to be proven wrong. But representatives of science as a body of knowledge and the institutions of science in particular are often unwilling to be proven wrong, or even to be second guessed. As a result, science is experiencing a number of crises at all levels, including a lack of successful replication and an explosion of unjustified or barely justified claims and counterclaims. Established publications favor established incumbent or fashionable opinions and topics, and funding is increasingly based on an ever-changing set of irrelevant political and cultural concerns. The tools, methods, skill sets, and good-natured disagreements that everyone knows lies at the heart of healthy science are ignored and set aside as unqualified people in</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>positions of authority think and believe their own opinions and impressions fully represent what we all should think and believe. Which they most certainly do not.</p> <p>Our often unjustified trust in the institutions of accumulated knowledge is not new. Consider the story of Galileo’s telescope; or rather, the story of two of Galileo’s contemporaries who became famous throughout history for one thing, and one thing only: their refusal to even look through it. Galileo did not invent the telescope, but he improved its design and demonstrated its usefulness for port and military operations via visual communication. When Galileo began building telescopes at higher magnifications specifically to view the night sky, and when he described what he saw, people were astonished. If you haven’t viewed the night sky through a telescope yet, you really should try it sometime. Even with a relatively inexpensive telescope, it is easy to see the three dimensional contours of mountains and craters on the moon, particularly near the current limb of illumination, and on clear nights (and far away from the ‘light pollution’ of the city) you can see the moons of Jupiter and the rings of Saturn. By watching Jupiter over time, Galileo was the first to see that these moons orbited that distant planet, just as our moon orbits us.</p> <p>But for formally educated people of Galileo’s time, and particularly for university educators, this was disturbing news. The contradiction between what they had assumed must be true based on accumulated knowledge (all presumably scientifically or rationally derived), and what any common, uneducated person could see by just looking through an eyepiece, led to some rather famous examples of self-delusion and stupidity. Two stand out.</p> <p>Cesare Cremonini was a friend and colleague of Galileo at the University of Padua. When Galileo announced that he had seen mountains on the Moon, Cremonini and others denounced the claim and refused to look through the telescope. The evidence refuting Aristotle's theory that the Moon was a perfect sphere would have made his position as Professor of Aristotelian Philosophy at the University untenable. In other words, people would no longer believe and respect everything he said, and this made Cremonini sad. Many seemingly complex and difficult but entirely false academic arguments that students are often recruited into joining actually come down to such simple-minded self-righteousness, even in our own time.</p> <p>Giulio Libri was a Professor of Aristotelian Philosophy at Pisa, and he was an open opponent of Galileo. Libri was particularly vehement in his denunciation of the telescope, which he considered to be a parlor trick, refusing to look. When Libri died, Galileo commented of him that "never having wanted to see Moons of Jupiter on Earth, perhaps he'll see them on the way to heaven."</p> <p>To us, Galileo represents science, and Cremonini and Libri represent anti-scientific views, but this is not what it seemed like to people at the time. To most, Cremonini and Libri represented the consensus regarding what was true. Now consider (for question 1) the following quotations from George Orwell’s essay “What Is Science?” that was published in the London Tribune on October 26<sup>th</sup>, 1945. In Orwell’s view we can all see that many non-scientists also keep rationality and objectivity, and even a willingness to be proven wrong, as their guideposts in their lives, even if they have nothing to do with the science of their time. On the other hand, scientists have often shown themselves to be unreliable practitioners of the scientific approach to knowledge and to life. One obvious example of this, according to Orwell, involves the history of scientific nationalism. The full essay can be found online in pdf form, if you are interested.</p> <p style="text-align: center;">“This confusion of meaning, which is partly deliberate, has in it a great danger. Implied</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>in the demand for more scientific education is the claim that if one has been scientifically trained one's approach to all subjects will be more intelligent than if one had had no such training. A scientist's political opinions, it is assumed, his opinions on sociological questions, on morals, on philosophy, perhaps even on the arts, will be more valuable than those of a layman. The world, in other words, would be a better place if the scientists were in control of it. But a 'scientist', as we have just seen, means in practice a specialist in one of the exact sciences. It follows that a chemist or a physicist, as such, is politically more intelligent than a poet or a lawyer, as such... But is it really true that a 'scientist', in this narrower sense, is any likelier than other people to approach non-scientific problems in an objective way? There is not much reason for thinking so. Take one simple test — the ability to withstand nationalism.”</p> <p>“Clearly, scientific education ought to mean the implanting of a rational, skeptical, experimental habit of mind. It ought to mean acquiring a method — a method that can be used on any problem that one meets, and not simply piling up a lot of facts. Put it in those words, and the apologist of scientific education will usually agree. Press him further, ask him to particularize, and somehow it always turns out that scientific education means more attention to the sciences, in other words — more facts. The idea that science means a way of looking at the world, and not simply a body of knowledge, is in practice strongly resisted. I think sheer professional jealousy is part of the reason for this. For if science is simply a method or an attitude, so that anyone whose thought-processes are sufficiently rational can in some sense be described as a scientist — what then becomes of the enormous prestige now enjoyed by the chemist, the physicist, etc. and his claim to be somehow wiser than the rest of us?”</p> <p>Textbooks often give the impression that the scientific body of knowledge contained within is relatively complete and settled. But as I said in the syllabus for this course, we need to distinguish the finger that is being used to point at some object of study, from the object itself. The tendency for educators and publishers to write with absolute self-assurance is often misleading. There is often a great deal more legitimate diversity of thought on even the most basic questions that you might find in the different fields of science than most textbooks would have us believe. That does not mean that anything can be valid. Mathematical representations, for example, are often essential to understanding, and they cannot simply be replaced by words. And texts that accurately represent scientific realities cannot be replaced by other texts just because those other texts seem to 'feel right' to someone. The practice of science requires rigorous understanding of what already exists within a given discipline, and this cannot be replaced by an active imagination alone. It always requires a lot of hard work.</p> <p>The politicization of science has certainly become apparent in recent years, to anyone who cares to look. Science works slowly to reform itself once it has been corrupted. The good news is that the scientific (as opposed to the political) approach to life generally succeeds, often many years later, in setting the record straight. Former CDC Director Robert Redfield recently testified before Congress and sat for several interviews. This one is from March, 2022:</p> <p><b>Recommended:</b> Dr. Redfield interview [the Hill]  <a href="https://youtu.be/3N676CD1rlw">https://youtu.be/3N676CD1rlw</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p style="text-align: center;"><b>1.2: Perceiving a changing world</b></p> <p>It should be obvious that situational awareness is critical for success. This is particularly true of our desire to understand and shape the human experience on this Earth. Watching and understanding the many natural processes and patterns that help to shape the human experience has always been a requirement for human success. It has been chilling to me, as an educator, to see this basic strategy belittled and ignored by many of the very people who claim to ‘stand with’ and represent science.</p> <p>Particularly near universities, bookstores throughout China remain filled with many intermediate and advanced books in the so-called STEM fields, in both Chinese and English. These books provide an education in the sorts of scientific, mathematical, and computational tools that anyone truly knowledgeable about the challenges we face will know are of central importance. These topics are seen by serious educators in China, India, and much of the developing world as key components in effectively understanding and influencing most of what we will cover over the next few weeks: urban life, agriculture, water security, infectious diseases, climate, etc. Much of my professional work and research has been in Remote Sensing, and I will briefly describe a program we had developed in what used to be the Department of Geography at SJSU.</p> <p><b>Watch:</b> What is Remote Sensing? [CIRESvideo]  <a href="https://youtu.be/xIsUP1Ds5Pg">https://youtu.be/xIsUP1Ds5Pg</a></p> <p><b>Watch:</b> What NASA Knows from Decades of Earth Observations [NASA Scientific Visualization Studio]  <a href="https://youtu.be/dzmktXUZag">https://youtu.be/dzmktXUZag</a></p> <p><b>Watch:</b> How can earth observations help predict next pandemics? [NASA Scientific Visualization Studio]  <a href="https://youtu.be/01OkR1Q-2KY">https://youtu.be/01OkR1Q-2KY</a></p> <p>In order to understand the world, we need to be able to recognize patterns. A real understanding of the methods of pattern recognition and data transformation is quite helpful in many domains, not only Earth observation. For example, it is usually possible to boil down most of the information contained in higher-dimensional data into two or three transformed dimensions, through a shift of perspective based on the statistics of the data itself. By ‘dimension’, we don’t necessarily imply spatial dimensions. A dimension is any characteristic of a thing that can change independently of other aspects, at least in principle. An n-dimensional system can be represented by vectors and matrices, or by tables. A well-established statistical method of helpfully shifting one’s perspective on higher-dimensional data is called principal components analysis. Many more sophisticated systems of AI utilize this and similar tools.</p> <p><b>Recommended:</b> Principal Component Analysis (PCA) [Serrano Academy]  <a href="https://youtu.be/g-Hb26agBFg">https://youtu.be/g-Hb26agBFg</a></p> <p>Transformations of this kind are routinely used to reveal important characteristics of the Earth’s surface region. For example, I used a transformation similar to PCA, called Tasseled Cap, and Landsat TM data, to generate the following images of Shanghai, China, at around 10 AM one day in August, 1989. The Tasseled Cap transformation reveals information about the reflectance (brightness), photosynthetic</p>

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		<p data-bbox="365 184 1469 283">activity (greenness), and wetness (moisture content) of each location on the landscape. The same color palette was used for each image, with white and red representing the highest values, and blue and black representing the lowest values.</p> <div data-bbox="370 321 1507 718" style="text-align: center;">  <p data-bbox="479 688 592 718">Brightness</p> <p data-bbox="868 688 982 718">Greenness</p> <p data-bbox="1250 688 1347 718">Wetness</p> </div> <p data-bbox="365 760 1502 1039">The brightness dimension represents the overall reflectance of sunlight from the landscape. The rivers are least reflective, and the older downtown areas are also low reflectance, due to the buildings and their shadows. A more reflective newer region forms a ring around the central city, followed by relatively less reflective agriculture. The highly reflective vertical white feature at the lower left (third row up from bottom, second column from left) is a highly reflective airport tarmac. Using the same color palette for the greenness dimension, we can visualize relative photosynthetic activity. Most active are the surrounding agricultural region, in red. Wetness portrays moisture, mostly in the soil, and it is highest in the agricultural regions, with significant variability within the city.</p> <p data-bbox="365 1075 1502 1249">By including the infrared portion of the spectrum, which human eyes cannot see, we can visualize in better detail the differences between rural and urban regions. For example, I formed the following images of Shanghai in 1989 (left) and 2005 (right) from of Landsat TM and ETM+ data by assigning the colors red, green, and blue to the near and mid infrared bands. Urban locations are in shades of gold and yellow, while rural regions are in blue. Open water is black.</p> <div data-bbox="511 1285 1360 1789" style="text-align: center;">  <p data-bbox="690 1753 755 1789">1989</p> <p data-bbox="1161 1753 1226 1789">2005</p> </div>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p data-bbox="370 184 1453 247">Here is a pair of images portraying the growth of one of Shanghai's suburbs, along with the retreat of agriculture (in blue) and aquaculture (in black), from 2000 to 2005.</p> <div data-bbox="402 289 1464 892" style="text-align: center;">  <p data-bbox="711 865 769 892">2000</p> <p data-bbox="1140 865 1198 892">2005</p> </div> <p data-bbox="370 940 1497 1180">The thermal infrared portion of the spectrum is at a much longer wavelength than the visible and mid infrared, and is an indication of how much sensible heat is being emitted from the landscape. The expansion of Shanghai's urban heat island from 1989 to 2005 is portrayed in the following pair of images. Warmest regions (at 10 AM on a clear day in August for both years) are in white and red. Cooler regions are in green and blue. The warmest neighborhoods on this particular day in 2005 are the white dots around the center of the image, in Shanghai's northern suburbs: the same region that had been relatively cool just a few years earlier on a very similar day.</p> <div data-bbox="397 1222 1474 1642" style="text-align: center;">  <p data-bbox="641 1612 699 1640">1989</p> <p data-bbox="1172 1612 1230 1640">2005</p> </div> <p data-bbox="370 1684 1485 1747">A number of Masters Theses in Geography at SJSU included substantive work with remote sensing from our lab in the former Department of Geography. Here are just a few of them.</p> <p data-bbox="370 1789 1485 1816">Karen used Landsat data to look at how changes in snow cover in the Sierra Nevada mountains over the</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>course of a year (the American River basin in particular), might affect reservoir storage, as reflected in lake levels. This sort of work illustrates how remote sensing is used to monitor and control the flow and distribution of freshwater resources (which we shall discuss in week 11).</p> <p><b>Recommended:</b> Examining the relationship between snow cover and reservoir storage in the American River basin, by Karen McGillis-Moskaluk  <a href="https://scholarworks.sjsu.edu/etd_theses/4291/">https://scholarworks.sjsu.edu/etd_theses/4291/</a></p> <p>Classification is the process of assigning a land cover or land use category for each perceptible patch of ground. The spatial resolution depends on the instrument being used. Landsat data is multispectral, freely available, covers the world, and goes back to the 1980s. In her thesis, Avivit used a form of approximate reasoning to classify a mixed rural/urban landscape in terms of partial membership in several broad categories, and validated her results with USGS classifications.</p> <p><b>Recommended:</b> Landsat image classification using fuzzy sets rule base theory, by Avivit Shani  <a href="https://scholarworks.sjsu.edu/etd_theses/2978/">https://scholarworks.sjsu.edu/etd_theses/2978/</a></p> <p>The use of remote sensing in assessing ecosystem and agricultural health is well established, and vegetation mapping is particularly interesting and productive with multispectral data. Julie performed classifications of the island of Palau using two different classification methods and compared the results.</p> <p><b>Recommended:</b> Comparison of two classification methods for vegetation mapping in Palau, by Julie K. Andersen  <a href="https://scholarworks.sjsu.edu/etd_theses/2938/">https://scholarworks.sjsu.edu/etd_theses/2938/</a></p> <p>The use of remote sensing in agricultural economics is well established, particularly in developing countries. In her work, Tapasi used multispectral data to estimate yield on particular tea plantations in northeastern India, and compared her results to actual market data for that region at the time. Work like this can help farmers make long-term agricultural decisions, like the planting of tea bushes in India, or of wine grapes in California.</p> <p><b>Recommended:</b> Tea bush health determination and yield estimation, by Tapasi Barman  <a href="https://scholarworks.sjsu.edu/etd_theses/3514/">https://scholarworks.sjsu.edu/etd_theses/3514/</a></p> <p>In his thesis work, Joseph used multispectral data to derive actual evapotranspiration within portions of Las Vegas. Evapotranspiration is the transformation of soil moisture or open water into water vapor through the physical process of evaporation, as well as the biophysical process of transpiration from leaves. The City of Las Vegas has begun to implement a policy intended to reduce the degree of evapotranspiration from the landscape. Joseph carefully compared the timeline of how this policy was implemented to actual evapotranspiration rates during this period. This is an example of how remote sensing can be used to assess the relative success of government policies.</p> <p><b>Recommended:</b> Effects of Water Conservation on Evapotranspiration in Las Vegas, Nevada, by Joseph Belli  <a href="https://scholarworks.sjsu.edu/etd_theses/3911/">https://scholarworks.sjsu.edu/etd_theses/3911/</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Topic 2: Modeling a changing world</b></p> <p>Any higher organism, if it is to survive, has no choice but to model the world. Models of one kind or another have always been used to advance understanding. Now, in the computer age, models can be formed that are more complex, abstract, explicit, and unambiguous than ever before. They are no longer limited by physical properties, but only by the human imagination, if that. Models can be powerful. They can reveal things about the real world that you may never have suspected to have been true. I have had this experience many times myself. This is one of the places where creativity in art and science can come together.</p> <p>But computer models can also mislead. They can obviously be designed to mislead. They can be inaccurate. They can be interpreted inappropriately. Their shortcomings can be significant. The list of problems with computer models is endless. I won't dwell on them here. I want instead to discuss emergent properties of the real world that even many computer models, particularly those based solely on past history, have a great deal of difficulty in capturing or simulating. The current debates over models in climate change research should address the ability of climate models to accurately simulate and possibly predict or forecast such emergent properties.</p> <p>Change of any kind, including social change, remains largely mysterious and notoriously difficult to predict accurately. This even applies to much of physics. At the very least, some degree of randomness is nearly always present, and this can affect the course events, particularly over the long term. Regardless of their source, unknown factors, often in the guise of randomness, must be taken into account if we are going to deal with life more soberly. The perpetual presence of human ignorance regarding what the universe may throw our way should not surprise us. Evolution may be a universal property of nature that guarantees the emergence of novel forms and functions (not necessarily biological) whose interactions with what already exists had never been predefined anywhere, or anytime, and what emerges from these interactions may also be entirely new. If this emergent property of nature is real, it has its potential down side, which is interestingly echoed by many ancient beliefs. The fundamentally evolutionary nature of all reality guarantees that, from the human point of view, troublesome forms or events that no one could have ever predicted will eventually appear. We often manage to recognize and avoid similar situations down the road, and that's obviously good. Nevertheless, some entirely new, unanticipated situation will always eventually arise. Unanticipated solutions to what may seem to be insurmountable problems can also appear, seemingly from nowhere. If nature is evolutionary, then even the most advanced future AI system, encompassing all of science, could still not possibly anticipate everything that will happen, including processes and events that, for good or ill, may affect our future survival. That this is indeed a universal property of nature is demonstrated in various ways by the uncertainty principle, quantum indeterminacy, and deterministic chaos in physics, by the Incompleteness Theorems of Kurt Gödel, and by additional indeterminacy results by Alan Turing and many others in the domains of computation and mathematics.</p> <p>Computer models do exist that capture, replicate, and accurately predict the circumstances under which emergent behavior occurs in populations of independent agents, like human societies. Given our discussion of human individuality and agency in week 1, I'd like you to learn a little about so-called agent-based models.</p> <p><b>Watch:</b> Agent-Based Modeling: An Initial Exploration [Complexity Explorer]  <a href="https://youtu.be/Z8Wf1vF_xgQ">https://youtu.be/Z8Wf1vF_xgQ</a></p>



Week	Due Date	Topics, Videos, Readings, Assignments
		<p>The Complexity Explorer channel has a series of connected videos on agent-based modeling, including descriptions of NetLogo, the system that we used in the Geography lab. They also have additional series on NetLogo itself, dynamical systems and chaos, the origins of life, machine learning, etc. The source of this channel, the Santa Fe Institute, has long been at the forefront of complexity research.</p> <p><b>Recommended:</b> Agent-Based Modeling: What is Agent-Based Modeling? [Complexity Explorer]  <a href="https://youtu.be/FVmQbfsOkGc">https://youtu.be/FVmQbfsOkGc</a></p> <p><b>Reference:</b> Creating an Agent-based Model to Examine Spatial Behavior of <i>Eriocheir Sinensis</i>, by Michelle Fong  <a href="https://scholarworks.sjsu.edu/etd_theses/4089/">https://scholarworks.sjsu.edu/etd_theses/4089/</a></p> <p><b>Watch:</b> An agent-based model of <i>Eriocheir Sinensis</i>  <a href="https://youtu.be/Zr7qOvs35H0">https://youtu.be/Zr7qOvs35H0</a></p> <p>Let's take a look at Michelle's Masters' thesis of 2011. The low resolution of the video makes the graphs difficult to read, but you should get the idea. This is the system described in. But the general operation is clear, and the process is not difficult to understand. The video portrays a dynamical agent-based simulation of an invasive crab species in San Francisco Bay. At each time step of the simulation, each simulated crab moves around in search of food or spawning grounds, depending on its age. Adult and juveniles are indicated in the model by black and red dots, respectively. Each simulated crab is born and interacts with its environment, moving in response to a local sense of conditions. If it meets those conditions and survives, it may reproduce, and all eventually die. The age of each natural death and other variables in the system are chosen randomly from normal distributions based on observations of real data. The simulated environment is a space-filling grid of values derived from remotely sensed or directly recorded data regarding water temperature, sediment content, chlorophyll content, etc. These values change throughout the entire bay each month, based on the corresponding month's typical values derived from twelve Landsat TM data scenes spanning a typical year. Each simulation cycles repeatedly through this typical year.</p> <p>Due to an intentionally introduced degree of randomness, each simulation is different. Many simulations can be run in batches and their statistics compiled for so-called Monte Carlo analysis. You can imagine how the data and techniques involved in this sort of model may be applied to a wide variety of settings, using human beings for example as mobile agents</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	08/28/23	<p><b>Homework 1:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Based on the quotations provided above, do you think that Orwell’s essay “What Is Science?’ might still describe our general perception of science and its institutions?</li> <li>2. What is remote sensing? Describe some of its technologies.</li> <li>3. Describe some of the ways our understanding of the Earth and of society is improving through remote sensing (other than to help predict pandemics).</li> <li>4. How might earth observations help predict pandemics?</li> <li>5. What is agent-based modeling? How does it work? Can you think of some examples of how these sorts of models may help us to understand human behavior?</li> </ol>
2		<p><b>Topic: Nonlinearities</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>The significance of nonlinear phenomena (that is to say, most things) cannot be determined by simple additive or multiplicative reasoning. Imagine bumping into a wall at 1 mile per hour. No big deal. Now imagine doing that same bump 10 times in a row. It would be kind of OCD but still, no big deal. Now imagine running straight into the wall just once, at 10 miles per hour. Obviously, a very different result from bumping into it 10 times at 1 mph. Also much greater than what you would get at 1 mph and just multiplying that insignificant effect by 10. At 20 or 30 mph, it could easily result in death. In order to translate velocity into significance, you would need to at least raise it to some power, rather than just multiply it by some value. That is the basis of nonlinearity. The events that often carry the most significance, possibly the only real significance, are often extremely powerful, carrying everything they interact with into qualitatively uncharted terrain. These are the sorts of events that actually change lives, nations, and civilizations.</p> <p><b>Watch:</b> Long Tail Distributions [Systems Innovation]  <a href="https://youtu.be/vIp1kY0H0yw">https://youtu.be/vIp1kY0H0yw</a></p> <p>Agents of change exist at every scale. They can be far smaller or far larger than anything we as human beings can directly perceive. They can occur far more quickly than we could ever have time to respond to, and they can happen far more slowly than we might even notice. The pandemic that we are going through now illustrates this point. Each virus particle is approximately 50–200 nanometers in diameter. Let’s say 100 nanometers, typically. That’s four orders of magnitude smaller than a millimeter, which is the finest mark that you might find on a common ruler. Ten thousand individual virus particles can be lined up between each of those millimeter marks. Roughly a hundred million particles could cover a square millimeter of surface. Now compare that to the surface area of a pair of human lungs, which is the</p>

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		<p>primary target of most variants of this particular virus. The alveolar surface area of a pair of human lungs is enormous, somewhere between 50 and 75 square meters! It is possible for Nature to fit such an enormous surface area into such a compact volume because lungs exemplify a fractal branching pattern, terminating in hundreds of millions of alveoli for gas exchange. If a hundred million virus particles can cover a square millimeter, and there are fifty square meters of surface available, you can imagine the sorts of battles that are being fought within the vast terrain (from the virus's point of view) available within a single human being. Now think about the spread of that virus to billions of people. The potential power of anything cannot be determined merely by its size or by our current awareness of its potentialities. This is one of the things that nonlinearity implies. Next week, we will look at how nonlinearity can lead to 'chaos', which has a very different meaning in science than it does in common usage.</p> <p style="text-align: center;"><b>1.1: Fractals</b></p> <p><b>Watch:</b> Could our universe be fractal? [Chillheimer]  <a href="https://youtu.be/tN_eNQFcv5E">https://youtu.be/tN_eNQFcv5E</a></p> <p>As an example of the sort of complexity that can come out of a relatively simple nonlinear relationship, consider the Mandelbrot Set, which can be generated by using a very simple iterative equation. As you zoom in towards some point along the boundary of converging solutions to that equation on the complex number plane, it reveals itself with infinite complexity, as shown in the video below. Notice that the fractal patterns that come out of this pure mathematics often appear to be more biological and crystalline than utterly abstract. The forms you can see emerging from the background and dissolving into the foreground as we zoom in are emerging from the calculations as they are performed. This concept of 'emergence' seems to be of fundamental significance within both the mathematical and observable world, although it is difficult to formalize in mere words.</p> <p><b>Examine:</b> Sapphires - Mandelbrot Fractal Zoom [Maths Town]  <a href="https://youtu.be/8cgp2WNNKmQ">https://youtu.be/8cgp2WNNKmQ</a></p> <p>Here's a zoom into the tip of the needle along the main axis. Things get interesting quickly, though.</p> <p>The Hardest Trip - Mandelbrot Fractal Zoom [Maths Town]  <a href="https://youtu.be/LhOSM6uCWxk">https://youtu.be/LhOSM6uCWxk</a></p> <p>Fractal mathematics is used to model and visualize many three-dimensional natural and artificial forms. One software package for generating such forms is called 'Mandelbulb'. If you search on that term in YouTube, you'll get results like the following three videos. They demonstrate that it is not particularly difficult to generate biological or geological forms using fractal geometry. While these are imaginary, it is not hard to see such methods being used to accurately represent natural structures.</p> <p><b>Recommended:</b> Emergence [Julius Horshuis]  <a href="https://youtu.be/G8qZvzv5ABg">https://youtu.be/G8qZvzv5ABg</a></p> <p><b>Recommended:</b> Mandelbulb 3D Animation [Russ McClay]  <a href="https://youtu.be/VGpnuTJhv1U">https://youtu.be/VGpnuTJhv1U</a></p>

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		<p><b>Recommended:</b> Virtual nature (fractal world ) [San Base]  <a href="https://youtu.be/79SqIC2bNcM">https://youtu.be/79SqIC2bNcM</a></p> <p style="text-align: center;"><b>1.2: Scale and pattern</b></p> <p><b>Watch:</b> The Science of Patterns [Systems Innovation]  <a href="https://youtu.be/kh6KMW8J3RQ">https://youtu.be/kh6KMW8J3RQ</a></p> <p>Many fractal patterns are ‘self-similar’ at different scales. Patterns might persist or repeat themselves, perhaps in modified form, as you zoom in and out. Natural branching patterns in particular are often like this. The sorts of patters that running water makes in the sand at your feet are very similar to the patterns that they might form at the landscape scale. It has been possible to examine hydrological patterns and design large scale structures in the landscape by using small scale models of water storage and flow. And as we’ll discuss next week, human lungs have a huge internal surface area precisely because of their branching fractal geometry. I’ve often thought about relationships between different scales of space and time. The following paper of mine is not required reading, but you may find it interesting:</p> <p><b>Recommended reading:</b> A Typology of Spatial and Temporal Scale Relations [Gary Pereira]  <a href="https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1538-4632.2002.tb01073.x">https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1538-4632.2002.tb01073.x</a></p> <p>The ability to work with patterns forms the basis of much of AI, neural networks, etc. Here is an example of some work that I was doing with agent-based models and the patterns they form. You can download my paper on this from the following site:</p> <p><b>Recommended reading:</b> Investigating the effects of functional diversity in spatially distributed geographic domains. Proceedings, Geocomputation 2005, Ann Arbor, 2005.  <a href="https://portfolium.com/entry/investigating-the-effects-of-functional-diversity">https://portfolium.com/entry/investigating-the-effects-of-functional-diversity</a></p> <p><b>Recommended:</b> Functional diversity in geospatial domains (1) [Gary Pereira]  <a href="https://youtu.be/rEb9XZyMsBQ">https://youtu.be/rEb9XZyMsBQ</a></p> <p>Scales of nature: lichens and terracettes form spatial patterns over long periods of time, and bird songs form temporal patterns over very short periods of time.</p> <p><b>Recommended:</b> Pattern formation in Nature 2: lichens and terracettes [Gary Pereira]  <a href="https://youtu.be/AZ14PyiqM28">https://youtu.be/AZ14PyiqM28</a></p> <p><b>Recommended:</b> Pattern formation in Nature 3: bird song [Gary Pereira]  <a href="https://youtu.be/UvGue54F4lk">https://youtu.be/UvGue54F4lk</a></p> <p style="text-align: center;"><b>1.3: Emergence</b></p> <p>‘Emergence’ is one of a set of several key ideas that encompass contemporary theories of complexity, as applied to the physical world. Evolutionary theory in biology has discovered many illuminating processes and principles that have proven to be useful in explaining the appearance of new forms and processes at</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	09/04/23	<p>biological, ecological, and social scales. Indeed, the evolutionary history of the universe itself is the central topic of cosmology. The appearance of each of the elements in the periodic table is the result of a kind of cosmic evolution. Most of the elements with which we are familiar first appeared hundreds of millions or even billions of years after the Big Bang, having been generated from fusion processes within earlier generations of stars, or from collisions between neutron stars or even black holes. We are, quite literally, made of stardust.</p> <p><b>Watch:</b> Emergence [Systems Innovation]  <a href="https://youtu.be/OItWZc7hKs">https://youtu.be/OItWZc7hKs</a></p> <p><b>Watch:</b> Synergies [Systems Innovation]  <a href="https://youtu.be/rsn5EQoAhUc">https://youtu.be/rsn5EQoAhUc</a></p> <p><b>Recommended:</b> Tom McLeish - Is Emergence Fundamental? [Closer to Truth]  <a href="https://youtu.be/GXCvQXUhbUk">https://youtu.be/GXCvQXUhbUk</a></p> <p style="text-align: center;"><b>1.5: Antifragility</b></p> <p>Usually the discussion of solution to our collective vulnerability to powerful events strung out along the tails of event distributions (events like pandemics, floods, earthquakes, etc.) revolves around terms like ‘resilience’ and ‘robustness’. However, an argument can be made (through simple observation of nature) that some other principle better characterizes the opposite of fragility: something that people have known about for a long time, but which Nassim Taleb recently termed ‘antifragility’.</p> <p><b>Recommended:</b> <a href="https://en.wikipedia.org/wiki/Antifragile">https://en.wikipedia.org/wiki/Antifragile</a></p> <p><b>Watch:</b> Nassim Nicholas Taleb explains Antifragile [Penguin Books UK]  <a href="https://youtu.be/tZonEaP5ts4">https://youtu.be/tZonEaP5ts4</a></p> <p><b>Homework 2:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. How are patterns defined by the Systems Innovation video? How might patterns be defined in time as well as space? Give me some examples.</li> <li>2. Describe the concepts of emergence and synergies, and try to illustrate them in the context of the natural sciences with a few examples.</li> <li>3. What are some of the characteristics of long-tailed statistical distributions?</li> <li>4. What is antifragility? Try to explain how it can be seen as different from resilience or robustness. Why might you think this concept is important in an era of climate change and pandemics?</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
3		<p>Topic: <b>The Earth-Sun system</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p style="text-align: center;"><b>1.1: Deterministic chaos</b></p> <p>Now for a topic that is actually central to any understanding of Earth systems, indeed of most complex systems. The popular use of the word ‘chaos’ is not what we will be talking about, so for most of you an accurate understanding of this topic may require you to actually try to ignore its popular definition, which is difficult. The science of chaos is actually far more interesting and engaging than our common use of the term would imply.</p> <p><b>Watch:</b> Nonlinear Dynamics &amp; Chaos [Systems Innovation]  <a href="https://youtu.be/qz6gXyfzV9A">https://youtu.be/qz6gXyfzV9A</a></p> <p>Keep in mind that the illustrative portrayal of chaotic systems is by means of the ‘trajectory’ the system follows through time, in terms of any important variables. Time is not represented explicitly, but only through the trace of the trajectory the system follows in terms of the values these variables take at each time step. Three (or more) variables are required, resulting in a 3D trace that can be rotated for different perspectives on the action. While the video above does a good job of explaining the fundamentals, it seems to imply that deterministic chaos occurs primarily in simple systems. It does not discuss actual chaos in nature or in complex systems or networks. All of these are in fact real, common, and of particular importance for this course.</p> <p>For example, consider the Lorenz attractor. This is the shape described by the trajectory of a point in three-dimensional ‘space’ of three variables, as described by a set of simple equations. Notice that through much of the trajectory, the path of the point is fairly predictable. Although the pathways never repeat perfectly, they are aligned like the rings of Saturn. But in certain regions, the paths can diverge wildly from nearly the same coordinate, moving in this example between the two distinct lobes (looking conveniently like the wings of a butterfly: just a coincidence). Check out the other attractors that the author programed with the same sorts of qualities. One thing to keep in mind about deterministic chaos: it is often fairly predictably, and it stays within certain bounds (the attractor), but it is also magnificently unpredictable at other points, and certainly unpredictable over the long term. That is fundamentally why weather prediction is limited.</p> <p><b>Watch:</b> Are there other Chaotic Attractors? [Orfeas Liossatos]  <a href="https://youtu.be/idpOunnpKTo">https://youtu.be/idpOunnpKTo</a></p> <p>We do not study chaos in order only to understand some of the limits of our knowledge and predictive abilities, but also to potentially overcome some of those limits. Thus titles of books in business and lifestyle on the topic of overcoming or controlling chaos. I’ve looked through some of these books, and most seem to be speculative, with little or no basis in the science of chaos. However, there is already scientific and engineering progress in not only understanding chaos, but in controlling it. This progress has huge implications for the climatic and ecological systems we will be studying here.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Watch:</b> How Chaos Control Is Changing The World [Sabine Hossenfelder]  <a href="https://youtu.be/q1-cwamhwag">https://youtu.be/q1-cwamhwag</a></p> <p style="text-align: center;"><b>1.2: The Milankovitch cycles</b></p> <p>This first video below is the best and most complete visual description of the motions of the Sun-Earth system that I've been able to find. It includes visual explanations of the seasons, different ways of measuring the length of a year, and changes in tilt and wobbles with periods of tens or hundreds of thousands of years (the Milankovitch cycles) that largely guide our global climate. I recommend that you watch it repeatedly to get a sense of the complexity of this motion.</p> <p><b>Watch:</b> Earth's motion around the Sun, not as simple as I thought [Aryan Navabi]  <a href="https://youtu.be/82p-DYgGFjI">https://youtu.be/82p-DYgGFjI</a></p> <p>The long-term variations in the Earth-Sun relationship are largely, but not solely, responsible for long-term changes to the Earth's climate. These variations must be understood in order to understand the Earth's climate, but they should not be used to excuse inaction with regard to anthropogenic climate change,</p> <p><b>Watch:</b> What Milankovitch Cycles Will Do To Earth [Astrum]  <a href="https://youtu.be/01aFP88qfQs">https://youtu.be/01aFP88qfQs</a></p> <p>How Ice Ages Happen: The Milankovitch Cycles [It's Just Astronomical!]  <a href="https://youtu.be/iA788usYNWA">https://youtu.be/iA788usYNWA</a></p> <p><b>Watch:</b> The Milankovitch Cycle Timeline: Where are we now?  <a href="https://youtu.be/eB3DJtQZVsw">https://youtu.be/eB3DJtQZVsw</a></p> <p style="text-align: center;"><b>1.3: Energy</b></p> <p>Now that we've covered what I consider to be some of the necessary background, we can begin discussing the traditional topics of a class in physical geography. Energy is the basis for all activity and change, and it is connected intimately to the Earth-Sun dynamics we just covered.</p> <p><b>Watch:</b> A guide to the energy of the Earth  <a href="https://youtu.be/fHztd6k5ZXY">https://youtu.be/fHztd6k5ZXY</a></p> <p><b>Reference:</b> Fundamentals of Physical Geography CHAPTER 6: Energy and Matter  <a href="http://www.physicalgeography.net/">http://www.physicalgeography.net/</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<p><b>09/11/23</b></p>	<p><b>Homework 3:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Can a system that is fully deterministic, also be chaotic? What does deterministic chaos imply about the limits of prediction? Why?</li> <li>2. Discuss how deterministic chaos might be controlled, as described by physicist Sabine Hossenfelder.</li> <li>3. Describe the Milankovitch cycles and their influence on the Earth's climate.</li> </ol> <p><b>(In accessing the textbook, please ignore the ads. Do not download the pdf version suggested by the website or popup. Just access the online version.)</b></p> <p>Access online the text <b>Fundamentals of Physical Geography</b>  CHAPTER 6: Energy and Matter  <a href="http://www.physicalgeography.net/fundamentals/chapter6.html">http://www.physicalgeography.net/fundamentals/chapter6.html</a></p> <p>Each chapter of the online text <b>Fundamentals of Physical Geography</b> includes a Study Guide page. At the bottom of each Study Guide page is a list of Essay Questions. Responses to questions from the book may be partially copied and pasted from the text, but most of the writing should be your own. Take your answers, at least in part, from the section of that chapter that discusses the topic at hand. Do not take them from the summary of the chapter. Use your own words most of the time, and incorporate what you learn from the videos.</p> <p>Chapter 6 Essay Questions 3, 5, 6, 7, 9 , 12:</p> <p>6.3. How do conduction, convection and radiation move energy from one place to another?</p> <p>6.6. Define the Stefan-Boltzmann Law, including each term expressed in the equation. What does it describe?</p> <p>6.7. Define Wien's Law, including each term expressed in the equation. What does it describe?</p> <p>6.12. How does angle of incidence control the intensity of solar radiation received at the Earth's surface?</p>
<p><b>4</b></p>		<p><b>Topic 1: Network science</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>Unless we happen to take a course in graph or network theory as part of a computer science, math, or engineering curriculum, most of us are never expected to learn relatively little of any real significance about networks. Even in technical or theoretical courses, it is difficult to find detailed analyses of how networks exist and operate in the real world, outside the specific domain of analysis. I expect that to</p>



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		<p>change, since we all participate in networks of all kinds: ecological, biological, communicative, financial, trade, energy, etc. If we could understand networks better, we might be better able to guide their development, and reduce their fragility. These are some of the topics we will introduce today, but I encourage you to read further and study on your own.</p> <p>There is a substantive science and mathematics of networks, and many valuable insights have emerged only recently. And as I've indicated, much of it has not made its way into popular understanding. Nevertheless, much of it is not really that hard to understand. Albert-László Barabási happens to be one of the most important figures in network sciences. He discovered and explored so-called scale-free networks, which dominate the natural and human worlds, and which share a characteristic with nearly all of nature, regardless of whether networks are involved. That is, rather than following a bell-shaped distribution of characteristics, populations of things and events in nature and in the human world often follow power law distributions. Earthquakes, for example: many, many small ones, up to only a few very large ones, which obviously have the most significance. Here is a clear introduction to network science by the man himself.</p> <p><b>Watch:</b> The hidden networks of everything   Albert-László Barabási [Big Think]  <a href="https://youtu.be/RfgiHoVCZwU">https://youtu.be/RfgiHoVCZwU</a></p> <p>The Systems Innovation channel provides a nice set of introductory videos on networks. You can check out the channel itself for a great deal more than what's listed here.</p> <p><b>Watch:</b> Network Paradigm [Systems Innovation]  <a href="https://youtu.be/9XEvXNrc-dg">https://youtu.be/9XEvXNrc-dg</a></p> <p><b>Watch:</b> Network Robustness &amp; Resilience [Systems Innovation]  <a href="https://youtu.be/_ztNkmDg0mw">https://youtu.be/_ztNkmDg0mw</a></p> <p><b>Recommended:</b> Network Theory Overview [Systems Innovation]  <a href="https://youtu.be/qFcuovfgPTc">https://youtu.be/qFcuovfgPTc</a></p> <p><b>Recommended:</b> Network Diffusion &amp; Contagion [Systems Innovation]  <a href="https://youtu.be/bTXUJQhEqL0">https://youtu.be/bTXUJQhEqL0</a></p> <p><b>Recommended:</b> How Networks Can Change Everything [Computational Social Science ETH]  <a href="https://youtu.be/PWx91zUnBVU">https://youtu.be/PWx91zUnBVU</a></p> <p><b>Topic 2: Coronal Mass Ejections and technological vulnerabilities</b></p> <p>Barnhardt: <i>Tell me, Hilda, does all this frighten you? Does it make you feel insecure?</i></p> <p>Hilda: <i>Yes sir, it certainly does.</i></p> <p>Barnhardt: <i>That's good, Hilda; I'm glad.</i></p> <p>(from "The Day the Earth Stood Still", 1951)</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	09/18/23	<p>In the 1951 film, an emissary from space pressed his demand for an audience with the world's political leaders by temporarily disabling everything that requires electricity, including military defense. A similar thing could happen quite naturally, and few people seem to be aware of it. Some things about a severe Coronal Mass Ejection (CME) would be different, and probably much worse than the fictional film. Some of its effects might pass with the event itself, but a great deal of permanent damage would be inevitable, requiring time-consuming repair. I wonder, would even our governing bodies, which seem increasingly to live on the Internet, survive disconnection for very long? Bear in mind, an event of this kind could very well be global in its effects. Can you imagine what a severe disruption of communications would do to international relations and trade?</p> <p><b>Reference:</b> <a href="https://en.wikipedia.org/wiki/Coronal_mass_ejection">https://en.wikipedia.org/wiki/Coronal_mass_ejection</a></p> <p><b>Watch:</b> The Carrington Event - A Short Documentary [Fascinating Horror] <a href="https://youtu.be/C9tfx6rfAIo">https://youtu.be/C9tfx6rfAIo</a></p> <p><b>Watch</b> at least one of the following three videos:</p> <p>How Solar Storms Could Knock Out Our Power Grid [NOVA PBS Official] <a href="https://youtu.be/7nkC8SXzHIs">https://youtu.be/7nkC8SXzHIs</a></p> <p>The Grid vs. The Next Big Solar Storm [Real Engineering] <a href="https://youtu.be/LLO9WxVO9s8">https://youtu.be/LLO9WxVO9s8</a></p> <p>What If a Massive Solar Storm Hit the Earth? [What If] <a href="https://youtu.be/q2kDvrs2VEs">https://youtu.be/q2kDvrs2VEs</a></p> <p><b>Watch:</b> How Long Would Society Last During a Total Grid Collapse? [Practical Engineering] <a href="https://youtu.be/OpC4fH3mEk">https://youtu.be/OpC4fH3mEk</a></p> <p><b>Homework 4:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Systems Innovation videos claim that economic globalization could only have reached the scale it has once certain thresholds in technology, innovation, and cooperation were crossed. What do you think may have been some of the historical developments that got us over these thresholds? I expect you to include the Internet as one of them, for sure, but you'll need to think back much further.</li> <li>2. Is it possible for the global economy to shift from one dominated by agriculture and industry, to one based on services and information (3:15 in the Global Cities: Globalization video)? Don't people still have the same material needs? You may explore reasons both for and against this idea.</li> <li>3. If we sustained a direct hit from a powerful Coronal Mass Ejection, what do you think might happen immediately? What might happen over time? What do you think could be done, given the technologically networked nature of the world we live in, to reduce and overcome the impact of such an event?</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
5		<p>Topic: <b>Hydrology and water resources</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>Fresh water availability is certainly at the top of any realistic list of social concerns for a great many people on this planet. Water is central to both agriculture and industry, and we cannot survive for long without it. Since it is often possible for people to withhold water from one another, water availability can and has become a source of violent conflict throughout history.</p> <p><b>Watch:</b> The Water Cycle [National Science Foundation]  <a href="https://youtu.be/al-do-HGuIk">https://youtu.be/al-do-HGuIk</a></p> <p><b>Watch:</b> Is the world’s fresh water supply running out? [PBS NewsHour]  <a href="https://youtu.be/iVcTQdOJMMw">https://youtu.be/iVcTQdOJMMw</a></p> <p><b>Recommended:</b> Inside Story - What can be done to stop global water scarcity? [Al Jazeera English]  <a href="https://youtu.be/JIIBBWSQMds">https://youtu.be/JIIBBWSQMds</a></p> <p><b>Watch:</b> For 15 Years, GRACE Tracked Freshwater Movements Around the World [NASA Goddard]  <a href="https://youtu.be/MaxBOvQ2a_o">https://youtu.be/MaxBOvQ2a_o</a></p> <p><b>Watch:</b> Water Resource Management [ThinkTVPBS]  <a href="https://youtu.be/odngssDFMrU">https://youtu.be/odngssDFMrU</a></p> <p>I worked for a couple of years at National Operational Hydrologic Remote Sensing Center (NOHRSC) (<a href="https://www.nohrsc.noaa.gov">https://www.nohrsc.noaa.gov</a>) which is NOAA’s “source for snow information” and other hydrological data products and models. Every winter day, several satellite datasets are downloaded to this facility and analyzed, and by evening a variety of maps and graphs are generated and uploaded onto the Internet for use by regional hydrological agencies, businesses, and others to inform their own work and decisions. One important variable that has to be mapped and used to forecast springtime flooding is called Snow Water Equivalent (SWE), which gauges the volume of liquid water that would result from melting a given area of snow cover. This can be checked manually on the ground at various points using automated ‘snow pillows’ and other devices, but it can also be checked from above. NOAA pilots run low altitude flight-lines over snow with instruments that estimate SWE by measuring the degree to which the natural radioactivity of the ground beneath is dampened, or attenuated by the snow. These NOAA Corps pilots travel all over the world gathering data and assisting researchers; one of the pilots in our office had overwintered at the South Pole.</p> <p><b>Recommended:</b> NOAA Commissioned Officer Corps  <a href="https://www.oma.noaa.gov/noaa-corps">https://www.oma.noaa.gov/noaa-corps</a></p> <p>Let’s take a brief look at our local water. The reservoir closest to us, from which some of our water might be drawn, is the Calaveras Reservoir. Unfortunately, the reservoir and the land around it are closed to recreation. Here’s a drive-by I shot.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Watch:</b> Calaveras Reservoir [Gary Pereira]  <a href="https://youtu.be/EqehbxjfUk">https://youtu.be/ EqehbxjfUk</a></p> <p><b>Reference:</b> Bay Area: Do You Know Where Your Water Comes From?  <a href="https://www.kqed.org/news/11886536/bay-area-do-you-know-where-your-water-comes-from-2">https://www.kqed.org/news/11886536/bay-area-do-you-know-where-your-water-comes-from-2</a></p> <p><b>Topic 2: Urban rivers and streams</b></p> <p>We can certainly look more closely at the connections between fresh water availability, population, climate, and urban life. California for example will soon face the challenge of diminishing (and eventually nonexistent) snowpack in the Sierras. Snow is a wonderful storage mechanism, since it can recharge aquifers and improve soil moisture as it slowly melts. Without it, most of our winter precipitation would be lost to the ocean.</p> <p>Open water (as well as trees) within a city can make it significantly cooler in the summer, reducing or eliminating the Urban Heat Island effect. Evaporation and transpiration are our friends. I studied the situation rather closely for Beijing and Shanghai, and although I haven't published the results, I think it is clear that these and other cities in China and elsewhere would have been significantly hotter without the re-establishment of healthy, flowing bodies of open water.</p> <p>When I was a graduate student at the University of Minnesota, in Minneapolis, several of my classmates had come from Korea just to study in the Geography graduate program. They were all interested in designing cities with nature in mind. One resulting dissertation for example concerned the creation of greenbelts around and within Korean cities. I'm sure that the subsequent appearance of parks and greenbelts around Seoul and other cities in Korea was at least partly due to their personal efforts.</p> <p><b>Watch:</b> How a City Demolished a Freeway to Restore an Ancient River System [Leaf of life Films]  <a href="https://youtu.be/-I5qMDCcvTI">https://youtu.be/-I5qMDCcvTI</a></p> <p><b>Examine:</b> Two or more of the following four videos:</p> <p>Cheonggyecheon and surrounding scenery at sunset [Bau Walk]  <a href="https://youtu.be/YNEymTSjpYA">https://youtu.be/YNEymTSjpYA</a></p> <p>Cheonggyecheon in the Evening (Sep.2021) [4K Korea]  <a href="https://youtu.be/LqEnkG5LY9k">https://youtu.be/LqEnkG5LY9k</a></p> <p>Beautiful night scenery of Cheonggyecheon in springtime [4K SEOUL]  <a href="https://youtu.be/zdVqvTNfZH4">https://youtu.be/zdVqvTNfZH4</a></p> <p>Night view of Cheonggyecheon Stream [4K SEOUL]  <a href="https://youtu.be/J1yN-i6ruAw">https://youtu.be/J1yN-i6ruAw</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<p><b>09/25/23</b></p>	<p><b>Homework 5:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Is the world's fresh water supply running out? Try to be geographically specific.</li> <li>2. What is an aquifer? What is the current state of aquifers around the world?</li> <li>3. Where does our local water come from?</li> <li>4. What are your impressions of the Japanese, Korean, and Chinese stream videos? Do they look like neighborhoods where you might be comfortable living? Discuss the benefits of the Cheonggyecheon River restoration. How do these scenes compare with urban streams with which you may be familiar, or perhaps may have ignored until now?</li> </ol> <p><b>(In accessing the textbook, please ignore the ads. Do not download the pdf version suggested by the website or popup. Just access the online version.)</b></p> <p>Access the text <b>Fundamentals of Physical Geography</b>  CHAPTER 8: Introduction to the Hydrosphere  <a href="http://www.physicalgeography.net/fundamentals/chapter8.html">http://www.physicalgeography.net/fundamentals/chapter8.html</a></p> <p>Essay Questions Chapter 8: 1, 3, 4, 7, 10</p> <ol style="list-style-type: none"> <li>8.1. What is streamflow? How can it be expressed in a mathematical model? Describe the effect of an intense 1 hour storm on streamflow over 24 hours using a hydrograph.</li> <li>8.3. Discuss the movement of water into soils. How and why does infiltration vary with time?</li> <li>8.4. Why does runoff occur?</li> <li>8.7. Describe the mathematical equation used to model stream discharge.</li> <li>8.10. What is potential evapotranspiration and how does it differ from actual evapotranspiration? What factors control the rate at which water leaves the Earth's surface by way of evaporation and transpiration?</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
6		<p><b>Topic 1: Agriculture and food security</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>It is important to underscore the ecological basis of all of human life. Although the ecological sciences are relatively new, much of it was understood, in some form, since ancient times. It was only by drawing from and working coherently with existing ecosystems that human beings managed to survive at all. The complexities and nonlinearities of the natural world must be known and understood, when your task is to find or produce food.</p> <p>Currently, we have two general trends at play. We have planners and their agendas. They see themselves as having an important mission: to keep the Earth’s population fed. This has thus far required, and may continue to require, according to this view, large amounts of artificially produced fertilizer, large scale production, and global shipping of grains and other foods. Soil health is generally expected to continue to decline, and crops may continue to be genetically modified in order to tolerate pesticides. Robotics and electricity are expected to further reduce the need for human labor. Vertical farms, hydroponics, and other technical means of producing food near urban centers may be used to generate local easily perishable produce. The following video describes some of the innovations that may be required in order to double production in the near future, according to this vision.</p> <p><b>Watch:</b> The Future of Farming [The Daily Conversation]  <a href="https://youtu.be/Qmla9NLFBvU">https://youtu.be/Qmla9NLFBvU</a></p> <p>Just a few seconds into the video, the narrator describes the changes described as allowing most of us to “do other things with our lives”. The assumption among planners seems to be that most of the Earth’s population will no longer be interested in being directly involved in producing its own food. Nearly all of us, presumably, have better things to do. This is tied to the generally favorable attitude shown regarding the migration worldwide of people from dispersed rural communities to dense urban centers.</p> <p>On the other hand, we have a significant and growing trend among some agriculturalists to produce food locally whenever possible, with maximum nutritional value, and as naturally, cleanly, and ethically. Soil health and carbon content are maintained and improved over time. Ecological principles are used to control pests and maximize yield, and chemical pesticides and other toxins are avoided entirely.</p> <p>When these two worldviews collide, we can expect to see political and economic disruption. A recent example of this occurred in Sri Lanka, whose former government had made some radical decisions.</p> <p><b>Watch:</b> Why Sri Lanka is Collapsing: the Coming Global Food Crisis [PolyMatter]  <a href="https://youtu.be/W5zxYDHwf-Y">https://youtu.be/W5zxYDHwf-Y</a></p> <p><b>Watch:</b> Sri Lanka economy: Fertilizer ban contributes to food crisis [Al Jazeera English]  <a href="https://youtu.be/-qsEvaZYGeo">https://youtu.be/-qsEvaZYGeo</a></p> <p><b>Watch:</b> Sri Lanka's economic crisis leaves tea farmers struggling [BBC News]  <a href="https://youtu.be/dse7Xwlqt64">https://youtu.be/dse7Xwlqt64</a></p>

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		<p><b>Recommended:</b> Why Sri Lanka Is Approaching Its ‘Worst Man-Made Disaster’ In History [Roar LK]  <a href="https://youtu.be/XBXQtGwZGxw">https://youtu.be/XBXQtGwZGxw</a></p> <p><b>Recommended:</b> How did Sri Lanka's organic dream turn into chaos? [SBS Dateline]  <a href="https://youtu.be/YWw5wIAf27g">https://youtu.be/YWw5wIAf27g</a></p> <p>The OECD video below briefly describes a rather optimistic globalist vision of the future. The second video, from the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), provides a more sanguine and far more detailed analysis of the path ahead.</p> <p><b>Watch:</b> The Future of Agriculture [OECD Trade and Agriculture]  <a href="https://youtu.be/uAM4Si_WhDk">https://youtu.be/uAM4Si_WhDk</a></p> <p><b>Watch:</b> How to feed the world in 2050: actions in a changing climate [CGIAR]  <a href="https://youtu.be/gjtII5B1zXI">https://youtu.be/gjtII5B1zXI</a></p> <p>From the heading of the following document: We, 50 organizations focused on food sovereignty and justice worldwide, want you to know there is no shortage of practical solutions and innovations by African farmers and organizations. We invite you to step back and learn from those on the ground.</p> <p><b>Read:</b> An Open Letter to Bill Gates on Food, Farming, and Africa [commondreams.org]  <a href="https://www.commondreams.org/views/2022/11/10/open-letter-bill-gates-food-farming-and-africa">https://www.commondreams.org/views/2022/11/10/open-letter-bill-gates-food-farming-and-africa</a></p> <p style="text-align: center;"><b>1.1: Rural wellsprings</b></p> <p>The following video is about a farming program here in the US run by the highly respected author and farmer, Wendell Berry. You might think of this as a distinctly American approach to a more distributed, truly diverse revolution in agriculture. In fact, the true cultural roots of agriculture are beginning to be appreciated throughout the world. The assumption among nearly all planners that people would rather occupy their time doing anything other than producing food is one of the factors driving the relentless growth of cities. But what if the planners have got it wrong?</p> <p>Even a gardener, over a period of years, develops a sense of coexistence with natural ecological phenomena that have existed long before us. A gardener might get a sense of how the soil itself changes , becoming rich with its own organisms and retaining moisture and nutrients over time. Over the years, a gardener might find a greater diversity of beneficial organisms, fewer troublesome ones, and synergies begin to develop between them. The garden might become less difficult to tend as it naturally becomes more attractive. The same thing can happen with larger scale agriculture, if the right people are involved.</p> <p><b>Watch:</b> Wendell Berry Farming Program [Religion and Ethics NewsWeekly]  <a href="https://youtu.be/vGG5BED6dZI">https://youtu.be/vGG5BED6dZI</a></p> <p><b>Watch at least two of the following:</b></p> <p>Ashland's Story   Wendell Berry Farming Program [Sterling College]  <a href="https://youtu.be/wS9HrvII0Gk">https://youtu.be/wS9HrvII0Gk</a></p>

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		<p>Lizzie's Story   Wendell Berry Farming Program [Sterling College]  <a href="https://youtu.be/iIoKiv-zQB8">https://youtu.be/iIoKiv-zQB8</a></p> <p>Emily's Story   Wendell Berry Farming Program [Sterling College]  <a href="https://youtu.be/c50alkjVSdo">https://youtu.be/c50alkjVSdo</a></p> <p>Gabriel's Story   Wendell Berry Farming Program [Sterling College]  <a href="https://youtu.be/pJEVG6EN1Ww">https://youtu.be/pJEVG6EN1Ww</a></p> <p style="text-align: center;"><b>1.2: Agricultural work in northeast China, 1968 - 1972</b></p> <p>Now I want to take you to the other side of the world, fifty years ago, and an entirely different approach to agricultural education. I recently documented the reunion of junior high school classmates who had been sent off as a group to be agricultural workers and to learn from the peasants as part of the Chinese Cultural Revolution. The intention was that these younger students learn directly from the farmers, while helping with labor. The part of the reunion portrayed in the film occurred at the spot in China's Northeast where they had been sent beginning in 1968. The archival film below shows a similar group of students from Changchun who left at about the same time as our group, from the same station. This video also shows groups of others who continued to live in the city but who took day trips to nearby farms to help with the planting and harvesting.</p> <p><b>Watch:</b> 1960s China, Students Leave City to Help on Commune Farms [thekinolibrary]  <a href="https://youtu.be/t4Dpo__a-Bg">https://youtu.be/t4Dpo__a-Bg</a></p> <p>The discussion below accompanies my video:</p> <p><b>Watch:</b> Down to the Countryside: a fifty year reunion [Gary Pereira]  <a href="https://youtu.be/d1nywzYowiI">https://youtu.be/d1nywzYowiI</a></p> <p>Once the train deposited our group in the rural agricultural town of Dehui in 1968, they were conveyed to their designated village by horse-drawn wagons. After the students arrived at their destination, members of the village gave them temporary quarters and helped them build a home. The countryside around Dehui, in northeast China (midway between Changchun and Harbin) is largely agricultural. Winters are brutal, and temperatures routinely stay below 10<sup>0</sup> F for long periods of time. It's kind of like northern Minnesota. As you can see from the video, homes in the region follow the same general plan. The front door is generally in the center at the front, and once inside you can go straight through to the kitchen, or you can go off to either side, which for our students was where the men's and women's sleeping quarters were located. The kitchen is often in the middle of the house because it is the source of heat. Exhaust from the oven and stove is channeled through sealed stone beneath the bed platforms, or 'kangs', before being vented outside. This is a safe and efficient system, since the exhaust is vented completely after giving up most of its heat to the brick and masonry kang, which slowly release it over the course of the night. The region around Dehui is not excessively hot in the summer, due to its latitude and the presence of vegetation and water. Passive solar building techniques help to keep the inside air temperate and clean.</p> <p>The floor plans of the homes in the village haven't changed much since 1968, but some of the building</p>



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		<p>materials have changed. In 1968, only dried mud bricks were available for building homes. Baked bricks were a luxury. Since mud bricks tend to crumble and break at the edges, they often had to be lined with wood to keep the edges intact. These days, permanent fire-hardened bricks and masonry are used. Roofs in 1968 were made of thatch. This worked well in insulating homes from both heat and cold, but it had to be replaced quite often. Thatch is no longer used for roofing homes, although it is stored and used for other purposes. There was limited access to electricity in 1968, but now everyone is on the electrical grid, and cellular internet access is available. The outhouses remain outdoors.</p> <p>During the Cultural Revolution, the number of years each person was required to stay in the countryside depended on that person's class and family background. Very little other than food was available locally. The members of our group were friends from school, and Dehui was a long difficult day's journey from their homes in Changchun. Individuals would make the journey periodically and return with supplies and treats not available locally. Young people were sent into the countryside in order to have them participate in agriculture and other labor-intensive activities, and to learn from this experience. Since very little agricultural machinery existed in China at the time, a great deal of human labor was required. The main source of energy, transportation, and non-human labor at the time in the region around Dehui was horses. Horses pulled wagons, and horses pulled plows. Crops were picked by hand, without gloves. The main crops were corn and soybeans. Some of the corn would be consumed locally, but the soybeans were sent off to the cities. Soybeans are particularly difficult to pick by hand, since they grow low to the ground and the leaves are abrasive. Nearly all of the corn plant was utilized, including the stalks and husks. The students often ate sorghum, or 'kaoliang'. As you can see from the video, sorghum is a very tough grain; it can also be difficult to digest. It is no longer being grown deliberately in the region, but it continues to grow wild by the side of the road. So does hemp, which was once grown locally for fiber.</p> <p>In 1968, each household produced its own vegetables, meat (generally poultry) and chicken and duck eggs. Many still do. Our host was one of the villagers who had originally helped the students get settled and accustomed to farm life. He still lives in the same house with his family. They call him 'second brother'; he is the gentleman wearing the white shirt in the video. As you can see from his home garden, he has a green thumb (with lots of beneficial ladybugs in his garden and no visible chemicals). He appears to be in excellent health, and is well into his 70s.</p> <p>Wintertime meant different kinds of work for the students 50 years ago. Since the watery bogs and depressions were frozen and could therefore be worked under the right conditions in the winter, the students hauled out organic material that would be worked into the fields later in the spring, when the ground was fully thawed. Snow in that region accumulates all winter, but the roads were never plowed by machine 50 years ago; they had to be cleared by hand. Fuel had to be gathered and dried to supplement their allotment of coal. There was always something that needed to be done throughout the year. Currently, many of those activities no longer occur, or they are done with machinery.</p> <p>In 1968, home and personal goods were hard to come by, and there were no stores nearby. You would have to walk or hitch a wagon ride from a friendly villager to a government depot some distance away for basic necessities. Even today, these households remain relatively isolated from the nearest stores, but as you can see from the video, merchants now travel up and down the road peddling various things.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	10/02/23	<p><b>Homework 6:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Describe the agricultural and economic crisis in Sri Lanka.</li> <li>2. Do you think it may be necessary to continue to intensify agriculture artificially by chemical and industrial means in order to continue to feed the world? Why/why not?</li> <li>3. Would a move toward more organically grown food and sustainable agricultural practices necessarily involve shortages, higher prices, or an expansion of farmland? Why/why not?</li> <li>4. Describe the Wendell Berry Farming Program and the experiences of its students.</li> <li>5. After reading the text and watching the videos on agricultural work during the Cultural Revolution, do you think that a similar program asking young people to work outdoors (with monetary compensation, insurance, and health care provided) could succeed in the US? What if a large scale tree planting program were initiated, for example, in locations likely to be successful long term? Would that be the kind of experience young people (and their parents) might appreciate or learn from?</li> </ol>
7		<p><b>Topic 1: The global climate system</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>It has been said that climate is long-term weather, but that's not strictly true. The climate system directly involves far more than just the atmosphere. The oceans, the cryosphere, and the continents all have a huge influence on the world's climate. Climate can be measured and defined over a wide variety of scales. The microclimate of a forest, a farm, a city, or of a park within a city is real and measurable, and it can be influenced both by any number of factors, many of which we have some control over.</p> <p>The paleoclimate record, found in Antarctic ice as well as many other sources, makes it clear that the Earth's climate has experienced many wide and often rather sudden shifts, as its oceans, ice, land, and biogeochemistry have responded in complex ways to subtle shifts in the Earth-Sun system due to the Milankovitch cycles. But during our most recent climatic period, the Holocene, the world's climate has been remarkably stable. Coincidentally, human civilization blossomed. We should try to keep in mind that nearly everything we have accomplished as a species has occurred under an unusual stable climate regime. Even without our influence, the Holocene will come to an end. Under unintended human influence we cannot be sure of what lies ahead, although rather abrupt changes are inevitable. The Earth's climate system is permeated with deterministic chaos (discussed earlier), and long term prediction may be fundamentally impossible. Nevertheless, we should keep in mind that biological organisms, ecosystems, and humankind in particular have shown a remarkable ability to adapt to radical environmental change, a characteristic attributable in part at least to the antifragility we looked at earlier. Humankind has the additional proven ability to shape and control aspects of the physical environment to an extraordinary degree. Despite the challenges, as understanding increases, we may find that the Earth's climate is</p>

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		<p>controllable, to some degree, in possibly subtle ways that we still haven't discovered.</p> <p><b>Watch:</b> What is a Climate Model?  <a href="https://youtu.be/bkcrH9tYv8g">https://youtu.be/bkcrH9tYv8g</a></p> <p><b>Watch:</b> An Atmospheric River from an Earth System Model [NASA Scientific Visualization Studio]  <a href="https://youtu.be/w3rtYM0HtIM">https://youtu.be/w3rtYM0HtIM</a></p> <p>As an example of how neglected connections in the climate/biosphere network may be some of the keys to successfully addressing climate change, I'd like you to learn something new about whales:</p> <p><b>Watch:</b> How Whales Change Climate [Sustainable Human]  <a href="https://youtu.be/M18HxXve3CM">https://youtu.be/M18HxXve3CM</a></p> <p>The focus has been on emissions through combustion, but more deep rooted processes have huge influences that are often ignored: for example, land use itself.</p> <p><b>Watch:</b> Climate Change : How Land Use is accelerating the crisis [Just Have a Think]  <a href="https://youtu.be/Scm46Ctn0Ig">https://youtu.be/Scm46Ctn0Ig</a></p> <p>Regardless of the relative validity of the various assessments and projections of the state of the global climate system, the importance of global, regional, and local climates and their associated systems to human well-being should be self-evident. The associations of climate with the rise and the fall of past civilizations are undeniable. There is abundant historical evidence, from all parts of the inhabited world, of people having had to struggle with changing climates. No divorce from nature is ever possible. We can probably expect this relationship to continue and to grow more difficult in the near future. Let's consider the idea that the climate is approaching a global tipping point that may challenge or even extinguish civilization. This is a popular claim, and it should be taken seriously. For more than ten years, I've been assigning readings and lectures from researchers themselves regarding tipping points in the Earth's climate, ecosystems, and biogeochemistry. For this course, I've pared it down to one lecture. Please watch it carefully. Regardless of how much you already know or manage to understand, I'm sure that you will learn something important. Hopefully, you can help others to deepen and broaden their understanding as well.</p> <p><b>Watch:</b> Early Warning of Climate Tipping Points [Understanding Climate Change]  <a href="https://youtu.be/5yTJzQzdYI">https://youtu.be/5yTJzQzdYI</a></p> <p>Here's a pdf of the slides from the lecture.  <a href="https://sustainabledevelopment.un.org/content/documents/3487lenton.pdf">https://sustainabledevelopment.un.org/content/documents/3487lenton.pdf</a></p> <p>Here is the latest news from one of the most troubling potential sources of sudden sea level change. You will find that ice shelf dynamics are, like many things, complex and difficult to assess, but that the trend may be one of accelerating sea levels in the near future. Think about this if you are even in the market for a house near an ocean or bay.</p> <p><b>Watch:</b> Antarctica latest research: Doomsday Glacier ice shelf gone in 5 years [Just Have a Think]  <a href="https://youtu.be/49NPdyUEos8">https://youtu.be/49NPdyUEos8</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>Tipping points exist at all scales, even in everyday life. But it can be difficult to extrapolate the idea to much longer time scales. Sea level rise is one of those topics. People will generally assume that a slow rise in sea level might be something relatively easy to adapt to, since it is likely to occur relatively slowly. But specific readjustments can in fact be quite rapid, due to tipping points in glacial dynamics. And even if the average change is slow, the effects can be quite sudden, as when they are triggered by a storm. New York City and adjacent coastal regions discovered this with Superstorm Sandy. Many such events, while not directly attributed to some global change, exemplify the sort of ‘flickering’ that may occur as a tipping point is being approached.</p> <p><b>Topic 2: Shifting climatic indicators in America’s heartland</b></p> <p>While some other regions of the world are likely to be at greater risk of disruption, I believe it would be helpful for us to briefly consider one of the changes taking place within America’s heartland.</p> <p><b>Reference:</b> The Future of Supercells in the United States, Bulletin of the American Meteorological Society, volume 104, issue 1. Online Publication: 04 Jan 2023  <a href="https://journals.ametsoc.org/view/journals/bams/104/1/BAMS-D-22-0027.1.xml">https://journals.ametsoc.org/view/journals/bams/104/1/BAMS-D-22-0027.1.xml</a></p> <p>This recent publication analyzes changes in tornado activity and violent storms in the United States:</p> <p>“A supercell is a distinct type of intense, long-lived thunderstorm that is defined by its quasi-steady, rotating updraft. Supercells are responsible for most damaging hail and deadly tornadoes, causing billions of dollars in losses and hundreds of casualties annually.”</p> <p>“Results reveal that supercells will be more frequent and intense in future climates, with robust spatiotemporal shifts in their populations. Supercells are projected to become more numerous in regions of the eastern United States, while decreasing in frequency in portions of the Great Plains. Supercell risk is expected to escalate outside of the traditional severe storm season, with supercells and their perils likely to increase in late winter and early spring months under both emissions scenarios. Conversely, the latter part of the severe storm season may be curtailed, with supercells expected to decrease midsummer through early fall. These results suggest the potential for more significant tornadoes, hail, and extreme rainfall that, when combined with an increasingly vulnerable society, may produce disastrous consequences.”</p> <p>Although people in what has been known as ‘tornado alley’ are generally prepared and educated regarding tornados and availability of underground shelters, people further east are not.</p> <p><b>Examine:</b> at least two of the following six drone videos showing the aftermath of recent tornados:</p> <p>Whiteland, Indiana [ABC7 Chicago]  <a href="https://youtu.be/BVTzCVCq9FU">https://youtu.be/BVTzCVCq9FU</a></p> <p>Little Rock, Arkansas [THV11]  <a href="https://youtu.be/bazeywcX4U0">https://youtu.be/bazeywcX4U0</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<b>10/09/23</b>	<p>Wynne, Arkansas [StormChasingVideo]  <a href="https://youtu.be/BOFOXp_r7GQ">https://youtu.be/BOFOXp_r7GQ</a></p> <p>Wren, Mississippi [StormChasingVideo]  <a href="https://youtu.be/LGnLc3AKN9g">https://youtu.be/LGnLc3AKN9g</a></p> <p>McNairy County, Tennessee [Live Storms Media]  <a href="https://youtu.be/F45NYmQWPI4">https://youtu.be/F45NYmQWPI4</a></p> <p>Sullivan, Indiana [Live Storms Media]  <a href="https://youtu.be/JSGMXh3GhJc">https://youtu.be/JSGMXh3GhJc</a></p> <p><b>Homework 7:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. How do climate models work?</li> <li>2. How are atmospheric rivers formed?</li> <li>3. How do whales affect the global climate?</li> <li>4. Explain the importance of nonlinearities, thresholds, tipping points, and surprises in the relationship of humanity with the Earth’s natural systems. What are some of the challenges we face in trying to avoid unpleasant surprises? Include in your discussion anything else you have found to be interesting or surprising about Dr. Lenton’s lecture.</li> <li>5. What can we surmise from observations of Antarctic ice shelves?</li> <li>6. A shifting pattern of tornados and other issues now plague the heartland of the United States. It would be disingenuous of us to ignore these facts, as we examine the rest of the world. To what extent do you think we as a nation are self-aware of our environmental vulnerabilities? What in a practical (rather than wishful or political) sense needs to be done?</li> </ol>
<b>8</b>		<p>Topic: <b>Addressing climate change</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>Proposals and activities that are intended to address climate change can be said to fall into two general categories. There are proposals and activities that are intended to <b>mitigate</b> global warming through the direct reduction of greenhouse gas emissions at their sources, or possible later reabsorption of these gases from the atmosphere into some kind of long term storage. There are also a great many proposals and activities intended to enable human and ecological <b>adaptation</b> to climate change, whatever that might imply, from local to global scales. Clearly, a great deal of normal human planning in the future will</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>necessarily fall into what we now think of as the latter category.</p> <p>I think that most of us would agree that rational, self-consistent but open-minded, adaptive, long-term thinking would probably help to create a future in which human beings and as many other species as possible continue to live on through the centuries in healthy ways. We hope that this can be achieved without the sorts of regional catastrophic histories that have occurred so often in the past, magnified to the immediate, global scales of modern life. But despite our hopes, catastrophism grabs attention. It grabs minds, so it's inherently political. We are entertained by it. Whenever it comes up, it takes over the stage, and people who proclaim it are considered sages and prophets by many. It's as if we are collectively preparing ourselves for, or distracting ourselves from, something big. Catastrophism makes us fearful. It turns people against one another.</p> <p>Last week, we saw how changes in complex systems like the climate can be difficult to understand and predict. Tipping points can be sudden, but warning signs might exist, and careful attention is required if we are to detect them. Back in week 5, we talked about the insufficient attention paid to observation and modeling, focusing on remote sensing. Hopefully, you can see now why I think this is important. Proclamations from educators, journalists, and politicians always seem to ignore this issue of scientific and technological competence, focusing instead on personalities, slogans, and political power.</p> <p>I'd like you to just consider the possibility that the wisdom and human energy required to overcome our difficulties need not come from any centralized leadership. If it comes at all, it is more likely to come from the distributed intelligence that exists within all of us, regardless of our status. How many times have you or someone you know expressed concern about something, but were ignored because of your low status? And even if it turned out that you were right, you continued to be ignored. How much better might things work if our ideas were actually considered on their merits, rather than on the status of the people who expresses them?</p> <p>There is so much wasted human intelligence and creativity out there. Being human is not easy, even under the best of circumstances. We are not all inclined to live our lives politically. As much of the world is finally rising above extreme poverty, the desire to live meaningful lives is stronger than ever. If people are allowed to become aware of one another's ideas and activities, local success can be duplicated and failures avoided under similar circumstances around the world. Successful solutions evolve over time. But mass coercion by any elite, even in pursuit of a greater good, only wastes the creativity that naturally exists in all human societies.</p> <p><b>Watch:</b> The Way We Talk About Climate Change Isn't Helpful   Chris Jordan [Sustainable Human]  <a href="https://youtu.be/4CaCsZKECB8">https://youtu.be/4CaCsZKECB8</a></p> <p>Energy sciences and technologies are yielding results that may change things dramatically if they pan out. I would like you to be aware of a YouTube channel called 'Just Have a Think', one of the few places to find discussion of new technologies and techniques that may turn out to be very helpful in addressing climate change. Always educational, and particularly helpful to people at the beginning of their careers. Also a potential source of future investment.</p> <p><b>Watch:</b> How to capture 2 billion tons of CO2 AND fix our oceans [Just Have a Think]  <a href="https://youtu.be/zr6CYS9ie5E">https://youtu.be/zr6CYS9ie5E</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Topic 2: Regional vulnerabilities and climate-related migration</b></p> <p>When large numbers of people migrate from one region or nation into another, serious incompatibilities between the respective cultures can often create tensions, suspicions, tribalism, and violence that threaten the integrity and sometimes the very existence of the host nation. This has happened throughout history, and it is taking place in parts of Europe right now. This particular legacy of colonialism, which happens to be inflicted largely upon the former colonizers, is seldom mentioned. Often, just mentioning problems associated with uncontrolled immigration gets people in trouble. We even seem to be expected, as good-hearted people, to reject the very idea of nationhood, at least with regard to our own nations. Wouldn't it be nice if there were no borders? Wouldn't it be nice, while we're at it, if human beings were some other species, from which all the bad stuff has been removed? Since no one seems to have found a better way of organizing a diverse array of often incompatible societies nonviolently upon the surface of the Earth, pretending to be 'post-national' in my opinion is just like pretending to be 'post-human'. Unless you are absolutely sure that a time-tested safety net exists out there, you and a whole lot of people would be jumping off a rocky cliff into an unknown, terrifying, dark, and possibly bottomless, chaotic void.</p> <p>Large numbers of people are now or may soon be at risk of losing their homes, communities, livelihoods, or even their very lives, at the hands of forces that are well beyond their control. Everything from armed conflict, civil collapse, criminality, and deliberate genocide, to floods, drought, crop failure and disease can drive massive numbers of people to flee their homes, often in desperation. Too often, there is no return from places of temporary refuge. Many populations have continued to live in refugee camps for generations. Add to this the flow of people who leave their homes in order to escape localized or regional economic difficulties, and rely instead on the good graces of people residing in what at the time happens to be more prosperous. This is doubtless an old story, but with the populations in existence today, it is accelerating, I am unaware of a general solution to the problems of mass migration. Social and environmental problems associated with migration itself are real, and unless we address them, they will only get worse. Although I think we should be careful about how much we attribute to climate change, most of the discussion has taken place in this context.</p> <p><b>Watch:</b> at least three of the following five videos.</p> <p>Climate Refugees: Nations under threat [CBS News]  <a href="https://youtu.be/4MXoUbsswHY">https://youtu.be/4MXoUbsswHY</a></p> <p>Fleeing climate change — the real environmental disaster [DW Documentary]  <a href="https://youtu.be/cl4Uv9_7KJE">https://youtu.be/cl4Uv9_7KJE</a></p> <p>Exploring the relationship between Climate Change and Human Migration in Africa [USFGsAL]  <a href="https://youtu.be/HtUw_jvv3GU">https://youtu.be/HtUw_jvv3GU</a></p> <p>Climate Change: Rising Sea Levels + Coastal Megacities = Forced Migration [Big Think]  <a href="https://youtu.be/s4UgekcYg2o">https://youtu.be/s4UgekcYg2o</a></p> <p>Changing Climate, Moving People: A film on climate stress related migration [TERI]  <a href="https://youtu.be/NjYR3LohMM0">https://youtu.be/NjYR3LohMM0</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	10/16/23	<p>Even if severe storms and flooding were not increasing, and even if sea levels were not relentlessly rising, the very fact that ever greater numbers of people are living and working pretty much at sea level results in unprecedented challenges regarding emergency evacuation, long term migration, and economic and political stability worldwide in coming years. Dhaka, the capital of the South Asian country Bangladesh, has a population that is booming. However, it stands as one of the world's poorest mega-cities, with some of the world's most challenging long term climate-related issues. Within the next 30 years, up to 20% of Bangladesh will disappear beneath the water as rivers and sea levels rise. This will put as many as 30 million people on the move.</p> <p><b>Watch:</b> Climate Change Impacts in Bangladesh [World Bank]  <a href="https://youtu.be/V3IL6Y1TDHo">https://youtu.be/V3IL6Y1TDHo</a></p> <p><b>Watch:</b> Climate refugees in Bangladesh [DW Documentary]  <a href="https://youtu.be/co5uywe-1Z8">https://youtu.be/co5uywe-1Z8</a></p> <p><b>Homework 8:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. What do you think of Chris Jordan's suggestion that the way we talk about climate change isn't very helpful?</li> <li>2. According to the Just Have a Think video, how might we capture 2 billion tons of CO2 and fix our oceans? Discuss one or two more specific technologies currently under development that may help us globally, regionally, or locally to deal with changing climates. You can get some ideas by looking through the videos in the 'Just Have a Think' channel on YouTube. Perhaps, if you or someone you know were interesting in investing in stocks, this might give you a few ideas.</li> <li>3. Describe the situation in Bangladesh and neighboring portions of India regarding the consequences of climate change, and what may happen over the next few decades.</li> <li>4. Where and why in the world might we find largest numbers of climate refugees in the coming years? Does most of the migration currently taking place seem to occur within or across national borders? As climate-related migration becomes increasingly international, which other states are or might become involved? What if those states have their own internally displaced populations to deal with? I've already asked about Bangladesh and India, but there are several other examples of difficult political situations arising from climate migration.</li> </ol>



Week	Due Date	Topics, Videos, Readings, Assignments
9		<p>Topic 1: <b>Climate types</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p><b>Reference: Fundamentals of Physical Geography</b>  CHAPTER 7: Introduction to the Atmosphere, Section v, Climate Classification and Climatic Regions of the World. In accessing the textbook, please ignore the ads. Do not download the pdf version suggested by the website or popup. Just access the online version. Sorry about that)  <a href="http://www.physicalgeography.net/fundamentals/7v.html">http://www.physicalgeography.net/fundamentals/7v.html</a></p> <p>I'm only listing this chapter of the textbook as a reference because, although its discussion is excellent, its categorization of climate and biome types are different from the following videos, which I prefer you watch and use in your response to question 2 (which I expect to be substantive).</p> <p>One of the most immediate and long-lasting impressions many people get from a class like this might be through their examination of the characteristics of different regional climate. Indeed, climate can even be examined at the local scale and microscale. As a human being who is likely to experience a few of these climate types over the course of your lifetime, a somewhat more complete understanding might help you on your way.</p> <p><b>Watch:</b> Secrets of World Climate Course – Introduction [Geodiode]  <a href="https://youtu.be/Y5NcKTFb3ck">https://youtu.be/Y5NcKTFb3ck</a></p> <p><b>Watch at least seven of the following twelve videos:</b></p> <p>Tropical Rainforest Climate [Geodiode]  <a href="https://youtu.be/wq0asIXcW7w">https://youtu.be/wq0asIXcW7w</a></p> <p>Tropical Savannah Climate and Tropical Monsoon Climate [Geodiode]  <a href="http://youtu.be/tqpA9tswQxM">http://youtu.be/tqpA9tswQxM</a></p> <p>Subtropical Highland Climate [Geodiode]  <a href="http://youtu.be/3vzP0kWm-AQ">http://youtu.be/3vzP0kWm-AQ</a></p> <p>Hot Desert Climate [Geodiode]  <a href="https://youtu.be/itnYTE-3u-o">https://youtu.be/itnYTE-3u-o</a></p> <p>Humid Subtropical Climate [Geodiode]  <a href="https://youtu.be/FHj71X_k8h0">https://youtu.be/FHj71X_k8h0</a></p> <p>Mediterranean Climate [Geodiode]  <a href="https://youtu.be/uk9Fyw2Okyw">https://youtu.be/uk9Fyw2Okyw</a></p> <p>Oceanic Climate [Geodiode]  <a href="https://youtu.be/vlNybvaGPpg">https://youtu.be/vlNybvaGPpg</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>Cool Desert Climate [Geodiode]  <a href="https://youtu.be/kSzuXA7oQ68">https://youtu.be/kSzuXA7oQ68</a></p> <p>Continental Climate [Geodiode]  <a href="https://youtu.be/IE1Z5PtkzXQ">https://youtu.be/IE1Z5PtkzXQ</a></p> <p>Subarctic Climate [Geodiode]  <a href="https://youtu.be/PtavJ3Tt9XE">https://youtu.be/PtavJ3Tt9XE</a></p> <p>Tundra Climate [Geodiode]  <a href="https://youtu.be/pNxgY4Ru3gs">https://youtu.be/pNxgY4Ru3gs</a></p> <p>Icecap Climate [Geodiode]  <a href="https://youtu.be/pRZgNGXmQoQ">https://youtu.be/pRZgNGXmQoQ</a></p> <p><b>Topic 2: The Biosphere</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p><b>Reference:</b> Fundamentals of Physical Geography CHAPTER 9: Introduction to the Biosphere  <a href="http://www.physicalgeography.net/fundamentals/chapter9.html">http://www.physicalgeography.net/fundamentals/chapter9.html</a></p> <p>Before getting into the biological and ecological consequences of the different climate types, we need to look briefly at some of the many connections between climate, the atmosphere, water bodies, ice, soil, and what is known as the biogeochemistry of the Earth. Flows and reservoirs of elements like carbon, sulfur, and nitrogen provide tremendous insight. Let's look briefly at nitrogen.</p> <p><b>Watch:</b> Plants Affect the Atmosphere  <a href="https://ca.pbslearningmedia.org/resource/nves.sci.earth.atmosphere/plants-affect-the-atmosphere/">https://ca.pbslearningmedia.org/resource/nves.sci.earth.atmosphere/plants-affect-the-atmosphere/</a></p> <p><b>Watch:</b> NOVA: Earth From Space   Lightning Produces Nitrates  <a href="https://ca.pbslearningmedia.org/resource/nves.sci.earth.nitrate/lightning-produces-nitrates/">https://ca.pbslearningmedia.org/resource/nves.sci.earth.nitrate/lightning-produces-nitrates/</a></p> <p>Besides a source of energy and water, life depends on the presence of a few other elements, particularly nitrogen. Most living things cannot get this nitrogen directly from the air; they get it indirectly from specialized microbes, as well as from lightning. Another direct link between the biosphere and the atmosphere that most of us are unaware of. Most life on Earth gets its energy from the sun, either directly or indirectly, via an evolved set of processes called photosynthesis and respiration. Carbon dioxide is required, and water and oxygen are released, globally, on a massive scale. Living things therefore are key determinants of just how much carbon is in the atmosphere, and so they are largely responsible for the sort of climate that has evolved on this planet. In order to fully understand climate, we have to understand life. We can change the direction that the world climate takes in the future, one way or another, depending on how well we understand and treat living things.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<b>10/23/23</b>	<p><b>Homework 9:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Discuss the specific characteristics of seven distinct climate types of your choice, based on the categorizations of the videos you chose to watch. Show me that you've watched them. Which two or three types do you find yourself most drawn to? Since there are only two questions this week, I expect you to put significant effort into this one.</li> <li>2. Describe the processes of photosynthesis and respiration. How do they relate to one another?</li> <li>3. How have plants contributed to making Earth a habitable planet?</li> <li>4. Why does the Amazon rainforest have such a dramatic impact on the atmosphere?</li> <li>5. On average, how many lightning strikes occur on Earth each second?</li> <li>6. How does lightning produce nitrate? Why is nitrate important for living things? How does nitrate produced in clouds end up in human bodies?</li> </ol>
<b>10</b>		<p>Topic: <b>Biomes and ecosystems</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>I'm only listing the textbook as a reference for the first topic because its categorization of biome types are different from the following videos, which I prefer you watch and use in your response to question 1 (which I expect to be substantive).</p> <p><b>Reference:</b> Access online the text <b>Fundamentals of Physical Geography</b>  CHAPTER 9: Introduction to the Biosphere, section (k). Characteristics of the Earth's Terrestrial Biomes  <a href="http://www.physicalgeography.net/fundamentals/9k.html">http://www.physicalgeography.net/fundamentals/9k.html</a></p> <p>Once we address the topic of life on Earth, we enter into a world of potentially infinite complexity. There is no way we can give any of these topics the attention they deserve. We'll look briefly at the science of ecology an example of how a specific species influences the physical geography of a landscape, and a few careers of interest. But first, we look at large-scale organizations of life called biomes. Watch these videos the same way you did with last week's list of climate types. There is clearly a relationship between the two, but it is complex. Climate types and biome types are not the same, and their boundaries do not necessarily correspond.</p> <p><b>Watch:</b> Biomes - The Living Landscapes of Earth, Introduction To Biomes Of The World [Geodiode]  <a href="https://youtu.be/o_AfNcjlOgU">https://youtu.be/o_AfNcjlOgU</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Watch any five</b> of the following 11 videos:</p> <p>Tropical Rainforest [Geodiode]  <a href="https://youtu.be/E6WdEyt93vA">https://youtu.be/E6WdEyt93vA</a></p> <p>Savannah [Geodiode]  <a href="https://youtu.be/Mle5gmEpYys">https://youtu.be/Mle5gmEpYys</a></p> <p>Shrubland or Scrub [Geodiode]  <a href="https://youtu.be/wcYWS-5iUcc">https://youtu.be/wcYWS-5iUcc</a></p> <p>Desert [Geodiode]  <a href="https://youtu.be/TSx1wP18hRE">https://youtu.be/TSx1wP18hRE</a></p> <p>Grasslands [Geodiode]  <a href="https://youtu.be/Yy191KVBNP0">https://youtu.be/Yy191KVBNP0</a></p> <p>Temperate Forests [Geodiode]  <a href="https://youtu.be/K8i0K0pZICM">https://youtu.be/K8i0K0pZICM</a></p> <p>Boreal Forest or Taiga [Geodiode]  <a href="https://youtu.be/OUmHWrF8MnY">https://youtu.be/OUmHWrF8MnY</a></p> <p>Tundra and Ice [Geodiode]  <a href="https://youtu.be/II15uUa1on0">https://youtu.be/II15uUa1on0</a></p> <p>Highlands [Geodiode]  <a href="https://youtu.be/UYFZA_aIjbY">https://youtu.be/UYFZA_aIjbY</a></p> <p>Wetlands [Geodiode]  <a href="https://youtu.be/4bRgUShrC1w">https://youtu.be/4bRgUShrC1w</a></p> <p>Shallow Seas [Geodiode]  <a href="https://youtu.be/atY1szpyeMs">https://youtu.be/atY1szpyeMs</a></p> <p><b>Watch:</b> Ecosystems [Systems Innovation]  <a href="https://youtu.be/H-RPVJaoj08">https://youtu.be/H-RPVJaoj08</a></p> <p><b>Watch:</b> How Wolves Change Rivers [Sustainable Human]  <a href="https://youtu.be/W88Sact1kws">https://youtu.be/W88Sact1kws</a></p> <p><b>Watch:</b> Top 5 Inspirational Animal Conservation Stories [BBC Earth]  <a href="https://youtu.be/zQZndqa2bIw">https://youtu.be/zQZndqa2bIw</a></p> <p><b>Recommended:</b> Modern day wildlife conservation   Nick Bubb [TEDx Talks]  <a href="https://youtu.be/BTzm6RKmaXs">https://youtu.be/BTzm6RKmaXs</a></p>


Week	Due Date	Topics, Videos, Readings, Assignments
	<b>10/30/23</b>	<p><b>Homework 10:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Discuss the characteristics of five distinct biomes types, based primarily on what you've learned from the videos.</li> <li>2. What are some of the characteristics of ecosystems, according to the Systems Innovation video? How does an ecosystem differ from a community?</li> <li>3. How do wolves change rivers?</li> <li>4. What is your favorite 'inspirational animal conservation story' from the video?</li> </ol> <p>Chapter 9 Essay Questions 2, 4, 11</p> <p>9.2. Compare and contrast the function and structure of the grazing and detritus food chain.</p> <p>9.4. Describe how evolution works through natural selection, spatial isolation, and gene mutation.</p> <p>9.11. Discuss the term dispersal. Include in your answer an explanation of why organisms want to disperse, and how organisms accomplish this life-cycle strategy.</p>
<b>11</b>		<p>Topic: <b>The Lithosphere</b></p> <p><b>Reference :</b> StayingSafeWhereTheEarthShakes_BayArea.pdf</p> <p><b>Reference:</b> PuttingDownRootsInEarthquakeCountry_BayArea.pdf</p> <p><b>Watch:</b> Geologists explain why Tasmania is different [ABC Science]  <a href="https://youtu.be/f_Hcyfv5rU">https://youtu.be/ f_Hcyfv5rU</a></p> <p>In discussing the lithosphere, it might be more instructive to look closely at a particular place whose characteristics illustrate nearly all of the elements of plate tectonics, than to take a typically textbook approach. I want you to watch the following [Deep Dive] video closely, since it's packed with information. Hopefully, you will get a more realistic idea of how many features of the solid Earth <b>and</b> ocean work together as a system.</p> <p><b>Watch:</b> Why China's Largest Volcano Is So Unusual [Deep Dive]  <a href="https://youtu.be/3C2HVOB-g5s">https://youtu.be/3C2HVOB-g5s</a></p> <p>I recently took a trip to the topic of the Deep Dive video: Changbaishan, or Changbai Mountain, also known in Korea as Mount Paektu. Changbaishan is located on the border between China and North Korea. This massive volcano last erupted, with tremendous force, about a thousand years ago. The scars remain, and within them have arisen some of the most unique ecosystems in northeast Asia.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Recommended:</b> 1442 Steps to Heaven Lake [Gary Pereira]  <a href="https://youtu.be/TsnoFuC4zrw">https://youtu.be/TsnoFuC4zrw</a></p> <p><b>Watch:</b> Will the Cascadia Earthquake be the Worst Disaster North America’s Ever Seen? [PBS Terra]  <a href="https://youtu.be/76b_WGzCI54">https://youtu.be/76b_WGzCI54</a></p> <p style="text-align: center;"><b>1.1: Lithium, cobalt, and rare earths</b></p> <p>We continue our discussion of energy resources with a couple of minerals that are playing an increasing role in energy production. Lithium, cobalt, and the so-called rare earths are critical ingredients for batteries in cars, homes, and electronic devices, and they may soon begin to provide large capacity storage for utility companies that are increasingly dealing with the intermittency of solar and wind energy sources. The demand for these resources is therefore anticipated to outgrow that for pretty much any other resources, over the short to near term future. And much of this is being mined from some of the poorest, most insecure places on Earth.</p> <p><b>Watch:</b> Companies race to mine lithium, a battery essential [PBS NewsHour]  <a href="https://youtu.be/su_UC9ZCD-0">https://youtu.be/su_UC9ZCD-0</a></p> <p><b>Watch:</b> Here's Where the Juice That Powers Batteries Comes From [Bloomberg Quicktakes]  <a href="https://youtu.be/50rXYrFCQMw">https://youtu.be/50rXYrFCQMw</a></p> <p><b>Watch:</b> Lithium Recycling FINALLY goes global! [Just Have a Think]  <a href="https://youtu.be/mbkhXAPIEQE">https://youtu.be/mbkhXAPIEQE</a></p> <p>Cobalt seems to be the more problematic substance, in human and environmental terms.</p> <p><b>Watch:</b> Whose Wealth? Cobalt from Congo [SOMO Researcher]  <a href="https://youtu.be/37iLD4lvfdI">https://youtu.be/37iLD4lvfdI</a></p> <p><b>Watch:</b> How do we solve the Cobalt problem? [Just Have a Think]  <a href="https://youtu.be/-WOOZYILyXI">https://youtu.be/-WOOZYILyXI</a></p> <p>Rare earths have unique electromagnetic properties. There are several of them, but they are usually found in the same deposits, which are found at various locations, including the sea floor, which we’ll be looking at in a couple of weeks.</p> <p><b>Watch:</b> How These Rare-Earth Elements Could Change Our Future [Spark]  <a href="https://youtu.be/88jpgxSRVZU">https://youtu.be/88jpgxSRVZU</a></p> <p><b>Recommended:</b> How the US plans on rivaling China in the production of critical earths [CNBC]  <a href="https://youtu.be/CW4TnJDIQUw">https://youtu.be/CW4TnJDIQUw</a></p> <p><b>Recommended:</b> Impact of Materials on Society- Rare Earth Elements [Materials Research Society]  <a href="https://youtu.be/C-b1NacN3IY">https://youtu.be/C-b1NacN3IY</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<b>11/06/23</b>	<p><b>Homework 11:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. How does Tasmania illustrate the concept of continental drift?</li> <li>2. Describe the process of plate tectonics between the Pacific and East Asia. Why is Changbai Mountain (Mount Paektu) so unusual, in a geological sense? What does this show about the role of water in plate tectonics?</li> <li>3. What are the characteristics of the Cascadia fault line, and why might an earthquake there be extremely deadly?</li> <li>4. Retrieve from Files and read through the two documents, “<b>Staying Safe Where The Earth Shakes_Bay Area</b>” and “<b>Putting Down Roots In Earthquake Country_Bay Area</b>”.</li> </ol> <p>In an essay, describe steps that should be taken before, during, and after a major destructive earthquake, from the perspective of you as a family member and/or neighbor, public servant, health care worker, business officer, planner, etc. in order to reduce suffering and loss. Assume that people around you may be in need of aid. Assume that gas lines, electricity, and communications have been disrupted. You may be at work, or school, at home or on the streets when it hits. You may fictionalize your account, with specifics, or you may write in a more straightforward manner.</p> <ol style="list-style-type: none"> <li>5. Describe the mining and processing of lithium, its uses, and opportunities for recycling.</li> <li>6. What are some of the current social and environmental issues associated with the mining of cobalt? According to the narrator of the ‘Just Have a Think’ video, is the cobalt problem bring solved?</li> <li>3. Why are rare earth elements important? Where are they found? Are there likely to be undiscovered deposits? Which nations are most involved in increasing the production of rare earth minerals?</li> </ol>
<b>12</b>		<p><b>Topic: Uranium, thorium, plutonium</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>Minerals and metals in the lithosphere are largely responsible for the presence of human civilization, and this continues to be true. Fossil fuels remain important, but we shall concentrate on what comes next. Improvements in energy storage are required in order to fully utilize technologies like solar and wind. Nuclear reactors are offered as a way around such difficulties, since they are designed to operate continuously. Both approaches are likely to be pursued with increasing intensity in the near future.</p> <p>Nuclear technologies yield power without directly generating atmospheric carbon, although the mining</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p>and refining of uranium and the building and decommissioning reactors remains carbon-intensive. The biggest concern remains the toxic nature of the fuel, partly because of the nuclear power and weapons industries' often ignored history of mistakes, disasters, and near-disasters, and partly because of its vulnerability to terroristic intentions. New reactor designs claim to address some of these issues. I'll leave these things for you to consider. Whatever ends up happening with uranium, plutonium, and thorium, it will probably play out in your lifetimes.</p> <p><b>Watch:</b> Thorium and the Future of Nuclear Energy [PBS Space Time]  <a href="https://youtu.be/EluIEJruhRQ">https://youtu.be/EluIEJruhRQ</a></p> <p><b>Watch:</b> Could Advanced Nuclear Power Replace Fossil Fuels? [Journey]  <a href="https://youtu.be/eg613DFBR8s">https://youtu.be/eg613DFBR8s</a></p> <p><b>Watch:</b> Small Modular Reactors. Are they now unavoidable? [Just Have a Think]  <a href="https://youtu.be/yofGtxEgpI8">https://youtu.be/yofGtxEgpI8</a></p> <p>Having asked students for several years now about this recent disaster, I remain unsurprised at how little discussion has taken place in the classroom or on the news. I have to give the Japanese reporters at NHK credit for having dug so deeply into the causes and consequences of placing nuclear reactors with fatal design flaws on one of the most seismically active coastlines in the world.</p> <p><b>Watch:</b> Understanding the accident of Fukushima Daiichi [IRSN]  <a href="https://youtu.be/YBNFvZ6Vr2U">https://youtu.be/YBNFvZ6Vr2U</a></p> <p><b>Watch:</b> Fukushima's ghost towns  <a href="https://youtu.be/xKfnsYzQWjw">https://youtu.be/xKfnsYzQWjw</a></p> <p style="text-align: center;"><b>1.1: Nuclear energy and conflict</b></p> <p><b>Watch:</b> At least three of the following five videos.</p> <p>How likely are nuclear disasters and cyber warfare in Ukraine?   DW News Mar 2, 2022  <a href="https://youtu.be/zOng3E4hzpo">https://youtu.be/zOng3E4hzpo</a></p> <p>Russian forces take control over Europe's largest nuclear power plant   DW News Mar 3, 2022  <a href="https://youtu.be/OrBP3sydgXg">https://youtu.be/OrBP3sydgXg</a></p> <p>Ukraine: Nuclear power plants under Russian control   DW News Mar 7, 2022  <a href="https://youtu.be/_QjTgF_c_nk">https://youtu.be/_QjTgF_c_nk</a></p> <p>Shelling at Ukraine nuclear power plant puts world on edge   DW News Aug 6, 2022]  <a href="https://youtu.be/aTxJpfbh2ko">https://youtu.be/aTxJpfbh2ko</a></p> <p>Shelling Zaporizhzhia would cause a disaster 'worse than Fukushima' [Times Radio, Aug 9, 2022 ]  <a href="https://youtu.be/YnbPKdZJAmE">https://youtu.be/YnbPKdZJAmE</a></p>



Week	Due Date	Topics, Videos, Readings, Assignments
		<p style="text-align: center;"><b>1.2: Memories of the Oyster Creek Nuclear Generating Station</b></p> <p>I'm probably one of the few people who worked as a technician on projects in both a commercial Nuclear Fission reactor and an advanced Nuclear Fusion project (many engineers and physicists must have worked in both domains, but I just played a minor role). I was hired to fill out a work team at the Oyster Creek Nuclear Generating Station, in Forked River, New Jersey:</p> <p><a href="https://en.wikipedia.org/wiki/Oyster_Creek_Nuclear_Generating_Station">https://en.wikipedia.org/wiki/Oyster_Creek_Nuclear_Generating_Station</a></p> <p>The reactor is in the cube-shaped building in the center of this picture:</p>  <p>The upper portion with the cladding around it is one large room, with the reactor embedded in the center and pools full of water to either side. Above on girders, a large industrial crane can lift the lid off the reactor, and remove the 'spent' fuel rods. The crane immediately lowers each rod into one of the refrigerated pools, where it continues to emit heat (and more dangerous forms of radiation) for many years. They are left there at least until they are sufficiently cooled. After the spent rods are removed, the crane can reload the reactor with new rods. The problem then was (and this continues to be a problem for the nuclear industry), where to then put the spent fuel (and any other contaminated material) more permanently. Since there is no reprocessing industry in the US, and since federal storage proposals are being challenged by states, the rods from such reactors often remain in sealed casks somewhere on the grounds.</p> <p><b>Recommended:</b> What If You Fell Into a Spent Nuclear Fuel Pool? [What If]  <a href="https://youtu.be/mM-5DhIhYmQ">https://youtu.be/mM-5DhIhYmQ</a></p> <p>Our team worked in that big room above the operating reactor. Our job was to rearrange brackets that had been installed on the floor of the pool in order to accommodate a higher density of fuel rods. Even in the 1970s, storage had become a problem. The technology we used was very basic: wrenches on long poles handled by technicians at the edge of the pool, as guided by other technicians with binoculars to screw and unscrew brackets that were deep underwater. You would not otherwise want to get anywhere near</p>

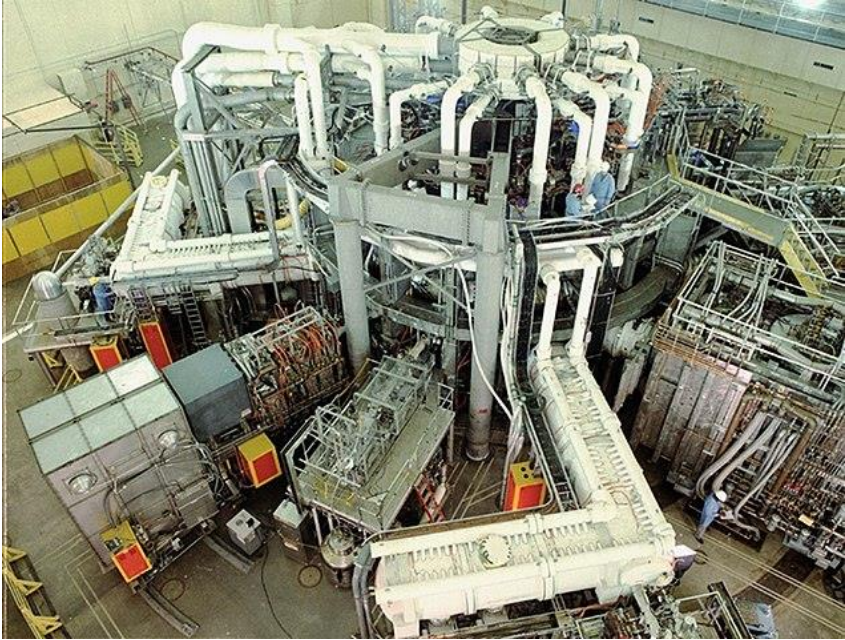
Week	Due Date	Topics, Videos, Readings, Assignments
	11/13/23	<p>that water. Anything coming out of the pool would need to be wiped down with acetone to reduce their potential toxicity. That was my job.</p> <p>The plant that I worked in is now shut down, but when I was there in the 1970s, it was in full operation. The room was physically hot, regardless of the season, as the result of its proximity to the reactor itself. The disposable outer clothing and booties that we wore were similar in style and effectiveness to the gear used in semiconductor manufacturing clean rooms today, but in a nuclear reactor they were required to keep contaminants away from your personal clothing and body. At the time, there was only one guard with a handgun at the entrance to the room above the reactor. The place made me uneasy, and I didn't stay long. When I left the plant for the last time, I was given a full body scan in a trailer that the NRC kept on site. They discovered that I had absorbed some radioactive iodine in my few weeks on the job. If I had taken iodine supplements prior to working there, my thyroid might not have absorbed any of the bad stuff. In fact, as part of its civil defense plan, the federal government had distributed iodine pills throughout the US during the Cold War in anticipation of a potential nuclear attack.</p> <p><b>Homework 12:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Describe some of the prospects for nuclear power around the world. Be region-specific if you can. What are some of the differences between traditional reactor designs and fuels and current generation designs, including 'small nuclear reactors' and those that use thorium?</li> <li>2. Describe the circumstances leading up to the Fukushima Daiichi disaster. You might begin with the decision to site nuclear plants on Japan's eastern shore. What precisely is the situation now? Why did Japan decide to go so strongly with nuclear energy? Has anything changed?</li> <li>3. Describe the situation with regard to Ukraine's nuclear power plants. Such facilities, regardless of whether they happen to be active, are vulnerable in many ways. In addition to the reactors themselves, there are backup generators, load balancing circuits, spent fuel storage, etc. that can quite easily be hit, leading potentially to massive releases of radiation and fallout. Given this situation, do you think the world is ready for a large increase nuclear power generation? Will small scale facilities really help out?</li> </ol>
13		<p>Topic 3: <b>The oceans</b></p> <p>The importance of the oceans themselves to world population cannot be overstated. Nations hungry for sea food troll the world's oceans, largely unhindered. One by one, the more desirable species are taken to near extinction. There is a great deal we haven't covered. However, given humanity's current thirst for minerals (some of which we will consider over the next two weeks) I think we should look at the recent discovery of some of these resources on the ocean floor and the development of technologies to exploit those resources, and what this implies for international relations and ocean ecosystems.</p> <p>Fissures along plate boundaries and near hotspots bring valuable minerals up from deep beneath the crust. Over time, these minerals precipitate and form nodules on the seabed. These environments also host some of the most fascinating and vulnerable ecosystems on earth. Forms of life that we have barely begun to</p>

Week	Due Date	Topics, Videos, Readings, Assignments
	11/20/23	<p>understand exist within environments that we may soon begin using large machines to dredge up.</p> <p><b>Watch:</b> 2023 ISA assembly: Deep-sea mining debate intensifies in Jamaica [Al Jazeera English]  <a href="https://youtu.be/-ES2ItUHOGw">https://youtu.be/-ES2ItUHOGw</a></p> <p><b>Watch:</b> The Next Frontier in Mining: Deep Sea Exploitation in the Pacific  <a href="https://youtu.be/PuEXmFOEJpw">https://youtu.be/PuEXmFOEJpw</a></p> <p><b>Reference:</b> Deep Sea Mining [Wikipedia]  <a href="https://en.wikipedia.org/wiki/Deep_sea_mining">https://en.wikipedia.org/wiki/Deep_sea_mining</a></p> <p><b>Reference:</b> Seabed mining is coming [Nature news feature, 24 July 2019]  <a href="https://www.nature.com/articles/d41586-019-02242-y">https://www.nature.com/articles/d41586-019-02242-y</a></p> <p><b>Reference:</b> International Seabed Authority [Wikipedia]  <a href="https://en.wikipedia.org/wiki/International_Seabed_Authority">https://en.wikipedia.org/wiki/International_Seabed_Authority</a></p> <p><b>Reference:</b> United Nations Convention on the Law of the Sea [Wikipedia]  <a href="https://en.wikipedia.org/wiki/United_Nations_Convention_on_the_Law_of_the_Sea">https://en.wikipedia.org/wiki/United_Nations_Convention_on_the_Law_of_the_Sea</a></p> <p><b>Recommended:</b> Deep sea gold rush [Al Jazeera English]  <a href="https://youtu.be/s1b4xVTAKcl">https://youtu.be/s1b4xVTAKcl</a></p> <p><b>Recommended:</b> Mining the Deep Sea [Massachusetts Institute of Technology (MIT)]  <a href="https://youtu.be/MWvCtF1itQM">https://youtu.be/MWvCtF1itQM</a></p> <p><b>Recommended:</b> Deep Sea Mining: Searching for the Next Mineral Boom [Roundtable]  <a href="https://youtu.be/-UPjsuuyvD4">https://youtu.be/-UPjsuuyvD4</a></p> <p><b>Recommended:</b> Seabed Mining in the Deep Sea [University of California Television (UCTV)]  <a href="https://youtu.be/ePm3Wbw2tyc">https://youtu.be/ePm3Wbw2tyc</a></p> <p><b>Recommended:</b> Introduction to the International Seabed Authority and Seabed Mining [dyaguilfoyle]  <a href="https://youtu.be/Tlumf1ivvPg">https://youtu.be/Tlumf1ivvPg</a></p> <p><b>Homework 13:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. What is a hydrothermal vent? Describe how hydrothermal vents produce nutrient-rich water.</li> <li>2. Discuss the status and prospects of deep-sea mining. What (if anything) is being done or should be done to regulate the exploitation of the seabed for minerals? Discuss the history and significance of national claims of exclusive rights over offshore resources.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
14	11/27/23	<b>Thanksgiving break</b>
15		<p>Topic: <b>Innovation</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <p>Let's end the semester by returning in a way to our first topic, that of individual human beings and their effect on the world. Regarding the challenges that human populations face with energy, water, agriculture, climate, and human nature itself, what level of agency might be required to generate and implement effective solutions? Do they emerge from some directorate, from individual human beings, or from collaborations at all levels of activity? These are variations on questions that we've considered throughout the semester, and just how you see things is up to you. Regardless of where and how it emerges, innovation will doubtless be key to finding our collective way forward. I'd like you think about the history of technological innovation, a couple of topics of particular relevance, and my own memories of working for a few years within a highly innovative environment.</p> <p>We all know the myth of the scientist or artist working alone and unappreciated, but developmental advances seldom occur that way. Look closely and you'll find that innovative people are nearly always part of a community, at least if they expect their work is to be appreciated within their own lifetimes. Invention and innovation are almost always group efforts. The following video provides an illuminating look at how Edison and others approached the challenges of their time.</p> <p><b>Watch:</b> The battle of the bulb: How the first lightbulb was built [Fox Business]  <a href="https://youtu.be/-yXWL1hCKjc">https://youtu.be/-yXWL1hCKjc</a></p> <p><b>Watch:</b> The War for AI &amp; Chip Supremacy is Underway. [Good Times Bad Times]  <a href="https://youtu.be/A45WuwfUK8o">https://youtu.be/A45WuwfUK8o</a></p> <p>The Systems Innovation channel is actually full of interesting videos that may be helpful to you in your professional career. There are few other sources of introductory information regarding complexity, networks, agency, and related topics that I can recommend to the beginner. You might find the following videos to be of particular interest with regard to the topic of innovation and invention.</p> <p><b>Watch:</b> Systems Innovation Overview [Systems Innovation]  <a href="https://youtu.be/rVGoeFAW0FM">https://youtu.be/rVGoeFAW0FM</a></p> <p><b>Recommended:</b> Emergence [Systems Innovation]  <a href="https://youtu.be/QIfTWZc7hKs">https://youtu.be/QIfTWZc7hKs</a></p> <p><b>Recommended:</b> Synergies [Systems Innovation]  <a href="https://youtu.be/rsn5EQoAhUc">https://youtu.be/rsn5EQoAhUc</a></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p style="text-align: center;"><b>1.1: Nuclear fusion</b></p> <p>Nearly all of the energy powering life on Earth is ultimately derived from the nuclear fusion process occurring within the sun. If we could create similar processes here on Earth, huge amounts of energy could be released through the use of a few very light, relatively safe substances. But this presents an enormous set of engineering challenges. Many of these challenges have already been met, or they soon will be. The developmental costs of the technology might mean that fusion energy might not be cheap or plentiful at first, but it as it scales up, it could go a long way toward reducing atmospheric carbon and solving our energy supply issues. The golden age of fusion energy research may be approaching. We've recently seen news from the Lawrence Livermore Lab with laser-induced fusion. We will concentrate here on the more likely pathway to power, magnetic confinement.</p> <p><b>Watch:</b> Nuclear Fusion 3.0: Real World Electricity is Coming [Electric Future]  <a href="https://youtu.be/4GJtGpvE1sQ">https://youtu.be/4GJtGpvE1sQ</a></p> <p><b>Watch:</b> Why Private Billions Are Flowing Into Fusion [Bloomberg Quick Takes]  <a href="https://youtu.be/Dp6W7g9no0w">https://youtu.be/Dp6W7g9no0w</a></p> <p>Helion is an interesting company with a unique approach to magnetic confinement fusion. Electricity is stored in capacitor banks between strokes of the 'engine', with the excess charge that is hopefully created by the fusion reaction bled off directly for immediate use. There is no need to convert heat or some other form of radiation into electricity; it is produced directly. This is real life steampunk. Can you imagine working for this company, particularly if they become successful?</p> <p><b>Watch:</b> A New Way to Achieve Nuclear Fusion: Helion [Real Engineering]  <a href="https://youtu.be/bDXXWQxK38">https://youtu.be/bDXXWQxK38</a></p> <p>There's some redundancy among the following recommended videos, but each one shows something different, particularly with regard to the history of magnetic confinement, so I didn't want to remove anything of potential interest. You might want to think about fusion for your final paper.</p> <p><b>Recommended:</b> Nuclear Fusion Breakthrough Rewrites Laws of Physics  <a href="https://youtu.be/G27M0eRTRZE">https://youtu.be/G27M0eRTRZE</a></p> <p><b>Recommended:</b> Major breakthrough on nuclear fusion energy - BBC News  <a href="https://youtu.be/0fYiNVRmOA4">https://youtu.be/0fYiNVRmOA4</a></p> <p><b>Recommended:</b> Scientists New Nuclear Fusion Breakthrough Changes Everything! [Tech Space]  <a href="https://youtu.be/fqBD8Cs4oWQ">https://youtu.be/fqBD8Cs4oWQ</a></p> <p><b>Recommended:</b> We Went Inside the Largest Nuclear Fusion Reactor [The B1M]  <a href="https://youtu.be/4BkOUOK0XzM">https://youtu.be/4BkOUOK0XzM</a></p> <p><b>Recommended</b> (beginning at minute 1:10): Wendelstein 7-X fusion device [Max Planck Institute]  <a href="https://youtu.be/51Hji5NfkdA">https://youtu.be/51Hji5NfkdA</a></p>

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		<p style="text-align: center;"><b>1.2: Memories of the Tokamak Fusion Test Reactor (TFTR)</b></p> <p>I'd like to end our series of chats with a little story of my own. None of my colleagues of the past 20 years cares about this part of my life, and this is one of the issues I have with the 'college educated' with regard to the rest of us. One the reasons I feel justified in telling you about this is my secret desire to pull down the high and mighty, particularly with regard to their pride in their educational (and presumably their intellectual) status. I had only a two-year degree in electronics engineering from DeVry when I did the work I'm about to describe, but I'd grown up building electronic circuits and devices, for fun. Just keep this in mind: your participation in some of the most important developments of the modern world does not necessarily depend on the level of your formal education.</p> <p>Science is a cooperative endeavor involving many non-scientists. I was fortunate to have been in the right place, at the right time, and with the right qualifications to have been hired onto a team of about a dozen electronics technicians that helped built, install, and maintain the instrumentation for the largest, most elaborate nuclear fusion device in the world at the time. The Tokamak Fusion Test Reactor was built on the grounds of the Princeton Plasma Physics Laboratory, amid the woods and cornfields just outside Princeton, New Jersey. Construction on TFTR began in 1980 and initial operations began in 1982. TFTR remained in use until 1997. It was dismantled in September 2002. My favorite memories of the tokamak were during the early stages of construction when the vacuum vessel was still visible. It was made of stainless steel, it was doughnut-shaped (a torus), and it was huge. The internal diameter of the vacuum vessel itself, within the body of the torus, was eight feet. Technicians could open it up and easily work on it from within.</p> <div style="text-align: center;">  </div> <p>Soon, however, the vacuum vessel was buried within a maze of instrumentation, magnets, and cryogenics. TFTR was the largest, most elaborate nuclear fusion device of its kind at the time. It was intended to test a the idea of whether confining a particular cloud of hydrogen isotopes within the tokamak, a torus-shaped vacuum vessel, heating it with microwaves and squeezing it magnetically, could ignite fusion reactions to the point of 'break even' energy generation. The name 'tokamak' sounds Russian because it is. The idea was originally proposed by the Soviet physicist, tsar bomba designer, and human rights campaigner, Andrei Sakharov. His story, by the way, is a fascinating one.</p>

Week	Due Date	Topics, Videos, Readings, Assignments
		 <p data-bbox="370 926 1495 1587">I was one member of a small group of electronics engineers and technicians that was called by the self-explanatory name with a cool acronym, ‘Central Instrumentation Control and Data Acquisition’ (CICADA). Most of the time, we worked in our own fabrication and testing labs upstairs and in the computer and control rooms downstairs. This was all in a fancy building with an auditorium and lunch and conference rooms several hundred feet away from the building that actually contained the tokamak device. These buildings were connected directly by means of an underground tunnel navigable through which we walked, and through which we installed the fiber optic bundles that were used to communicate with the device. Optical fibers, which were new at the time, were used to communicate with the tokamak because of their improved bandwidth but also in order to keep the control and computer rooms electrically isolated from the pulsed high voltages and currents that were used by the device itself. The power required to operate the device could not possibly be drawn from the electrical grid directly. In yet another building, two absolutely massive dynamos would draw current from the grid to gradually spin up to high speeds, like tops, on vertical axes in huge cylindrical pits. The current required by the tokamak would then be drawn off suddenly from these dynamos. As they experienced the resulting breaking action, those dynamos would scream, and the images on CRT screens near any resulting strong magnetic fields would bend for a few seconds. No one was allowed near the tokamak device while it was in operation, and I was assigned to install and maintain the card readers and cameras that made sure of that. Through this task, I got to know the head of security, an old gentleman who had flown missions over the Himalayas to China during WWII. But that’s another story.</p> <p data-bbox="370 1629 1495 1829">Since a great deal of fabrication was required at the component level (with lots of soldering iron action), technicians were often assigned to work jointly with particular engineers. I worked for several years with an absolutely brilliant engineer, Jane Montague, who was just a few years older than me (with a degree, I believe, from Stanford), on some of the project’s most critically important systems. Among the many systems we built, one of the most important was a complex master clock that synchronized a suite of operations involving control of the sensory instrumentation, and the acquisition of data during a run. All</p>

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	12/04/23	<p>of these operations occurred within just a few seconds, and most in under a second, which was about how long stable plasma conditions could be maintained at the time. Since our master clock assessed conditions and performed operations with microsecond precision, it was built with fast, ultrareliable components and an extremely fast internal clock. The observational data resulting from the operation of the tokamak was processed and stored on large frame computers in a separate computer room (I was sent to Ft. Lauderdale in the August heat for training), but these computers were not sufficiently fast or isolated from outside influences to do the work required of our master clock, as well as many, many other real-time specialized functions. The devices we built were integrated into crates, on racks in the control room.</p> <p>For most of our projects, Jane would first meet with physicists and other engineers in order to determine what the requirements were. The circuits she then designed were built by me with the most reliable military-grade devices that were available at the time. I would solder them onto circuit boards, which would then be initially plugged into testing crates in order to connect them to computers, displays, and other customized circuits. Jane and I often sat for hours, testing and modifying our circuits using mostly logic analyzers and oscilloscopes. Meanwhile, other teams would be doing similar things. It was actually very challenging work involving personal inventiveness, innovation, and craftsmanship on a scale that few people outside of such endeavors get to witness (along with, in my case, a willingness to be on call whenever for emergency technical services).</p> <p>The following is a promotional video from 1989 about the Plasma Physics Lab and the Tokamak Fusion Test Reactor (TFTR), with footage of the interior, machines, and scientists at work.</p> <p><b>Recommended:</b> Plasma Physics Lab and the Tokamak Fusion Test Reactor, 1989 [princetoncampuslife] <a href="https://youtu.be/TamkP8QrZak">https://youtu.be/TamkP8QrZak</a></p> <p><b>Recommended:</b> The Princeton Plasma Physics Laboratory [WebsEdge Science, Feb 28, 2014] <a href="https://youtu.be/b8iH1930p2s">https://youtu.be/b8iH1930p2s</a></p> <p><b>Homework 14:</b></p> <p>Reminder: check each week for any new <b>Announcements</b>.</p> <ol style="list-style-type: none"> <li>1. Magnetic confinement nuclear fusion may soon be achievable, after many decades of work by people from all over the world. The project I worked on seemed enormous to me at the time, and yet there is hardly a mention of it online. I could find no photos of the control and computer rooms, for example, or of any of the people who worked there. There were no reunions, as far as I know. And yet, we achieved something remarkable. Can you think of another example of group innovation in the modern world that may not have received much attention from society in general?</li> <li>2. Describe the approach that Edison took to the invention, production, and distribution of incandescent lighting. Why was it more than just inventing the right bulb?</li> <li>3. Can innovation in business or technology be achieved using some of the ideas expressed in the Systems Innovation Overview video?</li> </ol>



Week	Due Date	Topics, Videos, Readings, Assignments
16	12/11/23	<p><b>Term paper (Final Evaluation)</b></p> <p>Choose one of the topics we've covered (or something directly related) and write a thoughtful term paper. This will serve as your final evaluation. Provide at least four citations. It doesn't matter what format you use, so long as you are consistent. I suggest that you choose a serious topic that is aligned with your interests or career plans. The resulting paper's text should be at least four pages long, easily more. Use the same font and spacing as for the homework, please. You may also include graphics and extended quotations, if you provide citations. I encourage you to produce some of your own graphics if you are so inclined. You will find these to be useful if you upload your work to Portfolium. There is no upper limit to the length of the paper, but please don't lengthen it with unnecessary repetition. I expect all of you to produce a paper that you can publish online without further editing.</p>