San José State University
ENVS121 and GEOG121: Population and Global Change

Fall 2024

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Course and Contact Information

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Office Hours:	Please message me in Canvas 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. Reliable internet connectivity is required. The course material can be accessed through the Canvas Leaning Management System course login website, primarily through the **Announcements** and **Assignments** tabs for this class. Additional course materials (including this syllabus) may be 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. 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 some humor) my impression of the systems and applications that have become commonplace in education and elsewhere. You might notice something a little strange. The structure looming over the bench looks it might provide some shelter from the sun or rain, but in fact it does neither, at any time. One simple additional step in its design and construction would have made it quite useful, particularly since there is no other shelter for pedestrians on this walkway. But somewhere along the line, the purpose for building such a thing was lost – perhaps from the beginning – and no one seems to have noticed, or have had the courage to say something. Several of these were constructed, and it wasn't cheap or easy. Spikes had to be installed as a final step to prevent birds from perching and messing up the benches, which would have been left undisturbed, had these 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 structure looming above it might be taken to represent what I consider some of the less helpful aspects of Canvas, as well as many of the systems and published resources that students are often required to buy and to learn how to use. For this course, I have found that a few freely available readings are sufficient to supplement some carefully chosen Internet sources, as well as some of my own material. This strategy results in a more substantive, robust, personal, and direct understanding of the topics described here than some of the most expensive textbooks and their associated resources currently offer. Still, I remain a big fan of textbooks. I kept most of mine and collected more from used bookstores, on a variety of topics. I suggest that you do the same, if you're curious and want at least to understand the vocabulary of a particular domain. They can help you read papers and articles with better understanding.

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 is using to point out the moon for you, with the moon itself. The characteristics of the finger are 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 on purpose so that we can more flexibly 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 additional specific questions that may be posted within any Announcement.**

Regarding our metaphor about the moon - I'm only human, and my finger is special to me. We teachers can and do become self-absorbed. Each of us may think that our own fingers are better than someone else's fingers at pointing things out. From the student's point of view this may or may not be true, but since your goal is to achieve understanding, you are naturally aware of the essential silliness of this concern. Most real learning is done in relative solitude anyway, after all the pointing has already been done. At least that's been my experience.

But there is a tendency by many to conflate pointers to external objects of study, with those objects themselves, and this can result in some unfortunate delusions. For example, since we can manipulate our fingers any way we want, we might start to believe that by doing so we can somehow affect the characteristics or behavior of the object being pointed at. Please consider that, for the vast majority of cases, the opposite is in fact true. At least for purposes of education, I would like you to try to set aside the implications or significance of your own personal or collective identities, and those of your teachers, and just do your best to learn about what might exist well beyond (or invisibly within) yourself. By taking this approach, we can learn to more realistically evaluate and successfully address whatever Nature (and the human heart) might throw our way. Anyone who has seriously studied mathematics and the hard sciences knows what I mean.

Within **Announcements**, I might make observations or offer advice regarding previously submitted or future homework responses, but I promise never to identify students by name without prior permission. I further promise to keep any information exchanged via either messaging or homework completely private. You of course may share any such exchanges or documents with anyone, 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 comments on homework) with others. It has no effect on your grade. If you are consistently or significantly late submitting work, however, I do appreciate a short message of explanation. With Canvas messaging, conversations cannot be ignored, misplaced, manipulated, forged, modified, or shared with others. There are no such assurances with email, and that includes the account provided by the university (but run by Google) or with any other public social media platform. It has been my experience that email systems are routinely used as tools of power, manipulation, self-aggrandizement, confusion, and disrespect, particularly by people in positions of authority. I have found that people who make no secret of disliking me have seldom responded to my email messages, even important ones,

and even those I may have been required to send to them. I often have had no idea whether something that I may have spent many hours working on was ever read, even once. Physicists tell us that information cannot be lost from the universe, except possibly through a black hole. I believe I may have found another portal. For many reasons, therefore, I prefer not to use email in my role as educator. The address on page one of this document is the account that I check regularly, and it is a good way to get in touch with me down the line, regardless of my current status or your current status vis-à-vis SJSU. During this semester, however, **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 when you can and pin an explanatory message to the assignment itself, or message me separately regarding more serious issues.

I will not require you to share your work, your opinions, or even your image with others in the class, or with anyone or anything else that happens to be looking in. I don't think it's unreasonable to assume that every moment of screen time and every text message and written discussion can potentially be saved, shared, and even broadcast publically, to be misunderstood by someone or something that you might not even know about or be aware of, with the result that it can adversely affect your life and career and those of your family. I do not want anyone to experience any consequences for anything said or written for any of my classes. This is not an idle concern. It has happened to me repeatedly, and it is likely to happen again. It began for me in the1990s, when as a graduate student at the University of Minnesota I found that the texts of emails that I had written within presumably closed graduate groups could easily be found by anyone in the world just by googling my name. This sort of technological and social abuse continues to this day, and it's getting worse. Don't expect, as technology changes, that your privacy will be respected - just the opposite. For the foreseeable future, I will not ask students to use Zoom, or whatever, in order to present themselves within a box on a screen, at some particular time on some particular day. Nor will I organize or participate in any sort of online discussions, even if these are presumably closed, so long as innocent people like you and me remain under threat for expressing or even just exploring ideas that someone or something somewhere now or at some future time might find to be unacceptable.

Instead of endorsing the false choice of expressing your current thinking on any topic immediately for all the world to potentially see, or remaining silent, 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, and in a way that is fully under your own control** (e.g., via Portfolium, or better yet, Substack).

Please carefully read and view the material and discussion that I have provided for 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 soon be aware of that, 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 speak. 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 is about how human populations might interact with and respond to changing conditions in Earth services, as well as possible changes that may be occurring or may soon occur in all sorts of technological, socioeconomic, political, medical, and other human-centric systems. One or more broad themes are explored each week. First, we emphasize the human centrality of this course by discussing family, community, health, well-being, and global trends in urban life. We then move into an examination of fresh water availability and of agriculture, which are the two most critical connections between populations and their geography, particularly in light of potential climate change.

After a brief discussion of the science of demographics, we engage in three weeks of background investigations into nonlinearity, complexity, perception, comprehension, and modeling. I consider this material to exemplify the sorts of topics we need to understand and work with in order to properly address the topics and issues that are central to this course. It is my impression that topics like these have been under-represented in high school and university courses. These three weeks are merely introductory, and further investigation on the part of the student is encouraged.

Only then are we ready to move into a two-week discussion of climatic challenge, regional vulnerabilities, and potential human migration. Since energy is a key issue in the pursuit of climate stability, we then devote two weeks to aspects of our global energy challenge. First, we discuss nuclear fission and the possibilities of fusion, and then we discuss minerals that are currently required for the production of batteries. Although we don't have enough time to cover other critical issues in energy; I suggest you all pursue this topic further on your own.

Finally, we look at two aspects of our collective and individual relationship to all that we have discussed thus far, and more. We begin by discussing the manipulation of science and of reality itself in the pursuit of power and influence. We conclude with a discussion of human creativity, and of innovation.

Textbook

This course is not based on a textbook, and no textbook reading is required. I am providing one for you, however, for free. At times, you might want to reference portions of **Introduction to Human Geography**, by David Dorrell and Joseph P. Henderson. We can use this book freely because it is intentionally licensed for such purposes under a Creative Commons Attribution 4.0 International License by the University System of Georgia. Download it as a pdf file from Canvas **Files**.

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 well 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 text 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 with sufficient resolution to clearly see the details (including text). 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 videos on the same channel. 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. However, you should watch portions closely. You might want to scrub through segments and watch only those portions that look particularly interesting, or that 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 skip over these videos, since they nearly always connect with specific 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 2024', 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 three pages or more. 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 extra attention to another one within 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, or in Substack, for example. When you post something in Portfolium, you get immediate copyright protection. In my opinion, the work you are doing for this class and others should be used in support of your professional career. That's what you're paying for, right? Please read 'About your instructor', below, for additional discussion.

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%
Total	**100%**

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-
below 60%	**F**

About the instructor

I grew up in a semi-industrial town in New Jersey, near New York City. Outside my bedroom window, refinery flares lit the night sky. I attended 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 device in the world at the time. After working there for six years, and participating in the reactor's successful construction and operation, I worked as an electronics technician for the science departments of Brooklyn College in NYC, where I also 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 as a physical scientist 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, or even Substack. 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

EnvS121-80 and Geog121-80: Population and Global Change, Fall 2024

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 #, geog121-80 or envs121-80, Fall 2024.

Course Schedule

Week	Due Date	Topics, Videos, Readings, Assignments
1		**Watch**: General notes for my online classes [Gary Pereira] https://youtu.be/_AN8k0Ogwl0 This course does not require very much reading, but I do fully expect you to read and to think about each of these introductory discussions. They are intended to inform the responses you give. If you just skip to the questions, and particularly if you ignore the sources that I provide and just rely on your own resources without attribution, I will soon know it, and this awareness will be reflected in your grade. You will find that I respect independent thinking, even if it contradicts my own beliefs, but I also expect you to listen to what I might have to say first. Not doing so is just like walking into a classroom and falling asleep. It's very obvious. I'd like to begin with three topics that may seem to be disconnected from each other or from the theme of this course, which is human population and global change. Together, however, they provide a foundation for much of the rest of the semester. Topic 1: **The Sorcerer's Apprentice** If you have looked through the syllabus, you already know that I tend to describe things metaphorically, maybe because metaphors require active participation on the part of the listener, but also because it usually leads to less trouble for the speaker than just saying things directly, although I have a tendency to do that too much as well. Or possibly because metaphorical stories were part of my childhood, through fairy tales and the parables, for example. In any case, I'd like you to think about the applicability of this old German fable to various situations that we seem to be dealing with, globally, at present. **Reference:** The Sorcerer's Apprentice [Wikipedia] https://en.wikipedia.org/wiki/The_Sorcerer%27s_Apprentice "'The Sorcerer's Apprentice' (German: "Der Zauberlehrling") is a poem by Johann Wolfgang von Goethe written in 1797…. The poem begins as an old sorcerer departs his workshop, leaving his apprentice with chores to perform. Tired of fetching water by pail, the apprentice enchants a broom to do the work for him, using magic in which he is not fully trained. The floor is soon awash with water, and the apprentice realizes that he cannot stop the broom because he does not know the magic required to do so."

Week	Due Date	Topics, Videos, Readings, Assignments
		If you have not yet seen the Disney film, or if you'd like to refresh your memory, the latter two thirds of it are available to view below. 'The Sorcerer's Apprentice' was released as a segment of "Fantasia" in 1940, with a warning that it could scare young children, primarily because of these scenes. **Recommended:** The Sorcerer's Apprentice (Part 2) [DisneyLivin] https://youtu.be/m-W8vUXRfxU **Recommended:** The Sorcerer's Apprentice (Part 3) [DisneyLivin] https://youtu.be/GFiWEjCedzY Why bring this up? This film preceded by five years the explosive unlocking of nuclear fission, which it roughly illustrates, and the advent of nuclear weapons. I think it might present a powerful perspective on the character of some of the dilemmas we face today. It is quite possible to develop pathogens that could kill billions and set civilization back hundreds of years. We've just received a severe warning, but many in the scientific community keep tinkering away anyway. The casual generation of malevolent or brain-numbing memes through entertainment industries and social media can unleash unknown forces with unpredictable results. AI will add fuel to the fire. Forever chemicals in the environment, potentially toxic drugs and pharmaceuticals, and invasive new technologies like mRNA are all weakening us from within. The difference between the Disney film and reality is that, for us, no Sorcerer is expected to reappear to set things right. We'll need to sort things out for ourselves. Mickey displays all that is both clever and weak in human beings. He is good by nature, but he is often silly, and he possesses far too much self-confidence and hubris, given his actual status and ignorance of the sorts of realities that he himself has unleashed. Having come through the past few years, those of us who survive have an obligation to spotlight issues of science, truth, health, governance, education, and civic responsibility, issues that have been neglected for far too long. If we hope to set things right as a society, and as a species, we should be willing to engage in a sort of social archeology of the remnants of the recent past, and to shine a light on whatever might be revealed regarding, for example, corruption, incompetence, neglect, greed, thoughtlessness, mindlessness, and just fatheaded stubbornness within systems of control and influence in this highly interconnected world. In my opinion, we should support and encourage the people who do the revealing. Otherwise, governments, corporations, media, foundations, NGOs, and the rest will certainly continue to cover up their misdeeds and pretend they just aren't happening (but if they are, it's not their fault). Future historians might look back on our time as the age of the **Engineering of ALL things** - from viruses, to human beings, to societies, to the Earth itself and beyond. We are being warned about the potential dangers of AI for good reason. After having witnessed this world in operation for a few years, I'm pretty sure that your generation will be astonished by revelations of what has already happened, and of what is happening right now. Our social worlds and private lives are being shaped by people, algorithms, substances, organizations, and other uninvited agents of change about which we remain unaware, and may not even have heard of. It can get scary, but we shouldn't exaggerate, since things often turn out better than expected, for reasons we'll get to by the end. In any case, don't kill the messenger, including me. If this sort of discussion bothers you, you can drop the course now without penalty. Look over the rest of the schedule to see if you have any concerns.

Week	Due Date	Topics, Videos, Readings, Assignments
		Topic 2: **The individual and the collective** Analyses of human populations often make reference to certain characteristics that are attributable to human beings: nationality, race, ethnicity, class, livelihood, income, net worth, religion, political affiliations, age, sex, gender affiliation, marital status, etc. Twenty-five years ago, while working with old books of census data at the University of Minnesota, I discovered that many of these presumably stable categorizations actually come and go over time and space, and this is happening despite everyone's best efforts to keep them orderly, stable, and continuous. Any particular category may emerge out of nowhere or disappear entirely, depending on dynamically changing technological, cultural, and economic factors. Therefore, care, humility, and contextualization are required when making reference to social categorizations. In order to understand how and why human life changes on a local, regional or global level, we need to recognize that it depends upon multiple sources of agency that operate over a wide range of scales, the characteristics and actions of specific human beings, ephemeral circumstances, externalities, randomness, and any number of additional unknown factors. Social dynamics are often observable, and possibly explainable, only at a much finer resolution of discernment and over a greater range of scales than most social analyses manage to achieve. This semester, we will discuss ways of possibly addressing this shortcoming, but we should begin by recognizing its existence. We are often far more ignorant of the true nature of both social and physical realities than we care to admit. **Watch (or listen while reading):** Humanity [Gary Pereira] https://youtu.be/IeT2AObKkJM As you take in the sights and sounds of this video, which I shot early one weekday morning from the deck of a boat on the Yangtze River, you might think that the absolute numbers of people on this Earth are just too overwhelming to consider in individual terms. Nevertheless, I'd like you to try to do just that. Behind those windows, thousands of people are waking up to another day. Each one has their own unique experiences, attachments, dreams, ambitions, disappointments, successes, joys, and sufferings. Regardless of how distant much of the world may seem to be from our own experiences, we also know instinctively, without having to be told, that each of these people's lives is just as important to each of them as mine is to me and yours is to you. If we keep that in mind, we can learn a great deal more than we otherwise might. Most of us would probably accept the idea that every society, regardless of its size or complexity, is ultimately comprised of uniquely individualized human beings. Even within the largest of crowds, and even under the most oppressive of circumstances, there are no 'non-player characters'. Everyone is a player. Everyone, regardless of circumstances, has some sort of human agency. This message is often conveyed to the rest of us by people who have survived some of most horrific experiences imaginable. This access to an individualized human existence is pretty obvious to most of us as children, but as we grow older we often shape our inner selves to match outer expectations, categorize people in various ways, and form impressions about ourselves and others that may not actually be true. We may even lose sight of our own essential nature. Regardless of how mysterious or undefined 'human nature' may be, and whatever it is, most of us would recognize it as being present in each of us. I think it's easy to recognize the presence of individualized agency in members of other species as well, but for the most part we will

Week	Due Date	Topics, Videos, Readings, Assignments
		focus our attention on human beings. I just wanted to begin the semester with this simple point: we should keep in mind the significance of each of us as a human being, while we look at how our common needs and unique aspirations play out in space and time. Many people, including of course academics and intellectuals, like to speculate on a grand scale about societies and cultures. It is often said, for example, that Western societies have a more 'individualized' focus, while Eastern societies have a more 'collectivized' focus. You can find any number of videos with titles like "Me or We? Cultural Difference between East and West". I do not recommend that you accept any claims of this sort without first carefully examining the facts and your own experience in a detailed way. If you do, I think that you will find, as I have, that assumptions of this kind are often misleading or just plain wrong, when you compare them to what you might witness directly in this rapidly changing real world. Unless you have personally examined these or any other social or cultural premises or claims very carefully, I do not recommend that you rely on them as fact. I've tried to choose our sources carefully, rejecting dozens of videos for each one chosen, based mostly on their superficial and stereotypical rendering of human life. Cultural ideas that guide social dynamics have far more depth and subtlety than we often recognize. For example, with regard to individual and collective responsibilities, Confucianism continues to have significant influence in East Asian cultures, but to describe it as a philosophy of 'we before me' is to falsify it entirely. The genuine respect for individualized agency in fulfillment of social responsibilities that emerges in these cultures can be far more significant than attitudes about the individual that emerge from cultures that prioritize individualized freedom over everything else, including even biology, social and environmental stability, and family life. Is the individual human being really more valuable to a society that promises us every individual freedom, but expects nothing from us, than to a culture that selectively inhibits freedom in the provision of stability, but recognizes value in each individual's fulfillment of their own personal responsibilities? Of course, the latter is a characteristic of many traditional societies, but it is clearly at odds with most popular thought that is promulgated through our social media and educational institutions. ## Topic 3: **The significance of place** The notion of 'place' in the psychological sense is one of the principal themes that distinguish Geography from some of the other spatial disciplines. We all know what having a 'sense of place' means, so we don't need to formally define it here. I'll let you explore the idea in your assignments. It clearly involves our impressions or memories of locations or environments at various scales, particularly if they have personal significance. Most of us can conjure up spatial memories of familiar places. Words can create a powerful sense of place, and this is one of the characteristics of great literature. But for purposes of this class, I would like you to consider the idea that recognizing the character of the actual places through which we navigate our lives will help us to better appreciate the real significance of some of our most difficult environmental and social challenges. These may involve the deterioration of what I call 'place stability'. The loss of a sense of place often results from economic or social collapse, displacement, and migration, accompanied by urban, rural, and environmental decay. Let's face it: when people are rootless, they are less likely to respect and set about improving the places they actually occupy. That's just how things are. I've had some good results having students examine street videos, i.e., un-narrated high quality videos

Week	Due Date	Topics, Videos, Readings, Assignments
		shot by people walking, biking, or driving around different neighborhood in the world. Ambient street videos shot without narration encourage a more immersive experience than more explicitly informative travel videos that tell you up front what's important or what someone else thinks about it.. I want to encourage you to use your own judgement when interpreting the topics of this course, and this is an entertaining way to start. Taking notes on what you can see and possibly begin to interpret from these sorts of videos is a good way of exercising your own perception of unfamiliar surroundings, and this will be helpful to you in later life. Of course, our initial impressions are often incomplete, but we have to start somewhere. In any case, I just think that it's generally better to form and build upon our own impressions of reality than to just accept someone else's because of their alleged credentials. Detailed examination of social and environmental issues is provided in other videos. Don't be afraid to be wrong when you write your impressions down for this class. As I discuss more fully in the syllabus, you are graded on how much work you put into this, as compared with your peers, and not on whether I happen to think you're right. Remember, I promise never to share your work with anyone. Be sure to read the section in the syllabus titled **Videos**. Since they are mostly on YouTube, you can view them either within or outside of Canvas. If you click on the hyperlink above a video rather than the video itself, it should open up in a separate browser. If the video indicates that it cannot be embedded, you will have to view it in a separate browser. You might also want to view the videos and other resources on a device separate from the one you are using to write with. When examining a video, you might want to swipe slowly or sample segments at intervals to get an overall impression, and then go back and watch those segments that seemed to be most informative. Keep any relevant homework questions in mind (listed at the end of the discussion), and get in the habit of pausing videos to write down notes. In order to address some of the questions, you might take more time examining a video than just watching one. By recognizing the psychological significance of 'place', we can more realistically appreciate the changes that populations around the world are likely to face in the coming years. We can look at how populations have responded in the past to sudden changes in their local environments, due for example to weather events or conflicts, and we can look at how they have responded to larger economic forces. For example, in week 4, we will see how the Great Mississippi Flood of 1927 triggered a migration of rural, mostly Black people from the South to Chicago and other the manufacturing centers of the north. In week 3, we will see how many of the resulting communities in what have recently been termed the 'rust belt', have fallen on hard times. As we examine the whirlwind of change to which humans are subjected, it helps to keep in mind that human beings live and work in places that are psychologically significant to us ### 3.1: **Case study: Tokyo** Let's conclude this discussion of the importance of place by taking a look at some neighborhoods within one of the largest and most successful metro areas in the world, Tokyo. As you examine the videos below, keep the following stats in mind. **Reference:** Why so few people drive in Tokyo https://brandondonnelly.com/2023/04/21/why-so-few-people-drive-in-tokyo/ • Only about 12% of trips in Tokyo are completed with a car, whereas 17% of trips are done with a bicycle. Most people walk and/or take transit. Tokyo has the most-used public transit system in

Week	Due Date	Topics, Videos, Readings, Assignments
		the world — about 30 million people each day. • Car ownership is about 0.32 cars per household. • 35% of streets are not wide enough to fit a car. If you add in streets that are wide enough to fit a car but not wide enough that a car could stop and not entirely block traffic, this figure jumps to 86%. • 95% of streets do not allow any sort of street parking — day or night. **Reference:** How Japan Won its 'Traffic War' https://www.bloomberg.com/news/articles/2022-09-06/what-drove-japan-s-remarkable-traffic-safety-turnaround "The absence of parked cars along curbs enhances children's ability to see and be seen while walking, and speed limits, which are typically 40 kilometers per hour (25 mph) in urban areas and 30 kph (19 mph) on side streets, are low by North American standards. Most urban streets are so narrow that drivers naturally keep to lower speeds. And with cities so dense, many people of all ages choose to walk — and drivers are used to encountering them." **Examine:** at least two of the following recently recorded videos, with question 4 below in mind. Tokyo Nishiogikubo Night Walk [magwalk] https://youtu.be/SYyyAZhyooM An ordinary residential neighborhood in Tokyo, Zoshigaya [magwalk] https://youtu.be/jR_tLwiujcc Tokyo Higashikurume Japan Walk [magwalk] https://youtu.be/pJEG-lX2Q80 Tokyo Rainy Night Walk in Shinjuku [VIRTUAL JAPAN] https://youtu.be/SiryvrStb8E
	08/27/24	**Homework 1:** Reminder: check each week for any new **Announcements.** 1. This is a question that has no wrong answer, although I would appreciate some thoughtfulness in your response. I suspect that some of you may appreciate my Sorcerer's Apprentice reference, and some of you may not. The COVID pandemic brought many issues, organizations, and personalities to the attention of the world, and I am curious about the sorts of information you may have received and/or accepted as true, and from which sources. Where did you get news regarding the possible source of COVID and methods of dealing with it, as well as organizations and individuals like the World Health Organization (WHO), the Centers for Disease Control (CDC), the National Institutes of Health (NIH), the National Institute of

Week	Due Date	Topics, Videos, Readings, Assignments
		Allergy and Infectious Diseases (NIAID), Anthony Fauci, Pfizer Pharmaceuticals, etc.? Don't worry about what I think. I find the whole topic of where our news and information comes from to be very confusing, and I will make no judgements. I'm just curious. Keep in mind, as I spelled out in the syllabus, nothing that you write for this class will ever be shared by me with anyone.. 2. Same question, but regarding the wars in Ukraine, Gaza, and elsewhere, particularly if different somewhat from #1. 3. Describe one or two places that are special to you personally. Do they have very general or specific bounds, in space? What comes up in your memory when you think about them? Is a particular time of the year or of the day more significant to you? Is the presence of certain people significant, or is it the surroundings, the vibe, sounds, smells, etc.? 4. Discuss a few things about the street scenes from Tokyo that you found to be interesting or unexpected. How do people get around? Do they demonstrate an appreciation of the places where they live, shop, and work, or do they not? If you had a local Japanese companion to help you out, do you think you could feel comfortable in these surroundings? You may organize your response to observational questions like this any way you'd like: in paragraph form, or as lists or informative bullet points, for example.
2		Topic 1: **Family, community, health, and well-being** Reminder: check each week for any new **Announcements.** Some of you may never work with remote sensing, geospatial modeling, hydrology, agriculture, or some of the other topics that we'll be covering soon. But it's probably safe to assume that you are concerned about your own families' well-being, and that you participate somehow in the life of your community. In general, the health and well-being of ourselves and of the people around us are important, and we have significant concerns should something go wrong. A course on population and global change could begin anywhere, but the best place to start, given current conditions globally, and given what we've experienced the past few years, is with the general confluence of family, community, health, and well-being. I want to underscore the essentially human dimension of this course by first discussing matters of human concern. So here goes. Although much of the world's media and political elite are doing their best to gaslight us about this, the available evidence strongly indicates that the COVID-19 virus and resulting pandemic had their origins in one of several viral selection and enhancement research programs that apparently remain active in the US, China, and other nations. Some gain-of-function research with known pathogens was shifted from the US to China several years ago when it was discouraged by US lawmakers. Regardless of where these activities took place, records released under the Freedom of Information Act requests clearly show that the developers of this virus received encouragement, participation, and funding from American scientists and administrators, and ultimately, unknowingly, from American taxpayers. All of this occurred under the direction of many of the same people who were subsequently tasked by the US with responding to the consequences. One of the most troubling aspects of the COVID-19 pandemic has been the lack of genuine interest by our own political, managerial, scientific, and media elite in determining the origin of this virus, or in making

Week	Due Date	Topics, Videos, Readings, Assignments
		any genuine effort to prevent it from ever happening again. This suggests that the same thing could happen again, and quite soon, for similar reasons, possibly involving pathogens that may already have been developed and that happen to lie dormant (for the time being) in a freezer somewhere in the world. We are being encouraged by the medical/ pharmaceutical industry to prepare for 'the next pandemic' and for a lifetime of synthetic vaccines and treatments for a potentially endless sequence of emerging pathogens that are eagerly anticipated the WHO. Is this state of affairs now expected to become routine? If so, why? The continuing dull-witted disinterest in these fundamental issues of survival by people who should know better indicates to me that most of the people involved in managing things in this nation and elsewhere are simply cowards, and they are clearly not really very intelligent. They would rather look the other way than jeopardize their own comfortable lives and careers, even at the potential cost of many more millions or billions of deaths. Instead, they attack their fellow citizens for political and cultural wrongthink. Many of the people managing things now would have done quite well for themselves working for Joseph Stalin, who reputedly said that, while a single death may be tragic, a million are merely statistical. I wonder how many of us are aware of the astonishing numbers of adverse reactions from experimental injected substances have been expected to endure - unproven, untested, new technologies that we are told not only to accept for ourselves and others, but, amazingly, at this late date, despite all the evidence, we are still being advised by our very own governments to inject into our children. If that is not dystopia incarnate, I don't know what is. If the experience of the last several years does not illustrate a profound crisis in science, I don't know what does. Last week, we walked around Tokyo, and hopefully you noticed a few things that you found interesting or unexpected. This week, we will look more closely at family, community, and the well-being of people in Japan, Korea, and China. These are sort of randomly picked, and there's no reason to stick with this region, but I wanted to connect with issues we will discuss later with the ideas last week about the individual and society. **Watch any two** of the following seven videos about family life, intergenerational issues, and demographics in East Asia, for question 1: The Dark Side of Japan: The Lost Generation [Explained with Dom] https://youtu.be/tgGvUNiykyU Population Crisis/The divorce rate is surprisingly high in post-90s in China [China Insights] https://youtu.be/24H7ltivcSY China's Falling Birth Rate: Can It Sustain The Rise To Superpower? [CNA Insider] https://youtu.be/r7dFoCbE5zU Japan's population drops by 644,000 in a single year [South China Morning Post] https://youtu.be/vFfNoqdnUGU Why South Korea's Seniors Are So Poor [Asianometry] https://youtu.be/fvkGOeLoZG4 How Japan Keeps Clean [Life Where I'm From]

Week	Due Date	Topics, Videos, Readings, Assignments
		https://youtu.be/BOGMkgnc2YY What a Japanese Childcare Centre is Like [Life Where I'm From] https://youtu.be/1qRfqboYWNo ## Topic 2: **Human development** Health and well-being are often tied to an idea from economics called 'human development'. **Reference:** Human development (economics) [Wikipedia] https://en.wikipedia.org/wiki/Human_development_(economics) **Reference:** Human Development Index (HDI) [UN Development Programme] https://hdr.undp.org/data-center/human-development-index#/indicies/HDI > "The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions… The HDI simplifies and captures only part of what human development entails. It does not reflect on inequalities, poverty, human security, empowerment, etc." **Watch:** What is Human Development? [UNDP Kosovo] https://youtu.be/HwgZQ1DqG3w **Recommended:** How can countries measure the well-being of their citizens? [TED Institute] https://youtu.be/4PkD4JebMAY **Recommended:** The economics of human well-being | Jan-Emmanuel De Neve [TEDxINSEAD] https://youtu.be/DV1ks-TLYoM ### 2.1: **UN global goals** The Sustainable Development Goals (SDGs) or Global Goals are a list of seventeen interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all". The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by 2030. They are included in a UN-GA Resolution called the "2030 Agenda", or Agenda 2030. Like many UN documents, the descriptions and discussions surrounding Agenda 2030 are open to interpretation. These goals can therefore be many things to many people. We should not disparage the economic focus on lifting people out of poverty, and all that entails, while recognizing the value of individual or group freedom from excessive control, which is perhaps not so often discussed. **Reference:** Transforming our world: the 2030 Agenda for Sustainable Development

Week	Due Date	Topics, Videos, Readings, Assignments
		https://sdgs.un.org/2030agenda Here are the shortened titles of each goal. 1: No Poverty 2: Zero Hunger 3: Good Health and Well-being 4: Quality Education 5: Gender Equality 6: Clean Water and Sanitation 7: Affordable and Clean Energy 8: Decent Work and Economic Growth 9: Industry, Innovation and Infrastructure 10: Reduced Inequality 11: Sustainable Cities and Communities 12: Responsible Consumption and Production 13: Climate Action 14: Life Below Water 15: Life on Land 16: Peace and Justice Strong Institutions 17: Partnerships to achieve these goals The following site contains descriptions and discussions of each goal. **Reference:** Sustainable Development Goals https://en.wikipedia.org/wiki/Sustainable_Development_Goals In the following interview, Nobel laureate in economics Professor Amartya Sen discussed the past and future challenges to development. I recommend any of Sen's published works. He is absolutely brilliant, and he argues in a very reasonable and convincing way. When asked about the Sustainable Development Goals, Sen emphasized that democracy and human rights are key factors for such goals to succeed. He talks about what makes for good development goals, which might not always be quantifiable. **Watch:** Amartya Sen on the Sustainable Development Goals [UNU-WIDER] https://youtu.be/LggTrGMygFY ### 2.2. **Digital health certification** The World Health Organization (WHO) has been trying to implement a worldwide Digital Health Certification system, based in part on a system that has already been developed by the European Union. The goal of this system is to maintain real-time vaccination and other health related records for all people on Earth, so that vaccinations, isolation, lockdowns, vaccine passports, and travel restrictions, and other emergency measures deemed appropriate by the WHO could be more universally and efficiently implemented in the future. The leaders from 20 countries at a recent G20 Summit signed a declaration which states they agree to adopt 'vaccine passports' for their citizens, in order to facilitate international

Week	Due Date	Topics, Videos, Readings, Assignments
		travel. The current membership of the G20 accounts for more than 66 percent of the world's population. However, there has been some backtracking as details emerge, and as opposition parties within some of these nations have their say. Thus far, the WHO has not been successful in convincing member nations to give up their sovereign rights concerning these issues. **Reference:** Digital documentation of COVID-19 certificates: vaccination status [WHO] https://www.who.int/publications/i/item/WHO-2019-nCoV-Digital_certificates-vaccination-2021.1 **Watch:** How a Digital Health Passport Could Work [Wall Street Journal] https://youtu.be/wz-nq2mxnaA **Recommended:** WHO's Global Digital Health Certification Network [Dr. John Campbell] https://youtu.be/ixnqF6vEufA Microsoft founder Bill Gates and the Gates Foundation have a huge influence on the WHO. They are its second biggest contributor, after the US. Big advocates of jabs, big pharma, and big agriculture. Why is this man so influential? **Reference:** How is the World Health Organization funded [Euronews] https://www.euronews.com/next/2023/02/03/how-is-the-world-health-organization-funded-and-why-does-it-rely-so-much-on-bill-gates > "While the shape of WHO's total budget has changed over the years, the Gates Foundation has consistently remained among its top contributors. In 2018-2019, the United States was the largest donor at $893 million, accounting for around 15 per cent of WHO's budget. The Gates Foundation came only second, with $531 million. Germany briefly overtook the US as the largest donor in 2020-2021 during Trump-era funding cuts, but the Foundation kept its second place. Other top donors include the UK and the European Commission." ## Topic 3: **Pharmaceuticals and substance abuse** Turn on a television in the United States, and if you tune to something that elderly people might watch, you are likely to see advertisement after advertisement touting newly developed pharmaceuticals, replete with shiny happy people. They might not even tell you what condition it is intended to resolve. Anyway, off-label use is actively encouraged, as we can see with the current popularity of Ozempic. No other nation on Earth allows this. The pharmaceutical industry's power in the United States is enormous, and it's obviously increasing. For many years, even before the pandemic, in case you haven't noticed, much of our news was "brought to you by Pfizer". The pharmaceutical industry contributes to both political parties. As a result, much of their criminal behavior is ignored or forgiven. Typical American attitudes towards drugs astonish me. Rather than try to do the hard work of trying to fundamentally resolve health or wellness issues, which often requires difficult changes in lifestyle, we are tempted, indeed encouraged, take substances that temporarily relieve symptoms, and leave it at that. As a

Week	Due Date	Topics, Videos, Readings, Assignments
		society, many of us seem to be confident in differentiating between legal and therefore good drugs, and illegal and therefore bad drugs. But reality does not conform to this simple prescription. Many powerful substances that are often bad for us, like alcohol and tobacco, are perfectly legal (and are heavily taxed by the government). And some illegal substances, when supervised, have been shown to cure alcoholism, drug addictions, depression, and other psychiatric conditions. But even research into their possibilities has been actively suppressed for decades. Our collective hypocrisy regarding the use and abuse of both legal and illegal drugs is easy to see and to point out, but unless we decide to confront both the causes and consequences of substance abuse, we will continue to see scenes like the following. Geographically, people who use opioid-like substances will live close to reliable supplies, and exchanges are made on the street. Therefore, particular neighborhoods or blocks will sometimes accumulate populations of people who are there for one purpose: to score. These people are often poor, homeless, and/or mentally or physically ill, and they might seek comfort in a few moments of oblivion because there seem to be few other choices, from their perspectives. At least that's part of it. In any case, we should not turn away from these scenes. This may continue to be a significant component of our confrontation with global change, unless we change something within us, as I see it. **Examine:** Philadelphia, Pennsylvania [Hoods N Hollers] https://youtu.be/r5ECaCBCboU **Examine:** Philadelphia Pennsylvania at night [Hoods N Hollers] https://youtu.be/vKPI8vvw3uA **Watch:** Crews clear out Philly's Kensington Avenue [NBC10 Philadelphia] https://youtu.be/TGEzdvlgM_Q **Examine:** Anything Changed after Cleanup? [Kensington Avenue Philadelphia] https://youtu.be/nXF2UhIlUgw **Recommended:** DEVASTATED Colorado's Fentanyl Disaster [Mountain Time Media] https://youtu.be/0yQ6P0Yc3HM
	09/03/24	**Homework 2:** Reminder: check each week for any new **Announcements.** 1. Summarize and discuss any two of the seven videos about family and demographics in East Asia listed above. Identify each by its title. If you'd like to include two more, label them as '1B' for extra credit or to substitute and address only three of the following. **Address any four of the following five questions.** 2. What is human development? What is human well-being? What are some ways in which these social characteristics have been or might be measured? Do you think it is fully possible to accurately quantify human well-being across all cultures identically?

Week	Due Date	Topics, Videos, Readings, Assignments
		3. Do you think it would be possible to achieve agreement between nations on the implementation of the UN's sustainable development goals? Which goals do you think might be more difficult to legislate across cultures? Which might be interpreted differently by different nations and cultures? What might result, for example, from the enforcement of some of these sustainable development goals as interpreted by authoritarian regimes? What do you of Dr. Sen's argument that democracy is a key requirement for successfully sustainable development? Has this been properly addressed by the UN? 4. How might an international Digital Health Passport be implemented, and for what reason? Given the World Health Organization's own response to COVID, do you think digital health certification as administered by the WHO would prevent, stop, or help to find and eliminate the cause of any future epidemics? Why or why not? 5. Should a sovereign nation like the US give up its rights to decide whether to let its citizens travel, whether and how often to require its citizens to be vaccinated, and by what, and whether to lock down entirely, based on the authority of the World Health Organization? Why/why not? Do you think a worldwide system of digital health documentation for all human beings is a good idea? Why/why not? 6. Given current policies, how successful to you think Philadelphia and other cities will be in overcoming public substance abuse and the social issues that result? At a minimum, please reference the Kensington Avenue videos and provide your impressions of this public face of substance abuse.
3		Topic 1: **Urban life** Reminder: check each week for any new **Announcements.** Probably the most common trend throughout the world is the massive, relentless move of people away from rural areas and into cities of ever increasing size. Cities do often grow in part from the pressure of population growth, but economic, political, and cultural forces influence their growth as well. In other words, cities are growing even within nations that are not experiencing population growth. Urbanization often co-occurs with the depopulation of the rural countryside, which is a co-phenomenon that is often neglected. In addition, many rural areas around the world (including prime farmland) are being urbanized. Largely as part of this trend, but also as a result of greater food requirements worldwide, greater numbers of people are now living, and more intensive essential agriculture is occurring, in coastal environments. 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. The significance of 'place', which we discussed in week 1, certainly applies to the ways different sorts of urban environments can influence people's mental and physical health. Living one's life in a crowded, treeless refugee camp will certainly result in a different sort of outlook on things than living in peace and comfort, surrounded by a nurturing and abundant nature. I don't know why this never comes up in discussions of the radicalism of populations that live under such stressful or soul-crushing conditions.

Week	Due Date	Topics, Videos, Readings, Assignments
		1.1: **Megacities** The Greater Tokyo Area is currently the most populous metropolitan area in the world, with around 39 million people. I think that most of us would agree that the Japanese and Koreans have done a pretty good job of making their urban environments livable (each in the wake of wartime destruction), so I think it's a good idea to keep places like this in mind as we explore the world. A great many urban environments are surprisingly lovely, but they unfortunately remain exceptional in much of the world. **Recommended:** Japan Night Aerials in 8K [Armadas] https://youtu.be/6k7a8bw451M The following two videos present some extraordinary predictions regarding the likely locations and sizes of the world's largest cities by 2030 and 2100. Keep in mind that these projections do not include the tendency for cities to form larger extended metropolitan areas around them. So these numbers might grow much bigger, depending on a number of factors. **Watch:** Top 10 Largest Cities by 2030 [The B1M] https://youtu.be/N-_a0TCWb6E **Watch:** Top 10 Largest Cities by 2100 [The B1M] https://youtu.be/9OulEjWI-bE The following documentary provides a good overview and specific examples of current and developing megacities around the world. Not required viewing. **Recommended:** MEGACITIES of the World (Season 1 - Complete) [TDC] https://youtu.be/0ULzxD3w_c8 Topic 2: **Building upward** Regardless of their relative size, many large cities throughout the world contain regions of very high density. These are often densities with which we in the United States are generally unfamiliar. Most uf us would be very uncomfortable living for an extended period of time under such conditions. **Watch** from around minute 5, to the end: A walk and talk around a traditional 'urban village' in Shenzhen, China [Eric G] https://youtu.be/PPV0nG98Ihs As renewal must occur, where do all of these people go? For many nations, it is unlikely that they would be spread around suburban-style. Land is expensive, and it's not easily available. It is more likely that densities will be maintained in these neighborhoods by building upward, into the third dimension. Modern construction technologies and materials make this possible on a large scale.

Week	Due Date	Topics, Videos, Readings, Assignments
		In East Asia, for example, new urban development often includes neighborhoods of very tall residential blocks. This represents an astonishing change in the lives of a great many people. Imagine moving from a village or even a five-floor walkup into a new apartment on the 38th floor? The largely unwritten history of the development of reliable elevators, HVAC, modern plumbing, and other significant advances in construction technologies is enabling the creation of neighborhoods where people have mostly **walking** access to restaurants, shops, parks, and entertainment from their homes. It does seem possible that people in highly populated urban spaces of this kind can actually feel a greater sense of freedom from the costs of traveling and better access to goods and services. But it would certainly take some getting used to, I think, for most of us. Clearly, a respectful and law-abiding population is required for something like this to work. **Examine at least two** of the following four videos: Huaguoyuan, Guiyang, China, one of the largest residential area in Asia [Wang's record] https://youtu.be/Zvq9pybXg-4 People's life in Guiyang Huaguoyuan on a rainy day [Wang's record] https://youtu.be/Vf0dsRuRZWE An apartment complex for 500,000 in Guizhou Province, China [CN Walking] https://youtu.be/YuwZLyQEIh0 Songdo Central Park in Incheon, South Korea [Seoul Trip Walk] https://youtu.be/XP36tRBFbbU ## Topic 3: **Urban decay** In the natural world, life and growth are accompanied by decay. Despite their human origins, cities are no exception. Symptoms of decay in roads, civil infrastructure, homes, industrial sites, etc., through either use or neglect can be found nearly everywhere in the world, but their circumstances can vary widely. Urban decay often results from local or regional economic decline or collapse, as production shifts elsewhere and jobs are lost. As long as there have been cities, there has been urban decay and renewal. In many locations throughout the world, entire cities have been built upon the stones that remain of the ruins of earlier cities. The South Bronx is one example of decay and renewal that I personally saw happen in the space of a couple of decades. **Examine:** Harlem and the South Bronx in the 1970s and 1980s, compared with today [CharlieBo313] https://youtu.be/a1RCWCQ_6mo The street scenes listed below are from major cities and small towns, mostly in the rust belt states. We certainly could have included many examples from California, but I wanted to underscore the national extent of this problem. So-called 'flyover country' is where much of our food, energy, and manufactured

Week	Due Date	Topics, Videos, Readings, Assignments
		goods have come from. One thing that you should notice is that most of the homes in these videos were very well-built, and many of these were clearly originally quite beautiful. Had they not fallen into neglect, they would have remained so. **Examine at least three of the following videos:** Detroit, Michigan [Hoods N Hollers] https://youtu.be/RL8ME09602E Cleveland, Ohio [Hoods N Hollers] https://youtu.be/NxaruDP7HDc Chester, Pennsylvania [Hoods N Hollers] https://youtu.be/vYDdaOdVnHw Steubenville, Ohio [Hoods N Hollers] https://youtu.be/_tXgZyEynNA Cincinnati, Ohio [Hoods N Hollers] https://youtu.be/5wNqgn9RJ24 Brownsville, Pennsylvania [Hoods N Hollers] https://youtu.be/ptcgdJyE4g8 Camden, New Jersey [Hoods N Hollers] https://youtu.be/szRfMq-_614 Youngstown, Ohio [Hoods N Hollers] https://youtu.be/MQoc0pnwRKI East Liverpool, Ohio [Hoods N Hollers] https://youtu.be/OpyF_iq6d74 **Watch either one of the following two videos:** America's Fallen Cities: Cincinnati [Alexander Rotmensz] https://youtu.be/AClP40c7OcY America's Fallen Cities: Buffalo [Alexander Rotmensz] https://youtu.be/OQd4N7pW4MQ It is understandable why cities and towns in the Rust Belt and elsewhere have fallen on hard times. But economic factors are not the only consideration. Social and cultural change can have a significant impact. There may in fact be no reason, economically speaking, for a city to decline. We do not normally think of cities like San Francisco as having fallen. But in many ways, even our supposedly prosperous cities are not doing well. I think it is important to document and recognize these issues. If we turn away, they will certainly get worse.

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		Examine at least three of the following videos These are Leo's original titles, in chronological order. 'Every store' often means 'nearly every store'. Essentially the same. every store is CLOSED in Embarcadero San Francisco [METAL LEO] Jul 6, 2023 https://youtu.be/ILAYlTLdGvA every store is CLOSED on market st San Francisco [METAL LEO] Jul 27, 2023 https://youtu.be/5UWIyGDnHmk every store is CLOSED on mission St San Francisco [METAL LEO] Feb 23, 2024 https://youtu.be/A0Knxo7M04I every store is CLOSED in union square San Francisco [METAL LEO] Mar 8, 2024 https://youtu.be/McnjpZBeqd4 every store is CLOSED around Oracle Park San Francisco [METAL LEO] Mar 17, 2024 https://youtu.be/mLAE3d8LkhA every store is CLOSED on lombard st San Francisco [METAL LEO] Mar 22, 2024 https://youtu.be/AvPYSLL1zeI every store is CLOSED in Ocean Ave San Francisco [METAL LEO] Mar 29, 2024 https://youtu.be/myP8ppKKQnU San Francisco fisherman's wharf SHUTTERED [METAL LEO] Jun 22, 2024 https://youtu.be/lDcVyuVylYE fisherman's wharf SF and north beach DESERTED [METAL LEO] Jul 6, 2024 https://youtu.be/qQdjksr4t14 San Francisco stores LOOTED to EXTINCTION embarcadero [METAL LEO] Jul 27, 2024 https://youtu.be/ezgdCXpIdEU It's not only San Francisco that Leo's been documenting: every store is CLOSED in Berkeley [METAL LEO] Sep 16, 2023 https://youtu.be/Lv89eQqZ_6Q every store is CLOSED in San Jose [METAL LEO] Sep 1, 2023 https://youtu.be/kysFYKbqDyY every store is CLOSED in Oakland [METAL LEO] Aug 19, 2023 https://youtu.be/Hf36qNx_wm4

Week	Due Date	Topics, Videos, Readings, Assignments
		every store is CLOSED in HOLLYWOOD [METAL LEO] Apr 14, 2024 https://youtu.be/q-3c76f0USE every store is CLOSED in Los Angeles"[METAL LEO] Apr 13, 2024 https://youtu.be/I1-twsYoXgg DOWNTOWN Los Angeles COLLAPSED [METAL LEO] Apr 20, 2024 https://youtu.be/BZeidT2ZX9o Topic 4: **Urban renewal** For an already established urban neighborhood, the flip side of decay is renewal, and whether this happens also depends on economic, social, and political factors.. Renewal might occur in a decentralized manner, with governmental encouragement (but not full control), and with many people and businesses providing the work required to get it done. Or it may occur in a centralized manner, involving governmental funding, professional planning, vast sums of money, and often the total replacement of entire neighborhoods. Both approaches can succeed, and both can fail. Several efforts over the decades to renew Detroit, for example, have shown dismal results. A variety of approaches to urban renewal are being pursued worldwide, often regardless of the character of a nation's government, but often dependent on the availability of funding. **Watch either one of the following two videos:** America's Rising Cities: Savannah [Alexander Rotmensz] https://youtu.be/U_jJgOP6TW0 America's Rising Cities: Charleston [Alexander Rotmensz] https://youtu.be/DeXzUjYTPUY 4.1: **Case study: Seoul, South Korea** Within a typical city, open water and trees can make the microclimate significantly cooler in the summer, counteracting to some extent the Urban Heat Island effect. Evaporation and transpiration are our friends. I studied the situation rather closely for Beijing and Shanghai, my impression is that these and other cities in China and elsewhere would already have been significantly hotter without the re-establishment of healthy, flowing bodies of open water, and the growth of urban trees. 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.

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		Watch: How a City Demolished a Freeway to Restore an Ancient River System [Leaf of life Films] https://youtu.be/-I5qMDCcvTI **Examine:** Cheonggyecheon and surrounding scenery at sunset [Bau Walk] https://youtu.be/YNEymTSjpYA **Examine:** Cheonggyecheon in the Evening (Sep.2021) [4K Korea] https://youtu.be/LqEnkG5LY9k Mullae is a neighborhood in Seoul that used to produce steel and other metal parts and finished products in a large number of mostly small shops. These sorts of heavy industries have been in the process of moving out of the city for some time, but some hang on, since there is always a market for specialty items. However, the building and infrastructure are decaying, and someday the entire neighborhood may need to be replaced. But for now, the neighborhood is being populated by restaurants, cafes, studios, and workshops, as artists take over some of the disused metal shops. Reference: Mullae-dong [Wikipedia] https://en.wikipedia.org/wiki/Mullae-dong > "The neighborhood is most well known for its industrial factories. Because the neighborhood is one the least gentrified areas of Seoul, a lot of factories that manufacture a variety of goods from textile to steel are present… In fact, there is a street nicknamed "steel factory street" due to the abundancy of Metal fabrication factories…. Mullae-dong is also known for art. Numerous art studios, in which art exhibitions are sporadically conducted, as well as metal sculptures and commercial graffiti, can be found around the neighborhood." Is this combination so surprising? The idea that manufacturing and art are two entirely different worlds does not seem to recognize the importance and centrality of what we might refer to, in an utterly non-gendered way, as 'craftsmanship'. In particular, any artist dealing with physical forms, from sculpture to architecture, requires many of the same tools, skills, and research as does the manufacturer of common goods "from textile to steel". What should an artist who wants to learn how to work with metal do? Why not try to work near or with older crafts people on the verge of retirement who had managed to make a living and support a family on the basis of the local, small-scale production of manufactured goods? **Examine at least two of the following three videos:** Mullae Art Village by day [Walking On] https://youtu.be/s4_aU_46c1I Mullae Artist Village by night [Roaming Walker] https://youtu.be/Dwx32eh9M6Y A walk through the alleys of Mullae at night [kamain / 4k walk / korea] https://youtu.be/EYJXu2kRiJE

Week	Due Date	Topics, Videos, Readings, Assignments
	09/10/24	**Homework 3:** Reminder: check each week for any new **Announcements.** 1. List the projected numbers of people that will be living in each of the ten cities listed for 2030, and comment on at least three of them. Do you find this trend surprising in any way? Compare them to the numbers living in the world's largest cities today. 2. List the projected numbers of people that will be living in each of the ten cities listed for 2100, and comment on at least three of them. How have things changed since 2030? Has there been a shift, geographically? 3. The videos in the 'Building upward' discussion portray high-rise neighborhoods in China and South Korea. Describe the general vibe and in at least one of these locations, and whether you might feel comfortable living there, if you had a local companion, Assume you have no car and would generally have to get around by foot, bike, and public transportation. **Address any two of the following five questions.** 4. Urban (and rural) decay is not new, as the street scenes shown above from the 1970s South Bronx illustrate. Residential buildings have a limited lifespan, which depends of course on how well maintained they are. Over time, larger economic forces can destroy a neighborhood through mere neglect. Residents are left to fend for themselves, which often means moving away entirely. Give your impressions of three of the cities whose streets are portrayed in the [Hoods N Hollers] videos above. Using Wikipedia as a reference by searching within it for the city itself, provide a short history of at least one of them 5. Discuss what you learned about either Cincinnati or Buffalo from the [Alexander Rotmensz] videos on America's fallen cities. 6. Did Metal Leo's videos surprise you? Why do you think there are so many closed stores, banks, restaurants, and other businesses in major California cities? What can or should be done? 7. Discuss what you learned about either Savannah or Charleston from the [Alexander Rotmensz] videos on America's rising cities 8. Discuss the Cheonggyecheon River and its restoration project. How does this stream compare with urban streams with which you may be familiar, or may perhaps have ignored until now? What are your impressions of Mullae Art Village? Do you think this sort of temporary renewal of urban spaces for art and entertainment might be possible here?

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4		Topic 1: **Water resources** Reminder: check each week for any new **Announcements.** Of all the substances upon which human populations depend, fresh water stands supreme. Deny a population of water, and it will perish within days. Water is easily contaminated, and it is difficult to clean. It is not surprising therefore that settlements, cities, and civilizations of the past have often positioned themselves to best provide their populations with continuous sources of fresh water. The methods that have been developed around the world over thousands of years to capture and store water are often quite impressive. On the other hand, flooding has taken massive tolls on cities, settlements, and farms. Many ancient historical documents describe stories of both droughts and floods. Some of the most immediate indicators of climatic change involve modifications to the hydrological cycle. It makes sense therefore to begin our look outward with an admittedly selective look at water resources. **Watch:** Is the world's fresh water supply running out? [PBS NewsHour] https://youtu.be/iVcTQdOJMMw Each nation is unique in terms of its water resource challenges, a how they are tied to economic, agricultural, industrial, and urban concerns. Let's take a selective look at Egypt, Iraq, and China. **Watch:** any two of the following three videos **Egypt** Is A Ticking Time Bomb [Good Times Bad Times] https://youtu.be/Ar5e6Rl3X5Y **Iraq** is dying (skip over the embedded ad from 2:00 to 3:40) [Caspian Report] https://youtu.be/OqH_Wi5rcfw Why **China** is Running Out of Water [Arkive] https://youtu.be/TcC2MigiFEI Every major city in every developed nation has had a history of water supply solutions. Of all the cities I've lived in, I would say that New York City's water is the best. But this hasn't been easy. **Watch:** The Simple Genius of NYC's Water Supply System [Wendover Productions] https://youtu.be/IDLkOWW0_xg 1.1: **The Great Mississippi Flood of 1927** Floods have plagued humankind for as long as there have been agriculture and settlements. They have brought about mass migrations, a topic we will be discussing later. And these patterns of migration have served to define the character and subsequent history of nations. For example, in the United States, the 'Great Migration' of Black descendants of former slaves from Southern farmland to manufacturing work in the North and Midwest, was triggered by the Great Mississippi Flood of 1927.

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		From Wikipedia: "The Great Mississippi Flood of 1927 was the most destructive river flood in the history of the United States, with 27,000 square miles inundated in depths of up to 30 feet over the course of several months in early 1927… About 500 people died and over 630,000 people were directly affected; 94% of those affected lived in Arkansas, Mississippi, and Louisiana, especially in the Mississippi Delta region… More than 200,000 African Americans were displaced from their homes along the Lower Mississippi River and had to live for lengthy periods in relief camps. As a result of this disruption, many joined the Great Migration from the South to the industrial cities of the North and the Midwest." **Reference:** High Water Everywhere [Wikipedia] https://en.wikipedia.org/wiki/High_Water_Everywhere From Wikipedia: "'High Water Everywhere' is a Delta blues song recorded in 1929 by noted blues singer Charley Patton…The Great Mississippi Flood of 1927 devastated large parts of Louisiana and the Mississippi Delta, the home of Patton and many other early bluesmen. The flood exposed inequalities in the treatment of African Americans, and its outcome was a contributing factor to the exodus of many blacks to northern cities. Patton's lyrics include: 'I would go to the hill country but they got me barred' Patton was likely referring to the levee in Greenville, Mississippi, where black people were held in the aftermath of the flood and not allowed to leave. They were bound to the custody of the landowners for whom they served as sharecroppers and could not go where they wanted to. The song features Patton's intense vocals and rapid beating on the guitar body. It is regarded as one of the finest of his recordings and considered by some his magnum opus." **Recommended:** High Water Everywhere, Pt. 1 [Charley Patton – Topic] https://youtu.be/YKuq7p5MJ8E **Recommended:** High Water Everywhere, the Americans with Taj Mahal) [The Americans] https://youtu.be/LURh8xTXoWg **Reference:** When the Levee Breaks [Wikipedia] https://en.wikipedia.org/wiki/When_the_Levee_Breaks **Recommended:** When the Levee Breaks [Memphis Minnie & Kansas Joe – Topic] https://youtu.be/WSlt8-fmvas You may have already heard the following version of the song. This video includes a slide show of photos from the flood, with lyrics. You might want to turn down the volume. Or you might want to turn it up. **Watch:** When the Levee Breaks [Plumbum Zeppelin] https://youtu.be/eIn-IxY2kTI

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		 I worked for a couple of years at National Operational Hydrologic Remote Sensing Center (NOHRSC) (https://www.nohrsc.noaa.gov) 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. Let's conclude with a brief look at our local water. The reservoir closest to San Jose is the Calaveras Reservoir. Unfortunately, the reservoir and the land around it are closed to recreation. Here's a short

Week	Due Date	Topics, Videos, Readings, Assignments
	09/17/24	video that I shot from the public road. **Watch:** Calaveras Reservoir [Gary Pereira] https://youtu.be/_EqehbxjfUk **Reference:** Bay Area: Do You Know Where Your Water Comes From? https://www.kqed.org/news/11886536/bay-area-do-you-know-where-your-water-comes-from-2 **Homework 4:** Reminder: check each week for any new **Announcements.** 1. What is the general state of the world's freshwater supplies? Which regions or locations seem to be most vulnerable? What important source of fresh water worldwide do we know the least about? **Address any four of the following six questions.** 2. Describe the fresh water issues and their connections to planning, economics, trade, and politics for Egypt, based on the video provided. 3. Describe the fresh water issues and their connections to planning, economics, trade, and politics for Iraq, based on the video provided. 4. Describe the fresh water issues and their connections to planning, economics, trade, and politics for China, based on the videos provided. 5. Describe the history and development of New York City's Water Supply System, according to the [Wendover Productions] video. 6. What was the significance of the Great Mississippi Flood of 1927 in shaping American History? 7. What are some of the sources of fresh water for the Bay Area?
5		Topic 1: **Agriculture and food security** Reminder: check each week for any new **Announcements.** Although we won't be covering the ecological sciences in this course, it is important to remember the ecological basis of all of human life. The ecological sciences are relatively new, but much of the natural biological world and our relationship to it were 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. Now, with much larger populations, and with worldwide trade in food and fertilizer, we are encountering emerging challenges that require new approaches. The most prominent interface of the human species with the natural world is through agriculture, as well as ranching, fishing, and aquaculture.

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		Due to time constraints, we will concentrate on agriculture. It is often said that the current world population could not possibly be sustained without the production and use of chemical fertilizers and other methods of increasing yield, often at the expense of the land. As I see it, the cultures of growing food are under threat around the world. ### 1.1: **Soil and agricultural health** Throughout the world, people depend on agriculture for their survival. Agricultural output and quality in turn depend on water, soil, and nutrients. The composition of the soil itself influences its ability to retain water and nutrients. Many crops can thrive in temperatures that make humans uncomfortable, so long as they have water available for effective transpiration. Nitrogen (N), phosphorus (P) and potassium (K), the three main nutrients, are often added as fertilizer, but soil health itself is a complex function of the mineral structure, microbiota (including bacteria and fungi), and the presence of other substances taken up and processed by crops: nutrients like calcium, magnesium, and sulfur, and trace elements like iron, zinc, copper, manganese, boron, and molybdenum. In addition, the soils of the world have functioned as a carbon sink. Under the right conditions, they can remain so, but most human manipulation of the soil, including agriculture, results in a loss of carbon to the air. This is one important aspect of the relationship between climate and agriculture. Although agriculture is currently a significant contributor of atmospheric carbon (through soil deterioration, energy use, and fertilizer production, for example), it need not be. Although crops grown in soil amended by N, P, and/or K fertilizers often look healthy and strong, they may lack nutrients and elements like iron, zinc, and copper, which provide crops (and animals that eat them) with particular health-giving properties. We are increasingly eating plants (and meat) that have been deprived of important nutrients, as agricultural soils deteriorate essentially worldwide. A big challenge in coming years, as conditions become drier for many agricultural regions, is in trying to improve a given soil's ability to hold onto water and nutrients. Some suggested solutions, like non-toxic hydrogels, are fairly new, while others, like biochar, are thousands of years old. The human use of biochar in central Amazonia is probably responsible for the large regions of black earth that have been found there. **Watch:** What is Biochar? [Carbon Gold] https://youtu.be/7qVcEvKEfGc **Recommended:** Soil carbon sequestration: How can we increase carbon stocks in deep soil? [AGU] https://youtu.be/1tE7FYxBBdQ ### 1.2: **What is the future of farming?** Currently, we have two general trends at play. We have planners, who 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

Week	Due Date	Topics, Videos, Readings, Assignments
		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. **Watch:** The Future of Farming [The Daily Conversation] https://youtu.be/Qmla9NLFBvU 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 favorably attitude shown regarding the migration worldwide of people from dispersed rural communities to dense urban centers, which we've already examined. On the other hand, we have a significant and growing trend among 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. 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. **Watch:** The Future of Agriculture [OECD Trade and Agriculture] https://youtu.be/uAM4Si_WhDk **Watch:** How to feed the world in 2050: actions in a changing climate [CGIAR] https://youtu.be/gjtIl5B1zXI 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. **Read:** An Open Letter to Bill Gates on Food, Farming, and Africa [commondreams.org] https://www.commondreams.org/views/2022/11/10/open-letter-bill-gates-food-farming-and-africa **Recommended:** China's grab for the UN's Food and Agriculture Organization [DW Documentary] https://youtu.be/gOOyOWsQy-E **Watch:** What is Precision Agriculture? [PostHarvest Technologies] https://youtu.be/3E8yHlGhEdk **Recommended:** How data-driven farming could transform agriculture | Ranveer Chandra https://youtu.be/dpVylFjT-Cw

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		1.3: **Cultures of food production** After attending the University of Oregon in the 1975 summer session, I worked for a couple of weeks in an orchard in Hood River County, Oregon, picking apples. This is not easy work. You need to climb ladders, pick everything within reach, and fill heavy aprons, and then you have to climb down and dump the contents carefully into large bins. At the time, I got paid $7 per bin. I was terrible at it. Working alongside me (and far more efficiently) were entire families of migrant workers. So I became aware early in my life of the tremendous work ethic of migrant farm workers, doing what we normally don't watch people do, and of the uncertainties (regarding, for example, health care and education) that they must always live with. Paradoxically, despite the recent influx of people though the southern border, farmers in the US are having an increasingly hard time finding people to help with the harvest each year. But agriculture in the United States and worldwide is being increasingly captured by moneyed interests, which would like to replace farm families and migrant workers with robots and drones if they could. The assumption among nearly all planners of future agriculture is that people would rather occupy their time doing anything other than producing food. If true, this may be one of the factors driving the relentless growth of cities. But what if the planners have got it wrong? I would liken real agriculture to gardening. I've known plenty of people who have derived psychological benefit from gardening. I've also met a few farmers, psychologically grounded people despite the anxiety of doing business. Other activities from which such psychological benefits flow include activities like land or wetland restoration. Even if you just spend most of your time pulling invasive weeds, these activities require you to interact with soil, microbes, fungi, insects, the presence of large animals and plants, and life and death, at every moment - something you can never do in even the most advanced video game. Over a period of years, gardeners can develop a sense of how they should work with natural ecological processes. Good gardeners might get a sense of how the soil itself changes, and even if they start out with poor soil, it can become rich with its own organisms, and retain moisture and nutrients over time. Over the years, a gardener might find a greater diversity of beneficial organisms, fewer troublesome ones, and helpful 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 and the right approach is encouraged. The following video is about a farming education program here in the US that is run by associates of 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. I present it as an example of the true cultural roots of agriculture that are beginning to be appreciated throughout the world. . **Watch:** Wendell Berry Farming Program [Religion and Ethics NewsWeekly] https://youtu.be/vGG5BED6dZI **Watch at least two of the following:** Ashland's Story | Wendell Berry Farming Program [Sterling College] https://youtu.be/wS9HrvIlOGk Lizzie's Story | Wendell Berry Farming Program [Sterling College]

Week	Due Date	Topics, Videos, Readings, Assignments
		https://youtu.be/iIoKiv-zQB8 Emily's Story | Wendell Berry Farming Program [Sterling College] https://youtu.be/c50alkjVSdo Gabriel's Story | Wendell Berry Farming Program [Sterling College] https://youtu.be/pJEVG6EN1Ww Hannah's Story | Wendell Berry Farming Program [Sterling College] https://youtu.be/UIqR6zwrs7s **Reference:** 'Introduction' and 'Nature as Measure', from Bringing It to the Table, edited by W. Berry. From Wendell Berry's 1989 essay, 'Nature as Measure': "The singular demand for production has been unable to acknowledge the importance of the sources of production in nature and in human culture. Of course agriculture must be productive; that is a requirement as urgent as it is obvious. But urgent as it is, it is not the first requirement; there are two more requirements equally important and equally urgent. One is that if agriculture is to remain productive, it must preserve the land, and the fertility and ecological health of the land; the land, that is, must be used well. A further requirement, therefore, is that if the land is to be used well, the people who use it must know it well, must be highly motivated to use it well, must know how to use it well, must have time to use it well, and must be able to afford to use it well. Nothing that has happened in the agricultural revolution of the last fifty years has disproved or invalidated these requirements, though everything that has happened has ignored or defied them." ### 1.4: **Revisiting socialized agriculture in northeast China, 1968 - 1972** Now let's take an extended look at another farming experience 50 years ago, under very different social conditions. In 2018, I documented the reunion of a group of junior high school classmates who, instead of going to high school, had gone off as a group in 1968 to serve as agricultural workers for the Chinese Cultural Revolution. The stated intention of the 'Down to the Countryside' movement in China was to have young people learn directly from farmers and others, while helping as much as they could with labor. A hidden intention was to separate them from the harmful influence of older 'red guards,' whose uncontrollable behavior was becoming increasingly violent. So this shows another side of the Cultural Revolution, one that few Westerners have heard about, and that people are still proud of having participated in. The part of the reunion portrayed in the video I produced occurred in the village in China's Northeast where they had been sent in1968. But first, take a look at this archival film that shows a similar group of students from the same city, Changchun, who left from the same station, at about the same time as our group. This video also shows others who continued to live and work in the city, but who took day trips to nearby farms to help with the planting and harvesting. **Watch:** 1960s China, Students Leave City to Help on Commune Farms [thekinolibrary] https://youtu.be/t4Dpo__a-Bg

Week	Due Date	Topics, Videos, Readings, Assignments
		The discussion below accompanies my video: **Watch:** Down to the Countryside: a fifty year reunion [Gary Pereira] https://youtu.be/d1nywzYowiI Once the train deposited our group in the rural agricultural town of Dehui in 1968, they were conveyed to their designated village using the principal means of transport at the time, horse-drawn wagons. After they arrived at their designated destination, members of the community provided temporary quarters and helped them to 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 10^0 F for long periods of time. It's much like the northern plains, in our Midwest. As you can see from the video, homes in the region are simple and follow the same general plan. The front entrance is often at or near the center front, and once inside you can go straight through to the kitchen, or 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 in that region because it is the source of heat. Exhaust from the oven and stove is channeled through sealed stone 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 of the kangs, which slowly release it over the course of the night and are often used as sleeping platforms. The region around Dehui is not excessively hot in the summer, due to its latitude and the presence of vegetation and water in the environment. Passive solar building techniques help to keep the inside air temperate and clean. The floor plans of the homes in the village don't seem to have changed much since 1968, but some of the building materials have. In 1968, only poor quality dried mud bricks were available for building homes. Baked bricks were a luxury. Since bricks that haven't been baked tend to crumble and break at the edges, they often had to be lined with wood to keep them intact. These days, permanent fire-hardened bricks and masonry are used. In 1968, roofs were made of thatch. They worked well in insulating homes from both heat and cold, but had to be replaced quite often. Thatch is no longer used for roofing homes, although it is saved and used for other purposes. There was limited access to electricity in 1968, but now everyone is on the grid, and cellular internet access is available. The outhouses remain outdoors. By modern standards, this village remains a relatively poor place. But for many people who still live there and in places like this, it is a cherished home. During the Cultural Revolution, the number of years each student was required to stay in the countryside depended on that person's class and family background. Her professor father having been sentences for wrongthink, Cheri stayed the longest in our group: 3 ½ years. Other than food essentials, very little was available locally. Dehui was a long, full day's journey from their homes in Changchun, and they had to pay their own way when travelling. Individuals might save some of the very little money they earned in order to make the journey every few months, and they might return with a few supplies and treats not available in Dehui. China had opened its first tractor factory in Changchun in 1958, but very few agricultural machines were available in China for many years, and a great deal of human labor was still required for planting and harvesting. The main source of energy, transport, and non-human labor at the time in the region in question was horses. Horses pulled both wagons and plows. Crops were harvested by hand, without

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		gloves. The main crops in the region were corn and soybeans. A portion of the corn could be consumed locally, but the soybeans were all 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 also ate sorghum, or 'kaoliang'. As you can see from the video, sorghum is a very tough grain. Although nutritious, it can be difficult for people 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 throughout China for fiber. Hemp can still be found growing wild, or decoratively in yards. It's easier to deal with than bamboo. In 1968, each household produced its own vegetables, a little meat (generally poultry), and chicken and duck eggs. Many still do. The host for this reunion was one of the villagers who as a young man 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 in the white shirt in the video. As you can see from his home garden, he has a green thumb. There were lots of beneficial ladybugs, and no visible chemicals. He appears to be in excellent health, and is well into his 70s. Fifty years ago, wintertime meant different sorts of work for the students. When the watery bogs and depressions had become partially frozen and could therefore be worked by hand, they helped the villagers haul out some of the rich organic material that had accumulated over the years. This material would be worked into the fields later in the spring, when the ground had thawed. Although snow accumulates in that region all winter without melting, the roads were never plowed. Snow had to be cleared by hand, or trampled by horses. Fuelwood was gathered and dried out to supplement their small 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. In 1968, home and personal goods were hard to come by, and there were no stores close by. You would have to walk or hitch a wagon ride with a friendly villager to a government depot several miles away just for basic necessities. Even today, these households remain relatively isolated from the nearest stores, but as you can see from the video, merchants do travel up and down the road peddling various things. In my other courses, we discuss other aspects of the Chinese Cultural Revolution. I didn't want to get into all that here, because the main points I want to make are agricultural and social, not political. Very terrible behavior and crude modes of thought were generated, for sure, but this group was quite young when all of that was happening. Their politics was simple. They were not like the hotheads attending universities, who had set about turning everything upside down. When their schools were shut down at the end of their middle school years, these kids just wanted to help, and they would remain together. They were judged by authorities on the basis of their family background, and they were quite aware of it, since it determined the length of their stay in the village, but they did not judge one another on that basis. They commiserated with one another. The group we discussed here had remained friends for life. One marriage had resulted from this experience fifty years ago. The bride can be heard laughing in the video early on, when they first arrive back at the village. Just a few years earlier, China had experienced widespread famine, and a tremendous number of deaths. Regardless of what you may think of the PRC, keep in mind that it was a new, poor, and wounded nation had just emerged from years of invasion, occupation, and civil war. Regardless of their politics, the people had all suffered, and they were all tired of it. However, the PRC was isolated from any help that western nations could have provided, not because they posed a threat, but because western governments

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		explicitly sought the worldwide defeat of communism. As a result, China remained short on even the most basic tools that are required for an economy to begin operating, like agricultural machinery. The young teenage kids of 1968 represented the first generation of the new nation. Times were tough. They naturally felt a special responsibility to help with what their country needed most from them at the time. While many former Red Guards would like to forget, deny, or excuse their behavior 50 years age, very few would like to be identified publically, even now. But many of the young people who participated in the Down to the Countryside Movement, or at least those who were treated well, as our group was, hold those years as cherished memories. **Recommended:** Farmers' Market, Changchun, China https://youtu.be/7gtOG_qxMmY My video of a farmers' market in Changchun is very typical of the traditional food chains that continue to exist alongside modern supermarkets. Many (probably most) residents of Chinese cities still shop predominantly in such open-air markets. This particular one is held every morning and everything is completely cleaned up by 10 AM. This turned out to be one of my more popular videos; if I'd known I would have done a better job editing. Anyway, later you'll see people making crepes, crullers, etc. A popular breakfast item is a fried crueler wrapped in a crepe (keeping oil off your hand) dipped in warm freshly made soy milk. I have found the food in such markets to be safe and fresher than wrapped supermarket fare; since the Chinese seldom eat raw foods, and peel those they do, like fruit, contamination is less of an issue than it might be in another culture, under similar circumstances. ### 1.5: **Case study: Sri Lanka** In our discussions earlier of soil and agricultural health and of the future of agriculture, I basically outlined two approaches to agriculture: that of the technocrat (exemplified, I think, by software salesman Bill Gates) who sees agriculture single-mindedly as a source of food, eventually replaceable by artificial meat factories, for example. The other approach I think I've outlined sufficiently above: attention to soil health, for example, and fostering a culture of respect for the land. Unfortunately, economics often steers the ship, regardless of which way we'd like to see it move. When the two worldviews described above collide, rather than cooperate, 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. **Watch** at least two of the following four videos**:** Why Sri Lanka is Collapsing: the Coming Global Food Crisis [PolyMatter] https://youtu.be/W5zxYDHwf-Y Sri Lanka economy: Fertilizer ban contributes to food crisis [Al Jazeera English] https://youtu.be/-qsEvaZYGeo Sri Lanka's economic crisis leaves tea farmers struggling [BBC News] https://youtu.be/dse7Xwlqt64

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		How did Sri Lanka's organic dream turn into chaos? [SBS Dateline] https://youtu.be/YWw5wlAf27g
	09/24/24	**Homework 5:** 1. How might biochar and organic matter in soil help with both drought and excessive rain, and may help farmers adapt to changing climates? 2. Discuss alternative visions for the future of agriculture as described by the [The Daily Conversation] video, by OECD, and by CGIAR. 3. What is precision farming? How does it work? How might it help alleviate water, nutrients, and pesticide issues? 4. Describe the Wendell Berry Farming Program and the perspectives of some of its students. 5. After reading the text and watching the videos on agricultural work during the Cultural Revolution, do you think that similar volunteer programs for young people to work outdoors (with compensation and health care provided) could succeed in the US? What if a large scale urban tree planting program were initiated, for example, for young people to work in or near their own neighborhoods? 6. Describe the agricultural and economic crisis that recently occurred in Sri Lanka.
6		Topic: **Demographics** Reminder: check each week for any new **Announcements.** **Reference:** Chapter 2 of the textbook *Introduction to Human Geography*, edited by David Dorrell and Joseph P. Henderson, pdf pages 28-50. We can use this book freely because it is licensed for such purposes under a Creative Commons Attribution 4.0 International License by the University System of Georgia. You may download it from Canvas **Files**. The population of any spatially defined region is generally said to be the sum of four processes: birth, death, in-migration, and out-migration. This sounds simple, but the results you get depend very much on where you draw your analytical boundaries in space and time. Things can become difficult to disentangle when they play out in the real world. You might take national boundaries and national census statistics as your basis, but borders are porous, border crossings are often not documented, and census data vary enormously in quality. In much of the world, even birth and death statistics are notoriously inaccurate, particularly in regions of high poverty or in times of war. One of the most important concepts is that of the demographic transition:

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		Reference: Demographic transition [Wikipedia] https://en.wikipedia.org/wiki/Demographic_transition > "demographic transition is a phenomenon and theory which refers to the historical shift from high birth rates and high death rates in societies with minimal technology, education (especially of women) and economic development, to low birth rates and low death rates in societies with advanced technology, education and economic development, as well as the stages between these two scenarios." Population dynamics influence nearly everything having to do with human life, right down to the personal level. In this video, Professor Sarah Harper explains how the different age profiles of different societies around the world impacts on issues such as economic development, health care, and migration, and also on individuals' life opportunities. **Watch:** How will population change transform our world? [Oxford Academic] https://youtu.be/hDoGq3BaR8M The following video provides a more detailed discussion by Professor Harper. **Recommended:** How population change will transform our world [Oxford Martin School] https://youtu.be/el7_v86HQcc The following book is NOT recommended reading. It is mentioned here for historical purposes. **Reference:** The Population Bomb, by Paul Erlich https://en.wikipedia.org/wiki/The_Population_Bomb For a long time, we've been warned by supposedly smart people about an impending 'population bomb', beginning with this book from 1968. These and subsequent warnings turned out to be untrue. Nevertheless, I'm sure that the claims expressed in books like this prompted many people not to have children. This is an understandably sensitive issue for many people. Since most of you are young, it is likely to be on your minds. My only message is this: be careful who you listen to. Live your own life. Having spent most of my adult life around universities, I'm well aware of the degree to which academics seem to assume that they have all sorts of advice to give regarding how the rest of us should live our lives. The fact is, many of their own lives are dull and lonely; indeed, many don't' even seem capable of getting a handle on their own preventable health issues. Regardless of what the chattering classes have to say, I think you will find that many of their most cherished assumptions are often proven wrong after just a few years. It certainly seems to be true with regard to demographics. The reasons people give for not having children these days (or of not wanting to own anything of value) might involve the anxiety-filled concerns of the day: climate change, conflicts, pandemics, depressions, toxins, and resource consumption, for example, rather than the fear of impending famine and starvation, which they threatened us with just a few years ago. In any case, the tragedy lies in putting someone else's claims regarding these sorts of concerns above one's own desire to live a full life. I don't think that you should listen to anyone outside of your own immediate family when it comes to having children, particularly if you find yourself discouraged from doing so by people who have denied themselves that experience, or have found it wanting for one reason

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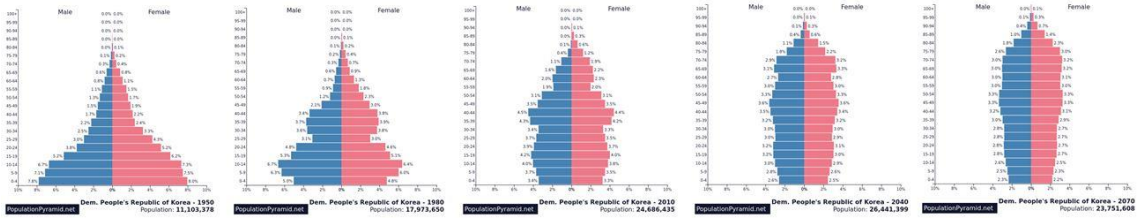
		or another. Don't be discouraged by other people's disappointments. Your life is yours to live. **Watch:** The overpopulation myth| Hannah Ritchie [Big Think] https://youtu.be/xrbyI-Cuze4 **Examine:** Current World Population http://www.worldometers.info/world-population/ ### 1.1: **Working with population pyramids** How we compile, summarize, and chart data are of fundamental importance. You should all become familiar with population pyramids. You will generate a few for the homework. **Watch:** Population pyramids: Powerful predictors of the future [TedEd] https://youtu.be/RLmKfXwWQtE **Watch:** 7 Billion: How Did We Get So Big So Fast? [NPR] https://youtu.be/VcSX4ytEfcE The NPR video physically simulates world population with flasks of liquid categorized by continent. Did you notice at the end of the video that the water is on the verge of spilling out over the top of the flask? Besides neglecting the effects of migration, this model suggests an upper limit to the world's population (where liquid spills out) somewhere above 10 billion. It doesn't explain what this is meant to represent, although the spill apparently deserved a 'close-up' shot. I see this video as manipulative. The "Population pyramids" video is more informative, but it also doesn't discuss the influence of in-migration and out-migration on the pyramids themselves. For small countries, and even lately for large countries, migration can be a significant factor. For the homework, I will ask you to choose a nation and create a set of population pyramids from an interactive website. Here is a set I selected for the Democratic People's Republic of Korea (commonly known as North Korea). It portrays the male (blue) and female (red) populations, at thirty year intervals, from 1950 to 2070. The last two charts are obviously projections, based on expected trends.  These graphs can be very instructive, but they must be read properly. First, always keep in mind that they show relative distributions, not raw numbers. The area enclosed by each of the distributions (the total red and blue shaded regions) remains the same regardless of the actual population size and how it changes. The actual total is indicated as a number at the bottom, and if you hover over any age group bar (when using the actual website), the numbers for that group pop up. The website also provides graphs of the

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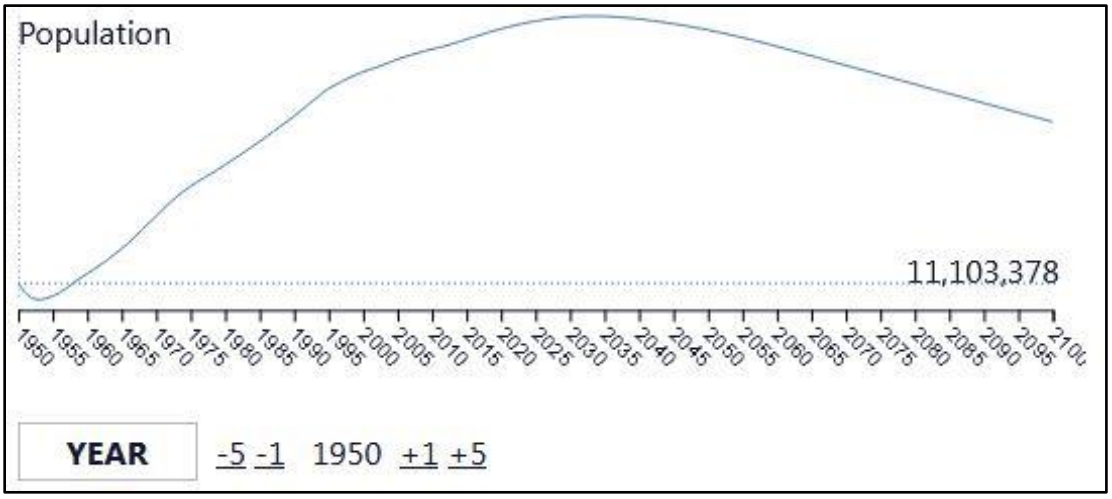
		actual population, as shown below. The value of a population pyramid lies in its shape. For example, the leftmost graph above portrays the population distribution in 1950. The Japanese occupation had ended, families were reunited, and despite the prevailing poverty, babies were being born. However, as the crosshairs at 1950 in the population graph below indicates, the population of North Korea in 1950 was only11.1 million.  But the Korean War (1950-1953) resulted in a significant decrease in births. While this does not appear in the 1950 pyramid, this becomes immediately apparent in the website's 1951, 1952, and 1952 pyramids, which I haven't portrayed. However, the effects of the Korean War can be seen in the 25-29 age group of the 1980 pyramid, which is the second from the left, above. A decline among newborns also appears in the 1980 pyramid. Wikipedia provides detail discussions of the demographics of many nations, which can shed light on data that are not easily explainable by historical events. It also provides valuable discussions regarding data reliability. Consider the following excerpt regarding North Korea's birth rates. **Reference:** Demographics of North Korea [Wikipedia] https://en.wikipedia.org/wiki/Demographics_of_North_Korea > "Assuming the data is reliable, reasons for falling growth rates and fertility rates probably include late marriage, urbanization, limited housing space, and the expectation that women would participate equally in work hours in the labor force. The experience of other socialist countries suggests that widespread labor force participation by women often goes hand-in-hand with more traditional role expectations; in other words, they are still responsible for housework and childrearing." As we can see from the population graph above, the population of North Korea is expected to peak after about 2030, at 26.6 million, and slowly decline thereafter. The shapes of the projected pyramids for 2040 and 2070 are consistent with this trend.

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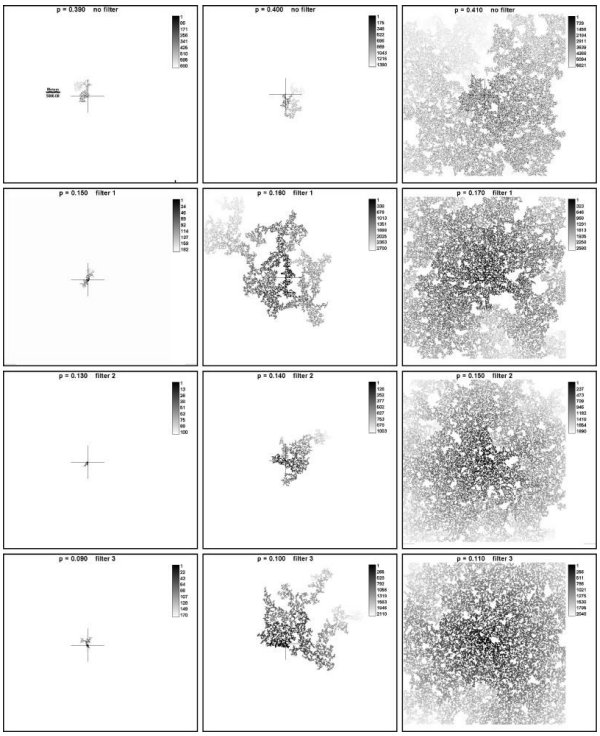
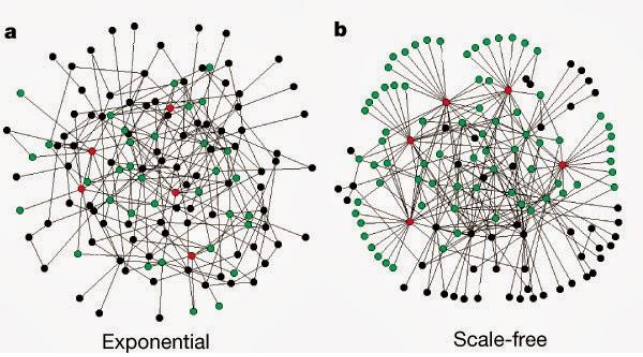
	10/01/24	**Homework 6:** Reminder: check each week for any new **Announcements.** 1. Describe some of the ways population change will transform our world, according to Professor Harper. 2. Why does data scientist Hannah Ritchie think that fears of world overpopulation are unfounded? 3. What is the current population of the world, rounded off to the nearest 100,000? 4. **Access the following website:** Population Pyramids of the World from 1950 to 2100 https://www.populationpyramid.net/world/ Choose any country (other than the Democratic People's Republic of Korea) whose recent history can be connected to its demographic distribution, possibly through war, migration, family planning, etc. Having first researched its demographics (for example, through Wikipedia), you will find that country using its proper name from the alphabetical list to the right and click. The population pyramid for that country for the year 2022 or so is portrayed. Also shown is the population graph from 1950 to 2100. If you change the year in the original window by clicking on -5 or -1, the year and corresponding pyramid will change. Click repeatedly, and you get an on-the-go movie. The crosshairs on the corresponding population graph also shift, and exact numbers involved become available. You can thus maneuver through time to display and download a series of pyramids describing that nation's demographics. Future trends are obviously projections, based on current assumptions. Your task is to capture population pyramid images for at least three different widely separated years for the country you have decided to examine. These years chosen should reflect interesting historical realities of that country.. You can also explore the future, but be aware that these numbers are speculative. If you click on 'Download' below the bottom left corner of the pyramid, it appears in a separate window and you may copy it or save as a file. There are different strategies you can use in order to get a sequence of at least three pyramids in your document as a single image, as I did above with five for North Korea. Or you may keep them separate but arrange them carefully on the page. Microsoft's snipping tool can work well for things like this. Please adjust the size and placement of the images so that the pyramids themselves are readable but fill no more than 1/3 of a page. Discuss the imprint that history has left on the nation's demographics: war and famine, recovery and boom, family planning, etc. Wikipedia may have a page on the demographics of your chosen nation. Using this or other resources, research that country's history before, during, and after the time periods you have chosen, and discuss the historical developments that helped shape that particular nation's pyramids.

Week	Due Date	Topics, Videos, Readings, Assignments
7		Topic: **Nonlinearities and complexity** Reminder: check each week for any new **Announcements.** Having looked at humanity's relationship with natural processes through the lens of food and fresh water, we will soon be ready to consider the Earth's climate, energy resources, and other key issues. Bu first we need to devote about three weeks to topics that are often omitted, neglected, or even brushed aside regarding the very nature of reality and how we might see and comprehend it better. It is not my impression that our educational system provides very much discussion of these topics, The universe itself, and nearly everything within it, behave and change nonlinearly. Linear phenomena can be portrayed mathematically by the addition, subtraction, and multiplication of independent terms, but nonlinear phenomena require exponents, or something like them, in order to be properly represented. Imagine bumping into a wall at 1 mile per hour. No big deal. Now imagine doing that same bump at 2 miles per hour. Bit of a jolt but still, no big deal. If you repeat this at incrementally greater speeds, you quickly begin to experience qualitatively different results: pain, tissue damage, and far more serious consequences; your body reacts nonlinearly to the changes in velocity. In order to relate velocity to something of biological significance, you would need to at least raise its representative term to some power, rather than just multiply it by some value. That is what is meant be exponential change, and it forms the basis of nonlinearity. As they occur in space and time, events that carry the most significance might happen very seldom, but they are often extremely powerful, and they might even carry everything they interact with into uncharted terrain. In the human world, these are the sorts of events that actually change lives, nations, and civilizations. Statistically, nonlinear phenomena often form distributions that carry small but significant probabilities much farther into extreme states than what we would expect from so-called 'normal' distributions. When graphed, they have long or 'fat' tails. Hence the names. **Watch:** Long Tail Distributions [Systems Innovation] https://youtu.be/vIp1kY0H0yw So how is this relevant? In order to understand some of the topics in this course, you need to adapt a more realistic approach to science, perception, and representation than what may have been suggested to you thus far in school science classes. Trying to study the complexity of the natural world in the context of a course like this is difficult. Many of its key concepts do not lend themselves easily to natural language. But we should try. Nonlinearities routinely create thresholds or tipping points. The biologically-based thresholds associated with the wall collisions hypothesized above, for example, involve injury and death. Very topic of this course involves such thresholds, whether we are aware of them or not. There are climatic, ecological, social, and psychological thresholds, many of which we remain unaware, even when we are about to cross them. Sometimes, systems can return to their earlier state, but often this turns out to be difficult, due in part to a condition called hysteresis, or possibly because the system itself changes in such a way that a return to its previous state becomes impossible. Consider the following graph of images from my 2001 dissertation. Each image portrays the result of a fire spread simulation under slightly different initial conditions, from left to right. The nearly total extent of burn in the rightmost column indicates that a very specific threshold has been crossed: the percolation

Week	Due Date	Topics, Videos, Readings, Assignments
		threshold, which was first discover using graph theory.  Although machines have their place, most things or processes are **not** mechanistic. The sun, moon, and stars may have appeared so to ancient people, but troubling details and sudden events made even these apparently predictable aspects of life suspect from the start. Every discovery since then has served to reveal a universe of tremendous diversity and unpredictability at the most fundamental level, wherein every situation is unique. Everything that exists now had to come into existence at some point in time, even the elements, even the most fundamental particles and fields. So if we are seriously interested in understanding ourselves and the world we inhabit, we need to pay attention to how things come into being, and how they eventually end. ### 1.1: **Emergence** Reference: Emergence [Wikipedia] https://en.wikipedia.org/wiki/Emergence > "In philosophy, systems theory, science, and art, emergence occurs when a complex entity has properties or behaviors that its parts do not have on their own, and emerge only when they interact in a wider whole." The concept of 'emergence' is seldom mentioned in the context of a course like this. . 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 biological, ecological, and social scales. Indeed, the evolutionary history of the universe itself is the central topic of cosmology. The appearance of each of

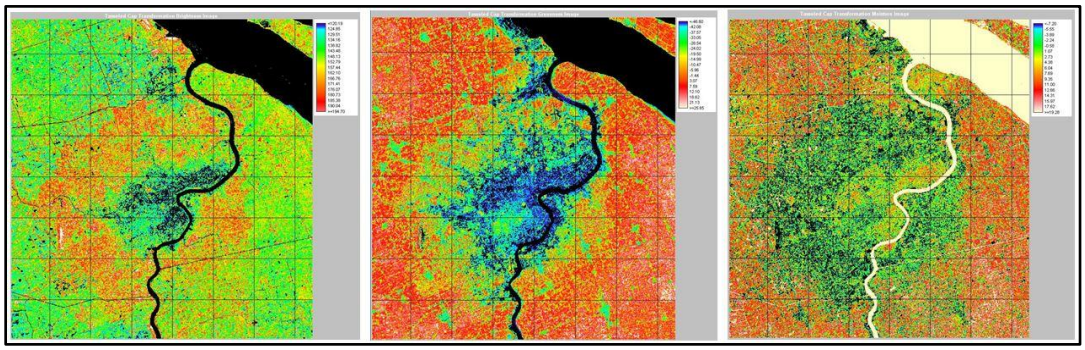
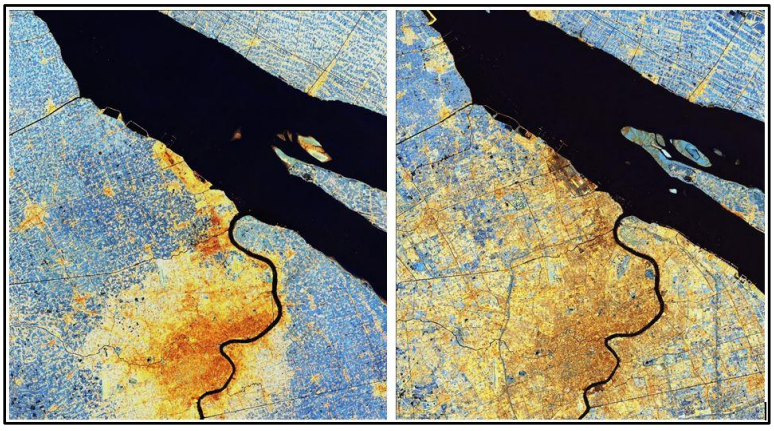
Week	Due Date	Topics, Videos, Readings, Assignments
		the elements in the periodic table is the result of a kind of cosmic evolution. Most of the elements with which we are familiar first appeared hundreds of millions or even billions of years after the Big Bang, having been generated from fusion processes within earlier generations of stars, or from collisions between neutron stars or even black holes. We are, quite literally, made of stardust. **Watch:** Emergence [Systems Innovation] https://youtu.be/QItTWZc7hKs **Watch:** Synergies [Systems Innovation] https://youtu.be/rsn5EQoAhUc **Recommended:** Tom McLeish - Is Emergence Fundamental? [Closer to Truth] https://youtu.be/GXCvQXUhBUk ### 1.2: **Scale, patterns, and fractals** In the following film, we begin with a couple in a park in Chicago, from which our point of view zooms up to astronomical scales, and then we zoom down from them to the subatomic scale. A great deal has been discovered since this was produced in 1977, and other versions of this film have been made, but this is the original. **Examine:** Powers of Ten™ (1977) [Eames Office] https://youtu.be/0fKBhvDjuy0 I've often thought about relationships between different scales of space and time. Much of my speculation has been informed by my research into ancient Taoist texts. You might find the following paper of mine to be interesting: **Recommended reading:** A Typology of Spatial and Temporal Scale Relations [Gary Pereira] https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1538-4632.2002.tb01073.x **Watch:** The Science of Patterns [Systems Innovation] https://youtu.be/kh6KMW8J3RQ 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. **Watch:** Could our universe be fractal? [Chillheimer] https://youtu.be/tN_eNQFcv5E 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

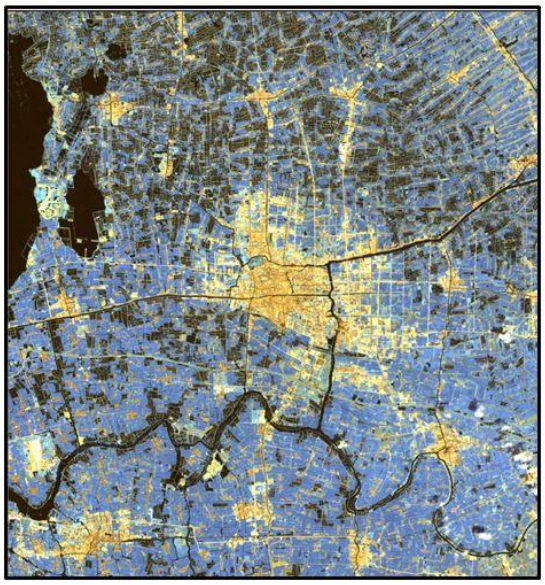
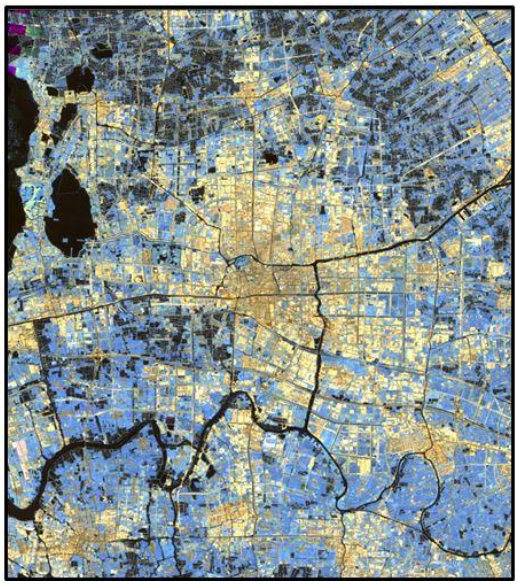
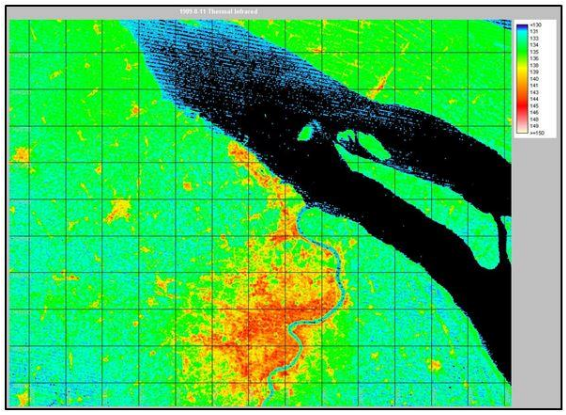
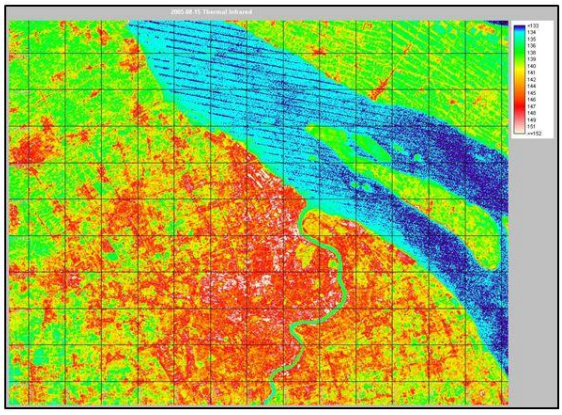
Week	Due Date	Topics, Videos, Readings, Assignments
		number plane, it reveals itself with infinite complexity, as shown in the video below. Notice that the fractal patterns that come out of this pure mathematics often appear to be more biological and crystalline than utterly abstract. The forms you 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. **Examine:** Sapphires - Mandelbrot Fractal Zoom [Maths Town] https://youtu.be/8cgp2WNNKmQ 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 video. They demonstrate that it is not particularly difficult to generate biological or geological forms using fractal geometry. **Examine:** Emergence [Julius Horshuis] https://youtu.be/G8qZvzv5ABg ### 1.3: **Deterministic chaos** 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. **Watch:** Nonlinear Dynamics & Chaos [Systems Innovation] https://youtu.be/qz6gXyfzV9A 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. For example, consider the Lorentz 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

Week	Due Date	Topics, Videos, Readings, Assignments
		unpredictable at other points, and certainly unpredictable over the long term. That is fundamentally why weather prediction is limited. **Watch:** The Lorenz Attractor Explained [Josh Kastof] https://youtu.be/VjP90rwpBwU **Recommended:** Lorenz Attractor Visualization [Visualization 101] https://youtu.be/oqDQwEvHGfE **Recommended:** Are there other Chaotic Attractors? [Orfeas Liossatos] https://youtu.be/idpOunnpKTo ### 1.4: **Networks** 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 change eventually, since we participate in networks of all kinds: ecological, biological, social, 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. 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. **Watch:** The hidden networks of everything | Albert-László Barabási [Big Think] https://youtu.be/RfgjHoVCZwU 

Week	Due Date	Topics, Videos, Readings, Assignments
	10/08/24	**Homework 7:** Reminder: check each week for any new **Announcements.** 1. Describe some threshold or tipping point beyond which no return to the previous state is possible. Describe another sort of tipping point that can be crossed repeatedly in either direction. 2. How are patterns defined by the Systems Innovation video? How might patterns be defined in time as well as space? Give me some examples. 3. Describe the concepts of emergence and synergies, and try to illustrate them in the context of the natural sciences with a few examples. 4. What are some of the characteristics of chaotic dynamics? Why isit often possible to predict systems like the weather short term, but long term prediction becomes impossible? 5. What are some of the characteristics of event types that have long-tailed statistical distributions? 6. Describe some of the hidden networks that rule our lives.
8		Topic: **Perception and comprehension** Reminder: check each week for any new **Announcements.** Suppose a group of people are 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 all follow a certain path, but he can't explain his reasoning to everyone's satisfaction. Someone else might make the same claim for a different path. 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 disrupt the little social dynamic that was developing and instead form a more 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. In general, they should push back the boundaries of their own ignorance. 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. It should be obvious that situational awareness is critical for success. This is particularly true of our desire to understand and guide the human experience on this Earth. Watching and understanding and having humble respect for the many natural processes and patterns that help to shape that experience has always been a requirement for success, even among our prehumen ancestors. It has been chilling to me, as an educator, to see this basic strategy belittled and ignored by many of the very people who proudly claim to 'stand with' and even represent science.

Week	Due Date	Topics, Videos, Readings, Assignments
		While general purpose bookstores are becoming increasingly rare in the US, bookstores in China remain filled with publications on many topics, including intermediate and advanced books in the so-called STEM fields, in both Chinese and English. These topics are seen by educators in China, India, and many developing nations as critical in tackling the sorts of issues that we will sample over the next few weeks: urban life, agriculture, water security, disease, climate, etc. It is unfortunate that we in the US seem to have decided that other priorities are more important. One discipline and set of technologies that is appreciated elsewhere much more than here at this time is collectively called Remote Sensing. ### 1.1: **Remote Sensing** **Watch:** What is Remote Sensing? [CIRESvideo] https://youtu.be/xIsUP1Ds5Pg **Watch**: What NASA Knows from Decades of Earth Observations [NASA Scientific Visualization Studio] https://youtu.be/dzmktnXUZag **Watch**: How can earth observations help predict next pandemics? [NASA Scientific Visualization Studio] https://youtu.be/01OkR1Q-2KY Although many populations depend upon the presence and purity of groundwater, these are very difficult things to detect and map out geographically. However, we are beginning to develop technologies that can help us better manage our groundwater resources. GRACE was a project that used pairs of satellites to detect subtle changes in the earth's gravity field, reflecting the relative localized presence or absence of groundwater, over large regions. Watch: For 15 Years, GRACE Tracked Freshwater Movements Around the World [NASA Goddard] https://youtu.be/MaxBOvQ2a_o In order to understand the world, we need to be able to recognize patterns. A conceptual and technical understanding of the methods of pattern recognition and data transformation that have been developed over the years is quite helpful in many domains, not only in 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 that was 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, matrices, tables, any number of ways. One 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. **Recommended:** Principal Component Analysis (PCA) [Serrano Academy] https://youtu.be/g-Hb26agBFg 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,

Week	Due Date	Topics, Videos, Readings, Assignments
		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 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.  Brightness Greenness Wetness 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. 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.  1989 2005

Week	Due Date	Topics, Videos, Readings, Assignments
		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.   2000 2005 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.   1989 2005 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. Karen used Landsat data to look at how changes in snow cover in the Sierra Nevada mountains over the

Week	Due Date	Topics, Videos, Readings, Assignments
		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). **Recommended:** Examining the relationship between snow cover and reservoir storage in the American River basin, by Karen McGillis-Moskaluk https://scholarworks.sjsu.edu/etd_theses/4291/ 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. **Recommended:** Landsat image classification using fuzzy sets rule base theory, by Avivit Shani https://scholarworks.sjsu.edu/etd_theses/2978/ 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. **Recommended:** Comparison of two classification methods for vegetation mapping in Palau, by Julie K. Andersen https://scholarworks.sjsu.edu/etd_theses/2938/ 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. **Recommended:** Tea bush health determination and yield estimation, by Tapasi Barman https://scholarworks.sjsu.edu/etd_theses/3514/ 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. **Recommended:** Effects of Water Conservation on Evapotranspiration in Las Vegas, Nevada, by Joseph Belli https://scholarworks.sjsu.edu/etd_theses/3911/

Week	Due Date	Topics, Videos, Readings, Assignments
	10/15/24	**Homework 8:** Reminder: check each week for any new **Announcements.** 1. What is remote sensing? Describe some of its technologies. 2. How might earth observations help predict pandemics? 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). 4. How do GRACE and other innovative remote sensing technologies help in the search for sustainable freshwater supplies? 5. Do you think that learning about the theory, mathematics, science, and technologies of remote sensing would be helpful to someone who is interested in a career in geography, environmental studies, urban planning, agriculture, water resources, meteorology, etc.? Should it be part of a university curriculum? Why or why not?
9		Topic 1: **Modeling a changing world** Reminder: check each week for any new **Announcements.** Living organisms have evolved various sorts of internal models that somehow represent behavior of things in the outside world, and these models help individual organisms make decisions that are more likely to lead to their survival. Among human beings, models of one kind or another have always been used to advance understanding between people about the nature of reality. Languages themselves reinforce particular models of reality, for example through the basic duality of things (nouns) and actions (verbs). For many of the topics discussed here, however, natural language alone, while necessary, is insufficient. Mathematics, or at least conceptual structures that can be expressed mathematically, form the basis of these sorts of models. I can say with confidence, having been mostly self-taught, that due to shortcomings in our mathematical education, the richness, imaginativeness, inventiveness, and depth of the last couple hundred years of development remain unknown to most of us. Fortunately, we can teach ourselves many things, if selectively build on what we already know. Wikipedia is good for mathematical concepts, and recorded lectures and graphical presentations are available on YouTube. In having studied computer science and geography, I came to understand (and to contribute in small ways to) the astonishing and still largely untapped power of mathematics in forming models to represent and simulate geographical domains like those discussed in this class. The purpose of these sorts of models may be to explain the past or to forecast the future; in any case, they are intended to help us to make better decisions leading to future survival and prosperity. Using ordinary computers, models are being formed

Week	Due Date	Topics, Videos, Readings, Assignments
		that are more complex, abstract, explicit, and unambiguous than ever before. They are not limited by the physical properties of our tools, or even by the human imagination. On the other hand, models can mislead, and depending on them too much can be very harmful. For example, epidemiological models that were used in the UK during the pandemic to justify lockdowns turned out to be wildly wrong. Global climate models remain quite unreliable due to inherent uncertainties regarding cloud cover, among other things. Having worked with hydrological models professionally at NOHRSC, and with models of all kinds in my research, I see things as follows. Having to formalize one's ideas in the form of a computer model means that you are forced into being explicit about you meaning. This is not necessarily true of natural language, and it is certainly not true of a great deal of academic literature. Vagueness, in the social sciences particularly, continues to have its appeal, for at least two reasons. First, the person presenting vague ideas need not even be capable of justifying them or of explaining them more precisely in some other way. If they are vague ideas, vague explanations are sufficient. Second, the person hearing the idea need not understand it in order to respond appropriately. If the ideas are vague, ambiguous, or even contradictory, a listener's response to them may also be vague, ambiguous, or contradictory, with no loss of meaning. Easy. But when you have to write precise code to accurately represent certain aspects of the real world, you have no choice but to be aware of and confront any vagueness, ambiguity, or contradictions in your understanding or thinking. If you cannot avoid these things, then you should not be surprised by any resulting shortcomings in your product. Computer models force you to be explicit about what is known, and they encourage you to be cognizant of what is not very well known or well-represented. They require a great deal more work to create and to interpret properly than people imagine. But as I said, models can mislead. They can be designed to mislead, or they can mislead unintentionally. They can be inaccurate. They can be interpreted inappropriately. Their shortcomings can be significant. The list of problems associated with computer models is endless. But models can reveal things about the real world that we may never have suspected to have been true. Some kinds of models can simulate emergent properties that actually occur in the domains under study. I have had this experience many times myself. However, many computer models, for example statistical models based solely on data of past history, have a great deal of difficulty in capturing or simulating emergent properties. Change of any kind, including social change, remains largely mysterious and notoriously difficult to predict accurately. This applies to much of the physical world, as we saw in our consideration of deterministic chaos. At least, some degree of randomness is nearly always present in any situation, and this can affect the course of events, particularly over the long term. Regardless of their source, the presence of unknown factors, often in the guise of randomness, should 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. From the human perspective, it can be either benevolent or malevolent. The fundamentally evolutionary nature of all reality guarantees that, from the human point of view, troublesome events that no one had ever predicted will eventually appear. If we navigate them successfully, we might manage to recognize and avoid similar situations coming down the road, and that's obviously good. Nevertheless, some entirely new, unanticipated situation will always eventually arise. But unanticipated solutions to what may seem to be insurmountable problems can also

Week	Due Date	Topics, Videos, Readings, Assignments
		appear, seemingly from nowhere. Even our most advanced exemplars of Artificial Intelligence base most of their decisions on models that were shaped by records of the past. That's how neural networks are generally formed and trained. If that training record is sufficiently rich, deep, and accurate, we can get astonishingly correct decisions from such networks very quickly. But consider the geographical world, which is filled with long-tailed distributions, which may contain extreme events for which no data is available. Some of our most significant events in terms of shaping the future occur so rarely that they might not be represented in the training records used in even the most sophisticated models. If field research uncovers examples of unanticipated catastrophic change in the past, we can reform our models appropriately, but there is always likely to be something, some possibility, that we don't know about. These unknown unknowns can be represented mathematically (for example, through the Theory of Evidence), in creating models that better recognize their own shortcomings. But if nature is evolutionary, then even the most advanced future AI system, encompassing all of science, could still not possibly anticipate everything that might happen, including processes and events that affect our future survival. It is my impression at this time that this is indeed a universal property of nature. It 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. Models of world dynamics require explicit representations of space and time. Often, space is simplified to two rather than three dimensions, depending on the application. Devices that interact with the real world now also use such models. Consider this screenshot from a robotic vacuum cleaner app. The robot has already mapped out the house by following every edge, and the map that it created can then be used to direct the vacuum to work in specific rooms or areas within the house.  ### 1.1: **Agent based modeling** Useful models must capture something significant about the domain being modelled. They help us to make sense of our perceptions. Other species use them, and they have been part of our cognitive processes since our prehumen origins. So there exists a huge diversity of model types, even among formal models expressed mathematically. Although many are important, there is no way that we could begin to tackle this diversity in one week. I would however like to discuss one way of thinking about the world that lends itself to the sorts of systems we are discussing in this class. Suppose we represent the world in terms of fields, and entities. Fields can hold any number of values,

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		representing any number of characteristics that vary in space (geographically, we usually simplify things and talk about surfaces, or 2-dimensional spaces). Representationally, we usually tessellate the surface with imaginary grids, like checkerboards, and assign values to represent these characteristics for each grid location. The grid itself may be an agent, and each location may be an agent, but not necessarily so. Thus will make sense in a minute. The entities that exist in these sorts of models are called agents, and they might be represented spatially as points, or as polygons, for example. It should be easy to see that these sorts of models are compatible with well-established Geographic Information systems technologies. Indeed, research into these compatibilities has been going on for some time. Whatever their geometries are, agents exist within the same virtual landscape that contains the gridded fields, but they can dynamically change over time, possibly changing location, shape, and size, as well as their behavioral characteristics. Agents might interact most with neighboring agents, but agents can also be non-spatial, or they may interact via non-spatial networks. In any case, the entities in agent-based models are assumed to have the ability to be self-directed and to exhibit agency. That means, in programming terms, that the data structures representing agents have within them dynamic routines that can operate selectively under different conditions, independently of the spatial environment, but which can influence the agent's interactions with other agents and with their environments. Agents might behave mechanically, or they may exhibit some degree of randomness or even deep understanding. Agent-based models have been shown to 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 think this is particularly relevant. I also think that the basic ideas are easy to understand, particularly for those of you who grew up with modern video games. **Watch:** Agent-Based Modeling: An Initial Exploration [Complexity Explorer] https://youtu.be/Z8Wf1vF_xgQ 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. **Recommended:** Agent-Based Modeling: What is Agent-Based Modeling? [Complexity Explorer] https://youtu.be/FVmQbfsOkGc Let's take a look at Michelle's Masters' thesis of 2011 (below). 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

Week	Due Date	Topics, Videos, Readings, Assignments
		from twelve Landsat TM data scenes spanning a typical year. Each simulation cycles repeatedly through this typical year. **Reference:** Creating an Agent-based Model to Examine Spatial Behavior of *Eriocheir Sinensis*, by Michelle Fong https://scholarworks.sjsu.edu/etd_theses/4089/ **Watch:** An agent-based model of *Eriocheir Sinensis* https://youtu.be/Zr7qOvs35H0 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. ### 1.2: **Modeling diversity** The concept of 'diversity' has generated a great deal of discussion, but little real clarity. That is a shame, since the condition of diversity among interacting entities is a requirement for evolution to take place, and for a great deal more to exist in nature, including human nature. Is it possible therefore that the sciences and mathematics of nature might have something to teach us, even regarding the representation and function of diversity in human affairs. Conceptually, it can be challenging to change scale from that of an individual person's immediate interactions, to that of a society that contains multitudes of such individuals, with multitudes of interactions. Regardless of the number of entities, agent-based models can provide unique internal representations not only of their immediate characteristics, but also each individual's internal processes and motivations. I'd like to describe some simple work I did along these lines, whose results surprised me. You can judge for yourself whether this sort of result is applicable to real world situations involving human beings. The following video and paper portray a model I wrote in NetLogo in order to explore whether a society of mobile agents consuming a spatially explicit regenerating resource from a simulated landscape will form different sorts of collective behavior if the individuals are allowed to hold a diverse range of values of their principle characteristic (velocity), compared with a world in which all agents can only move at precisely the same rate. For example, rather than being allowed to move precisely one cell at a time in search of the consumable resource, they each hold a value taken from a normal distribution around one cell per time step. Some move slightly faster, and some slower. The reason to move is to find an available patch of resource. If sufficient resource is found and consumed, each mobile consumer agent can reproduce, otherwise, they will die. What I found, in addition to an increase in total consumption, was the emergence of organized, spatial wave-like patterns. In the close-up screen shot below to the right, the current direction of each agent is portrayed, and the resource availability is portrayed in shades of gray. Even if we begin with a random landscape of availability, the society of agents with a diverse set of velocities tern to form what can be described as cooperative patterns; the variation in potential velocity self-organizes peaks and troughs

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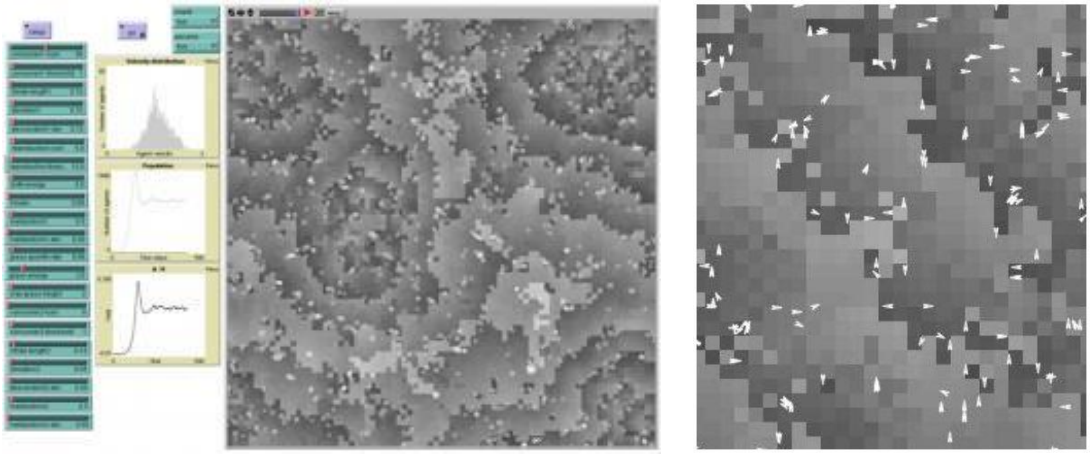
		spatially, resulting in dynamic wave-like patterns. Such patterns are often found in populations of organisms in nature, often for similar reasons. **Watch:** Functional diversity in geospatial domains [G Pereira, as secondary channel Evolutionary Geocomputation] https://youtu.be/rEb9XZyMsBQ **Reference:** Pereira, G. M., Investigating the effects of functional diversity in spatially distributed geographic domains. Proceedings, Geocomputation 2005, Ann Arbor, MI, 2005. https://portfolium.com/entry/investigating-the-effects-of-functional-diversity 
	10/22/24	**Homework 9:** Reminder: check each week for any new **Announcements.** 1. Describe two or more spatial mental models or maps that you might use in a typical day. Are these models rationally connected, are they purely contextual, or somewhere in between? Is the spatial model that you might use when driving a car the same as the one you world use a s a pedestrian on the same street? 2. What is agent-based modeling? How does it work? Provide an example or two of how agent-based models may help us to understand human behavior. 3. Statistical and Bayesian models anticipate future behavior on the basis of the record of past behavior. In a scale-free, nonlinear world, characterized by long-tailed rather than normal distributions, significant events may occur so seldom that the statistical record might not have anticipated. Such models can underestimate the possible future occurrence of large-scale, possibly catastrophic events. Do you think it might be possible to anticipate events about which we know little or nothing? How should we consider risk? If it turns out to be impossible to accurately gauge risk, should that influence our decision processes?

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10		Topic: **The global climate system** Reminder: check each week for any new **Announcements.** Climate is sometimes described as long-term weather, but that's not really 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 measureable, and it can be influenced both by any number of factors, many of which we have some control over. 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. Much of this change occurs as the Earth's oceans, ice, land, and biogeochemistry respond in complex ways to subtle shifts in the Earth-Sun system (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 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, 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 that evolutionary processes help organisms to develop. Humankind has the additional 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 controllable, to some degree, in possibly subtle ways that we still haven't discovered. **Watch:** What is a Climate Model? https://youtu.be/bkcrH9tYv8g 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: **Watch:** How Whales Change Climate [Sustainable Human] https://youtu.be/M18HxXve3CM 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. **Watch:** Climate Change : How Land Use is accelerating the crisis [Just Have a Think] https://youtu.be/Scm46Ctn0Ig 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

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		human well-being should be self-evident. The associations of climate with the rise and the fall of historical 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. **Watch:** Early Warning of Climate Tipping Points [Understanding Climate Change] https://youtu.be/5yTJZzQzdYI Here's a pdf of the slides from the lecture. https://sustainabledevelopment.un.org/content/documents/3487lenton.pdf 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. **Watch:** Antarctica latest research: Doomsday Glacier ice shelf gone in 5 years [Just Have a Think] https://youtu.be/49NPdyUEos8 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. **Watch:** Bay Area 2050: How climate change will impact region [ABC7 News Bay Area] https://youtu.be/uAtRalzXK4Q ### 1.1: **Shifting climatic indicators in America's heartland** 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.

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		Reference: The Future of Supercells in the United States, Bulletin of the American Meteorological Society, volume 104, issue 1. Online Publication: 04 Jan 2023 https://journals.ametsoc.org/view/journals/bams/104/1/BAMS-D-22-0027.1.xml This recent publication analyzes changes in tornado activity and violent storms in the United States: "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." "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." 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. **Examine:** at least two of the following six drone videos showing the aftermath of recent tornados: Whiteland, Indiana [ABC7 Chicago] https://youtu.be/BVTzCVCq9FU Little Rock, Arkansas [THV11] https://youtu.be/bazeywcX4U0 Wynne, Arkansas [StormChasingVideo] https://youtu.be/BOFQXp_r7GQ Wren, Mississippi [StormChasingVideo] https://youtu.be/LGnLc3AKN9g McNairy County, Tennessee [Live Storms Media] https://youtu.be/F45NYmQWPI4 Sullivan, Indiana [Live Storms Media] https://youtu.be/JSGMXh3GhJc

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	10/29/24	**Homework 10:** Reminder: check each week for any new **Announcements.** 1. How do climate models work? 2. How do whales affect the global climate? 3. 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? How might government become more responsive to such changes? Do you think that popular understanding of these issues matches their known realities? Include in your discussion anything else you have found to be interesting or surprising about Dr. Lenton's lecture. 4. What is the recent news from observations of Antarctic ice shelves? 5. How will climate change impact our region over next few decades, according to ABC7 News? 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?
11		Topic 1: **Addressing climatic change** Reminder: check each week for any new **Announcements.** 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 **mitigate** 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 **adaptation** to climate change, whatever that might imply, from local to global scales. Clearly, a great deal of planning in the future will necessarily fall into what we now think of as the latter category. Changes in complex systems like the climate itself, or any of its subsystems, are often difficult to understand and predict. Tipping points can be sudden, but warning signs might exist. Careful attention is required if we are to detect them. 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 us all, regardless of our status. How many times have you or someone you know expressed concern about something, or offered an interesting solution, 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 ideas were actually considered on their merits, rather than on the status or identity of the people who express

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		them? There is so much wasted human intelligence and creativity out there. Being human is not easy, even under the best of circumstances. It can be very hard. Many of us are not inclined to live our lives politically. But if people who are working on solutions become aware of one another's ideas and projects, local successes might be duplicated, and failures might be avoided, around the world. Like natural processes, successful solutions to human problems evolve over time. But I'm afraid that coercion or even too firm a control by any elite, even in pursuit of a greater good, only wastes the creativity that naturally exists in all human societies. **Watch**: The Way We Talk About Climate Change Isn't Helpful | Chris Jordan [Sustainable Human] https://youtu.be/4CaCsZKECB8 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. **Watch:** How to capture 2 billion tons of CO2 AND fix our oceans [Just Have a Think] https://youtu.be/zr6CYS9ie5E ### 1.1: **Trees** I know it's not considered an important topic by many, but I personally insist that urban trees are important, particularly in stabilizing and moderating local microclimates. It has long been assumed that increasing the amount of carbon that is sequestered in trees would do little to impact the level of atmospheric CO_2. Based on the sort of research described in the following video, this view is being revised. **Reference:** Climate Central, "The Power of Urban Trees", Climate Matters, May 2, 2023 https://www.climatecentral.org/climate-matters/the-power-of-urban-trees-2023 **Watch:** The Surprising Truth behind Planting Trees and Climate Change [PBS Terra] https://youtu.be/LDdKOmvIKyg Many YouTubers have pointed out that tree planting should be done intelligently, if it is to work. They seem proud to dwell on misguided failures (which often have a corporate origin), and neglect small scale success. I remain astonished at how little real appreciation supposedly clever people (like the ever-present Bill_Gates) have for simple things like trees. I've been witnessing a significant increase in the numbers of urban trees in China. Driving around, it is easy to find teams of people planting trees, shrubs, and flowers along the roads and interchanges. The benefits were almost immediately apparent. I did some analysis of Landsat data of Beijing and Shanghai neighborhoods before and after such campaigns. Data are difficult to analyze, due to the natural variability of weather, but there does seem to have been an effective counteraction to the Urban Heat

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		Island effect, from which both of these cities suffer.. But even at just a psychological level, it is undoubtedly beneficial to human populations to be around trees, or something similar. Consider for a moment the Gaza Strip. You've all seen the pictures, even before the recent war. Consider living there one's entire life. Consider how beneficial it would be to your mental health to experience, instead, a serene forest? Topic 2: **Regional vulnerabilities and climate-related migration** When large numbers of people migrate from one region or nation to another, economic effects and incompatibilities between cultures can often create tensions, suspicions, tribalism, and violence that threaten the integrity and sometimes the very existence of the host nation. 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. Large numbers of people are now or may eventually 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 places that happen to be more prosperous at the time. 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 problem of mass migration. We need to recognize that social and environmental problems associated with migration itself are real and legitimate, 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. **Watch** at least three of the following six videos: Climate Refugees: Nations under threat [CBS News] https://youtu.be/4MXoUbsswHY Fleeing climate change — the real environmental disaster [DW Documentary] https://youtu.be/cl4Uv9_7KJE Exploring the relationship between Climate Change and Human Migration in Africa [USFGsAL] https://youtu.be/HtUw_jvv3GU Climate Change: Rising Sea Levels + Coastal Megacities = Forced Migration [Big Think] https://youtu.be/s4UgekcYg2o Changing Climate, Moving People: A film on climate stress related migration [TERI]

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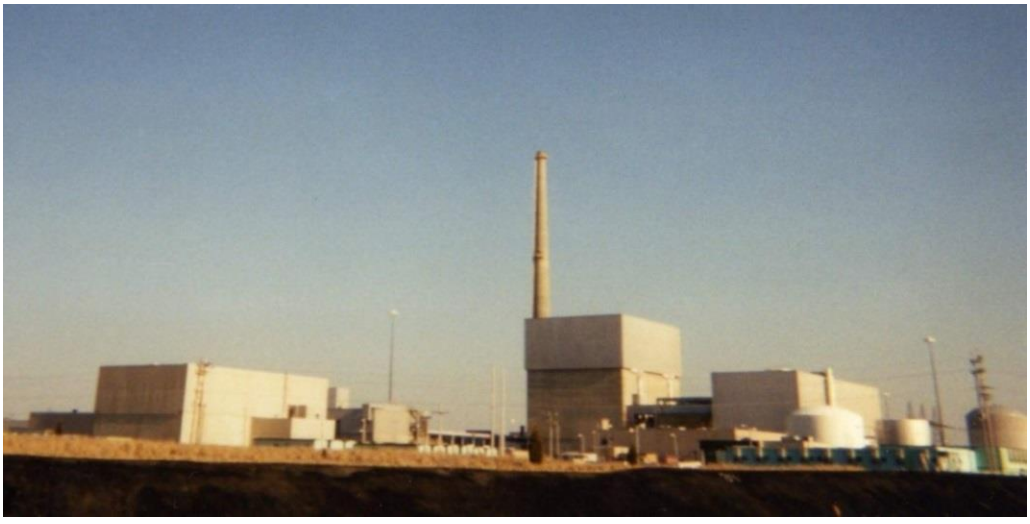
		https://youtu.be/NjYR3LohMM0 Even if severe storms and flooding were not increasing, and even if sea levels were not relentlessly rising, the very fact that ever greater numbers of people are living and working pretty much at sea level results in unprecedented challenges regarding emergency evacuation, 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. **Watch:** Climate Change Impacts in Bangladesh [World Bank] https://youtu.be/V3IL6Y1TDHo **Watch:** Climate refugees in Bangladesh [DW Documentary] https://youtu.be/co5uywe-1Z8
	11/05/24	**Homework 11:** Reminder: check each week for any new **Announcements.** 1. What do you think of Chris Jordan's suggestion that the way we talk about climate change isn't very helpful? 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. 3. What are some benefits of urban trees? 4. 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. 5. 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.

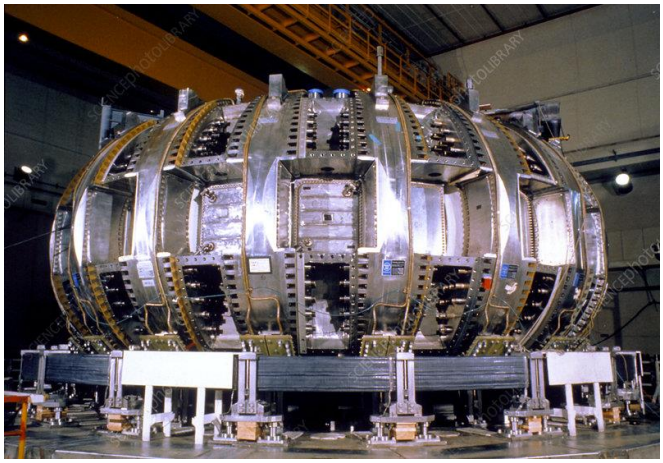
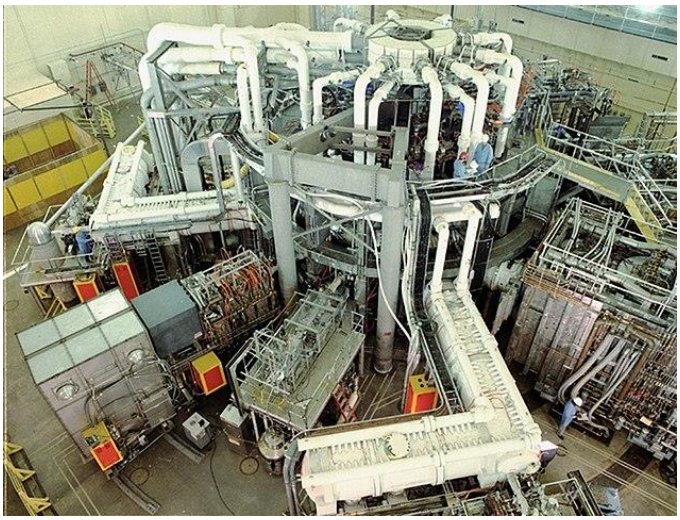
Week	Due Date	Topics, Videos, Readings, Assignments
12		Topic 1: **Energy generation** Reminder: check each week for any new **Announcements.** Energy generation is clearly a key issue when it comes to world population, and it is also a key issue with respect to global climate change. Along with water, energy is a necessary requirement for modern life in most of the world. Energy in some form is required for heating, cooling, lighting, cooking, transportation, transport, agriculture, and many other activities that affect human well-being. Minerals and metals found in the lithosphere have been central to the success of civilization since ancient times, and this continues to be true. Energy production is one of the most significant tasks at hand at this time. The burning of wood and fossil fuels has resulted in tremendous advances in human progress, but we cannot continue to rely on carbon combustion, particularly as world populations emerge from poverty and require ever more energy. Fossil fuels remain important, particularly natural gas or LNG, but we will concentrate our attention here on some of what comes next. Discontinuous suppliers of energy, like solar and wind, are certainly helpful despite their own environmental impacts, but improvements in energy storage and grid balancing are required if other more continuous sources are unavailable. It has been argued that 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 intensively in the near future. Each approach requires different sets of metals and minerals. In addition, hydropower continues to be harnessed worldwide, with all of the potential benefits and harms resulting from the impoundment of water. The megaprojects described in the following video provide an astonishing view into the importance of energy to our general theme of populations and global change. **Watch** at least two of the following seven segments, for question 1 below. Swipe to the beginning time as indicated, or use hyperlinks provided in the description if viewed in a separate browser The World's Biggest Energy Megaprojects Explained Jul 21, 2024 [The B1M] https://youtu.be/kdiZUFKy2jg 0:29 - 7:08 Olkiluoto Nuclear Plant, Finland 7:09 - 13:51 Nord Stream 2 13:52 - 23:08 International Thermonuclear Experimental Reactor (ITER) 23:09 - 32:00 LNG Canada 32:01 - 39:56 Ethiopian Renaissance Dam 39:57 - 51:02 Plant Vogtle, USA 51:03 - 1:01:02 Dismantling Bohunice Nuclear Power Planet (BNPP)

Week	Due Date	Topics, Videos, Readings, Assignments
		Topic 2: **Nuclear fission: uranium, thorium, plutonium** Nuclear technologies yield power without directly generating atmospheric carbon, although the mining and refining of uranium and the building and decommissioning of reactors are processes that remain carbon-intensive. One of the biggest concerns 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 malevolent intentions. New reactor designs claim to address some of these issues. In addition, there is currently no closed-loop recycling of spent fuel and other waster in the United States. I'll leave these things for you to consider. Whatever ends up happening with uranium, plutonium, and thorium, much of it will probably play out in your lifetimes. **Watch:** Thorium and the Future of Nuclear Energy [PBS Space Time] https://youtu.be/ElulEJruhRQ **Watch:** Could Advanced Nuclear Power Replace Fossil Fuels? [Journey] https://youtu.be/eg613DFBR8s **Watch:** Small Modular Reactors. Are they now unavoidable? [Just Have a Think] https://youtu.be/yofGtxEgpI8 2.1: **Inherent vulnerabilities** The events of both Chernobyl and Fukushima should be familiar to every educated person on this Earth. Unfortunately, awareness of issues surrounding nuclear power has decreased, rather than increased, in recent years. Our media and educational establishment seem to have decided that such things are too complex for people to understand, so they should probably be decided for us. Having asked students for several years now about their prior knowledge of the Fukushima 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. **Watch:** Understanding the accident of Fukushima Daiichi [IRSN] https://youtu.be/YBNFvZ6Vr2U **Watch:** Fukushima's ghost towns https://youtu.be/xKfnsYzQWjw 2.2: **Nuclear energy and conflict** Nuclear power plants, regardless of whether they happen to be generating power at any particular time, are vulnerable in many ways. In addition to the reactors themselves, there are backup generators, load balancing circuits, spent fuel storage casks, etc. that can be damaged, leading potentially to massive releases of radiation and fallout, hundreds of thousands of deaths, and the permanent evacuation of vast

Week	Due Date	Topics, Videos, Readings, Assignments
		regions. **Watch:** At least three of the following five videos. How likely are nuclear disasters and cyber warfare in Ukraine? | DW News Mar 2, 2022 https://youtu.be/zOng3E4hzpo Russian forces take control over Europe's largest nuclear power plant | DW News Mar 3, 2022 https://youtu.be/QrBP3sydgXg Ukraine: Nuclear power plants under Russian control | DW News Mar 7, 2022 https://youtu.be/_QjTgF_c_nk Shelling at Ukraine nuclear power plant puts world on edge | DW News Aug 6, 2022] https://youtu.be/aTxJpfbh2ko Shelling Zaporizhzhia would cause a disaster 'worse than Fukushima' [Times Radio, Aug 9, 2022] https://youtu.be/YnbPKdZJAmE 2.3: **Memories of the Oyster Creek Nuclear Generating Station** 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. The reactor is in the cube-shaped building in the center of this picture.  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

Week	Due Date	Topics, Videos, Readings, Assignments
		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 is sealed casks somewhere on the grounds. **Recommended:** What If You Fell Into a Spent Nuclear Fuel Pool? [What If] https://youtu.be/mM-5DhIhYmQ 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 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. The station that I worked in is now shut down and decommissioned, 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 being right above 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 they were disposed of as 'low level waste' after just one use. In a nuclear reactor, this sort of gear is required to keep contaminants away from your personal clothing and body. It's just the opposite in semiconductor manufacturing. At the time I worked there, the plant was fully on and generating electricity. There was one guard with a handgun at the entrance to the room above the reactor. The place made me uneasy, and I didn't keep the job for very 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 detected the signal for radioactive iodine that I had absorbed in my few weeks on the job. Much later, I discovered that if I had taken iodine supplements prior to working there, my thyroid might not have absorbed the bad stuff. 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. Don't be surprised if it happens again. ## Topic 3: **Nuclear fusion** 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

Week	Due Date	Topics, Videos, Readings, Assignments
		here on the more likely pathway to power, magnetic confinement. **Watch** at least one of the following three videos: Nuclear fusion's hope - The dream of endless clean energy [DW Documentary] https://youtu.be/sBaU4BVM5h8 Nuclear Fusion 3.0: Real World Electricity is Coming [Electric Future] https://youtu.be/4GJtGpvE1sQ Why Private Billions Are Flowing Into Fusion [Bloomberg Quick Takes] https://youtu.be/Dp6W7g9no0w **Watch** at least one of the following five videos: A New Way to Achieve Nuclear Fusion: Helion [Real Engineering] https://youtu.be/_bDXXWQxK38 Nuclear Fusion Breakthrough Rewrites Laws of Physics https://youtu.be/G27M0eRTRZE Major breakthrough on nuclear fusion energy - BBC News https://youtu.be/0fYiNVRmOA4 We Went Inside the Largest Nuclear Fusion Reactor [The B1M] https://youtu.be/4BkOUOK0XzM Wendelstein 7-X fusion device [Max Planck Institute] (begin at minute 1:10) https://youtu.be/51Hji5NfkdA ### 3.1: **Memories of the Tokamak Fusion Test Reactor (TFTR)** Science is often 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 (TFTR) was built on the grounds of the Princeton Plasma Physics Laboratory, amid the woods and cornfields just outside of Princeton, New Jersey. Initial construction on TFTR began in 1980. Operation began in 1982, and TFTR remained in use until 1997. It was dismantled in September 2002. I was hired prior to the initial construction, and I stayed through the first few years of operation. In the early stages of construction, 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, within the body of the torus, was eight feet. Technicians could open doors and work within the vessel itself.

Week	Due Date	Topics, Videos, Readings, Assignments
		 Soon after this picture was taken, however, the torus was locked within a maze of instruments, magnets, and cryogenics. The Tokamak Fusion Test Reactor was the largest, most elaborate nuclear fusion device of its kind at the time. It was intended to test whether confining a plasma of light isotopes magnetically in the shape of a ring within the center of a torus-shaped vacuum vessel, and heating it with microwaves, would ignite fusion reactions within the plasma 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. **Recommended:** Andrei Sakharov [Wikipedia] https://en.wikipedia.org/wiki/Andrei_Sakharov  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

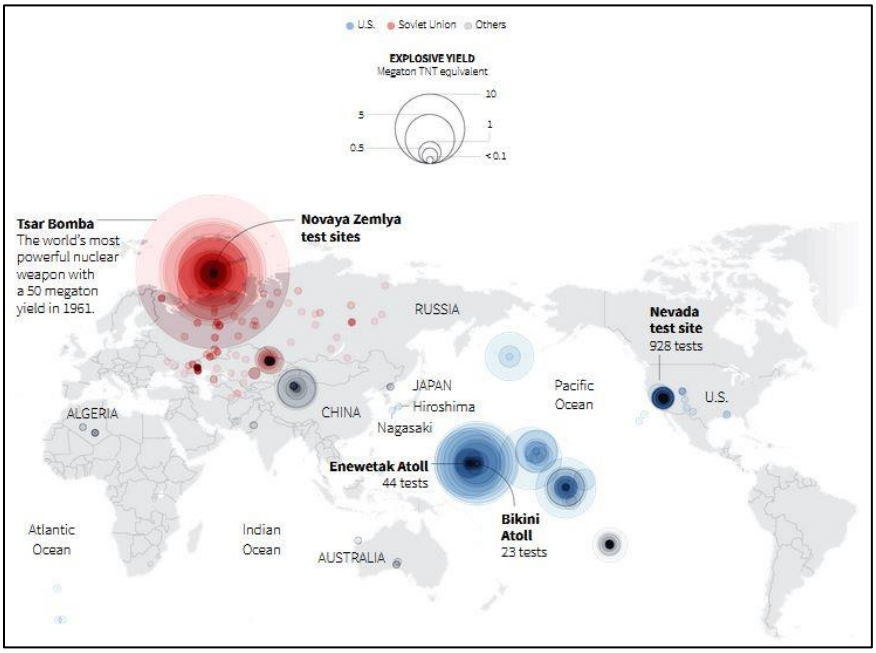
Week	Due Date	Topics, Videos, Readings, Assignments
		Recommended from about 3:30 to 21:00: TFTR First Plasma [John Coonrod] https://youtu.be/39D7M-1PfHs This building, which had lunch and conference rooms, was several hundred feet away from the building in the photograph that actually contained the tokamak device. These two buildings were connected directly through an underground tunnel through which we often walked, and through which we installed the fiber optic bundles that were used to communication with the device. Optical fibers were relatively new at the time, and they were used to communicate with anything in the device building because of their improved bandwidth, but also because it helped to keep the control and computer rooms electrically isolated from transients associated with the pulsed high voltages and currents used for the device itself. The power required to operate the device was short-term but massive, and it could not possibly be drawn directly from the electrical grid. Instead, in yet another building, two absolutely massive dynamos were used to draw current from the grid and gradually spin up to high speeds like tops, on vertical axes, in huge cylindrical pits. The current required by the tokamak could then be safely drawn off suddenly from these dynamos. As they experienced the resulting breaking action, the dynamos would scream, and the images on CRT screens in the vicinity would bend for a few seconds. Since in was inherently unsafe to be near so much energy, and because high energy neutrons could be emitted by the device itself, no one was allowed near the tokamak while it was in operation. I was assigned the task of installing and maintaining the card readers and cameras to make sure. 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. Customized fabrication of complex electronic devices involving TTL and CMOS integrated circuits was required at the component level, with many hours of soldering iron action. As part of their duties, individual technicians often worked closely with individual engineers. For all my years there, I worked for an absolutely brilliant engineer, Jane Montague. Jane was just a few years older than me, and she worked on some of the project's most critically important systems. Among the many systems we built, one of the most important was a complex clock that synchronized a whole suite of operations controlling sensory instrumentation and the acquisition of data during each 'run'. All 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. 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 and tested 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 to connect them to computers, displays, and other customized circuits. Jane and I often sat for hours, testing and modifying our circuits using 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 24 hour call for emergency technical services during operation). 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,

Week	Due Date	Topics, Videos, Readings, Assignments
	11/12/24	machines, and scientists at work. **Recommended:** Plasma Physics Lab and the Tokamak Fusion Test Reactor, 1989 [princetoncampuslife] https://youtu.be/TamkP8QrZak **Recommended:** The Princeton Plasma Physics Laboratory [WebsEdge Science, Feb 28, 2014] https://youtu.be/b8iH1930p2s **Homework 12:** Reminder: check each week for any new **Announcements.** 1. Describe the energy sources, technologies, and status of at least two of the following megaprojects. If you care to describe at least two more, you may designate your additional responses at '1B', and it may replace any one of the remaining questions, or alternatively be counted as extra credit. Olkiluoto Nuclear Plant, Finland Nord Stream 2 International Thermonuclear Experimental Reactor (ITER) LNG Canada Ethiopian Renaissance Dam Plant Vogtle, USA Dismantling Bohunice Nuclear Power Planet (BNPP) 2. Describe some of the prospects for nuclear power generation 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? 3. 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 is the situation now? Why did Japan decide to go so strongly with nuclear energy? Has anything changed? 4. Given the current situation regarding Ukraine's nuclear power plants, for example, do you think the world is ready for the risks involved in a large increase nuclear power generation? 5. Describe some developments in nuclear fusion technology. Why is nuclear fusion seen by many as a potential way out of our energy/climate dilemma? What sorts of fuel would be required?

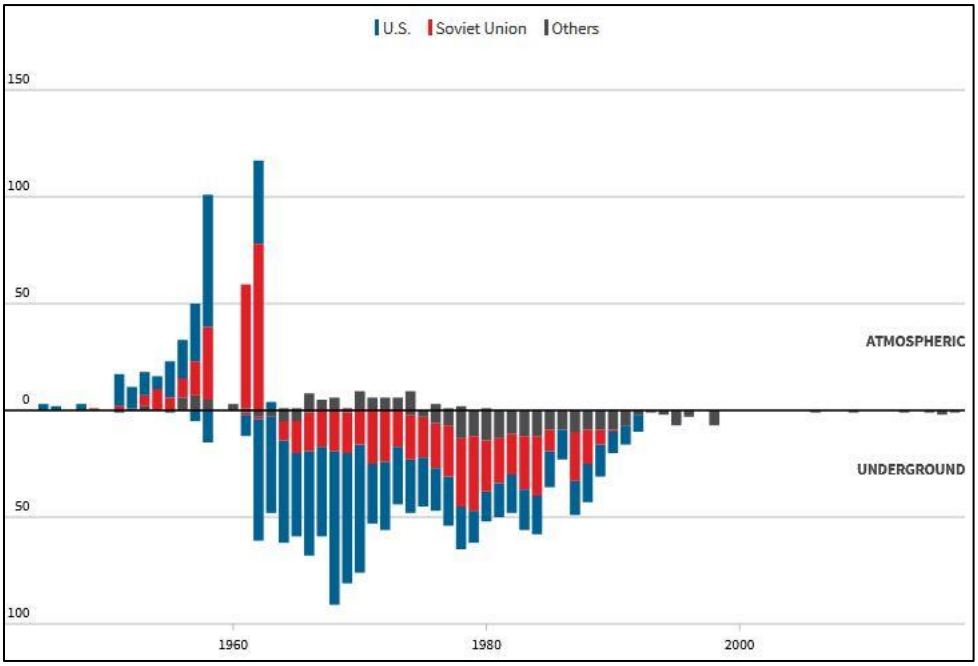
Week	Due Date	Topics, Videos, Readings, Assignments
13		Topic 1: **Minerals: lithium, cobalt, rare earths** Reminder: check each week for any new **Announcements.** We continue our discussion of energy resources with a couple of minerals that are playing an increasing role in energy production. Lithium, 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. **Watch:** Companies race to mine lithium, a battery essential [PBS NewsHour] https://youtu.be/su_UC9ZCD-0 **Watch:** Here's Where the Juice That Powers Batteries Comes From [Bloomberg Quicktakes] https://youtu.be/50rXYrFCQMw **Watch:** India discovers $410 billion lithium deposit [CaspianReport] https://youtu.be/auvqexcfVRo Cobalt seems to be the more problematic substance, in human and environmental terms. **Watch:** Whose Wealth? Cobalt from Congo [SOMO Researcher] https://youtu.be/37iLD41vfdI How cobalt mining became a disaster for Congolese communities [DW News] https://youtu.be/OvKnn8BRRI8 **Watch:** How do we solve the Cobalt problem? [Just Have a Think] https://youtu.be/-WOOZYlLyXI Rare earths have unique electromagnetic properties that make them valuable for a variety of technologies. There are several such substances, but they are usually found in the same deposits, at various locations within the lithosphere, including the sea floor. **Watch** at least one of the following two videos: How These Rare-Earth Elements Could Change Our Future [Spark] https://youtu.be/88jpgxSRVZU America and China fight for mineral monopoly [Caspian Report] https://youtu.be/RjMtfGpjh58

Week	Due Date	Topics, Videos, Readings, Assignments
		1.1: **Deep sea mining** 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 understand exist within environments that we may soon begin using large machines to dredge up. **Watch:** 2023 ISA assembly: Deep-sea mining debate intensifies in Jamaica [Al Zazeera English] https://youtu.be/-ES2ItUHOGw **Watch:** The Next Frontier in Mining: Deep Sea Exploitation in the Pacific https://youtu.be/PuEXmFQEJpw **Reference:** Deep Sea Mining [Wikipedia] https://en.wikipedia.org/wiki/Deep_sea_mining **Reference:** International Seabed Authority [Wikipedia] https://en.wikipedia.org/wiki/International_Seabed_Authority **Reference:** United Nations Convention on the Law of the Sea [Wikipedia] https://en.wikipedia.org/wiki/United_Nations_Convention_on_the_Law_of_the_Sea Topic 2: **A short history of nuclear weapons testing** All of my life, surrounding the topic of population and global change, has been the role of nuclear weapons. Recently, however, the topic seems to have been ignored in favor of what seem to be more pressing concerns. Recently, a well-known American, the one with the power to launch such weapons, proclaimed without hesitation that climate change is the ONLY existential threat to humanity. This betrays a social and historical amnesia of enormous proportions. In fact, we have never been closer to participating in nuclear war than we are now, partly as a result of this particular American's policies. So let's spend just a little time reviewing the history of nuclear weapons testing. Such weapons continue to be developed and refined, but most testing occurs in simulation. Much of what is known about the effectiveness of different weapons types has been established already, as the result of the following tests. Let's look at a map and graph first, and then we'll watch the animation. The US concentrated its testing in the South Pacific and in Nevada. Many of the earliest test and all of the H-bomb tests were conducted in the Pacific. Russia conducted its earlier tests in Kazakhstan, at the Semipalatinsk Test Site, shifting its larger tests to Novaya Zemlya. **Reference:** Semipalatinsk Test Site https://en.wikipedia.org/wiki/Semipalatinsk_Test_Site **Reference:** Novaya Zemlya https://en.wikipedia.org/wiki/Novaya_Zemlya

Week	Due Date	Topics, Videos, Readings, Assignments



Reference: A tally of nuclear tests, Reuters, SEPTEMBER 22, 2017
http://fingfx.thomsonreuters.com/gfx/rngs/NORTHKOREA-MISSILES/010050Y324P/index.html



The graph above portrays the number of nuclear weapons tested per year (regardless of yield) since the end of WWII. Tests by the US are in blue, and tests by the USSR are in red. You should notice a discontinuity in 1958, when the United States instituted a self-imposed moratorium on nuclear tests. On October 31, 1958, the United States entered into a unilateral testing moratorium, announced by President

Week	Due Date	Topics, Videos, Readings, Assignments
		Eisenhower, with the understanding that the former Soviet Union also would refrain from conducting tests. There was, in fact, a period of apparent inactivity, but I'll ask you to describe what you see afterwards in the animation. There was another discontinuity that is apparent in the graph. On October 7, 1963, President Kennedy signed the ratified Partial Nuclear Test Ban Treaty, along with the Soviet Union, which prohibited nuclear weapons tests or other nuclear explosions under water, in the atmosphere, or in outer space. It allowed underground nuclear tests as long as no radioactive debris falls outside the boundaries of the nation conducting the test. The history leading up to this is amazing, and few people remember it. Here's part of it. We already mentioned Andrei Sakharov in connection with the tokamak. He was also a lead engineer for Soviet H-bombs. He received as a result the highest honors and privileges. However, he used this influence to write an open letter to Khrushchev and Kennedy, which was published in the West, pleading with them to stop atmospheric testing because it was killing so many people. (It turns out that he had turned down the potential yield of Tsar Bomba to 54 MT, rather than the planned 100 MT, due to these concerns.) Although they listened to him end ended up doing what he suggested, the fact that he had spoken to the West meant that he was removed from his positions and all security access, and he was hounded, imprisoned, and harassed for many years by Soviet state authorities, until they themselves were finally defeated. He subsequently contributed to the new constitution. If anyone deserves a movie of the stature of Oppenheimer, it would be Andrei Sakharov. France was not a signatory of the Partial Nuclear Test Ban Treaty, and so that nation continued to detonate nuclear weapons in the atmosphere and ocean (most of the short bars above the line from 1963 until about 1980). One of the original purposes of the Greenpeace organization was to disrupt such tests. In response, France blew up a Greenpeace ship while in was in a New Zealand harbor, resulting in the death of one of its crew members. The following animation is quite famous, well produced and researched, and geographically precise. Please watch it carefully. **Watch:** A Time-Lapse of Every Nuclear Explosion Since 1945 - by Isao Hashimoto [Physics Simulation] https://youtu.be/T2EgzSwoKm4 **Reference:** List of nuclear weapons tests [Wikipedia] https://en.wikipedia.org/wiki/List_of_nuclear_weapons_tests **Recommended:** Tsar Bomba [Imdiatimes] https://youtu.be/Ptub8p9bMrQ **Recommended:** 1961 Tsar Bomba [Reuters] https://youtu.be/YtCTzbh4mNQ Let's look at which tests had the greatest power, and where and when they occurred. As indicated in the table below, the Soviet Union was responsible for the five most powerful blasts, all at Novaya Zemiya. The yield of Tsar Bomba has been various estimated as 50 to 58 MT. But there were an additional four Soviet tests, one delivered by missile (!), that were all larger than the infamous Castle Bravo test, which the United States conducted at the Bikini Atoll.

Week	Due Date	Topics, Videos, Readings, Assignments

Date (GMT)	Yield (megatons)	Deployment	Country	Test Site	Name or Number
October 30, 1961	50	parachute air drop	Soviet Union	Novaya Zemlya	Tsar Bomba, Test #130
December 24, 1962	24.2	missile warhead	Soviet Union	Novaya Zemlya	Test #219
August 5, 1962	21.1	air drop	Soviet Union	Novaya Zemlya	Test #147
September 27, 1962	20.0	air drop	Soviet Union	Novaya Zemlya	Test #174
September 25, 1962	19.1	air drop	Soviet Union	Novaya Zemlya	Test #173
March 1, 1954	15	ground	USA	Bikini Atoll	Castle Bravo
May 5, 1954	13.5	barge	USA	Bikini Atoll	Castle Yankee
October 23, 1961	12.5	air drop	Soviet Union	Novaya Zemlya	Test #123
March 26, 1954	11.0	barge	USA	Bikini Atoll	Castle Romeo
October 31, 1952	10.4	ground	USA	Enewetak Atoll	Ivy Mike
August 25, 1962	10.0	air drop	Soviet Union	Novaya Zemlya	Test #158
September 19, 1962	10.0	air drop	Soviet Union	Novaya Zemlya	Test #168

Watch: Atomic Testing in the Marshall Islands [unnaturalcausesdoc]
https://youtu.be/Tvj7MscvSrg

Watch: Marshall Islands: A third of the nation has left for the US [PBS NewsHour]
https://youtu.be/ZB8s_Yqp3ko

Examine: This Concrete Dome Holds A Leaking Toxic Timebomb [ABC News In-depth]
https://youtu.be/autMHvj3exA

Watch at least one of the following four videos about the Castle Bravo test:

Castle Bravo: The Largest Nuclear Explosion in US History [Untold History]
https://youtu.be/3K_XcJDJ6fI

The Castle Bravo Disaster - A "Second Hiroshima" [Kyle Hill]
https://youtu.be/ew064gt2thY

A personal perspective from participants in castle bravo
https://youtu.be/BddCmfRue0E

Castle Bravo Nuclear Test [rammy9]
https://youtu.be/fd1IFjBNNVo

Recommended: American propaganda film, Operation Castle (1954)
https://youtu.be/kfbHwj71k48

Week	Due Date	Topics, Videos, Readings, Assignments
	11/19/24	**Homework 13:** Reminder: check each week for any new **Announcements.** **Address any five of the following seven questions.** 1. Describe the mining and processing of lithium, its uses, and opportunities for recycling. 2. 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 being solved? 3. What are the 'rare earth' minerals used for? Where are they found? Are there likely to be undiscovered deposits? Which nations are most involved in their production and use? 4. 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. 5. After watching the 'Time-Lapse of Every Nuclear Explosion Since 1945', and examining the graphs above, give me your general impressions regarding the history of nuclear testing by the US, USSR, and others. How has it changed over time? Technologies and designs for the production of nuclear weapons have been accessible for several decades. North Korea, for example, received some of their initial technology from a Pakistani engineer. Meanwhile, keep in mind that warfare is being escalated in Europe, the Middle East, and elsewhere with a savagery that has not been seen in many decades. Some of our most prominent politicians claim that climate change is our only existential threat, so nuclear weapons do not seem to worry them very much. Do you think the world is really safer now from the threat of nuclear weapons, compared with other threats, than it has been in the past? Do you think that people's thinking may be influenced by the apparent indifference of politicians and mass media? 6. Describe the history of nuclear weapons testing in the Marshall Islands, and their consequences. 7. Describe the Castle Bravo test specifically. What went wrong? What were the consequences?
14	**11/26/24**	**Thanksgiving break**

Week	Due Date	Topics, Videos, Readings, Assignments
15		Topic 1: **Who or what is in control?** Reminder: check each week for any new **Announcements.** Let's think back to the topics of week 7, and once again examine the graphs below. The sorts of systems we have been discussing all semester, including human systems or systems in which humans play a significant role, all tend to resemble scale-free networks, rather than random or exponential networks. If you look at the number of connections each node has in this particular scale-free network, you will find a great many with only one attachment, with smaller but still significant numbers of nodes that have relatively many connections. If graphed, this displays a more long-tailed distribution than other network types. So why is this important? First, it demonstrates that hierarchical organization of some kind is present throughout nature. When their connections are mapped out, they map as scale-free networks. Some nodes always have more direct influence than others, simply because they have more direct connections to other nodes. But that does not mean that a node with a single connection cannot be important, since whatever it communicates can propagate easily up and down the hierarchy. It can do this more easily than if only randomly organized communications were available. It is not surprising that Nature, including biological nature and human nature, have evolved to reap the benefits of hierarchical organization. But Nature is also flexible, and networks in Nature change over time to more appropriately reflect or deal with current conditions. Otherwise, the very structure of the network itself can get in the way of its operating as originally intended. Hierarchical networks can become particularly troublesome when nodes with many connections, and therefore a great deal of power, refuse to sever any of those connections and distribute that power to other nodes, even if it would improve the network as a whole if they did. This stubbornness certainly applies to people. Look up someone like Anthony Fauci on Wikipedia, for example, and be amazed at how much direct power over scientific research funding one person can accumulate over time. Please indulge me for a moment. I attended public schools in the 1960s and early 70s. I remember the Kennedy assassination and subsequent events. My middle school and high school offered classes in wood, metal, print, and automotive technology shops, as well as drafting, chemistry, physics, biology, photography, and electronics labs. Anyway, my high school chemistry teacher, Mr. Salzer, was a middle aged man whose family had perished twenty-five years earlier in the Holocaust. One day, he introduced us to a short book of essays called *Brave New World Revisited*, by Aldous Huxley, published in 1958 and available at the time as a paperback. Mr. Salzer introduced this little book to us more than fifty years ago. If you haven't heard of it, I introduce it now to you now. Along with Orwell, Huxley was one of the first authors on social issues who influenced me because each seemed to understand something true and terrifying about the world. The video below is a contemporary discussion of the book. **Recommended:** Do We Live in a Brave New World? - Aldous Huxley's Warning [Academy of Ideas] https://youtu.be/aPkQ57cXrPA In other courses (and in this one, in previous semesters), I've ask students to study the Chinese Cultural Revolution. I did that quite deliberately, despite the discomfort, because in many ways it really is like

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		looking in a mirror, over the past few years. All that I'd really like to leave you with regarding the topic of politics, which I've deliberately avoided earlier, is the following quote from a Chinese political prisoner. Wei Jingsheng was tried and jailed repeatedly in the wake of the Cultural Revolution, when a fledgling 'Democracy Wall' movement in which he participated was quickly shut down. "Fatheadedness has so reduced everything but politics into matters of such insignificance that the sole factor determining human existence in China is politics. Therefore, people have little choice but to waste most of their energy on politics, which has been blown way out of proportion for far too long. This has served to increase both the intensity and complexity of political disputes, and caused the vulgar ruthlessness of politics to infect and disease science and culture as well. To use political standards to judge science and culture, not to mention people of talent, is as worthless as breeding a donkey with a thoroughbred. It blurs the lines between right and wrong, and good and bad in science and culture, and breaks down the natural process of weeding out the inferior and choosing the superior." - Wei Jingsheng, July 20, 1982. Excerpt from a letter to the "Members of the Commission for Discipline Inspection of the Central Committee and Members of the Standing Committee of the People's Political Consultative Conference". The Courage to Stand Alone: Letters from Prison and Other Writings, Penguin 1997. ### 1.1: **Social credit systems** The quantification and commodification of virtue is not new, of course. The priests of the past made a living of it, and some still do. But these days, the quantification, commodification, and enforcement of virtue have become the arm of public education, business, and government, rather than of religion. Even with the absence of any sort of God or higher being in their lives (or perhaps because of it), people are obsessing over, judging, and ranking one another's thoughts, emotions, and personal lives in terms of a very Western, neoliberal, post-puritanism. Accelerated by the Internet and other technological changes, the forms that this movement can take in the modern world are frightening. The concept of 'social credit' is being applied now with increasing ferocity not only to people, but also to business, education, law enforcement and other public services, health care providers, anything in fact that provides its employees with a paycheck. Social credit scores are being generated for every possible sort of social organization. The panels of judges applying these rules tend to be unelected bureaucrats and IT professionals for now. With the advent of AI, this may be transitioning soon over to nameless, faceless algorithms. Here I get into some controversial issues, since so many people in higher education are utterly devoted to this particular three letter acronym. The quantification of virtue in Western countries like the United States often takes the form of something called Environmental, Social, and corporate Governance (ESG), which has its origins with publications and announcements from United Nations officials and bureaucrats. **Reference:** Environmental, social, and corporate governance (ESG) [Wikipedia] https://en.wikipedia.org/wiki/Environmental,_social,_and_corporate_governance Environmental, social, and corporate governance (ESG), also known as environmental, social, governance, is an approach to investing that recommends taking environmental issues, social issues and governance issues into account when deciding which companies to invest in. Since

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		2020, there has been accelerating incentives from the United Nations (UN) to overlay ESG data with the Sustainable Development Goals (SDGs), based on their work, which began in the 1980s. How do other nations and cultures respond to these sorts of ideas? Philosophically, they seek to unite capitalism with socialism, taking what their proponents see as the best from each. However, as I will argue later, it can easily be seen that such mechanistic, potentially coercive approaches leave little room for individual human freedom. And freedom I would argue is the necessary catalyst for innovation to occur. So it is only natural that people might seek to limit their cooperation with such plans. This is true of countries that are run by authoritarian socialist or theocratic governments, since people everywhere value personal freedom. But Western governments and media have never let up on their criticisms of nations with which members of our own current government happen to be at odds, or at least pretend to be so, in order to whip up political support. So one tactic often used by members of our own government, a complicit press, and even much of our so-called alternative media, is to exaggerate the degree to which China and other nations manage to control their own populations through the application of social credit. Take China, for example. To what degree has China succeeded in quantifying virtue? Let's take a look. **Watch:** The Truth About China's Social Credit System [PolyMatter] https://youtu.be/Kqov6F00KMc ### 1.2: **Stakeholder capitalism** Environmental, social, and corporate governance scores are at the heart of what many members of the World Economic Forum (WEF) call 'stakeholder capitalism', which is based on 'stakeholder theory': **Reference:** Stakeholder Theory [Wikipedia] https://en.wikipedia.org/wiki/Stakeholder_theory "The stakeholder theory is a theory of organizational management and business ethics that accounts for multiple constituencies impacted by business entities like employees, suppliers, local communities, creditors, and others. It addresses morals and values in managing an organization, such as those related to corporate social responsibility, market economy, and social contract theory." Like many supposedly self-evidently beneficial ideas, stakeholder capitalism sneaks in an important assumption, which is that any number of non-human entities can have special rights and responsibilities that might easily be equal to or greater than those of human beings. Stakeholder capitalism makes itself sound innocent by emphasizing the supposed responsibilities of powerful non-human actors in helping people, but it is often implied that this corporate responsibility can easily dwarf the rights of individual human beings, and the 'help' being offered is often misguided and unwanted. It seems clear to me that stakeholder capitalism inevitably leads to a bifurcated class-centered society full of mostly angry, powerless, frustrated people. It is not surprising that the former head of the WEF talks like a Bond villain. He claims that elections will

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		soon become unnecessary because stakeholders using AI will run the world more efficiently. He seriously talks and writes like that. People with too much power and influence often resemble cartoons characters, rather than real human beings. But I am astonished at the respect that the WEF continues to get from the political elite of the United States and China. Both of these nations were supposedly founded on the primacy of people. Speeches made at recent WEF meetings in China are frightening. Anyway, here's a sober assessment from the Financial Times of London. **Watch:** Is stakeholder capitalism building a better world, or just empowering the rich? [Financial Times] https://youtu.be/nrk-8KfLY98 ### 1.3: **Central bank digital currencies (CBDC)** Do you want government bureaucrats or AI algorithms to control your access to your own money? Do you want them to be aware of every transaction you make? That is precisely what may happen soon. **Reference:** Central bank digital currency [Wikipedia] https://en.wikipedia.org/wiki/Central_bank_digital_currency I think that the topic of government-issues digital currencies should be included in this discussion because of its obvious potential for abuse. Troubling also is the lack of recognition or admission of this potential. For example, the Federal Reserve claims that CBDC "might affect financial-sector market structure, the cost and availability of credit, the safety and stability of the financial system, and the efficacy of monetary policy", but there is no mention of its effect on individual liberties. Many governments are looking into implementing their own CBDCs, including our own, and they all claim to have no interest in controlling people politically through their money and possessions. They already make assurances about systems that will be put in place to make sure this never happens, etc. However, it has already happened, even without CBDCs. In Canada. For example, Trudeau's government closed down the back accounts of people they accused of supporting in the Canadian truckers' strike. ### 1.4 **Big data** Social media and online commerce require and produce massive amounts of highly detailed data. There is actually very little that we can do as individuals to prevent corporations, governments, NGOs, and private individuals from accessing anything about us that is in digital form, including financial and health records. Corporations in collusion with governmental bureaucracies have enabled these vulnerabilities to accumulate and to cloud our lives. Still, they expect us to trust them, even after they have been repeatedly shown themselves to have been untrustworthy. Orwell was too conservative in his assessment of the future. But there's a different side to big data that I'd like to spotlight – its physical infrastructure. Data might seem to be virtual, but it requires massive amounts of hardware to exist, as well as energy. As these networks and databases grow, so will their hardware requirements. We've all heard of cyberwarfare. It's been going on for some time, and defenses have been developed. But if missiles or drones were to obliterate a critical data center or two, it would be cyberwarfare at a whole different level, and you can

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		imagine the chaos that might ensue. We can expect our world, in future, to be punctuated with physical data centers. What sorts of vulnerabilities do they represent? Might they become physical targets of warfare? Here's a little story to provide some perspective on the immediate reality of this trend in building data centers. Think back to our discussion in week 1 about the significance of place. **Reference:** "**Tokyo residents seek to block building of massive data centre**", by Mariko Katsumura for Reuters. The full article is here. "TOKYO, July 10, 2024 (Reuters) - A group of residents in Tokyo said on Wednesday they were aiming to block construction of a massive logistics and data centre planned by Singaporean developer GLP, in a worrying sign for businesses looking to Japan to meet growing demand. The petition by more than 220 residents of Akishima city in western Tokyo follows a successful bid in December in Nagareyama city to quash a similar data-centre plan. The Akishima residents were concerned the centre would threaten wildlife, cause pollution and a spike in electricity usage, and drain its water supply which comes solely from groundwater. They filed a petition to audit the urban planning procedure that approved GLP's 3.63-million-megawatt data centre, which GLP estimated would likely emit about 1.8 million tons of carbon dioxide a year. "One company will be responsible for ruining Akishima. That's what this development is," Yuji Ohtake, a representative of the residents' group, told a press conference. Global tech firms such as Microsoft (MSFT.O), opens new tab, Amazon (AMZN.O), opens new tab and Oracle (ORCL.N), opens new tab also have plans to build data centres in Japan. The residents estimated that 3,000 of 4,800 trees on the site would have to be cut down, threatening the area's Eurasian goshawk birds and badgers. "It's an unbelievably negligent plan," said representative Hiroyuki Hasegawa. The group was considering filing for arbitration to steer GLP towards reconsidering its plan, in which it is set to commence building in February, with completion by early 2029. GLP declined to comment on the residents' action. Japan's data centre market is expected to grow 10.8% in 2027 and 7.6% in 2028 amid demand from digital transformation and cloud services, according to real estate services firm Jones Lang Lasalle. In 2023, Japan saw a record 112 billion yen ($694 million) direct investment into data centre real estate, JLL's data showed. Local opposition has also been growing over the construction of a data centre in Kashiwa city near Tokyo." **Examine** one or two of the following four street videos from Akishima, Tokyo. Akishima [Tokyo View Collection] Nov 14, 2021 https://youtu.be/xsWCwPPmAyQ

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		Akishima [Let's Walk in Japan] Aug 15, 2023 https://youtu.be/iUiJbVQGEkI Akishima [Let's Walk in Japan] Dec 18, 2021 https://youtu.be/Vh9hJhvRUNQ Akishima at night [machidori.channel] Dec 8, 2021 https://youtu.be/NwoUX-CwPbg Topic 2: **Innovation** I'd like to end the semester with a different approach to the question of 'who or what is in control?' I'd like to challenge the question itself. Why should we assume that any of the systems we've discussed so far operate in such a way that controlling them is desirable, or even possible? Control implies that we represent a source of agency that is external to the system we are trying to control. Of course, one part of any system can control some other part of the system; in this sense, the system can control itself. But in many of the systems that we've been discussing, there is no clearly defined agent of control, either within or external to that system. Instead, the results that are produced, and the dynamics that are expressed, emerge from the uncontrolled interaction of autonomous, distributed sources of agency. So why do we often assume that explicit control of the levers of change is required? It comes naturally to us. We as a species have managed to survive by controlling aspects of our environment. We represent an extremely powerful source of agency on this planet. Based on our collective memory, we might assume that a loss of control means at best suboptimal results, and that it can lead to disaster. That is how many of the systems that we have created and with which we interact seem to work. But many of the systems with which we interact operate differently. Systems composed of autonomous components that operate cooperatively to achieve success are not so easily controlled. Metaphorically, there may be no handle with which to grab such a system. No part of it is so critical that changing its course deliberately would affect the system as a whole very much. The Internet is supposed to operate this way. In week 8, we considered a group of people hiking through a forest without a map or electronic devices, and they get lost. I argued that they should probably try to form a coherent picture of the situation before deciding upon any particular course of action. That is why I asked you to spend two weeks discussing perception, comprehension, and modeling, before embarking upon the truly difficult topic of climate change. I am more interested in introducing you to some of the technical details of these sorts of tasks, than in concentrating on discussions involving social engineering. We can use the tools we have more intelligently, and gain wisdom, if we do not always assume that we need to use them to control our environments, or worse yet, to control other people. Using a diversity of tools intelligently requires a great deal of study and hard work. A lack of diversity in our perceptual, mathematical, conceptual, and technological tools just leads to greater fear and more control. If all you have is a hammer, the entire world looks like it's full of nails. In week 7, we discussed the concept of emergence as a characteristic of the natural world. In week 9, we discussed the concept of functional diversity, and how unanticipated patterns of cooperative behavior can

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		emerge when individualized sources of agency are allowed to vary in their functionality. The point I'd like to make here is this: if emergent properties are indeed at work in the world, **the past cannot fully predict the future**. In the human realm, if diversity of thought and behavior is encouraged (to a reasonable degree) among people whose underlying intentions or goals are compatible, it is possible achieve positive results that no one might have predicted or anticipated. But simulations discussed in week 9 also indicate that excessive diversity in functionality can lead to a low-production, chaotic world, particularly if the individual agents do not have a common goal, and if the variables of interest do not settle into relatively stable distributions around a single mode. Perpetual revolutions or even bimodal systems with excessive functional variation can experience wild swings in behavior that are far from beneficial. I think we have seen that happening repeatedly with our own two-party political system. I would suggest that the sorts of innovation that produce the most beneficial results occur when the system itself is both strong and malleable. It should not be too tightly controlled. Even randomly generated diversity allows it to explore previously unknown potential strategies. Nevertheless, the principal sources of agency in the system should share a well-defined set of simple global goals. ### 2.1: **Competition and cooperation** We've all seen movies about scientists or inventors working alone, in relative isolation. This does happen, particularly at the beginning of someone's career, but most developmental advances that result in new ideas, products, or services seldom occur that way. Innovative people nearly always seek to become members of a community, at least if they expect their work is to be appreciated. Although initial or key ideas ultimately come from individuals, invention and innovation are almost always group efforts. For example, Thomas Edison was credited with inventing the incandescent light bulb because he found the right filament. But that's just part of the story. The following video provides an illuminating look at how Edison and his team approached the challenges of their time. **Watch:** The battle of the bulb: How the first lightbulb was built [Fox Business] https://youtu.be/-yXWL1hCKjc Now let's look at one aspect of the current situation. **Watch:** The War for AI & Chip Supremacy is Underway. [Good Times Bad Times] https://youtu.be/A45WuwfUK8o I think that many of you would derive benefit from watching videos from the [Systems Innovation] channel, beginning with the following, which relates to question 5. **Watch:** Systems Innovation Overview [Systems Innovation] https://youtu.be/rVGoeFAW0FM

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	12/03/24	**Homework 15:** Reminder: check each week for any new **Announcements.** **Please address any five of the following seven questions.** 1. What are the different sorts of social credit systems that operate (or have operated) in China? How have people responded to efforts to implement such systems? Would it be fair to say that all such programs are centrally or governmentally controlled? Why or why not? Watch the video carefully. If you just repeat mainstream (or alternative) assumptions regarding the power and reach of China's social credit systems, I will know that you did not watch the video. 2. In many places around the world now, people pay for things with their phones. These extensions of social media apps are considered reliable and convenient. The next step may be to eliminate physical representations of money altogether. Do you think digital currencies, particularly those issued by governments, are a good idea? Do you think we may already have become over-dependent on electronic currencies and transactions? What would happen, for example, if the Internet itself stopped working? We will return to this in week 6. 3. Do you think that stakeholder capitalism is likely to build a better world? Why/why not? What might be the significance of governments adopting central bank digital currencies? Ow might these ideas affect human rights? 4. Data centers provide essential hubs to an ever-expanding Internet, and they provide storage for ever-expanding sets of data derived from Internet activity, including data generated by financial and other critical services. They require significant amounts of continuous power to operate. It is easy to see how data centers would be prime targets in future wars. Do you think that mixed-use data centers should be constructed? Is it reasonable to construct such centers in or near residential neighborhoods like Akishima, or San Jose? After all, they're just buildings. They seem innocent enough. 5. Describe the approach that Edison took to the invention, production, and distribution of incandescent lighting. Why was it more than just finding the right filament and inventing the bulb? 6. Outline the basis for what the 'Good Times Bad Times' channel describes as a war for AI and chip supremacy. 7. How does the [Systems Innovation] video suggest we apply systems thinking in order to enable transformative change within complex organizations?

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16	**12/12/24**	**Term paper (Final Evaluation)** 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 yourself without further editing.