San José State University
Department of Urban and Regional Planning
Geog01: Geography of the Natural Environment, Section 2

Spring 2021

January 13, 2020

Course and Contact Information

Instructor:	Gary Pereira
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Office Hours:	Please contact me if you would like to set up an appointment.
Class Days/Time:	Weekly homework and announcements as scheduled.
GE/SJSU Studies Category:	Area B1

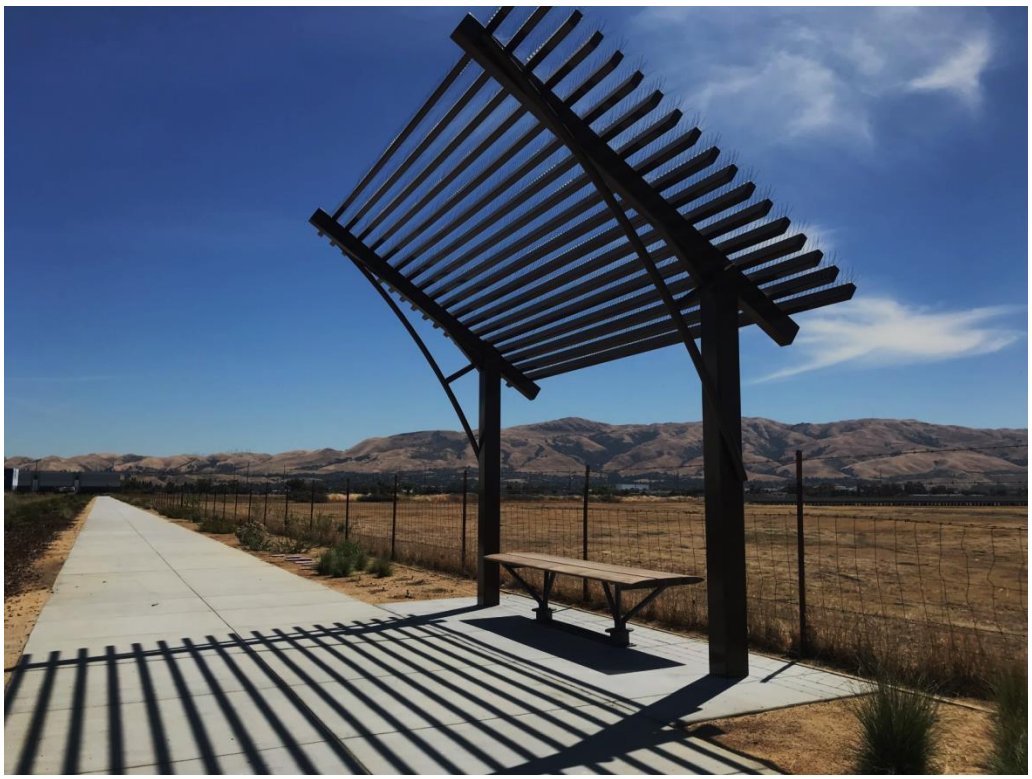
Course Format

This is an online only course. Internet connectivity and computer are required. Many of the resources that we will use are from safe, reliable sources on the Internet. The course itself can be accessed through the Canvas Leaning Management System course login website, primarily through the **Announcements** and **Assignments** for this class. Additional course materials (including this syllabus) can be found and uploaded from **Files**, as prompted in 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 recent **Announcements**. Please check the Announcements at least once a week, particularly before submitting homework. Your grades may suffer if you repeatedly fail to address the questions that may have been posted 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 a Canvas message or with one pinned to the submission itself. Comments may be pinned to particular submissions by either the instructor or student. I will try to get to each submission within a week after its due date, although I may run late. Check your submission for any comments I may have left, regardless of whether you have received a grade, and address any pressing requests expressed there. If you would like to respond to a pinned comment, please do so with an independent message, since I am unlikely to return to that particular submission once it has been graded unless I've been prompted to do so by you.

The photo below represents (with a little humor) my impression of some of the online educational technologies that we are often encouraged to use. If you look closely, you might notice something odd. The metal structure looming over the bench looks it might provide some sort of shade or shelter from rain, but in fact it does neither, at any time. Nevertheless, spikes are required to keep birds from perching on it and messing up the bench.



You might take the bench in the photo to represent the parts of Canvas that we will use: **Files, Announcements**, and **Assignments**, communicating as necessary via messaging. The stylish structure looming over the bench might be taken to represent my impression of some of the less helpful parts of Canvas, as well as many of the published textbooks and resources that students are often required to buy. For this course, I have found that a free online textbook is sufficient to supplement some carefully chosen Internet sources, along with some of my own material.

The subject matter should be what makes a course engaging, not its structure. Let's not mistake the finger pointing at the moon, for the moon itself. The characteristics of the finger are not important. It just points the way. That's part of my role, but I can also provide feedback when appropriate and follow current events and recent discoveries wherever they might lead in real time. In order to allow for that kind of flexibility, it's often better to have less formal structure and superfluous interaction. Nor should we rely on the overpriced products of publishing houses that jazz up and help push a particular pundit's point of view. I would prefer to have us sample freely from any number of qualified sources of information, analysis, and wisdom that exist throughout out the world. Conforming to the changing protocols of educational and social media is not the goal of any of my courses. I hope to keep that stuff to a minimum.

Within the **Announcements**, I might make some general observations and offer some general advice regarding earlier homework responses, but I will never identify students by name without prior permission. I further promise to keep any information we exchange via either messages or homework (other than your pointing out one or more of my many potential typos and simple errors that I need to tell the rest of the class about) **completely private**. Nevertheless, you may share any such exchanges or documents with anyone at any time.

Within **Canvas messaging**, conversations cannot be easily ignored, misplaced, tampered with, and shared with others. There are no such assurances with email, which has as a result become a tool for manipulation, power, confusion, and disrespect, even by people in authority. That is why I would prefer not to use email in my role as educator. Canvas messaging is sufficient. Text my private number if you have an emergency. Being late with your homework is not an emergency.

Please read and view the material at the beginning of each **Assignment**, as well as any new **Announcements**, every week. These are where the material that would otherwise be covered in lectures will be located. Homework questions are posed within each **Assignment**. If I pose an additional question for your homework in a recent **Announcement** and you have not addressed it, this may 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 and reasoning. I am looking mostly to see that you have actually accessed and examined the material in question. If you are uncertain, make adjustments based on prior grades and comments. 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 complete attribution, by means of notes or references (a URL alone is not enough).

The university expects that each student put at least nine hours of work per week into each three-credit course. 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 impressions 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 videos.

Course Description

This course covers the basic sciences that describe the Earth's atmosphere, hydrosphere, biosphere, and lithosphere.

Course Goals and Learning Outcomes

This course is approved for General Education Core Physical Science area, B1. Upon successful completion of this course, students will be able to:

1: use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations. Evidence-based learning and discovery form the basis of scientific inquiry. The focus of this class is therefore on evidence, rather than belief. Challenges to existing explanations are approached through examination of evidence.

2: demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues. The technical and cognitive methods of understanding used by researchers in physical geography are described throughout the course. The goal of achieving relative independence of the natural sciences from social belief systems is recognized, as is the influence of such belief systems on the process of achieving that goal. The influence of the resulting comprehension of natural systems on human societies is emphasized throughout the course, particularly with regard to natural disasters like earthquakes, as well as the complex impact of climate change on social systems.

3: recognize the methods of science, including quantitative, analytical reasoning techniques. The tools and methodologies of the physical geographical sciences, as well as the analytical and algorithmic reasoning techniques, are studied in some detail. Students shall understand how knowledge is achieved and improved on an ongoing basis.

Textbook

The **Fundamentals of Physical Geography** (2nd edition) is a free online textbook with over 300 pages and 400 illustrations, photos and animated graphics. It is the work of two professors from the University of British Columbia Okanagan – Dr. Michael Pidwirny & Scott Jones. Important terms are hyperlinked to a glossary. There are links to study guide pages and additional reading within each chapter. Most importantly, 'weblinks' are provided for each chapter that provide a wealth of well-respected sources of additional data and social media. The textbook is accessible here:

http://www.physicalgeography.net/fundamentals/contents.html

Additional Readings

Additional readings are required for certain assignments. These files are all available from Canvas, under **Files**:
NCA4_Ch25_Southwest_Full.pdf
2018indicatorssummary.pdf
StayingSafeWhereTheEarthShakes_BayArea.pdf
PuttingDownRootsInEarthquakeCountry_BayArea.pdf

Videos

Videos are a big part of this course, and much of the homework will be judged on the basis of how closely you consider them in your discussions. If you are accessing each assignment directly through CANVAS **Assignments**, you can watch the videos coming from YouTube directly within CANVAS, but you also have the choice of running each video in a separate browser. Watching videos within separate browsers often provides you with additional textual information, as well to the author's channel. You might want to watch videos on a tablet as you write on a laptop. Use whatever method

feels comfortable, but make sure you have a large enough screen to clearly see the details (including text) in the videos. You also obviously need sufficient bandwidth, which may change for you over the course of a typical day. Each video listed in the schedule is preceded by either Watch or Examine:

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

If you open YouTube videos in a separate browser, you will find that some of them contain ads. Usually, these can be cut short by clicking on '**Skip Ad**' at the lower right of the browser, or by clicking on the **X** if it's a popup. There are never ads on my own videos, and I get no monetary benefit from YouTube. I do not often provide tags, and I do often disable comments. In addition, embedded Canvas views are not counted as views by YouTube. As a result, most of my videos get few views. However, you may share my videos with anyone at any time. YouTube, along with most other social media, is becoming increasingly censorious, and this is a problem, but it remains the principle depository of educational videos.

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 should all be submitted, even if late. Please submit all files via Canvas; never email them to me. If you are having difficulties, message me through Canvas. If Canvas goes down or if you are having difficulties communicating, just be patient, try again later or the next day, and let me know about it. 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, 'Pereira', 'geog12-2' or 'geog12-3', and 'Spring 2021', 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 must all include full attribution (not just the URL). In other words, be honest about which words, figures and images are yours, and which are from other sources. You will need to be especially careful if you decide to publish or post your work in an online portfolio. Although it is often helpful to include external material in the form of extended quotes, graphs, and figures, these should be explicitly cited and referenced. They should be there for an important reason, otherwise leave them out. Most of the text in each homework submission should be your own.

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, if it leads to further understanding. If your writing style is

average, and you avoid redundancy, and you put in the time expected of you, each homework assignment should probably run at least three pages.

Don't expect an A+ (or even an A) just for being 'correct'. 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, particularly if it hasn't been graded. I may be a few days late with grades on occasion. If you would like to begin or continue a conversation about an assignment, please do so with an independent Canvas message. I encourage you all to go back and expand and polish up some of your most interesting essays and **publish them online**, in Portfolium at a minimum. In my opinion, the work you are doing for this class and others should be used in support of your professional career. Please read **'**About your instructor', below.

Announcements

Please check the **Announcements** tab every week. Discussions of homework results and expectations, current events, and other issues of interest to this class will be posted there. Additional homework questions may also be posted, due more than a week after posting.

Final Evaluation

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

I don't believe in having students review one another's work, but I do encourage you to make your best work available to the world, on your own terms. That is what **Portfolium** and similar online services are for. I advise you all to polish up and recombine some of the work you do for this class and others, create some graphical, illustrative material, and put it online. Portfolium is designed to be a one-stop shop for potential partners, employers, and clients who want to get an idea of just how bright you might be. You all should create and begin populating your own accounts, which you can constantly revise and over which you have total control. It's free.

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.

Determination of Grades

Homework assignments (6.5% each) x 14	91%
Final Evaluation	9%
Total	**100%**

98% and above	A+
94% - 97%	A
93% - 90%	A-
89% - 87%	B+
86% - 84%	B
83% - 80%	B-
79% - 77%	C+
76% - 74%	C
73% - 70%	C-
69% - 67%	D+
66% - 64%	D
63% - 60%	D-
below 60%	**F**

University Policies

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found in University Policy S12-3 at http://www.sjsu.edu/senate/docs/S12-3.pdf.

Note that "All students have the right, within a reasonable time, to know their academic scores, to reWatch their grade-dependent work, and to be provided with explanations for the determination of their course grades." See University Policy F13-1 at http://www.sjsu.edu/senate/docs/F13-1.pdf for more details.

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/

About your instructor, Gary Pereira

I grew up in New Jersey, in an industrial city near NYC. I had various jobs thereabouts, from working in the downtown single-screen movie theater to working as an untrained technician at a now decommissioned nuclear power plant.

I began working professionally as a technician with an associates' degree in electronics engineering. For six years, I helped to build and maintain the data acquisition and instrument control system for Princeton University's huge experimental nuclear fusion reactor. I got to know graduate students and townies at the university and in downtown Princeton, which is absolutely soaked in history and greatness. After TFTR was completed, I went to work as a technician for Brooklyn College, where I also earned a master's degree in computer science. I had the opportunity to meet some of the giants in computer science and Artificial Intelligence, at both Brooklyn College and at the Graduate Center on 42nd Street in Manhattan. I met and married Cheri while in Brooklyn. We had a child and moved to Bethlehem, PA, where I worked and studied at Lehigh University for another few years, later at Lockheed Martin. We moved again to Minnesota, where I worked with a small federal agency in Chanhassen that uses remote sensing, GIS, and hydrological modeling to produce online data products (often involving snow cover) for the US weather services and hydrological agencies and industries. I earned a PhD in Geography at the University of Minnesota, where I met or studied under some of the most outstanding scholars in the field and researched methods of modeling and reducing fire spread in Amazonia. We finally moved again to the Bay Area, and I've been teaching at SJSU for about 18 years.

Why do I encourage you all to join professional organizations as students and participate in whatever online learning opportunities they offer? Why do I encourage you at the very least to put your best work online, within something that potential employers can access, like Portfolium? I can think of plenty of reasons, involving everything from the state of the world to my own lived experience. For example, while I was working as a technician at Lehigh University, I took all of the classes that were required for a PhD in Computer Science, but we moved to Minnesota before I could make much progress on a dissertation. Oh well. It didn't really matter. None of that learning was wasted. Since I was interested in pattern recognition, simulation, modeling, and visualization, as well as the natural sciences, I independently developed a software system using principles from pattern recognition, remote sensing, GIS, and AI that I presented at a conference in Vancouver. I had no financial support. I paid for the travel, lodging and registration myself. A couple of weeks after the conference, I got a call from someone at Lockheed Martin Corporation who'd seen me there. They had a GIS project within commuting distance of my home that might interest me. They gave me an interview, and they offered me a job as a systems engineer, which I accepted.

Shine a light.

https://portfolium.com/garympereira/portfolio

Geog1-02, Geography of the Natural Environment, Spring 2021

Please submit your homework responses as Word or pdf files by the due date indicated. Use 10 point font, with 1 ½ line spacing and normal margins. Put on the first page of each submission your name, my name, the homework #, geog01-02, Spring 2021.

Course Schedule

Week	Due Date	Discussion, Readings, Videos, Assignments
1		Topic: **The nature of the natural sciences** If you haven't already done so, please **Watch:** General notes for my online classes [Gary Pereira] https://youtu.be/_AN8k0Ogwl0 In this course, I intend to plunge directly into real contemporary science. The most important sorts of science, in my view, are those that directly recognize and address the most difficult open questions regarding all of those things that we do not completely understand. Textbooks often give the false impression that the science contained therein is settled. If you don't believe, go find a textbook in nearly any field from 30 or even 10 years ago. For one thing, there is often a great deal more diversity of thought among scientists than the textbooks would have you believe. When I first studied physics and astronomy for example we had protons, neutrons, electrons, etc.; relativity, quantum theory and the Big Bang. Now, in just a few years, we see quarks and strings, cosmic inflation and multiverses, our own absolutely dominated by the still utterly unknown nature of dark matter and dark energy. I'd like to start off by challenging the assumption that the physical sciences are necessarily a materialist project. Much of contemporary, cutting edge science actually has more to do with information than with materiality. Please indulge me by watching this, even if it isn't quite what you expected. I want to start with someone who challenges common notions. **Watch:** Rupert Sheldrake - The Science Delusion [revolutionloveevolve] https://youtu.be/JKHUaNAxsTg Sheldrake's descriptions of physics are accurate, although his views of course remain controversial. There is absolutely nothing wrong with controversy in science or philosophy. I've asked you to watch this in order to disabuse you of the notion that the big questions in science have all been answered; they have not. It's not only the very big and the very small that remain mysterious. Even things at our own scale remain mysterious. For example, nonlinearities (in the mathematical sense) yield all sorts of weird and wonderful things at all scales. Nature itself is almost entirely nonlinear in form and function. As we begin to look ever more closely at astronomical objects for example, from stars to galaxies and beyond, they reveal themselves to be as complex in their own way as living things. As we have seen it more closely, the universe itself has revealed to us its own evolution. The universe and everything in it are actually far more intricate at all scales than we realize. **1. Complexity and fractals** **Watch:** Fractals: a world in a grain of sand | Ben Weiss [TEDx] https://youtu.be/DHNooAe44dY As you look down on the Earth from above, is there anything that is NOT fractal?

Week	Due Date	Discussion, Readings, Videos, Assignments
		Examine: The Blue Pearl III [Sean Doran] https://youtu.be/FYOH_54XEJY As an example of the sort of fractal complexity that can come out of a relatively simple nonlinear relationship, consider the Mandelbrot Set, which is generated by a very simple iterative equation. As you zoom in towards some point along the boundary of converging solutions to that equation on the complex number plane, it reveals itself with infinite complexity, as shown in the video below. Notice that the fractal patterns that can come out of 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. The 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. Nevertheless, we shall explore it next week. **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: **Examine:** Mandelbulb 3D Animation [Russ McClay] https://youtu.be/VGpnuTJhv1U **Examine:** Virtual nature (fractal world) [San Base] https://youtu.be/79SqIC2bNcM **2. Scale and pattern** You will notice that fractal patterns are to some degree scale-independent. That is, they persist or repeat themselves in slightly different forms at different scales. Natural branching patterns are often like this. I've been thinking about relationships between scales for some time. The following is not required reading by any means, but you may find it interesting: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1538-4632.2002.tb01073.x Finally, I want to introduce the science of patterns. My first specialized success in creative computer science was with pattern recognition. As applied to real or projected space, this might include computer vision. But patterns can be detected, examined, or formed at any scale in any abstract 'space' of any dimension, within a computer. We don't need to be able to see multidimensional spaces in order to work with them. This ability to work with patterns forms the basis of much of AI, neural networks, etc. **Watch:** The Science of Patterns [Systems Innovation] https://youtu.be/kh6KMW8J3RQ Combining the ideas of pattern and scale, of space and time, we can better appreciate the patterns that emerge from natural phenomena. In the following videos, I look at lichens and terracettes, which grow over long periods of time, and bird song, which forms patters over very short periods of time. In both

Week	Due Date	Discussion, Readings, Videos, Assignments
	02/03/21	cases, the scales of activity fall to some extent outside of direct human perception. **Examine:** Pattern formation in Nature 2: lichens and terracettes [Gary Pereira] https://youtu.be/AZ14PyiqM28 **Examine:** Pattern formation in Nature 3: bird song [Gary Pereira] https://youtu.be/UvGue54F4lk **Homework 1:** 1. Fractal mathematics can be used to describe forms in space and events in time that operate over a range of scales. Were you ever provided with a description of fractal mathematics in school? Had you heard of fractals before or seen videos of this kind? Why is it easier to describe a leaf or a cloud or a coastline with fractal than with traditional geometry? 2. The spatial and temporal (time) scales of human understanding have expanded tremendously as the result of scientific work. I would argue that this capability may help to prevent the eventual extinction of the human species. For example, we could not ever hope to prevent the next asteroid-induced mass extinction unless we understand and go into outer space. We could not hope to defeat the COVID-19 virus unless we could analyze and manipulate things at the nanoscale. Please describe some additional examples of how our collective scientific understandings of things that are normally invisible to us help us to survive and thrive.
2		Topic: **Emergence and evolution** **Watch:** Emergence – How Stupid Things Become Smart Together [Kurzgesagt] https://youtu.be/16W7c0mb-rE **Watch:** Emergence [Systems Innovation] https://youtu.be/QItTWZc7hKs **Watch:** Synergies [Systems Innovation] https://youtu.be/rsn5EQoAhUc Regardless of what you think about the ultimate 'reality' of the principles of emergence, it is one of a set of many ideas that encompass contemporary theories of complexity, as applied to the physical world. Evolutionary theory in biology has also discovered many illuminating processes and principles, that ave proven to be useful at ecological and social scales. Indeed, the evolutionary history of the universe itself is the central topic o cosmology. The evolution of the elements in the periodic table is far more involved than you may think. The vast majority appeared hundreds of millions or billions of years after the Big Bang: **Not required:** Where do atoms come from? [Sabine Hossenfelder] https://youtu.be/yszguz5uAW4 The significance of nonlinear phenomena (that is, most things) cannot be determined by addition and subtraction alone. Imagine bumping into a wall at 1 mile per hour. No big deal. Now imagine doing that

Week	Due Date	Discussion, Readings, Videos, Assignments
		fifty times in a row. It would be kind of silly but still, no big deal. Now imagine bumping into the wall just once, but moving at fifty miles per hour. Obviously, a very different result from doing it fifty times at 1 mph. A great deal of what happens in the real world is not simply additive. The sorts of events that carry the most significance (possibly the only significance) are often very those rare events that are strung out along the long tail of the powerfulness v frequency distribution. These are the events that actually change lives, nations, and civilizations. **Watch:** Long Tail Distributions [Systems Innovation] https://youtu.be/vIp1kY0H0yw Usually the discussion of solution to our collective vulnerability to powerful events strung out along the tails of event distributions (events like pandemics, floods, earthquakes, etc.) revolves around terms like 'resilience' and 'robustness'. However, an argument can be made (through simple observation of nature) that some other principle better characterizes the opposite of fragility: something that people have known about for a long time, but which Nassim Taleb recently termed 'antifragility'. **Watch:** Nassim Taleb Explains Antifragility in Under 5 Minutes https://youtu.be/C40zwpdc_yo https://en.wikipedia.org/wiki/Antifragile **02/10/21** **Homework 2:** 1. Describe the concepts of emergence, synergies, and pattern formation, and try to illustrate them in the context of the natural sciences with a few examples. 2. What are long-tailed statistical distributions? How might events following a power-law or long-tailed distribution make assumptions of long-term normality nonsensical? In other words, are common statistical terms always meaningful? For example, can the mean of a power-law distribution ever be determined? This is an important point, given the fact that many natural distributions do indeed have very long tails. 3. What is antifragility? Try to explain how it can be seen as different from resilience or robustness. Why might you think this concept is important in an era of climate change and pandemics?
3		Topic: **Pandemics** Throughout the semester, it will be helpful to keep in mind that important agents of change exist at every scale. They can be far smaller or far larger than anything we as human beings can directly perceive. They can occur far more quickly than we could ever have time to respond to, and they can happen far more slowly than we might ever notice within an entire lifetime. The pandemic that we are going through now is a perfect illustration of this point. Each SARS-CoV-2 virus particle is approximately 50–200 nanometers in diameter. Let's say 100 nanometers, typically. That's four orders of magnitude smaller than a millimeter, which is the finest mark that you would typically find on a common ruler. So ten thousand individual virus particles can be lined up between those millimeter marks. Square that number: a hundred million could cover a square millimeter of surface with a single layer.

Week	Due Date	Discussion, Readings, Videos, Assignments
		Now think about the surface area of human lung tissue, which is the target. The alveolar surface area of a pair of human lungs varies from 50 to 75 square meters. That huge surface area is possible in such compact volume because (as we've seen last week) lungs like many things in nature are fractal, terminating in hundreds of millions of alveoli for gas exchange. You can imagine the sorts of battles that are being fought at molecular scales upon the vast terrain (from the virus's point of view) of available human lung tissue within a single human being. Now think about the spread of that virus to hundreds of millions, potentially billions of humans everywhere on earth. The point is, don't judge the potential power of any agent of change by its size or by our current awareness of its potentialities. Very few of us were warning anyone about this sort of thing happening here in the US. My late father-in-law was a professor in China specializing in the diagnosis and treatment of diseases of animals, particularly those that spread to humans (zoonotic diseases). My son is a PhD scientist working on quick field diagnosis of COVID-19 and other diseases, particularly those found in underdeveloped nations. I realize that this is a course in physical geography, but I could make a very good argument that our current situation regarding COVID-19 is a perfectly relevant topic of study here. Hopefully, by the end of the semester, you will all have come to understand some of the many connections between human health, animal welfare, and the natural environment. We'll begin with the basics of spatial epidemiology. **Watch:** How Pandemics Spread [TED-Ed] https://youtu.be/UG8YbNbdaco **Watch:** Spatial Epidemiology & Geography of Disease [The Great Courses Plus] https://youtu.be/-T4VUZmohAo **Examine:** Viral Intelligence: What Is Coronavirus? [The Great Courses Plus] https://youtu.be/P2AueO_pcAU **Examine:** Introduction to Infectious Diseases: Travel, War, Natural Disasters [The Great Courses Plus] https://youtu.be/sghMinCXX4Y **Examine:** How we conquered the deadly smallpox virus [TED-Ed] https://youtu.be/yqUFy-t4MlQ **Watch:** Why are outbreaks of infectious diseases on the rise? [DW News] https://youtu.be/4J1AqK0ayTE Next week begins our more traditional sequence in physical geography, using the textbook in part. I wanted to address these other topics first because it is too easy to assume some sort of false hierarchy, with the biological and ecological sciences and concerns described last, and no mention at all of some of the more helpful recent conceptual tools involving complexity theory. I think the approach I've taken here serves you better.
	02/17/21	**Homework 3** (I expect substantive answers in response to each question): 1. What is spatial epidemiology? Describe the history and current status of this field of science. 1. How is a pandemic defined? How do pandemics spread? 2. Why are outbreaks of infectious diseases on the rise?

Week	Due Date	Discussion, Readings, Videos, Assignments
4	**02/24/21**	**Topic:** Energy **Watch:** A guide to the energy of the Earth https://youtu.be/fHztd6k5ZXY Access the text **Fundamentals of Physical Geography** http://www.physicalgeography.net/fundamentals/contents.html **Read** CHAPTER 6: Energy and Matter Each chapter of the online text **Fundamentals of Physical Geography** includes a Study Guide page. At the bottom of each Study Guide page is a list of Essay Questions. Responses to questions from the book may be partially copied and pasted from the text, but most of the writing should be your own. Take your answers, at least in part, from the section of that chapter that discusses the topic at hand. Do NOT take them from the summary of the chapter. Use your own words most of the time, and incorporate what you learn from the videos. **Homework 4:** 1. Describe some internal and external sources of energy for the Earth. Chapter 6 Essay Questions 3, 4, 5, 6, 7, 9 , 10, 11, 12: 6.3. How do the three mechanisms of conduction, convection and radiation move energy from one place to another? 6.4. Outline the three laws of thermodynamics. 6.5. What is radiation? How is it created? What factors determine its quantity and quality? 6.6. Define the Stefan-Boltzmann Law. What does it describe? 6.7. Define Wien's Law. What does it describe? 6.9. How does the Sun create the energy that drives most systems on the Earth? 6.10. How does the tilt of the Earth's axis influence the annual solar insolation received at a site located at 50 degrees North latitude? 6.11. What influence does Earth rotation have on solar insolation received at the equator? 6.12. How does angle of incidence control the intensity of solar radiation received at the Earth's surface?

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5	**03/03/21**	Topic: **The Atmosphere** **Watch:** Careers In Atmospheric Science https://youtu.be/Fk-uqrXkkG8 Access the text **Fundamentals of Physical Geography** http://www.physicalgeography.net/fundamentals/contents.html **Read** CHAPTER 7: Introduction to the Atmosphere **Homework 5:** 1. Describe the sort of careers in atmospheric science from in the video that you find most interesting. Chapter 7 Essay Questions 3, 4, 5, 6, 7 7.3. Why is ozone important for life on Earth? Where is it found and how is it formed? How is human activity influencing this important atmospheric gas? 7.4. How is the incoming shortwave solar radiation from the Sun modified by the atmosphere and the Earth's surface? 7.5. Describe the difference between the following two terms: heat and temperature. 7.6. Describe the shortwave radiation cascade as it relates to the Earth's energy balance. 7.7. Discuss how the Greenhouse Effect works. How has human activity over the last few centuries enhanced this natural process? How will global warming change the environment of the Earth?
6	**03/10/21**	Topic: **The Atmosphere** **Watch:** Water Vapor Fuels Hurricane https://ca.pbslearningmedia.org/resource/nves.sci.earth.hurricane/water-vapor-fuels-hurricanes/ **Watch:** NOVA: Earth From Space | Monitoring Earth's Water Vapor https://ca.pbslearningmedia.org/resource/nves.sci.earth.vapor/monitoring-earths-water-vapor **Homework 6:** 1. What is the primary function of the Aqua satellite? How does it monitor the production of water vapor? 4. What is a geostationary orbit? Why do you think it would be useful to have a satellite remain in orbit over one point on Earth? Why do scientists combine data from multiple satellites in geostationary orbit? 5. Explain how topography, latitude, and other factors combine to change the impact of water vapor

Week	Due Date	Discussion, Readings, Videos, Assignments
		regionally, as described in the video. Chapter 7 Essay Questions 10, 13 7.10. What is a hurricane? Where, when and why does it form? How is global warming likely to influence hurricane intensity and frequency? 7.13. Discuss the formation and characteristics of the various types of thunderstorms (see also the videos).
7	**03/17/21**	**Topic:** Climate Climate is obviously an issue of central concern, and it is important to get an adequate understanding of the totality of nature involved: it's not just the atmosphere. I'm likely to have a few things to sat in announcements, since our changing climate is never far from the news. **Watch:** NOVA: Extreme Ice | Ice-Core Record of Climate https://ca.pbslearningmedia.org/resource/nvei.sci.earth.climate/ice-core-record-of-climate/ **Watch:** NASA | The Ocean: A Driving Force for Weather and Climate https://youtu.be/6vgvTeuoDWY **Watch:** What is a Climate Model? https://youtu.be/bkcrH9tYv8g **Watch:** Why It's Usually Hotter In A City [NPR] https://youtu.be/Y-bVwPRy_no **Homework 7:** 1. What is an ice core? Why is it useful? 3. What precisely is the relationship between greenhouse gases, global temperatures, and sea level? 4. Why are the oceans a driving force for weather and climate? 5. How do climate models work? Chapter 7 Essay Questions 15, 21 7.15. What factors are responsible for the altered micro-climate of urban areas? 7.21. Why do urban areas have more energy available for the creation of sensible heat than rural areas?

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8	**03/24/21**	**Topic:** The Hydrosphere I worked for a couple of years for the National Operational Hydrologic Remote Sensing Center, or NOHRSC: https://www.nohrsc.noaa.gov NOHRSC 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 is called 'snow water equivalent', or SWE: the liquid water equivalent of a given volume of snow. This can be checked 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. **Watch:** The Water Cycle https://youtu.be/al-do-HGuIk **Watch:** Is the world's fresh water supply running out? https://youtu.be/iVcTQdOJMMw **Watch:** Water Resource Management https://youtu.be/odngssDFMrU **Examine:** Calaveras Reservoir [Gary Pereira] https://youtu.be/_EqehbxjfUk I may have more to say about projects like the Three Gorges Dam in eth announcements; here is a taste of what it's like there, from a visitor's point of view (me). **Examine:** The Three Gorges Dam [Gary Pereira] https://youtu.be/pPKV_GTI4gk **Examine:** The Three Gorges [Gary Pereira] https://youtu.be/yQ7lrqE_bKU **Homework 8:** 1. Is the world's fresh water supply running out? Try to be geographically specific. 2. What is an aquifer? What is the current state of aquifers around the world? 3. What are some of the careers described in the video on water resources management?

Week	Due Date	Discussion, Readings, Videos, Assignments
		4. Why was the new Calaveras Reservoir Dam designed to safely hold up to four times as much water as it is currently holding, other than for seismic reasons? (see video) Access the text **Fundamentals of Physical Geography** http://www.physicalgeography.net/fundamentals/contents.html **Read** CHAPTER 8: Introduction to the Hydrosphere Chapter 8 Essay Questions 1, 3, 4, 7, 10, 12 8.1. What is streamflow? How can it be expressed in a mathematical model? Describe the effect of an intense 1 hour storm on streamflow over 24 hours using a hydrograph. 8.3. Discuss the movement of water into soils. How and why does infiltration vary with time? 8.4. Why does runoff occur? 8.7. Describe the mathematical equation used to model stream discharge. 8.10. What is potential evapotranspiration and how does it differ from actual evapotranspiration? What factors control the rate at which water leaves the Earth's surface by way of evaporation and transpiration? 8.12. Explain how relative humidity is measured.
9	**03/31/21**	**Recess**
10	**04/07/21**	Topic: **Sense and Representation; Endeavors in Science** I'd like to concentrate this week on some of the most important technologies currently available to understand and monitor the health of the Earth's atmosphere, oceans, polar regions, forests, cropland, urban areas… the list is endless. **Watch:** What is Remote Sensing? https://youtu.be/xIsUP1Ds5Pg **Watch:** How Does LiDAR Remote Sensing Work? Light Detection and Ranging https://youtu.be/EYbhNSUnIdU **Watch:** Satellite Remote Sensing for Environmental Protection https://youtu.be/aKfsh2NAuR8 **Homework 9:** 1. What is remote sensing? What types of remote sensing instruments have been developed to monitor

Week	Due Date	Discussion, Readings, Videos, Assignments
		the Earth? What sorts of things do they measure? 2. How Does LiDAR Remote Sensing Work? 3. Describe some of the ways satellites are being used to observe and characterize the world's environments. **4.** Look through the many pages of videos available at the following Public Television website: http://ww2.kqed.org/quest/tag/tag-video/ Use the 'next page' button at the bottom of each page to access additional pages. Choose any four videos, and write a summary and discussion of what you found most interesting about each of them, as well as any questions they bring to mind. Indicate the title of each video as subheadings. Make sure to look through a few pages before making your selections. Don't just stick with the first couple of pages. Each summary should cover half a page, full page easily.
11	**04/14/21**	**Topic:** The Biosphere **Watch:** Plants Affect the Atmosphere https://ca.pbslearningmedia.org/resource/nves.sci.earth.atmosphere/plants-affect-the-atmosphere/ **Read** CHAPTER 9: Introduction to the Biosphere Most life on Earth gets its energy from the sun, either directly or indirectly, via an evolved set of processes called photosynthesis and respiration. Carbon dioxide is required, and water and oxygen are released, globally, on a massive scale. Living things therefore are key determinants of just how much carbon is in the atmosphere, and so they are largely responsible for the sort of climate that has evolved on this planet. In order to fully understand climate, we have to understand life. We can change the direction that the world climate takes in the future, one way or another, depending on how well we understand and treat living things. **Homework 10:** 1. What primary components of Earth's atmosphere do plants modify through photosynthesis and respiration? 2. How do photosynthesis and respiration relate to one another? 3. How have plants contributed to making Earth a habitable planet? 4. Describe how Earth's atmosphere changes over the course of 24 hours. 5. Why does the Amazon rainforest have such a dramatic impact on the atmosphere? Chapter 9 Essay Questions 2, 3, 5, 9, 10

Week	Due Date	Discussion, Readings, Videos, Assignments
		9.2. Compare and contrast the function and structure of the grazing and detritus food chain. 9.3. What is an ecosystem? How does it differ from a community? What are some of its important components? 9.5. Explain in detail how energy moves through the grazing food chain and the detritus food chain. Also, discuss how these food chains are related to each other and are necessary for the cycling of nutrients in an ecosystem. 9.9. What are some of the major components of ecosystems? How are these components related to each other? 9.10. Describe how energy flows through ecosystems.
12	**04/21/21**	**Topic:** The Biosphere **Read** CHAPTER 9: Introduction to the Biosphere **Watch:** NOVA: Earth From Space | Lightning Produces Nitrates https://ca.pbslearningmedia.org/resource/nves.sci.earth.nitrate/lightning-produces-nitrates/ Besides a source of energy and water, life depends on the presence of a few other elements, particularly nitrogen. Most living things cannot get this nitrogen directly from the air; they get it indirectly from specialized microbes, as well as from lightning. Another direct link between the biosphere and the atmosphere that most of us are unaware of. **Homework 11:** 1. On average, how many lightning strikes occur on Earth each second? 2. How does lightning produce nitrate? 3. Why is nitrate important for living things? 4. How does nitrate produced in clouds end up in human bodies? Chapter 9 Essay Questions 11, 14, 4: 9.11. Discuss the term dispersal. Include in your answer an explanation of why organisms want to disperse, and how organisms accomplish this life-cycle strategy. 9.14. Compare and contrast the characteristics (climate, plant types, animal life, soil types, etc.) of the following biomes: Tundra, Temperate Deciduous Forest, Desert, and Tropical Rainforest. 9.4. Evolution describes the process by which species come to possess adaptations. In an essay, describe how evolution works through natural selection, spatial isolation, and gene mutation.

Week	Due Date	Discussion, Readings, Videos, Assignments
13	**04/28/21**	**Topic:** The Lithosphere **Access via CANVAS (Files):** StayingSafeWhereTheEarthShakes_BayArea.pdf PuttingDownRootsInEarthquakeCountry_BayArea.pdf **Access:** CHAPTER 10: Introduction to the Lithosphere **Homework 12:** 1. In an essay, describe steps that should be taken before, during, and after a major destructive earthquake, from the perspective of you as a family member and/or neighbor, public servant, health care worker, business officer, planner, etc. in order to reduce suffering and loss. In other words, I want to know more than just what you would do for yourself during and immediately after the earthquake. I also want to know about long-term planning, and about the long-term aftermath. Assume that the earthquake has caused casualties, and that people around you are in need of first aid, at the very least. Assume that gas lines are ruptured, that electricity is off, and that communications via cell phone is unreliable. Assume that you have the ability to move and do things. You may be at work, or school, at home or on the streets. You may fictionalize your account, with specifics, or you may write in the manner of the USGS documents. This essay should take at least a couple of pages. Chapter 10 Essay Questions 6, 12, 14, 17, 20: 10.6. What geologic features are found at the boundaries of tectonic plates? Briefly explain how plate tectonics is responsible for their formation or occurrence. 10.12. Describe the various layers that make up the solid Earth. 10.14. What is a volcano? Where and why do they form? Describe the five different types of volcanoes. 10.17. Outline the various processes of physical, chemical, or biological weathering. 10.20. Describe the physical characteristics of a location that would favor each of the following types of mass movements: rock fall, rockslide, mudflow, slump, and creep.
14		Topic: **The Lithosphere** Recently, I took a trip to a massive volcano called Changbaishan, or Changbai Mountain, also known as Mount Paektu. Changbaishan is located on the border between China and North Korea. It last erupted, with tremendous force, about a thousand years ago. The scars remain, and within them have arisen some of the most unique and magical ecosystems in northeast Asia. Anyone who grew up with Lord of the Rings or Harry Potter would love this place. The border between China and North Korea border runs right through the mountain's crater lake, which is the site of the Korean people's origin myth. Kim Jong Un has visited the lake several times, as have several Chinese leaders. If you look at a map (or watch the beginning of the first video below) you'll

Week	Due Date	Discussion, Readings, Videos, Assignments
		notice that the China/DPRK border was intentionally diverted to allow Korean access to and dominion over at least part of this lake. Unfortunately, the North Korean people do not seem to have been given such access. But despite the fact that getting there is still difficult, many South Koreans who travel to China continue to visit from Chinese access points. **Examine:** 1442 Steps to Heaven Lake [Gary Pereira] https://youtu.be/TsnoFuC4zrw **Not required:** Valley Float Stone Forest of Changbai Mountain [Gary Pereira] https://youtu.be/_HSdtL-AQyM **Not required:** Jinjiang River Canyon [Gary Pereira] https://youtu.be/l_JWAZkvNQk **Not required:** Natural History Museum of Changbaishan [Gary Pereira] https://youtu.be/Un6ig2Z9lIY I wanted you to get a good understanding of lithospheric processes and how they connect with hydrological, geochemical and biological processes through the following excellent explanation. Opening this video in a separate browser gives you access to all reference URLs and papers. Try to watch it carefully, and put everything you can into addressing question 1. **Watch:** Why China's Largest Volcano Is So Unusual [Deep Dive] https://youtu.be/3C2HVOB-g5s
	05/05/21	**Homework 13:** 1. Describe the process of plate tectonics between the Pacific and East Asia. Why is Changbai Mountain (Mount Paektu) so unusual, in a geological sense? What is the role of water? **Read:** CHAPTER 10: Introduction to the Lithosphere Essay Questions 21, 25, 28, 32, 33, 34 10.21. What is a glacier? What conditions are necessary for a glacier to form? Why did continental glaciers form over certain specific regions of the North American continent? 10.25. How do glaciers influence the surface configuration of the Earth by way of erosion and deposition? 10.28. How does beach drift and longshore drift move sediment along coastlines? 10.32. Describe some of the landforms common to environments influenced by eolian processes. 10.33. Describe some the important characteristics of soil.

Week	Due Date	Discussion, Readings, Videos, Assignments
15		**Topic:** The Oceans **Watch:** Nutrients from Deep-Sea Vents https://ca.pbslearningmedia.org/resource/nves.sci.earth.hydro/nutrients-from-deep-sea-vents/ **Watch:** Deep-sea mining could transform the globe https://youtu.be/IYKaKeJv2dQ **Watch:** The Next Frontier in Mining: Deep Sea Exploitation in the Pacific https://youtu.be/PuEXmFQEJpw https://en.wikipedia.org/wiki/Deep_sea_mining https://www.nature.com/articles/d41586-019-02242-y https://en.wikipedia.org/wiki/International_Seabed_Authority https://en.wikipedia.org/wiki/United_Nations_Convention_on_the_Law_of_the_Sea Countries bordered by oceans often claim an exclusive economic zone that extends far out to sea. Many of these waters are disputed among various nations (e.g., the South China Sea). Fissures along plate boundaries and hotspots in the deep ocean bring minerals up from deep beneath the crust. Many islands and seamounts associated with such processes have abundant minerals in their seabed. Unknown forms of life, that we have barely begun to understand, exist in these environments as well.
	05/12/21	**Homework 14:** 1. What is a hydrothermal vent? 2. Describe the process by which hydrothermal vents produce nutrient-rich water. 3. What did scientists see in NASA's Aqua satellite data that indicated a phytoplankton bloom? **4.** What (if anything) is being done to regulate the exploitation of the seabed for minerals? Discuss the history and significance of national claims of exclusive rights over offshore resources.
16	**05/19/21**	**Final Evaluation:** Choose either Option 1 or Option 2 and write a thoughtful term paper on some aspect of that topic. The paper should begin with an introduction to the topic, and a conclusion, but it need not be comprehensive. 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

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		useful if you upload your work to Portfolium. There is no upper limit to the length of the paper, but please don't lengthen it with unnecessary repetition. I expect all of you to produce a paper that you can publish online without further editing. **Option 1:** Write an essay on **some aspect** of the COVID-19 epidemic that intersects with global travel, global health, or wildlife. I do not want a general essay on the pandemic itself. You might want to look through some of the following videos first to get some ideas. **Option 2:** Write an essay having to do with regional vulnerabilities to climate change and the possibilities of future climate refugees. Again, you might want to look through some of the videos further below, to get some ideas. **Option 1: the following videos and essays may be helpful** COVID-19: Where It Starts and Stops [Wildlife Conservation Society] https://youtu.be/_D_6a56zI_U How wildlife trade is linked to coronavirus [Vox] https://youtu.be/TPpoJGYlW54 Covid 19 is causing a conservation crisis. Endangered species at risk [Evening Standard] https://youtu.be/CGJ9X2MGzxw How deforestation helps deadly viruses jump from animals to humans https://theconversation.com/how-deforestation-helps-deadly-viruses-jump-from-animals-to-humans-139645 How Climate Change Is Contributing to Skyrocketing Rates of Infectious Disease [ProPublica] https://www.propublica.org/article/climate-infectious-diseases **Option 2: the following videos and essays may be helpful** 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 Here's an interesting report from Elizabeth White of the University of San Francisco's Geospatial Analysis Lab: 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 (The transcript of Dr. Khanna's talk is available in the notes below the video if you open it in a separate

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		browser.) Climate change and migration: How do they connect? [DIEnewsflash] https://youtu.be/t5SygtZCFzo Climate Change Impacts in Bangladesh [World Bank] https://youtu.be/V3IL6Y1TDHo Climate refugees in Bangladesh [DW Documentary] https://youtu.be/co5uywe-1Z8 Changing Climate, Moving People: A film on climate stress related migration [TERI] https://youtu.be/NjYR3LohMM0