

**San José State University  
Department of Geography  
Geog130: Natural Resources, Section 80**

**Spring 2020**



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**Course and Contact Information**

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**Class Days/Time:** Online course.

## Course Format

This is an online course. Internet connectivity and a computer are required. Course materials (including this syllabus) can be found on the Canvas Learning Management System course login website at <http://sjsu.instructure.com>, under **Files**. Assignments are all listed and described under **Assignments**. Additional guidance and discussion will be posted periodically under **Announcements**. You will generate documents and submit them online as homework assignments and a final paper.

## Course Description

The purpose of this course is to achieve fuller comprehension of those products of the natural world that provide significant resources for human well-being. The course content is organized roughly into two parts, which are divided by the Spring Break. The first part concentrates on traditional means of deriving energy and materials from the Earth. Many of these activities have helped to lift the ever-increasing human population from poverty, but often at significant cost to the environment. We end by asking whether nations rich in such resources might suffer from a 'resource curse' and, if so, what might be done about it. In the second part after the break, we discuss current ideas in resource management and carbon-free means of meeting our energy and material needs, as well as ecological and fresh water resources. Clearly, each of these topics deserves a semester or more of further study. This course is meant as a general introduction. Hopefully, the topics discussed in the second section will inspire you to connect these trends to your own lives and careers. The topics, described further in the schedule below, are as follows:

### Part 1:

- Population, urbanization, consumerism, and resources
- Mining
- Coal and natural gas
- Oil
- The Seabed
- Metals and rare earths
- Uranium, thorium, plutonium
- Fusion; biofuels
- Corruption, insecurity, and conflict

### Spring Break

### Part 2:

- Adaptive management
- Solar, wind, and tidal energy resources
- Hydro and geothermal energy resources
- Ecological resources
- Fresh water

## Course Learning Outcomes (CLO)

Upon successful completion of this course, students will have become familiar with the most significant aspects of natural resource extraction and processing, and with the management of these activities. Students will have achieved a better understanding of the relationships between natural resource extraction and use, population growth, and urbanization. Students will have a better sense of the possibilities offered by cleaner energy and material resources. And finally, students will have understood the importance of ecosystem services and clean water as natural resources.

## Required Texts/Readings

Several readings have been uploaded to Canvas, under the **Files** tab. These should be downloaded and read as directed in the homework assignments. With most of these readings, I suggest that you read the introduction, section titles, and the last section. Then you might want to read or study in more detail anything you find particularly interesting or relevant to the homework questions. There is no need to read every paper thoroughly from beginning to end, unless you care to do so.

## Videos

Online videos are a big part of this course, and much of the homework will be judged on the basis of how closely you considered them in your discussions. If you are accessing each assignment through CANVAS **Assignments**, you might be given the choice of opening a video in a separate browser or of watching it embedded within CANVAS. Whichever method you use, feel free to pause each video frequently or watch portions repeatedly in order to take notes as you watch. Watching videos within separate browsers often provides you with additional information, as well as access to other material on the author's channel. I encourage you to explore the work of any YouTube contributor whose work you appreciate.

Many YouTube videos are preceded by ads. Usually, these ads can be cut short by clicking on 'Skip Ad' at the lower right of the screen, or by clicking on the x at the upper right of an embedded ad. There are never ads on my own videos, and I get no monetary benefit from YouTube. I also provide no tags on my videos. This reduces significantly the numbers of views, which is fine with me. If you view something within Canvas, this is not counted as a view by YouTube. It is fine with me, however, if you share my videos with others, and feel free to subscribe to my channel.

## Course Requirements and Assignments

**Homework:** Fourteen homework assignments should be completed on or before the due dates, as described in the course schedule below. Each must be submitted in any case, even if late. Please submit these responses via Canvas. For each homework assignment, I would prefer you use primarily 10pt font with 1½ line spacing. Put your name, the homework number, 'Pereira', 'geog120-80' and 'Fall 2018', arranged at the upper right of the first page. Text, figures, and images lifted from documents or screenshots may be embedded in your homework, but these should include attribution.

## Final Evaluation

A term paper will serve as the final evaluation. The term paper should be at least five pages long (10 point font, 1 ½ spaced) and contain a formal list of references. The resulting document should qualify for publication in your undergraduate portfolio, if you have one.

## Determination of Grades

Fourteen homework assignments (6.5% each)	91%
Term paper	9%
<b>Total</b>	<b>100%</b>

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-
<b>below 60%</b>	<b>F</b>

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 review 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.



## Geog130-80: Natural Resources Course Schedule

Week	Due Date	Topics, Videos, Readings, Assignments
<b>1</b>		<p><b>Topic: Population, urbanization, consumerism, and resources</b></p> <p>‘Natural resources’ refers to the human use of certain substances or properties found at particular regions or locations on Earth. This makes the study of natural resources both a natural and a social science. The nature of minerals for example can be understood largely in terms of chemistry and geology, but their use as a resource requires a somewhat wider focus. Therefore, we need to begin with a discussion of two significant social trends that will influence our study: human population growth and urbanization. To remind yourself of the significance of the former, watch the following portrayal of human population growth through time. Pay particular attention to everything after minute 3.</p> <p><b>Watch:</b> Human Population Through Time [American Museum of Natural History]  <a href="https://youtu.be/PUwmA3Q0_OE">https://youtu.be/PUwmA3Q0_OE</a></p> <p>Urbanization, which often co-occurs with rural depopulation, has a significant but complex effect on resource use. It’s difficult to convey the vast scope of this process in many nations. In order to convey with imagery what urbanization often implies for some of the world’s most populous nations, I’d like you to start with a couple of my own videos. Of course, you can find a great deal more on YouTube. The first shows a typical example of a medium sized city in China. Note that their more recent housing strategy is largely vertical. This is largely intended (in many regions) to allow for more open space, but these buildings require central air conditioning and heating, effective plumbing and fire suppression, and highly reliable elevators.</p> <p><b>Watch:</b>  Qingdao [Gary Pereira]  <a href="https://youtu.be/qyYWqZG157U">https://youtu.be/qyYWqZG157U</a></p> <p>The second video is just a long shot (and soundscape) of residential buildings on the north bank of the Yangtze River approaching Chongqing, in central China, early one morning. It is intended to be an impressionistic a meditation on the multiplicity of individual histories, abilities, and aspirations that exist in any large city, anywhere in the world. Behind those windows are individually unique ordinary people about to start their day. While automobile ownership is growing, most people still walk to the subway or bus stop, or they hop on a bicycle or scooter. In any case, there is a great deal more walking than is typically done in the US.</p> <p><b>Watch:</b>  Humanity [Gary Pereira]  <a href="https://youtu.be/IeT2AObKkJM">https://youtu.be/IeT2AObKkJM</a></p> <p>The metropolitan area encompassing the central urban area Chongqing was estimated to have, as of 2010, a population of 17 million, so it qualifies as a megacity. Although most urban growth continues to be dominated by smaller cities, the number and size of megacities are expected to continue to grow at an incredible rate. This often happens under conditions that are far less beneficial to the people involved than what we see happening in China. Consider the startling forecasts in the following video:</p> <p><b>Watch:</b>  Top 10 Largest Cities by 2100 [The B1M]  <a href="https://youtu.be/9OulEjWI-bE">https://youtu.be/9OulEjWI-bE</a></p> <p><b>CONTINUED ON NEXT PAGE</b></p>







Week	Due Date	Topics, Videos, Readings, Assignments
	01/29/20	<p>I want to acknowledge right from the start my recognition of the importance of consumerism in ramping up the extraction and processing of natural resources. Consumer goods make our lives more interesting, and potentially more productive, but this often occurs at great cost. These costs are often treated culturally as externalities. The point of this course is to overcome that wall of ignorance, and to bring these externalities back within the realm of careful consideration.</p> <p>I often pass and walk around some tennis courts nearby, with twelve foot high fencing around two groupings of courts. If a ball were to fall anywhere outside the fence, it would require less than a minute of walking to retrieve it. No one ever does. If you were to walk back there, you would have noticed that it fell into a broad field layers deep in tennis balls, some new and some in various stages of disintegration. Clearly, several years, possibly decades, of the past are recorded there. I'd film it, but I hesitate to embarrass the college that owns it. Anyway, when I was young, we retrieved all of our tennis balls (and threw the dead ones away) rather than just leave them to rot just outside the fence. Why are things so different now? For one thing, when players arrive, they carry with them baskets and baskets and baskets of balls. They never have to stop play if they don't want to until it gets dangerous, then they pick up the ones they see. Who even notices if a few have gone missing?</p> <p>So although consumerism, planned obsolescence, waste, and recycling are all important topics that we could be covering, let's leave it up to you. We won't be concentrating on these issues explicitly but you may of course address them in your homework and final paper.</p> <p>The following two papers are directly relevant to the homework questions. In this and all future homework assignments, try to refer to at least some of the points made in the papers that I ask you to read, in your responses. I expect some of your classmates will often do so, and they will probably get the higher grades. You are not expected to read in full any of the papers listed for this course, except possibly with regard to their relevance to homework questions and the final paper. I suggest that you keep the readings for future reference.</p> <p><b>Read:</b> (Huang) The transition to an urbanizing world and the demand for natural resources.</p> <p>With most of these readings, I suggest that you read the introduction, section titles, and the last section. For Huang's paper, this is called Prospects. Then you might want to read or study in more detail anything you find particularly interesting or relevant to the homework questions. There is no need to read each and every paper thoroughly from beginning to end, unless you care to do so.</p> <p><b>Read:</b> (Chow) Energy Resources and Global Development.</p> <p><b>Read:</b> (Hoekstra) humanity's unsustainable environmental footprint</p> <p><b>Homework 1:</b></p> <p>1. Consider the urban landforms that are developing in response to population pressures and urbanization (Qingdao can be taken as an example), discuss the influence of culture, governance, and social norms on the kinds of housing, transportation, etc. that might be found there. Do you think the sort of urban forms found now in China, including many very tall apartment buildings, would be considered acceptable or desirable in much of the United States?</p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Homework 1 continued:</b></p> <p>2. How might the development of different sorts of urban forms affect the rate at which natural resources are extracted and used? For example, housing large numbers of people in large, tall buildings requires a great deal of steel and concrete. On the other hand, it reduces the consumption of fossil fuels for heating and cooling, for many years after the building is completed. Try to think of some other examples, from different settings and climates, of how the availability of natural resources might influence urbanization.</p> <p>3. Compare a specific growing city in a developing country with a specific growing city in the US (e.g., Phoenix). Discuss ways in which the components of urbanization, including housing and infrastructure, might affect society's need for (and ability to extract or import) particular natural resources. How about a society that might have remained largely rural and poor, despite its growing density? What resource issues might it have? We haven't gotten into the details yet, so I don't expect brilliance here. This assignment is meant to encourage you to think in geographical terms. Please frame your discussions in terms of place and time. If you feel lost, take a look ahead at some of the categories of natural resources we'll be discussing.</p>
2		<p><b>Topic: Mining</b></p> <p>Mining processes are some of the most significant and environmentally consequential methods of extracting natural resources from within the Earth. The materials that are mined are generally non-renewable and geographically specific; as a result, mines and quarries have for thousands of years been treated as treasured source of riches for kingdoms, and as spoils of war. We will concentrate over the next few weeks on the mining of fossil fuels and minerals, and of the expansion of this activity onto the seabed and into the Arctic. First, let's look at the state of the art in underground mining equipment, from one of its leading manufacturers.</p> <p><b>Watch:</b> Pioneering Underground Mining [JoyMiningMachinery] <a href="https://youtu.be/649dZPCTD30">https://youtu.be/649dZPCTD30</a></p> <p>This week we look specifically at diamond mining in two different settings. Together they illustrate some important factors that are common to many other sorts of mining operations as well, although they do not fall neatly into the main categories we will discuss. Diamonds and other rare gems that are valued and are therefore mined for their beauty; industrial diamonds and crystals for electronics of better quality can now be manufactured. I suggest that you always keep the homework questions (below) in mind when viewing the videos. Also, please keep the Promised Land documentary in mind in a few weeks when we discuss the so-called 'resource curse'. Remember to hit 'Skip Ads' at lower right after 5 seconds, and to click on the x at upper right of any popup ads that may appear.</p> <p><b>Watch:</b> Diamond Mining: Inside Earth's Gigantic Holes [Bloomberg] <a href="https://youtu.be/8uLuecS_PTK">https://youtu.be/8uLuecS_PTK</a></p> <p><b>Watch:</b> Diamond Mining 1/4 - The Promised Land [Paul Glynn] <a href="https://youtu.be/u0855HBj31s">https://youtu.be/u0855HBj31s</a></p> <p><b>Watch:</b> Diamond Mining 2/4 - The Promised Land [Paul Glynn] <a href="https://youtu.be/6htaddGYp3k">https://youtu.be/6htaddGYp3k</a></p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	02/05/20	<p><b>Watch:</b> Diamond Mining 3/4 - The Promised Land [Paul Glynn] <a href="https://youtu.be/SXlu80i5OxU">https://youtu.be/SXlu80i5OxU</a></p> <p><b>Watch:</b> Diamond Mining 4/4 - The Promised Land [Paul Glynn] <a href="https://youtu.be/Vv9JmltivU">https://youtu.be/Vv9JmltivU</a></p> <p><b>Watch:</b> World's Top Diamond Producing Countries 1970 to 2018 [Animated Stats] <a href="https://youtu.be/XduChfWC0iE">https://youtu.be/XduChfWC0iE</a></p> <p><b>Homework 2:</b></p> <p>1. How much money, per year, is generated by the newer diamond mine in Siberia, portrayed in the first video? How powerful is the mining company locally, in terms of politics and media? Do you think that the remoteness of this location might have anything to do with the acceptability of the social situation and damage done to the environment? Is it important that people of a region become aware of the existence of open pit mines of this type?</p> <p>2. The documentary Promised Land (in four parts) portrays a sort of diamond mining that is clearly very different from the mines shown in the previous video. Technologically, it's primitive. Using the diamond as an example, discuss ways in which the availability of cheap labor, government, climate, and relative remoteness of mining operations might affect the ways in which mines are operated. After watching all four parts, please discuss anything you may have found to be surprising or instructional about this sort of operation.</p>
3		<p><b>Topic: Coal and natural gas</b></p> <p>You will view several videos this semester that use animated bar graphs to portray important trends in natural resource extraction, production, and use. These come from different channels, so they may differ somewhat in style. Pay close attention to the time period covered, which varies between videos, and keep in mind that the x axis is often self-adjusting. This can help with making comparisons between countries, but it can be misleading in terms of actual numbers (unless you watch closely).</p> <p><b>Watch:</b> Top 10 Countries by Coal Productions 1981-2018 [Stats Media] <a href="https://youtu.be/qmIS138WgzE">https://youtu.be/qmIS138WgzE</a></p> <p><b>Watch:</b> Coal Mining's Environmental Impact   From The Ashes [National Geographic] <a href="https://youtu.be/ynN39sfqT8w">https://youtu.be/ynN39sfqT8w</a></p> <p>You might want to take a break here and address the first homework question. Now we shift to natural gas, which is closely associated with coal but releases comparatively less carbon dioxide per unit of energy produced than coal. It's also cleaner in other ways. Using the following two videos, you will be asked to compare statistics for proven reserves with production. Again, I don't expect you to run each in its entirety. Use your browser's pause and slide controls freely while you take notes.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>



Week	Due Date	Topics, Videos, Readings, Assignments
		<p><b>Watch:</b> World's Top Countries by Proven Natural Gas Reserves 1960 to 2018 [Animated Stats] <a href="https://youtu.be/mRZiq67OgCg">https://youtu.be/mRZiq67OgCg</a></p> <p><b>Watch:</b> Top 20 Natural Gas Producing Countries 1970 to 2018 <a href="https://youtu.be/DSGK26TKEKs">https://youtu.be/DSGK26TKEKs</a></p> <p>Fracking has served to significantly increase the production of natural gas in recent years in the US. We shall only introduce the topic here; please feel free to do more research on your own.</p> <p><b>Watch:</b> Fracking explained: opportunity or danger [Kurzgesagt – In a Nutshell] <a href="https://youtu.be/Uti2niW2BRA">https://youtu.be/Uti2niW2BRA</a></p> <p>Liquid fuels will remain in demand for transport (of goods and materials) and transportation on land, on the seas, and in the air for the foreseeable future. Biofuels and hydrogen are relevant options, but liquefied natural gas (LNG) is on the rise as well. A few technical videos from Shell and others to educate ourselves on some of these issues won't hurt.</p> <p><b>Watch:</b> What is LNG? Turning natural gas into liquid   Natural Gas [Shell] <a href="https://youtu.be/QgtSoEJD9HE">https://youtu.be/QgtSoEJD9HE</a></p> <p>Natural gas is on the rise, and coal is on the decline, worldwide. Changes and innovations are taking place with the fossil fuels industry.</p> <p><b>Watch:</b> An Introduction to Natural Gas from Coal [UnconventionalGas] <a href="https://youtu.be/jSTGDBkMeRY">https://youtu.be/jSTGDBkMeRY</a></p> <p><b>Watch:</b> China switch from coal to natural gas [CGTN America] <a href="https://youtu.be/fyYnh8veNg">https://youtu.be/fyYnh8veNg</a></p> <p><b>Read:</b> (Jakob) Unburnable fossil-fuel reserves.</p> <p><b>Read:</b> (Palmer) Mountaintop Mining Consequences</p> <p><b>Read:</b> (Kerr) Natural Gas From Shale Bursts Onto the Scene.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	02/12/20	<p><b>Homework 3:</b></p> <ol style="list-style-type: none"> <li>1. How has coal production shifted between countries in recent years? Which nations currently produce the most coal?</li> <li>2. Coal mines played a critical role in the Industrial Revolution, but their utility has since declined. Currently, mountains are being blasted away in the US for coal extraction. What are some of its environmental and social consequences?</li> <li>3. How has natural gas production shifted between countries in recent years? Which nations currently produce the most natural gas?</li> <li>4. Discuss the extraction of natural gas from shale in the US and from coal, particularly in China.</li> <li>5. Compare the environmental consequences of natural gas extraction with the extraction of coal. The unintentional release of natural gas adds significant amounts of methane and other gases to the atmosphere. Why is methane specifically so worrisome?</li> </ol>
4		<p><b>Topic: Oil</b></p> <p>This is the city I grew up in: Linden, New Jersey (exit 13 on the Turnpike). From my bedroom window, I could see the sun rise behind the Bayway Refinery.</p> <div style="display: flex; flex-wrap: wrap; justify-content: space-around;">     </div> <p>Several times, I remember mishaps at the refinery that resulted in explosions. One time, papery white particle floated down from the sky. Representatives from Esso (subsequently renamed Exxon), which operated the refinery at the time, came to our school once and talked to us about the importance of oil. We were each given a gift: A plastic replica of an iceberg, for some reason. It was the early 1960s. I haven't been back there for a while, but Linden was and remains an industrial town. Lots of storage tanks. Petrochemical companies. A General Motors assembly plant and Budweiser factory; these are gone now. You get the idea. Of course, the residential neighborhoods are nice. New Jersey is actually very green and lush in the summertime, and the experience of green pine woods in freshly fallen winter snow is something I miss very much.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	<b>02/19/20</b>	<p><b>Watch:</b> Drilling 101: How a deep water well is drilled [Shell] <a href="https://youtu.be/Do9dz6ypD7w">https://youtu.be/Do9dz6ypD7w</a></p> <p><b>Watch:</b> Tapping into Oil Over 30,000 Feet Deep [Shell] <a href="https://youtu.be/V2Ubd-ZEGeY">https://youtu.be/V2Ubd-ZEGeY</a></p> <p><b>Watch:</b> Deepwater Horizon Blowout Animation [USCSB] <a href="https://youtu.be/FCVCOWejlag">https://youtu.be/FCVCOWejlag</a></p> <p><b>Watch:</b> Animation of 2015 Explosion at ExxonMobil Refinery in Torrance, CA <a href="https://youtu.be/JplAKJrgyew">https://youtu.be/JplAKJrgyew</a></p> <p><b>Watch:</b> Top 20 Crude Oil Producing Countries 1965 to 2018 [Animated Stats] <a href="https://youtu.be/2gzBMmGk4Ig">https://youtu.be/2gzBMmGk4Ig</a></p> <p><b>Watch:</b> Top 15 countries by Oil Consumption   The Richest [Stats Media] <a href="https://youtu.be/FLhNtM3B8ec">https://youtu.be/FLhNtM3B8ec</a></p> <p><b>Watch:</b> Cold Rush. Drilling For Oil Amid Arctic Ice [RT Documentary] <a href="https://youtu.be/mxN1yc_DikU">https://youtu.be/mxN1yc_DikU</a></p> <p><b>Watch:</b> Plastics 101 [National Geographic] <a href="https://youtu.be/ggh0Ptk3VGE">https://youtu.be/ggh0Ptk3VGE</a></p> <p><b>Read:</b> (Allred) Ecosystem services lost to oil and gas in North America.</p> <p><b>Read:</b> (Joye) Deepwater Horizon five years on.</p> <p><b>Homework 4:</b></p> <ol style="list-style-type: none"> <li>1. Discuss the process of extracting oil from beneath the seabed. What exactly happened with the Deepwater Horizon? What have been some of the consequences of that disaster?</li> <li>2. Compare changes over time in which countries produce the most oil, with countries that have the largest proven reserves.</li> <li>3. Discuss the timeline of top oil consuming countries in the world, in recent years. Compare this history with the timeline of countries producing the most oil in recent years. You can choose your focus, but be specific. How might this relationship between oil producing and consuming nations have played a role in international relations?</li> <li>4. Discuss some of the challenges of extracting oil from Arctic seas, and how that might be changing.</li> <li>5. Discuss the production of plastics and petrochemicals from oil.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
5	02/26/20	<p><b>Topic: The Seabed</b></p> <p>This week we shift our focus from resource types to resource locations. We've already looked at drilling for oil beneath the seabed, but the seabed itself is becoming a source of metals, minerals, and other resources. You may be surprised by what you see.</p> <p><b>Watch:</b> TechKnow - Deep sea gold rush [Al Jazeera English] <a href="https://youtu.be/s1b4xVTAKcl">https://youtu.be/s1b4xVTAKcl</a></p> <p><b>Watch:</b> Mining the Deep Sea [Massachusetts Institute of Technology (MIT)] <a href="https://youtu.be/MWvCtF1itQM">https://youtu.be/MWvCtF1itQM</a></p> <p><b>Watch:</b> Deep Sea Mining: Searching for the Next Mineral Boom [Roundtable] <a href="https://youtu.be/-UPjsuuyvD4">https://youtu.be/-UPjsuuyvD4</a></p> <p><b>Watch:</b> Seabed Mining in the Deep Sea [University of California Television (UCTV)] <a href="https://youtu.be/ePm3Wbw2tyc">https://youtu.be/ePm3Wbw2tyc</a></p> <p><b>Watch:</b> Introduction to the International Seabed Authority and Seabed mining part 1 [dyaguilfoyle] <a href="https://youtu.be/TlumflivuPg">https://youtu.be/TlumflivuPg</a></p> <p><b>Read:</b> (Rona) resources of the sea floor.</p> <p><b>Read:</b> (Halfar) danger of deep-sea mining.</p> <p><b>Read:</b> (Gramling) seafloor mining plan advances.</p> <p><b>Read:</b> (Wedding) managing mining of the deep seabed.</p> <p><b>Homework 5:</b></p> <ol style="list-style-type: none"> <li>1. Discuss advances in the technology of seabed mining, and current activities.</li> <li>2. Discuss the legal and regulatory status of seabed mining, and future plans.</li> <li>3. Discuss the possible positive and negative consequences of seabed mining, including its potential impact on barely understood ecosystems.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
6	03/04/20	<p><b>Topic: Metals and rare earths</b></p> <p><b>Watch:</b> Top Iron Ore Producing Countries in The World 1900 to 2017 [Animated Stats] <a href="https://youtu.be/emm5aHAifMg">https://youtu.be/emm5aHAifMg</a></p> <p><b>Watch:</b> Top 20 Steel Producing Countries 1967 to 2018 [Animated Stats] <a href="https://youtu.be/yqF5pYDEpRM">https://youtu.be/yqF5pYDEpRM</a></p> <p><b>Watch:</b> Minnesota Iron Mining Process [Minnesota Iron] <a href="https://youtu.be/7foK-wVNSMw">https://youtu.be/7foK-wVNSMw</a></p> <p><b>Watch:</b> How steel is produced [worldsteel] (fascinating visuals; no narration) <a href="https://youtu.be/YZjgUyDSq40">https://youtu.be/YZjgUyDSq40</a></p> <p><b>Watch:</b> Top 20 Largest Aluminium Producing Countries in the World [Animated Stats] <a href="https://youtu.be/BEmO8lKxwq8">https://youtu.be/BEmO8lKxwq8</a></p> <p><b>Watch:</b> Top Copper Producing Countries in The World 1970 to 2017 [Animated Stats] <a href="https://youtu.be/2u1ufq21Oh4">https://youtu.be/2u1ufq21Oh4</a></p> <p><b>Watch:</b> Asteroid Mining Mission Revealed [Planetary Resources, Inc.] <a href="https://youtu.be/zXXJtSZffVg">https://youtu.be/zXXJtSZffVg</a></p> <p><b>Watch:</b> Impact of Materials on Society (IMOS) - Rare Earth Elements [Materials Research Society] <a href="https://youtu.be/C-b1NacN3lY">https://youtu.be/C-b1NacN3lY</a></p> <p><b>Read:</b> (Gordon) metal stocks and sustainability.</p> <p><b>Read:</b> (Wall) Don't stop using rare earths.</p> <p><b>Homework 6:</b></p> <ol style="list-style-type: none"> <li>1. How has the mining of iron ore and the production of steel shifted internationally in recent years? Describe the mining of iron in Minnesota's iron range.</li> <li>2. Discuss the international shift in the production of aluminum and copper in recent years.</li> <li>3. What are the prospects for extraterrestrial mining? (By the way, there is a pathway for star evolution that leaves only carbon behind after fusion burns off the other elements. That carbon star would actually be in the form of a diamond. An extremely massive diamond. In the sky. I digress.)</li> <li>4. Rare earths have unique electromagnetic properties. Which are most sought-after? What are they used for? Where are they found? Are they really that rare; i.e., are there likely to be undiscovered deposits? Where?</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
7		<p><b>Topic: Uranium, thorium, plutonium</b></p> <p>I'm probably one of the few people who worked as a technician on projects in both a commercial Nuclear Fission reactor and an advanced Nuclear Fusion project (many engineers and physicists have worked in both domains, but I just played a minor role). Those years left me with some lasting memories, some of which I'll briefly mention here.</p> <p>In the late 1970's, I was hired to fill out a work team from Rhode Island at the Oyster Creek Nuclear Generating Station, in Forked River, New Jersey:  <a href="https://en.wikipedia.org/wiki/Oyster_Creek_Nuclear_Generating_Station">https://en.wikipedia.org/wiki/Oyster_Creek_Nuclear_Generating_Station</a></p> <p>The reactor is in the cube-shaped building in the center of this picture:  <a href="https://en.wikipedia.org/wiki/File:Oyster_Creek_Nuclear_Generating_Station_-_1998.jpg">https://en.wikipedia.org/wiki/File:Oyster_Creek_Nuclear_Generating_Station_-_1998.jpg</a></p> <p>The upper portion with the cladding around it is one large room, with the reactor embedded in the center and pools full of water to either side. Above on girders, a large industrial crane can lift the lid off the reactor, remove spent fuel rods and lower them into the refrigerated pools, where they continue to emit heat for many years. They are left there until they are sufficiently cooled. The crane can then 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 challenged by states, for many reactors the rods remain in sealed casks somewhere on the grounds.</p> <p>Our team worked in that big room. 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 already become a problem. The technology was very basic: wrenches on long poles were used by technicians at the edge of the pool to screw in and unscrew structures that were underwater. Anything coming out of the pool would need to be wiped down with acetone to reduce their potential toxicity; that was my job. Binoculars were used to see what was happening at the bottom of the pool. The plant that I worked in is now shut down, but when I was there, the room was hot; the reactor itself kept the space uncomfortably warm. The disposable clothing and booties that we had to wear were similar in style to the clothing used in clean rooms, but were used for the opposite reason: to keep contaminants away from your clothing and body. At the time, there was one guard near the entrance to the room, sitting at a desk, with a handgun. There seemed to be no additional armed security at the time. It was pre-9/11.</p> <p>Working there was not something I intended to do for very long. I was anti-nuclear but needed a job and wanted to get an inside look at what it was like. I'd driven by so many times. When I left, I was given a full body scan in a trailer that the NRC kept on site. They found that I had absorbed some radioactive iodine during my time there. I learned later that iodine pills had been distributed throughout the US during the cold war, in the event of nuclear war. If you take iodine supplements then your thyroid is saturated and tends not to absorb the bad stuff if it comes along.</p> <p>I'll discuss a much more interesting few years I had with nuclear fusion, in next week's homework.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>



Week	Due Date	Topics, Videos, Readings, Assignments
	03/11/20	<p><b>Watch:</b> World's Top Uranium-Producing Countries 1970 to 2018 [Animated Stats] <a href="https://youtu.be/K6zL9N81NzI">https://youtu.be/K6zL9N81NzI</a></p> <p><b>Watch:</b> Thorium and the Future of Nuclear Energy [PBS Space Time] <a href="https://youtu.be/EluleJruhRQ">https://youtu.be/EluleJruhRQ</a></p> <p><b>Watch:</b> Could Advanced Nuclear Power Replace Fossil Fuels? [Journeyman Pictures] <a href="https://youtu.be/eg613DFBR8s">https://youtu.be/eg613DFBR8s</a></p> <p><b>Watch:</b> Understanding the accident of Fukushima Daiichi [Institut de Radioprotection et de Sûreté Nucléaire – IRSN] <a href="https://youtu.be/YBNFvZ6Vr2U">https://youtu.be/YBNFvZ6Vr2U</a></p> <p><b>Watch:</b> Fukushima's ghost towns <a href="https://youtu.be/xKfnsYzQWjw">https://youtu.be/xKfnsYzQWjw</a></p> <p><b>Read:</b> (Clery) new dawn for the nuclear industry.</p> <p><b>Read:</b> (Hayashi) The Fukushima nuclear accident</p> <p><b>Read:</b> (Yidong) Asia's Demand for Electricity Fuels a Regional Nuclear Boom</p> <p><b>Homework 7:</b></p> <ol style="list-style-type: none"> <li>1. Describe the prospects for the nuclear power industry 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 those that use thorium?</li> <li>2. Discuss the various isotopes of uranium, plutonium, and the various by-products of fission. Discuss the difference between closed and open fuel cycles. Why does the issue of spent fuel present such a problem for the US? What might be done about it?</li> <li>3. Describe the circumstances leading up to the Fukushima Daiichi disaster. You might even start with the decision to site nuclear plants on Japan's eastern shore. Include technical details, and discuss the sorts of assumptions that were made in the design of these reactors. Describe its long-term consequences, and where the situation stands now. You may need to do your own research.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
8		<p><b>Topic: Fusion; Biofuels</b></p> <p>If success is achieved in using nuclear fusion to generate electricity, the use of natural resources for energy production will shift. This will depend very much on the economics of production. As far as fuel is concerned, it may require relatively small quantities of three fairly common single-proton isotopes to work: hydrogen, deuterium, and tritium. The former is abundant, and the isotopes with extra neutrons also occur naturally in water on Earth. The whole point of fusion would be to overcome the limitations of currently used resources. But building the reactors might be resource-intensive. There are two main branches of fusion power research: laser induced fusion and magnetic confinement fusion.</p> <p>Years after my experience at the Forked River fission plant, after a degree in electronics engineering, I worked for six years at the Princeton Plasma Physics Laboratory, which was a complex of buildings located in the middle of some cornfields (at the time) a few miles south of the main Princeton University campus. I played a small part in building and maintaining the Tokamak Fusion Test Reactor, or TFTR:</p> <p><a href="https://en.wikipedia.org/wiki/Tokamak_Fusion_Test_Reactor">https://en.wikipedia.org/wiki/Tokamak_Fusion_Test_Reactor</a></p> <p>You can see a few people in this photo of the completed device, which was isolated within its own building some distance (through an underground tunnel) from its control room.</p> <p><a href="https://en.wikipedia.org/wiki/File:TFTR_1989.jpg">https://en.wikipedia.org/wiki/File:TFTR_1989.jpg</a></p> <p>When the device was in pulsed operation, no one was allowed to come near it. It required a tremendous amount of electricity to power the confinement magnets for even fraction of a second. That energy was drawn from rapidly decelerating huge dynamos, turning rapidly on vertical axis in pits in their own building; these dynamos had earlier been revved up very slowly from the power grid. You could hear them whine as all that kinetic energy that accumulated for so long was rapidly converted back into electricity. There is no way a device like this could take the energy it needed directly from the grid.</p> <p>Buried within the jumble of control magnets, plasma injectors, and instruments in the picture above is a beautiful stainless steel vacuum vessel several meters in diameter, in the form of a torus. This sort of device is called a tokamak. The vacuum vessel was actually visible only during the early stages of construction. When a tokamak is in operation, a beam of mostly hydrogen ions is injected into the vacuum vessel. These particles follow a circular path through the center of the interior of the torus, due to the influence of some very powerful magnets surrounding the vessel. Magnets are then used to squeeze the plasma into an ever narrower beam. This increases the density of particles, possibly to the point of initiating fusion reactions between them. The present challenge is not just to achieve ignition; this was explored in devices like TFTR. The big challenge now is to make the fusion reaction self-sustaining, drawing away energy to power its own magnets and deliver electricity to the community.</p> <p>When we built the data acquisition and control electronics for TFTR, fiber optic cables and associated electronics, which had only recently become available commercially, were used to communicate with the reactor and with all of the instruments surrounding it. Using fiber optics avoids conveying dangerous electrical spikes that can damage sensitive circuitry. It also has a much higher bandwidth than wire, allowing for more information to pass. Many of the processes involved making things happen and then seeing what happened can take only a very small fraction of a second. This information needs to flow freely.</p> <p>I built (using good old soldering irons) and tested much of the digital circuitry that controlled the master clock for the data acquisition instruments, as well as a number of other functions. I worked closely with the engineers who were designing the circuits, most notably a brilliant woman named Jane Montague.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	03/18/20	<p>I learned a lot from her, particularly about circuit design. Personal computers did not exist at the time. Microcomputers and other circuits were implemented on standard sized circuit boards that were inserted into crates; these crates provided communication buses between the boards, and were eventually placed in racks in the control room. There were no personal computers. Large mainframe computers and disk drives were used to store and organize the huge amounts of data that came from the reactor. The computer room was climate controlled, with removable panels and cabling under the floor. The control room was adjacent to the computer room and looked sort of like a space flight center. For its time, it was really very impressive. There were often brilliant people always coming in and out. This was the best reactor of its type in the world at the time, and it was part of Princeton University, after all.</p> <p>When the fuel in a fusion reactor is squeezed and ignited, fusion produces huge amounts of energetic neutrons, Streams of energetic free neutrons, like high-energy electromagnetic radiation, can be lethal to living things. They also make metallic devices like vacuum vessels brittle and radioactive. Unless these particles are captured and their energy utilized in some other way, fusion reactor s of this kind would have a limited lifetime. But a fusion reactor could be clad with uranium to absorb these free neutrons, becoming a ‘breeder reactor’ to produce plutonium for subsequent use in fission reactors. So fusion is not necessarily a completely independent alternative to fission. If self-sustaining magnetic confinement fusion reactions are achieved, they may help to give the fission industry a boost. This is not something that is often discussed.</p> <p>Biofuels are the final category of carbon-based energy resources we shall cover here. There are many living sources of biofuels, from forests to agricultural fields to algae, so their connections to natural resources are diverse. They release atmospheric carbon, but if that carbon was originally absorbed from the atmosphere, such fuels are potentially carbon-neutral.</p> <p><b>Watch:</b> Biofuel and Ethanol [Iken Edu] <a href="https://youtu.be/xAms3Q_3pXg">https://youtu.be/xAms3Q_3pXg</a></p> <p><b>Watch:</b> Biofuels: Renewable Jet Fuel [Boeing] <a href="https://youtu.be/kKO6TuH_OeQ">https://youtu.be/kKO6TuH_OeQ</a></p> <p><b>Watch:</b> How the Technology Works - algae to biofuels [Algaetec biofuels] <a href="https://youtu.be/QP_HbQ5cWSk">https://youtu.be/QP_HbQ5cWSk</a></p> <p><b>Read:</b> (Goldemberg) Ethanol for a Sustainable Energy Future.</p> <p><b>Read:</b> (Richard) Challenges in Scaling Up Biofuels Infrastructure.</p> <p><b>Homework 8:</b></p> <ol style="list-style-type: none"> <li>1. Discuss the importance of ethanol, and its production methods. What substances are required?</li> <li>2. Can jet fuel and other liquid fuels be economically generated from biological sources? What would be the advantages of doing so?</li> <li>3. Discuss the production of biofuels from algae. Why are algae potentially such an important source of fuel?</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
9	03/25/20	<p>Topic: <b>Corruption, insecurity, conflict</b></p> <p><b>Watch:</b> Profits Over People: Mining Ruins Lives in Malawi [Human Rights Watch] <a href="https://youtu.be/qD4WlqL5fwg">https://youtu.be/qD4WlqL5fwg</a></p> <p><b>Watch:</b> Nigeria: Poverty despite oil wealth   DW Business [DW News] <a href="https://youtu.be/PZXH2LJN3ZY">https://youtu.be/PZXH2LJN3ZY</a></p> <p><b>Watch:</b> South Sudan's 'oil curse' [Al Jazeera English] <a href="https://youtu.be/Y2Y6XmPZATY">https://youtu.be/Y2Y6XmPZATY</a></p> <p><b>Watch (you may start at minute 1 or 2):</b> Counting the Cost - Is Mongolia over-reliant on its resources? [Al Jazeera English] <a href="https://youtu.be/ol_zpzp6ZnU">https://youtu.be/ol_zpzp6ZnU</a></p> <p><b>Watch:</b> Botswana proves Africa can avoid the 'resource curse' [Devex] <a href="https://youtu.be/OgfgsGAHmnk">https://youtu.be/OgfgsGAHmnk</a></p> <p><b>Read:</b> (Brunnschweiler) linking natural resources to slow growth and more conflict</p> <p><b>Read:</b> (Douglas) High-value natural resources: Linking wildlife conservation to international conflict, insecurity, and development concerns</p> <p><b>Read:</b> (Sachs) the curse of natural resources</p> <p><b>Read:</b> (Auty) natural resources, capital accumulation and the resource curse</p> <p><b>Homework 9:</b></p> <ol style="list-style-type: none"> <li>1. Discuss similarities and differences between the resource-related social situation in Malawi, Nigeria, and South Sudan.</li> <li>2. How might Botswana's experience provide a solution to the conditions in the nations discussed in 1?</li> <li>3. About a minute in to the Mongolia video, we discover that mineral wealth: coal, copper and gold. What is Mongolia's reputation for corruption? How has Mongolian life been changing? What is the government response?</li> <li>4. Describe the challenges to wildlife conservation due to conflict, insecurity, and development.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
10	04/01/20	<b>Recess</b>
11		<p data-bbox="370 258 771 289"><b>Topic: Adaptive management</b></p> <p data-bbox="370 331 1495 640">This second part of the course focuses on topics that are likely to rise in importance over the course of your working lives: the pursuit of carbon-free energy, the protection of ecological resources, and the generation of effective responses to the complex issues relating to natural resources, some of which we examined earlier. We begin with the generation of effective responses by asking you to consider something that can be implemented anytime, anywhere, and without any prerequisites or other requirements: wise management. Few material resources are required for this to work, but it is easier said than done. I am referring to the partially psychological process of making decisions and acting on the basis of those decisions more effectively. Decision science is indeed a science, and computation has revolutionized the field, as you might expect.</p> <p data-bbox="370 682 1495 1096">I would hope that university students would be interested in getting a leg up on wisdom, even if you can only apply to self-management at the moment. We've already seen wisdom in action, in some of the videos from week 9 for example. We see it more often at the local level, where individuals have direct connection in their lives and livelihoods with the extraction of natural resources, either through mining or harvesting. Innovations that have developed in response to new challenges now have a better chance of being heard and appreciated elsewhere, if internet-based interaction is encouraged. But there is a great deal more that should be mentioned in this regard. The natural, human, and computational sciences are converging in their ability to accurately and deeply model many important aspects of how our world, and how much of this activity is likely to respond to stress. Climate models are part of this achievement, but many aspects of our world, from traffic flow to crowd behavior to the structure and metabolism of ecosystems, are better understood because of improvements in the way we can conceptually and symbolically model their behavior with computers.</p> <p data-bbox="370 1138 1495 1446">The Rammel paper below (one of my long-time favorites) mentions agent-based models. Regardless of the field of study you are interested in, this sort of modeling might interest you. Most of you grew up playing video games. The characters that you control, and the characters that the program controls, are agents. Sometimes that agency comes from human beings, and sometimes from increasingly intelligent routines that determine their activity. Agent-based models work in much the same way, and you can get as much of a surprise working with them as you might from a video game. Counter-intuitive things might happen in a simulation that might have never occurred to you had you not seen it played out. If you are interested, you can download a very user-friendly agent-based programming environment from Northwestern University, called NetLogo:</p> <p data-bbox="370 1488 763 1520"><a href="https://ccl.northwestern.edu/netlogo/">https://ccl.northwestern.edu/netlogo/</a></p> <p data-bbox="370 1562 1495 1766">It can be easily installed on a laptop computer, and you may run a large number of provided models in order to get the idea. It's very game-like. Eventually, you can modify programs and write your own, using a combination of a visual programming environment and some java-like code. One of my graduate students, Michelle Fong, used NetLogo to model the potential behavior and population dynamics of an invasive species of crab present in San Francisco Bay. Here is a short video of a typical simulation run, which I uploaded to my research channel:</p> <p data-bbox="370 1803 743 1835"><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	04/08/20	<p>movie1 [evolutionary geocomputation]  <a href="https://youtu.be/Zr7qOvs35H0">https://youtu.be/Zr7qOvs35H0</a></p> <p>The first video and the first reading this week offer examples of the importance of innovation in natural resource management. Many of these opportunities have been made possible by the Internet. Certainly, effective conservation and switching away from fossil fuels to alternative sources of energy would create a sea change in world affairs. But a great many other unique problems that are bound to come up in various places at various times, for which there is no ready-made solution, can only be reliably tackled in an atmosphere that promotes independent thinking. This I believe is the fatal flaw of socialist governance in this regard. Socialism and other top-down approaches to governance tend to prevent such independence of mind from acting openly and achieving results that had not been previously anticipated and sanctioned by the state.</p> <p>The development of technical innovations, the availability of timely sensory data, and the application of computational logic, decision science, and modeling are among the prerequisites for what might be called adaptive management. The paper by Williams provides a detailed consideration of how adaptive management might be performed in the context of natural resource extraction and use.</p> <p><b>Watch:</b>  Unleashing innovation in a resource limited world [Australian National University]  <a href="https://youtu.be/maUkJza9Ct8">https://youtu.be/maUkJza9Ct8</a></p> <p><b>Watch:</b>  California's Renewable Energy Problem [Real Engineering]  <a href="https://youtu.be/h5cm7HOAqZY">https://youtu.be/h5cm7HOAqZY</a></p> <p><b>Read:</b>  (Whitesides) Don't Forget Long-Term Fundamental Research in Energy.</p> <p><b>Read:</b>  (Rammel) Managing complex adaptive systems — A co-evolutionary perspective on natural resource management.</p> <p><b>Read:</b>  (Williams) Adaptive management of natural resources.</p> <p><b>Homework 10:</b></p> <ol style="list-style-type: none"> <li>1. How might innovations in communication (enabled by the Internet) help to reduce the rate of consumption of goods tied to resource extraction?</li> <li>2. We haven't gotten into the details of renewable energy options yet, but it is not too early to begin thinking about them in the context of adaptive management. Describe California's renewable energy problem, as outlined in the video, and discuss the role of effective management.</li> <li>3. Why is fundamental and applied scientific research important for the future of resource management?</li> <li>4. What is co-evolution, and how is this applicable to the management of natural resources?</li> </ol>



Week	Due Date	Topics, Videos, Readings, Assignments
12	04/15/20	<p>Topic: <b>Solar and wind energy resources</b></p> <p><b>Watch:</b> Impact of Materials on Society (IMOS) – Photovoltaics [Materials Research Society] <a href="https://youtu.be/efMKfHUIw3s">https://youtu.be/efMKfHUIw3s</a></p> <p><b>Watch:</b> Top Solar Energy Producing Country   Solar Energy Data [Stats Media] <a href="https://youtu.be/xTrd3Sxqhds">https://youtu.be/xTrd3Sxqhds</a></p> <p><b>Watch:</b> The thrilling potential for off-grid solar energy   Amar Inamdar [TED] <a href="https://youtu.be/20adDr7Felw">https://youtu.be/20adDr7Felw</a></p> <p><b>Watch:</b> Puerto Rico's solar energy insurrection [Quartz] <a href="https://youtu.be/7ekFQ0xOwDw">https://youtu.be/7ekFQ0xOwDw</a></p> <p><b>Watch:</b> Morocco turns the Sahara desert into a solar energy oasis [PBS NewsHour] <a href="https://youtu.be/ZSDo67E1k3s">https://youtu.be/ZSDo67E1k3s</a></p> <p><b>Watch:</b> Top 15 Countries by wind power production [Stats Media] <a href="https://youtu.be/HSNmkJVYdlk">https://youtu.be/HSNmkJVYdlk</a></p> <p><b>Read:</b> (Service) Is It Time to Shoot for the Sun?</p> <p><b>Read:</b> (Ganesh) electricity generation from sunlight.</p> <p><b>Homework 11:</b></p> <ol style="list-style-type: none"> <li>1. Discuss the material requirements of photovoltaics, in terms of natural resources. How easily are these substances acquired? What sort of processing is required?</li> <li>2. Discuss the recent history of nations with the largest power generation from photovoltaics. For example, describe the situation every five years since 1995.</li> <li>3. Why is off-grid power generation and storage a valuable goal?</li> <li>4. How are deserts in places like Morocco and California becoming important for the large-scale centralized production and distribution of solar energy? What sorts of technologies are being considered? You may need to do a little research here.</li> <li>5. Discuss the recent history of nations with the largest power generation from wind turbines. For example, describe the situation every five years since 1995.</li> </ol>

Week	Due Date	Topics, Videos, Readings, Assignments
13		<p>Topic: <b>Hydro, tidal, and geothermal energy resources</b></p> <p><b>Watch:</b>            Could Earth's Heat Solve Our Energy Problems? [Real Engineering]  <a href="https://youtu.be/vZLo0-lwK1k">https://youtu.be/vZLo0-lwK1k</a></p> <p><b>Watch:</b>            How a Geothermal Plant Works [alternativeenergycom]  <a href="https://youtu.be/kjpp2MQffnw">https://youtu.be/kjpp2MQffnw</a></p> <p><b>Watch:</b>            Top 5 Geothermal Energy Producing Countries   2017 [Present Tech]  <a href="https://youtu.be/QEC83nW5_Jo">https://youtu.be/QEC83nW5_Jo</a></p> <p><b>Watch:</b>            Kenya joins world leaders in geothermal energy production [africanews]  <a href="https://youtu.be/XcMN-C4GoKA">https://youtu.be/XcMN-C4GoKA</a></p> <p><b>Watch:</b>            Top 20 Country by Hydropower Electricity Generation (1965-2019) [Wawamustats]  <a href="https://youtu.be/wcwryKJiozU">https://youtu.be/wcwryKJiozU</a></p> <p><b>Watch:</b>            Hydropower: China's world "business card" [CGTN]  <a href="https://youtu.be/fhPNRpuPZEA">https://youtu.be/fhPNRpuPZEA</a></p> <p>China's current enthusiasm for hydropower is reminiscent of the US in the 1930s. This enthusiasm has clearly spread to powerful people in developing nations, particularly in Africa. Proven Chinese engineering and plentiful manpower in Africa contribute to this trend.</p> <p>Having toured the Three Gorges segment of the Yangtze River, I am well aware of the ecological damage and social consequences of the dam. However, the region remains breathtakingly beautiful, even around the dam itself. River traffic is fairly light, and it's quiet; hear the birds singing from both banks. Development along the river is limited and controlled, but long-time towns remain above the waterline, or were moved to higher ground.</p> <p><b>Optional:</b>            The Three Gorges [Gary Pereira]  <a href="https://youtu.be/kNk0BJwheh4">https://youtu.be/kNk0BJwheh4</a></p> <p>The very highest river level previously achieved behind the dam is demarcated by the line of vegetation on the riverbank. Higher water levels due to the dam have made the gorge of the Daning River tributary accessible to tourist boats.</p> <p><b>Optional:</b>            Little Three Gorges of the Daning River [Gary Pereira]  <a href="https://youtu.be/ZY9Ug2CXFwo">https://youtu.be/ZY9Ug2CXFwo</a></p> <p><b>Optional:</b>            The Three Gorges Dam [Gary Pereira]  <a href="https://youtu.be/pPKV_GTI4gk">https://youtu.be/pPKV_GTI4gk</a></p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	04/22/20	<p><b>Watch:</b> Can Underwater Turbines Solve Our Energy Problems? [Real Engineering] <a href="https://youtu.be/CIYA6Jwwp4s">https://youtu.be/CIYA6Jwwp4s</a></p> <p><b>Read:</b> (Qiu) trouble on the Yangtze.</p> <p><b>Homework 12:</b> You should be actively working on your final paper by now. Please read ahead.</p> <ol style="list-style-type: none"> <li>1. How is geothermal energy utilized? What are the prospects for its increased use? Where is it being utilized most at present, and where is it likely to grow in importance?</li> <li>2. Which nations have been most active in developing hydropower historically, which dominate now, and which are on the rise? Where are older dams being dismantled? What are some of the unintended consequences of dam construction? You may need to do some research.</li> <li>3. Discuss the use of underwater turbines and/or other means of utilizing tidal resources. Where are such methods likely to be most useful?</li> </ol>
14		<p><b>Topic: Ecological resources</b></p> <p>Biological and ecological resources are often absent from discussions of ‘natural resources’, and yet they are often among the most important and most severely threatened. Along with water resources, they deserve at least another semester of study, so this week’s material is meant to be a quick introduction. Ecological resources are often discussed in terms of the ‘ecosystem services’ that offer benefits to human societies.</p> <p><b>Watch:</b> Ecosystem services [California Academy of Sciences] <a href="https://youtu.be/BCH1Gre3Mg0">https://youtu.be/BCH1Gre3Mg0</a></p> <p>It is often with ecological resources that individual human beings have a powerful influence. Through the actions of specific people, entire species have escaped extinction. Keep this in mind, please, if you ever wonder about your place in the world, and what you might do in real terms to help.</p> <p>Ecosystems tend to become self-stabilizing, given half a chance, but many are not being given that chance. In some regions, climates are changing so rapidly that the natural processes of species dispersal and migration cannot often keep up. Some species are migrating poleward or upward in altitude; others have to deal with increased drought and fire. Many animals and plants die, and local extinction becomes more and more common. Most recently, Australia has lost a great deal of its wildlife to fire.</p> <p>That is where human intervention is so important. Acting on behalf of wildlife and naturally diverse ecosystems may be some of the most challenging, time-critical, but ultimately fulfilling domains of natural resource management that we have seen and will continue to see in the near future. Once again, Africa finds itself at the heart of this struggle, and the fight to save African wildlife is something you should educate yourself about; there are many good documentaries on topics like elephants, gorillas and other primates, big cats, etc. that you should watch.</p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	04/29/20	<p>For now, as an example, let's remain with Australia, and with the ocean, and look at the Great Barrier Reef. Coral reef loss is accelerating throughout much of the world. Scientists are actively looking at ways of modifying coral DNA (possibly using species from the Red Sea) that would allow them to survive in warmer, more acidic waters.</p> <p><b>Watch:</b> The Reef Pt 1: Is it too late to repair the Great Barrier Reef?  <a href="https://youtu.be/Rmkvj9qghGY">https://youtu.be/Rmkvj9qghGY</a></p> <p><b>Watch:</b> The Reef Pt 2: Could farming changes help save the Great Barrier Reef?  <a href="https://youtu.be/ICKV22wDrBA">https://youtu.be/ICKV22wDrBA</a></p> <p><b>Watch:</b> The Reef Pt 3: Where do we need to invest to save the Great Barrier Reef?  <a href="https://youtu.be/NYtslfmX9pk">https://youtu.be/NYtslfmX9pk</a></p> <p><b>Read:</b>  (Cardinale) biodiversity loss and its impact on humanity</p> <p><b>Homework 13:</b></p> <ol style="list-style-type: none"> <li>1. What are ecosystem services? What services are most important in sustaining the human population of a given region? Might they be different from one region to another? How does this tie in with the idea of adaptive management?</li> <li>2. What did you learn from these videos about the complexities and difficulties involved in managing the health of a natural resource like the Great Barrier Reef.?</li> <li>2. Cardinale et al.'s reviews research into "how biodiversity per se—that is, the variety of genes, species, or functional traits in an ecosystem—has an impact on the functioning of that ecosystem and, in turn, the services that the ecosystem provides to humanity." This is a detailed paper, and I don't expect you to take it all in, but briefly describe the scientific case for biodiversity's importance as a natural resource worth preserving.</li> </ol>
15		<p><b>Topic: Fresh water</b></p> <p>The last topic we've got time for may be the most pressing natural resource issue facing humankind now and in the foreseeable future: the worldwide availability of fresh water. The following story about water scarcity in Yemen was produced in 2009. Think about what has been happening there since then.</p> <p><b>Watch:</b>  Water Scarcity in Yemen [Mario Alemi]  <a href="https://youtu.be/QtQypN8ODH4">https://youtu.be/QtQypN8ODH4</a></p> <p>Closer to home:  <b>Watch:</b>  Mexico City faces growing water crisis [PBS NewsHour]  <a href="https://youtu.be/0E_VpTjx-y0">https://youtu.be/0E_VpTjx-y0</a></p> <p><b>CONTINUED ON NEXT PAGE</b></p>

Week	Due Date	Topics, Videos, Readings, Assignments
	05/06/20	<p><b>Watch:</b>  Inside Story - What can be done to stop global water scarcity? [Al Jazeera English]  <a href="https://youtu.be/JIIBBWSQMds">https://youtu.be/JIIBBWSQMds</a></p> <p><b>Watch:</b>  Our Freshwater Future   Rosemary Knight   TEDxStanford [TEDx Talks]  <a href="https://youtu.be/AFO77hDGBII">https://youtu.be/AFO77hDGBII</a></p> <p><b>Read:</b>  (Gleeson) Water balance of global aquifers.</p> <p><b>Read:</b>  (NRDC) stormwater capture potential in urban and suburban California.</p> <p><b>Homework 14:</b></p> <ol style="list-style-type: none"> <li>1. Why, in many developing (or even developed) countries, do the poor pay more for water than do the rich? What is being done, if anything, to address this concern?</li> <li>2. Much of Yemen's and Mexico City's water is extracted from non-renewable groundwater. This is the case in many locations throughout the world. According to Gleeson, which regions have the greatest challenge regarding the water balance of their associated aquifers?</li> <li>2 According to some of the people interviewed in the Al Jazeera video, what can be done to stop global water scarcity?</li> <li>4. Summarize the talk by Rosemary Knight; discuss the use of remote sensing in assessing groundwater reserves.</li> </ol>
16	05/13/20	<p><b>Term paper (Final Evaluation)</b></p> <p>In place of a final exam, I want you to submit a paper on a topic of your choice, possibly expanding on one of the topics we've already covered, or introducing something new. Provide at least three citations, including at least one that you have found yourself. Choose a topic that you are genuinely interested in educating yourself further about. The resulting paper should be at least five pages long, easily more. There is no upper limit on length. Please do not just resubmit portions of earlier homework assignments with minor modifications. There should be substantive improvement and discussion. In other words, this is a warning: resubmitted homework responses for which you may have received A's can easily earn you a B or less here if there are no substantive additions.</p> <p>This should be something that you would consider submitting to a newspaper or journal, post online, and add to your undergraduate portfolio. You should create such a portfolio, if you haven't already done so, in Portfolium.</p>