San José State University
Department of Geography and Global Studies
GEOG 121 / ENVS 121, Population and Global Change, Spring 2019

Course and Contact Information

Instructor: Gary Pereira

Office Location: Washington Square Hall 113

Telephone: (510) 825-3506

Email: **CANVAS messaging preferred, or text 510-825-3506.**
gary.manuel.pereira@gmail.com

Office Hours: Text 510-825-3506 if you need to set up an appointment.

Class Days/Time: Online

Course Format

This is an online course. Internet connectivity and a computer are required.

Course materials (including this syllabus) can be found on Canvas Leaning Management System course login website at http://sjsu.instructure.com, under **Files**. Assignments are all listed and described under **Assignments**. Additional discussion may be provided under **Announcements**. You may communicate with me privately as much or as little as you want, through CANVAS messaging. I may provide feedback on particular assignments, but I encourage you to continue such conversations outside of that particular assignment, which I am unlikely to check back on once it's graded.

Course Description

The purpose of this course is to examine, analyze and comprehend connections between human demographics and human well-being and how they influence and are influenced by physical and social conditions and changes that are taking place on this planet.

Course Learning Outcomes (CLO) (Required)

Upon successful completion of this course, students will be able to:

1. describe the transitional processes and characteristics of human populations in the modern world, and be capable of intelligently project this understanding into future scenarios;

2. understand and describe the physical, biological, ecological, personal, social, and cultural practices that shed light on the relationship between human populations and those biospheric domains upon which we depend.

Textbook

There are no textbooks for this course.

Other Readings

Approximately thirty carefully chosen documents are provided on CANVAS, under **Files**. Please access each document in the order indicated in the Course Schedule below by the assigned date.

Other technology requirements / equipment / material

A device capable of streaming video from the Internet is required for this course. You should use a computer with a sufficiently large screen if possible; I do not recommend that you watch on your phone. Most of these streaming videos (including my own) are being offered in high definition. Your computer and Internet connection should be sufficiently powerful to portray them at the original resolution.

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 within CANVAS. I suggest you open videos in separate browsers and possibly take notes as you watch; that is why a bigger screen is preferable. Separate browsers often also provide additional information, as well as full access to other material on the author's channel. I encourage you to explore the work of any YouTube contributor whose work you appreciate.

However, you might want to open videos by clicking on the embedded option within CANVAS (if access is offered), and read over the assignment as you watch. It's up to you. I've included some of my own videos in the homework, and I might provide links to others in the **Announcements**. I'm working on narration.

Some YouTube videos may be preceded by ads. Usually, these ads can be cut short by clicking on 'Skip Ad' at the lower right of the screen. There will never be ads on my videos, and I get absolutely no monetary benefit from YouTube.

There is a great deal of excellent educational material on the Internet, but you have to search for it. The best isn't often easy to find. If you have any suggestions or discoveries that you think I might appreciate, please let me know. But nothing politically partisan please, one way or the other.

Course Requirements and Assignments

Your responsibilities for this course lie entirely in submitting homework assignments and a final evaluation. I encourage you to discuss any relevant matter with me via CANVAS messaging. You may do so as much or as little as you like. Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally 3 hours per unit per week) for preparation/studying or course related activities.

Grading Information

Homework: Fifteen homework assignments should be completed by the due dates, as described in the Course Schedule below. Submit these responses via CANVAS as either Word or pdf files. Use 10 pt. font, with 1 ½ line spacing and normal margins. Please include the following information at the upper right of the first page of each homework submission:

Your name
Geog121-02 or Envs121-02
Spring 2019
Homework #

Figures, images, and quotations from the references listed here or from other sources may be embedded in your homework responses, but you must provide attribution. Citations should be explicit and complete. Regarding the length in pages or word count expected for each assignment: this depends on the topic and your writing style. I'm looking for understanding, substance, and a willingness to sufficiently pursue each point you are making. Each assertion should be supported by evidence; in fact, you should be spending more time in discussing evidence (for and against particular claims) than in making assertions. It's OK to be unsure about topics that you are just beginning to understand. This course

is intended to be rooted in science. Doubt and uncertainty are virtues. If your writing style is average, and you avoid redundancy, each homework assignment should probably run at least three pages.

You will be graded relative to the performance of your classmates in the current and former semesters. I may offer comments or advice in CANVAS for each assignment. Check back on each assignment not only for your grade, but also for any comments I may have left. If you'd like to continue the conversation (which I welcome) please do so as a CANAS message to me independently of that particular assignment, which I am unlikely to check back on.

Final Examination or Evaluation

Near the end of the semester, you will choose one of your homework responses and expand it into a well-written term paper. This will be your final exam. You should by now have developed the skills required to reason logically and write well. That is what you are being judged on here. You will be required to provide at least three citations.

Determination of Grades

15 Homework assignments (6% each)	90%
Final Exam	10%
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**

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.

University Policies

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/"

Geog121-02 / EnvS121-02: Population and Global Change, Spring 2019

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 at upper right on the first page of each submission your name, the homework #, geog/envs121, Spring 2019.

Course Schedule

Week	Due Date	Topics, Viewings, Readings, Assignments
1		Topic: **Simpson's Paradox** **Watch:** How statistics can be misleading - Mark Liddell https://youtu.be/sxYrzzy3cq8 **Access via CANVAS (Files):** (Pearl) understanding simpsons paradox For further information on Simpson's Paradox (or any other topic discussed in this course) I encourage you to try Wikipedia. The document called *Understanding Simpson's Paradox* **is not** required reading, but you might want to download it anyway for future reference. 'Simpson's Paradox' is paradoxical only in the psychological sense. It can usually be overcome with a little thought. It is not a true paradox in the mathematical sense. Dr. Pearl states that "we must first distinguish between 'Simpson's reversal' and 'Simpson's paradox'; the former being an arithmetic phenomenon in the calculus of proportions, the latter a psychological phenomenon that evokes surprise and disbelief." He examines ways of detecting situations where such reversals (leading to apparently paradoxical outcomes) can occur. **Watch:** Humanity https://youtu.be/IeT2AObKkJM This course is called Population and Global Change, but I will try not to take a collectivist perspective. Dr. Liddell indicated in his video that it might be better do consider situations in the aggregate (implying that individual actors may continue to maintain their full identities for our consideration) than to put our trust in categories, natural or otherwise. Individual cases may continue to be important in providing insights that typical statistical analyses often miss. Dr. Pearl expands and formalizes this insight. I would add that the natural tendency for such categories to change over time makes even apparently natural categories pop in and out of existence as rogue variables in historical or cross-cultural analyses. It seems clear to me (having grown up in a nation that presumably values the individual) that human societies, no matter how large or densely packed, are all comprised of uniquely individualized human beings. This might seem to be transparently obvious, but it is often overlooked. Unfortunately, too many things seem to 'go without saying' these days. Over the next couple of weeks, you will be studying topics in human demography. Do not lose sight of the fact that we are still talking about individual people- each of whose lives are as important to each of them as yours is to you. You might think that this Humanity video was intended to portray the collectivist nature of Chinese society. I do not see it that way at all. Behind those windows are individually unique people, each with their own particularized dreams and ambitions. So this course is about human ecosystems in the aggregate, global, and biological sense, and it is also very much about **individual human beings**. Any intermediate categories should be considered carefully before being accepted as contingently valid. Often, arguments based on such categories are not fully justified. All too often, they are downright wrong. **Watch:** Late 1890s - A Trip Through Paris, France https://youtu.be/NjDclfAFRB4 **Watch:** PARIS WALK | Street Market by Eiffel Tower https://youtu.be/Huf3QpHTSyk **Week 1 (homework 1: due 1/28) continues on next page.**

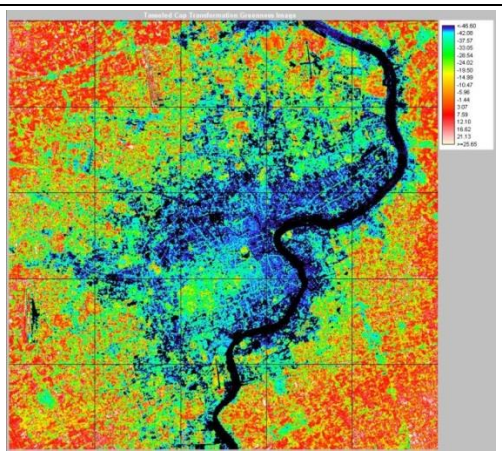
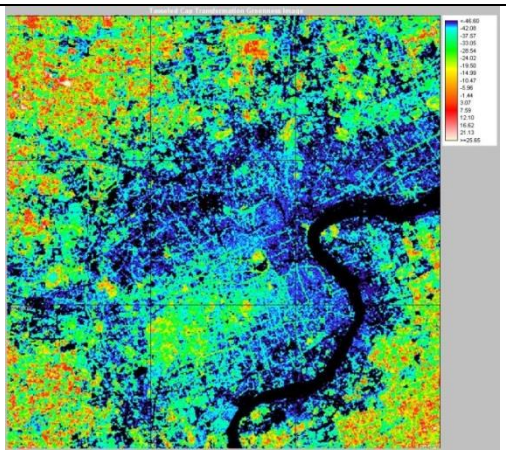
Week	Due Date	Topics, Viewings, Readings, Assignments
	1/28/2019	**Homework 1**: Begin by discussing differences you can see in the videos (and whatever else you might know or assume) between the Paris of the 1890's and the Paris of today, in terms of transportation, communication, commerce, heat, light, fashion, livelihood, demographics, etc. Think about and describe co-dependencies among these categories of human activity, as well as dependencies on external influences. For example, you'd expect there to be fewer blacksmiths and stables in Paris today, due to changes in transport. Entire occupations (e.g., cleaning up the streets after the horses) are likely to have disappeared. Fewer haberdashers as well, due to changes in fashion. You can imagine networks of such co-dependencies that change through time. Network representations are increasingly used to overcome the tendency of categorical statistics to fall prey to Simpson's Paradox. Look through Dr. Pearl's paper if it helps, and in your own words try to describe (possibly by way of example) why **networks** might help to explain complex relationships better than the piecemeal linear approaches that are often used to justify a claim. Use Wikipedia or other sources to research and describe for me so-called **Bayesian Networks**, which are increasingly used to more effectively understand geographical relationships.
2	**2/04/2019**	Topic: **Demographics** **Access:** Current World Population http://www.worldometers.info/world-population/ **Watch:** 7 Billion: How Did We Get So Big So Fast? https://youtu.be/VcSX4ytEfcE **Watch:** Population pyramids: Powerful predictors of the future - Kim Preshoff https://youtu.be/RLmKfXwWQtE **Access via CANVAS (Files):** (Cohen) human population – the next half century The 7 Billion video physically simulates world population with flasks of liquid categorized by continental. Did you notice at the end of the video that the water is on the verge of spilling out over the top of the flask? Besides neglecting the effects of migration, this model suggests an upper limit (where liquid spills out) somewhere above 10 billion. It doesn't explain what they mean by this, although it apparently deserved a close-up. The video is clever, but emotionally manipulative. The "Population pyramids" video is far more informative, but it also doesn't discuss the influence of in-migration and out-migration on the pyramids themselves. For small countries in particular, these can be significant factors. Nevertheless, this video, along with the article by Cohen, should help you very much in doing the homework. **Homework 2:** Access the following website: Population Pyramids of the World from 1950 to 2100 https://www.populationpyramid.net/world/ Choose any country from the alphabetical list to the right of your screen. The population pyramid for that country for the year 2017 is portrayed. Click on 'Download' below the bottom left corner of the pyramid; a PNG image should appear in a separate window. Copy this image and paste it into your homework document. Change the year in the original window by clicking on -5. The year and corresponding pyramid should change to 2012. Click on -5 again, and the year and pyramid change to 2007. **Week 2 (homework 2) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
		Capture population pyramid images for at least three different years for the country you chose in order to reflect the historical realities of that country. Discuss the effects of war and famine, recovery and boom, family size, etc. These pyramids should be separated from on another by at least fifteen years; you can go back to 1950 if you want. You choose which years to image. You can also explore the possible future, but be aware that these numbers are speculative. Discuss the historical developments that helped shape that particular nation's pyramids, as Dr. Preshoff did in the video. Now do the same thing for one more country. Two countries total. As with the firs,t include a pyramid for 2017, and a couple other years you deem interesting. Please adjust the size and placement of the images so that each country's set of pyramids fills no more than half a page. Most of your document should be taken up by your insightful prose.
3	**2/11/2019**	Topic: **Demographics** **Watch:** How will population change transform our world? https://youtu.be/hDoGq3BaR8M **Watch:** "How population change will transform our world" with Prof Sarah Harper https://youtu.be/el7_v86HQcc **Access via CANVAS (Files):** (Bloom) 7 billion and counting (Oeppen) broken limits to life expectancy (Lee) the outlook for population growth. (McMichael) longer lives and lower birth rates (Bongaarts) population policy in transition in the developing world **Homework 3:** In the first video, Professor Sarah Harper manages to say in three minutes what it might take most of us far longer. She provides an excellent introduction to the implications of population change. Hopefully, you will be inspired to watch the full lecture she gave at Oxford, "How population change will transform our world". In addition, read at least some of the texts listed above (as well as last week's listing of Cohen), and reference at least a couple of them in the following discussion. Describe the "demographic transition". What are some historical, climatic, medical and technological forces that might influence its development? How and why might it be different for different countries or regions? Why are most demographers (e.g. Bongaarts et al) so supportive of increased attention to family planning in the developing world? Has this received the attention it deserves?
4		Topic: **Nuclear weapons** Before we explore demographic trends and their implications any further, I want to introduce a topic that is important to the general idea of global change in a human context, that of nuclear and other advanced weapons technologies. The massively destructive effects of nuclear weapons are not often discussed in this context, but maybe they should be. Thermonuclear weapons, with destructive potentials hundreds or thousands of times as great as the uranium and plutonium bombs that were dropped on Japan, have not yet been used as tools of war, and globally we seem to have avoided or contained most accidents thus far (often through pure luck). There is plenty of footage of nuclear weapons tests and related topics in YouTube. I've selected a couple of bomb test videos with the most informative narration. **Week 4 (homework 4: due 2/18) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
		Tsar Bomba, the largest thermonuclear bomb ever detonated, with a yield of 50 megatons, has an interesting backstory that the video does not mention. Khrushchev initially ordered the development of a 100 megaton bomb. The lead designer, a brilliant physicist named Andrei Sakharov, deliberately scaled back the yield to 50 because he was aware of the huge risk all such bombs pose in terms of fallout, which would inevitably, eventually, result in many deaths. For his work in weapons development, he was awarded the Soviet Union's highest honors. He subsequently wrote an open letter (which was published in the West) to the leadership of the Soviet Union and of the United States, requesting an end to all atmospheric testing. Remarkably, in due course, they followed his advice, but he was hounded and imprisoned by the Soviet state, his clearance and access taken away, his health destroyed. He remained a very active dissident, supporting other dissidents and calling for democratic reform. He was eventually 'rehabilitated' after the fall of the Soviet Union, and even contributed to the writing of a new constitution. A great man, whom most of you have probably never heard of. In addition to the historical footage of bomb tests, I wanted to make you aware of some important new developments, as described in the paper by Gsponer as well as in the video on 4th generation weapons. Thus far, thermonuclear weapons have required the initial fission of uranium or plutonium to trigger the fusion reaction. If (or rather when) fusion weapons are developed that can detonate without fission, it would be possible to deploy such weapons at any yield (from that of conventional weapons, upward possibly without limit) with immense blast and radiative power, without the release of any long-lived radioactive isotopes. Such localized contamination and extended fallout are unavoidable with current weapons, which would make the target unapproachable without special gear, and would contaminate the entire Earth through the atmosphere and oceans. Thus, thermonuclear weapons could become far more tempting as tools of war than they are now. When I was young, the threat of nuclear war (and the rapid pace of nuclear testing) created what was for many people of my generation, including myself, a difficult world to understand. I became periodically fascinated and depressed by both nuclear weapons and nuclear power. In order to experience the generation of nuclear power firsthand, I worked for a month at the Oyster Creek Nuclear Generating Station in New Jersey, in a vast room above the reactor, where we realigned brackets in pools on either side that are used to cool and store spent fuel. I am no fan of nuclear power and of these older plants in particular, and I remain ambivalent about new fission technologies. But fusion energy is something else. I worked for six years as an electronics technician for Princeton University, helping to build what was at the time the largest nuclear fusion device in existence, the Tokamak Fusion Test Reactor (TFTR). That was a much more positive and interesting experience. **Watch:** All The Largest Nuclear Explosions In History https://youtu.be/Jgi7WgB05Jo **Watch:** 5 Declassified Nuclear Explosions Caught on Film https://youtu.be/n82pfo-LzXY **Watch:** 4th Generation Nuclear Weapons https://youtu.be/M5VNnmAoIYI **Access via CANVAS (Files):** (Gsponer) fourth generation nuclear weapons
	2/18/2019	**Homework 4:** I'm curious about the extent to which people might be thinking about the existence and possible use of nuclear weapons. I'd also like to know whether there is any connection between the weapons and nuclear power. Consider the US as well as the rest of the world, as you understand things to be. Did you find any of these films surprising? To what extent have you discussed these issues in school or among your friends? Tell me what you know, as opposed to what you think might be true or are unsure about. You are graded on how hard you work on exploring your impressions or beliefs in these responses, not on what you believe.

Week	Due Date	Topics, Viewings, Readings, Assignments
5	**2/25/2019**	Topic: **Urbanization** **Watch:** Top 10 Largest Cities by 2030 https://youtu.be/N-_a0TCWb6E **Watch:** Top 10 Largest Cities by 2100 https://youtu.be/9OulEjWI-bE **Homework 5:** Of all the videos that have been produced on the topic of megacities, I found these to be the most informative and fascinating. We will delve further into the human dimension of cities next week, but for now I want you to appreciate the enormous change of scale such current and future megacities represent. With regard to the 2030 projection, I want you to comment on Tokyo, which is an unusual case in that, as the speaker indicated, Japan's total population is not likely to grow much, if at all. The greater Tokyo region will continue to absorb people from throughout rural Japan. Keep in mind Japan's vulnerability to earthquake and tsunami. Much of the countryside, presumably, is becoming depopulated even as the population ages. Is there something about Japan's economy and culture that results this degree of urbanization? Young people are naturally attracted to cities; country life can be boring and lack work opportunities. I found this to be the case in China. But what about elderly people? Might even elderly Japanese be attracted to cities after a lifetime of rural living for the social interaction, well-developed service industries, and quality health care? Might this be a trend for other developed nations? Try to do a little independent research on this question. Keep in mind that whenever I ask for your impression or opinion on something, I don't just want an opinion; I expect you to back it up. And you can say anything else that makes sense to you and is relevant. In the next video, by 2100, things get really interesting. Notice how countrywide or regional demographic trends that you looked at with population pyramids have come to dominate the picture, and how environmental change might often make urbanization the only choice for vast numbers of people (e.g., rising sea levels in Bangladesh and drought in Niger). List for me the projected numbers of people that will be living in each of the ten cities listed for 2100, and keep in mind that a growing number of unmentioned megacities, many larger than today's largest, will be also grow to enormous size. Do you think that these cities of the future would be like today's cities? For example, could they sustain the sort of automotive transportation we find in the largest cities today? What sort of planning do you think will be necessary for such cities to be sustainable? Should they grow 'organically' as many now do, or should they be fully or partially planned? Do you think the relevant governmental bodies are up to the task? Do you think places like Afghanistan, Niger, and Pakistan will be more or less governable as the possible result of continuing political instability, social conflict, and high birth rates, despite their urbanization?
6		Topic: **Urbanization and development** **Watch:** Harnessing Urbanization for Growth and Poverty Alleviation https://youtu.be/nTAlOxqKYNo **Watch:** Megacities Reflect Growing Urbanization Trend https://youtu.be/eFboV2m1yuw **Access via CANVAS (Files):** (Montgomery) the urban transformation of the developing world (Dye) health and urban living **Week 6 (homework 6: due 3/04) continues on next page.**

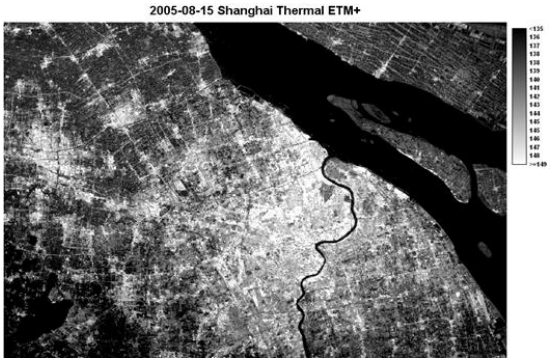
Week	Due Date	Topics, Viewings, Readings, Assignments
	3/04/2019	**Homework 6:** Montgomery outlines the rapid transition from rural to urban life that is now occurring throughout the world. The World Bank video "Harnessing Urbanization for Growth and Poverty Alleviation" claims that urbanization drives growth, creates jobs, and reduces poverty. The NPR report on Dhaka, Bangladesh ("Megacities Reflect Growing Urbanization Trend") paints a more complex story. Dye points out that urban life may actually widen the gap in quality of life between the rich and the poor, and it places a greater responsibility and new challenges to governance. It may be true that in many cases, economic growth and poverty reduction are positively correlated with urbanization. But is urbanization the causative factor? Is modernization possible without such extremely large cities? Why or why not? A primary factor enabling such radical urbanization has of course been the rather recent ability to grow vast amounts of food using relatively few people (but often at the cost of huge energy expenditures, soil depletion, pollution, etc.). We will return to this topic in a few weeks.
7		Topic: **Urban planning and engineering** This week, we sample some applications of urban remote sensing, as well as some innovative approaches to urban planning, civil engineering, landscape ecology, eyc.. **Watch:** Science Bulletins: Urban Sprawl— Baltimore https://youtu.be/wXVUNOs-P5E Remote sensing provides a great deal of information regarding the precise spatial and physical characteristics of urbanization. For example, the USGS provides a high resolution data detailing the presence of impermeable surfaces in the United States. The video above discusses some of the significance and usefulness of 'impermeable surface' classification and analysis. **Watch:** 3 Cool Ways to Cool Our Cities https://youtu.be/V4Y7VYVVD68 At about minute 3 in this video is a discussion of the use of reflective coatings on urban surfaces like roads and rooftops. I can personally attest to the effectiveness of such methods. When I lived in a two-story tenement row home in Pennsylvania, the second floor often became unbearably warm during the summer evenings, even after it had already cooled off outside. After I painted the flat black roof with a reflective coating, the problem was solved. It was a dramatic change. Urban growth and the 'Urban Heat Island' effect are topics that I have brought up quite often in the context of remote sensing, and I've done a little bit of research on them myself. For example, the images below (in the syllabus version of this assignment) portray the 'Greenness' axis of the Tasseled Cap Transformation of Landsat TM data. Greenness reveals the degree of photosynthetic activity. In these images of Shanghai in August 1989, the most heavily vegetated regions are in portrayed red, tapering off into orange and yellow. These regions are found, as expected, in the agricultural countryside. Except for airport tarmacs, much of peripheral Shanghai was also fairly well vegetated at the peak of summer. The oldest parts of the city are the least vegetated, except for the Luwan district around the Shanghai Library. Zooming into the city, we can find evidence of tree-lined streets. I have observed personally and from aerial photos that urban tree canopy has increased significantly in Beijing and Shanghai in recent years, and an analysis of thermal data from ETM+ indicates that these trees (and improved surface hydrology) have indeed helped to keep portions of these cities cooler despite their rapid expansion into the agricultural countryside.

Week	Due Date	Topics, Viewings, Readings, Assignments
		 

In the space of only five years, from 2000 to 2005, as Shanghai grew, its thermal signature also grew. Since the instantaneous measurement of this attribute is influenced by current weather conditions as well as the thermal characteristics of the urban environment, changes in this signature are not always easy to quantify. The two near-anniversary images shown below (in the syllabus version) were obtained from Landsat ETM+ thermal infrared sensors.

2000

2005



Watch: What are "Smog-Eating" Buildings?
https://youtu.be/9jyoA3MIf1c

Watch: What are Microgrids?
https://youtu.be/IVlIPoV3Va4

3/11/2019

Homework 7: Use these videos and any additional sources to briefly describe three or four innovations in urban technologies involving intelligent monitoring and control, civil engineering, landscape and structural architecture, energy generation and distribution, human mobility, comfort, livability, etc. Tell me whether you think these innovations are likely to be used in various contexts and climates around the world.

Week	Due Date	Topics, Viewings, Readings, Assignments
8		Topic: **Biospheric change** **Watch:** Scientists explain what a Tipping Point is https://youtu.be/Zx9uMIVni40 **Watch:** Climate Change and Population https://youtu.be/Q5gDij1O1AE **Watch:** Climate Change Formula: Rising Sea Levels + Coastal Megacities = Forced Migration https://youtu.be/s4UgekcYg2o **Access via CANVAS (Files):** (Barnosky) approaching a state shift in earths biosphere (Liu) complexity of coupled human and natural systems We have no time to cover the physical processes that are important to understanding climate change. There are three topics I'd like you to think about this week: the often sudden, counterintuitive nature of complex interconnected systems; connections between climate and living ecosystems; and extending those connections into the human sphere. Regardless of the relative validity of various assessments and projections of the state of the global climate system, the importance of climate and associated systems to both the rise and the fall of past civilizations is undeniable. There is abundant historical evidence, from all parts of the inhabited world, of people having to work hand-in-hand with nature, for better or worse. We have left behind ruins in deserts where great forests once had grown, and we have created garden ecosystems where once there had only been stone. No divorce from nature is ever possible. We can expect this relationship to continue and to grow more unstable in the near future. What emerges will depend largely on what we do. Viewed this way, from outside of ourselves, it should be clear that human beings as an exceptional species have huge responsibilities that have been neglected for a very long time. We find ourselves in a precarious position. In order to make the right decisions and act on them, we need at the very least to fully open our eyes and look around carefully and with intelligence at the situation we are in. To me, that means using all the technology and human talent that are available to us. It means losing no time in gathering important information, doing valid analyses that recognize and represent the complexity of the systems involved, and communicating effectively with everyone involved in making important decisions (which in a democracy should be everyone) what we find in a timely manner. Unfortunately, many of our educational institutions have not been particularly helpful in this regard. I've seen students discouraged from engaging in truly serious study or what many in our universities disparagingly call 'job training'. It is truly my impression that we are experiencing a 'cultural revolution' in our schools and in society. If you think that's a good thing, I'm afraid you don't know as much as you should about history. My advice to you is to motivate and educate yourselves independently as much as you can, outside of the classroom if necessary. Investigate well-written books, online tutorials, learning communities, and student software licenses. On the topic of complex interconnected systems, please read the articles by Barnosky and Liu. The video "Scientists explain what a Tipping Point is" provides a brief introduction to the concept underlying the possibility of catastrophic change that can result from the long-term evolution of a system. After such events, the system might begin operating in a very different way: its 'regime' will have changed. For example, in the American West, including California, a tipping point in wildfire dynamics may be changing the nature of entire ecosystems from forest to grassland. **Week 8 (homework 8: due 3/18) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
	3/18/2019	We could easily discuss and study the many connections between climate and living ecosystems for a year and still not fully grasp their significance. Nevertheless, these topics are essential to any reasonable understanding of the implications of climate change, which is why I titled this week's topic 'biospheric change'. We will look soon at some of implications of climate change for agriculture and hydrology, but we will not have time to go into the important topics of ecosystem health, species extinction, invasive species, biogeochemical change, etc. All of these underlie the general topic of population and global change, but for the moment I would refer you to classes, books, and online materials in the relevant sciences. That leaves us with the human sphere. Watch "Climate Change and Population" for a general overview by Brian O'Neill, a scientist with the Center for the study of Society and Environment at NCAR, and watch "Climate Change Formula: Rising Sea Levels + Coastal Megacities = Forced Migration" for an example of how biospheric change that ties directly into our earlier discussions of urbanization. **Homework 8:** Explain the importance of nonlinearities, thresholds, and surprises in the relationship of humanity with the Earth's natural systems. What are some of the challenges we face in trying to avoid unpleasant surprises? Do you think that governance is up to the task? Do you think that popular understanding of these issues matches their known realities? Sea level rise is one of those topics there people assume that a slow rise in sea level might be something we could easily adapt, since it is occurring relatively slowly. Empirically, of course, we can see that this is just not so. Often, the effects can be quite sudden, as when they are triggered by a storm. New York City and adjacent coastal regions discovered this with Superstorm Sandy. Consider the predicament of Bangladesh; Dhaka is bound to become an ever-larger megacity as agriculture in the lower Ganges delta becomes increasingly untenable. Do you think that the trend of increasing urbanization will have some influence (positive or negative) on the ability of human societies to cope with the sort of shocks that climate and complexity sciences are warning us about? Include in your discussion anything else you have found to be interesting or surprising about this week's material.
9	**3/25/2019**	**Spring Recess**
10		Topic: **Fresh water** I worked for a couple of years for the National Operational Hydrologic Remote Sensing Center, or NOHRSC (https://www.nohrsc.noaa.gov) which is NOAA's "source for snow information" and other hydrological data products and models. Every winter day, several satellite datasets are downloaded to this facility and analyzed, and by evening a variety of maps and graphs are generated and uploaded onto the Internet for use by regional hydrological agencies, businesses, and others to inform their own work and decisions. One important variable that has to be mapped and used to forecast springtime flooding is called 'snow water equivalent', or SWE, which gauges the volume of liquid water that would result from melting a given area of snow cover. This can be checked manually on the ground at various points using automated 'snow pillows' and other devices, but it can also be checked from above. NOAA pilots run low altitude flight-lines over snow with instruments that estimate SWE by measuring the degree to which the natural radioactivity of the ground beneath is dampened, or attenuated. **Week 10 (homework 9: due 4/01) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
	4/01/2019	The Water Planet: Managing Earth's Most Precious Resource https://youtu.be/hPRhstZ-Xas **Watch:** Is the world's fresh water supply running out? https://youtu.be/iVcTQdOJMMw **Watch:** For 15 Years, GRACE Tracked Freshwater Movements Around the World https://youtu.be/MaxBOvQ2a_o **Access via CANVAS (Files):** (Massoud) projecting groundwater storage changes in the Central Valley (Solander) GRACE satellite observations of water in the US (Hoekstra) humanity's unsustainable environmental footprint (Vorosmarty) global threats to human water security and river biodiversity **Homework 9:** What does Lauren Herzer Risi say in the "Water Planet: Managing Earth's Most Precious Resource" video about water planning recommendations issued as part of the recent federal climate assessment? What are some of her other points and recommendations? What important source of fresh water worldwide do we know the least about? What is happening to these sources worldwide and in California? How do GRACE and other innovative remote sensing technologies help? Why does Hoekstra stress the importance of determining humanity's environmental footprint across the entire supply chain in terms of resources like water, by both producers and consumers of goods? Do you think that "major transformations to the world economy" are required in order to establish sustainable practices in the use of resources like fresh water? Why or why not? If you are interested in this sort of thing, I've produced a few ambient films involving China's freshwater resources, e.g.: The Three Gorges Dam https://youtu.be/pPKV_GTI4gk The Three Gorges https://youtu.be/yQ7lrqE_bKU Little Three Gorges of the Daning River https://youtu.be/ZY9Ug2CXFwo
11		Topic: **Food and agriculture** **Watch:** The Future of Agriculture https://youtu.be/uAM4Si_WhDk **Watch:** How to feed the world in 2050: actions in a changing climate https://youtu.be/gjtIl5B1zXI **Watch:** The Future of Farming & Agriculture https://youtu.be/Qmla9NLFBvU **Access via CANVAS (Files):** (UNEP) Agriculture- investing in natural capital (CCAFS) Final Report from the Commission on Sustainable Agriculture and Climate Change (Mooney) confronting the human dilemma **Week 11 (homework 10: due 4/08) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
	4/08/2019	The UNEP film "The Future of Agriculture" briefly describes a rather optimistic 'globalist' vision of the future. I've included here a more detailed UNEP report makes the case for "greening agriculture". The second video, from the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), provides a more sanguine and far more detailed analysis of the path ahead. I've included here their report from 2012. Rounding out the topic for this week is a brief article by Mooney that connects agriculture to ecosystem services. Pay particular attention to a box within the article describes the choice between crop intensification on less acreage, versus "expanding cultivated area in lower-yielding systems using farming practices that preserve environmental services at the field and local levels." **Homework 10:** The Haber process (for the production of nitrogen fertilizer) and the green revolution are the reason agricultural production has not constrained global population growth – yet. There seems to be a diversity of opinions regarding the ease with which we can achieve ever greater yields and nutrition through, for example, genetic manipulation and crop intensification. Given the demographic trends that we studied earlier in the semester, what do you think of Mooney's analysis? Judging from this week's material, do you think it will be necessary to continue to 'intensify' agriculture artificially by chemical and industrial means in order to continue to feed the world? Would a move toward more 'organic' and sustainable agricultural practices necessarily involve shortages, higher prices, or an expansion of farmland? Do you think it might be useful to distinguish food (and fuel) production from nutrition?
12	**4/15/2019**	Topic: **Food and agriculture** **Watch:** Agriculture, Population Growth, and the Challenge of Climate Change https://youtu.be/gWORvA_p9i0 **Access via CANVAS (Files):** (CGIAR) Climate, agriculture and food security - a strategy for change (UN) Food and agriculture- the future of sustainability (Howden) adapting agriculture to climate change (Giles) how to survive in a warming world **Homework 11:** The video is a 1 hour 20 minute lecture by Lincoln Taiz at UC Santa Cruz. I want you to watch the whole thing. After watching the video and looking through the readings, try to summarize what they have to say about the nexus of population growth climate change, and agriculture. Describe those points you find most interesting or important. There is too much for me to formulate specific questions, so I'm giving you free reign. Demonstrate to me at least that you have watched the lecture.
13		Topic: **Rural China** **Watch:** Down to the Countryside: a fifty year reunion https://youtu.be/d1nywzYowiI **Just for fun:** A Wild Ride through the Countryside https://youtu.be/kNk0BJwheh4 Let's take a break this week from all that heavy thinking. I'd like to describe for you how global change is reflected in one little corner of rural Jilin Province, China. In 1968, members of my wife's junior high school graduating class were asked to go 'down to the countryside' as part of the Chinese Cultural Revolution. This film documents part of that group's fifty year reunion. There isn't much documentation of their original experience in English, but I'll outline it here. The countryside around Dehui, China (midway between Changchun and Harbin) is largely agricultural. Winters can be brutal (it happens to be 9 degrees F there at the moment). Different members of this group of young teenagers stayed for different periods of time, depending on their personal situation. My wife's father, an army college professor of

Week	Due Date	Topics, Viewings, Readings, Assignments
		veterinary diseases, had been made a political prisoner and was relegated to a hog farm, so she stayed the longest, for 3 ½ years. When our students arrived in 1968, members of that small village community helped them to build their own home. As you can see from the video, houses in that area follow the same general plan. The front door is often in the center, and you can either go straight in to the kitchen, or off to either side. The kitchen is generally in the middle because it is the source of heat. The student group's home had two bedrooms: one for the boys and one for the girls, on either side of the kitchen. In all of these houses, exhaust from the stove is channeled through sealed stone beneath the bed platform, or 'kang', in both rooms before being vented. This is a very efficient system, and it's safe, since the exhaust is vented completely after giving up most of its heat to the kangs, which slowly release it over the course of the night. These houses haven't changed much since 1968. They still don't have air conditioning, but summer temperatures in Jilin Province are seldom extreme, and Dehui is surrounded by the cooling effect of vegetation and a nearby river. Roofs in 1968 were made of thatch, which insulated homes from both heat and cold, but which had to be replaced periodically. Thatch is no longer used for roofing homes. There was limited access to electricity in 1968 now everyone is on the grid. The outhouse was always out back, and it still is, but like everything else it reflects the villagers' relative prosperity now as compared with fifty years ago. Participation in agriculture (along with keeping them clear of the troubles occurring in the cities) was of course the purpose of our students' stay in 1968. The main source of transportation and non-human labor at the time was horses. Horses to pull wagons and horses to pull plows. Crops were picked entirely by hand. At the time, these included corn and soybeans, which were sent off to the cities. They were not allowed to eat the soybeans, which are particularly difficult to pick by hand, since they grows low to the ground and their leaves are abrasive. All the corn was and continues to be utilized, including the stalks and husks. Nevertheless, corn was a treat for our students. They often had to eat sorghum, or 'kaoliang'. As you can see in the film, sorghum is a very tough grain that can be difficult to digest. Sorghum is no longer being grown deliberately, but it continues to grow wild by the side of the road. So does non-psychoactive hemp, which was once grown for fiber. Each household, including that of our students, tried to produce vegetables, meat (generally poultry) and eggs for themselves. You can see from the film that many households still do. Our host was one of the villagers who originally helped the students get settled and accustomed to farm life in 1968. He still lives in the same house with his family. They call him 'second brother'; he is the gentleman wearing the white shirt in the video. As you can see from his home garden, he remains a real farmer, and he appears to be in excellent health well into his 70s. At this time, all of the fields are devoted to corn, which the villagers sow and harvest by machine. Corn is grown because it provides the highest yield; China now imports most of its soybeans from Brazil and the US. At the time we were there, the corn was about to be harvested, and you could see that it covered nearly all of the available land. Groves of trees are maintained, fortunately, and the soil in that part of China is quite fertile, but it is probably becoming depleted under these conditions. Wintertime meant different kinds of work in 1968. Since the watery bogs and depressions were firmer and could then be worked, our students had to haul out composted organic material to spread on the fields. The roads were not plowed, and they had to clear their own snow. They had to gather fuel to supplement their share of coal. That was winter, but any number of tasks had to be done, throughout the year. Many of those activities no longer occur, or they are tackled with machinery. In 1968, goods were hard to come by; there were no stores, only a government depot for basic necessities some distance away; you'd have to hitch a ride there on a wagon from a friendly villager. Even today, the village remains relatively isolated even from the nearest stores in Dehui City, but as you can see from the video, a few merchants now travel up and down the road peddling various things.
	4/22/2019	**Homework 12:** Pick any rural agricultural location somewhere on Earth (even maybe Santa Clara Valley) and describe how life there has changed in the past fifty years. Do your own research. Internet sources of info and photos are fine, but please provide attribution.

Week	Due Date	Topics, Viewings, Readings, Assignments
14		Topic: **Health and disease** **Watch:** How we conquered the deadly smallpox virus https://youtu.be/yqUFy-t4MlQ **Watch:** Epidemics, Outbreaks and Pandemics https://youtu.be/CUl87kYHT3I **Watch:** How Pandemics Spread https://youtu.be/UG8YbNbdaco I hope you find the last video, How Pandemics Spread, as compelling as I do. If you were to compare epidemics and pandemics through much of human history, when regional and global travel was conducted largely on foot, by wagon, or by boat, with those of today, when mobility is rapid and distances are irrelevant, it would seem that such diseases could spread more rapidly and extensively, within much larger populations, today than in days past. However, as the video indicates, we have some advantages afforded by science and technology. The video does not elaborate, but I want you to try to do that here. During the SARS scare, travelers were getting checked for fever at airports and even at the doors of embassies. These were mostly handheld screening devices that were brought into close proximity to the skin. Not entirely reliable, but at least partially effective. Unfortunately, my wife and son were on a plane where someone several rows away later became ill after disembarking. The passengers from that section of the plane were called two days into their trip and quarantined in a hotel for two weeks. Needless to say, it ruined the trip, and it apparently turned out to be a false alarm anyway. So we in the modern world seem to have the ability to shut down flights, quarantine passengers, monitor skin temperatures, and just generally have staff keep an eye on things, but such steps alone do not engender much confidence. Maybe we've just been lucky so far (or at least since 1918).
	4/29/2019	**Homework 13:** What is the difference between an epidemic and a pandemic? Is there a clear difference? A disease that spreads throughout several nations in one region of the world but no further would seem to be more than an epidemic, but is it a pandemic? Given what we've covered so far, are the mechanisms that are being used to shut down disease outbreaks before they become epidemics or pandemics sufficient? Will they be sufficient in the future? Do you think that tighter methods of surveillance (like examining saliva, or routine multiple temperature scans) could or should be used routinely to reduce the risk of transmission? Is there a significant connection with migration? With economic globalization?
15		Topic: **Mineral resources** Unfortunately, we don't have time this semester to cover energy resources as they should be covered. Energy alone would require an entire semester. I suggest you find a course ad study on your own. A great many career opportunities are sure to open up related to electrical energy and liquid fuels, particularly if transportation continues to evolve at a rapid pace. Nor can we cover the entire spectrum of mineral resources upon which we depend, and in the pursuit of which a great many other ecosystem services have been compromised, around the world. Think back on the mindset that brought up the "10 biggest nuclear tests". If it weren't for the fallout, these sorts of devices would have torn up far more by now than they have, in the pursuit of minerals. Long-term, we might be mining asteroids, but for now, we should probably learn to make due with less, no? This week, we will concentrate on a facet of mineral resources that is about to emerge in a startling way (although mainstream journalists will probably continue to ignore it in favor of providing us with a steady stream of politics and pop culture). As professionals, however, it is our responsibility at least to make ourselves aware of these developments. **Week 15 (homework 14: due 5/06) continues on next page.**

Week	Due Date	Topics, Viewings, Readings, Assignments
	5/06/2019	**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 Countries bordering oceans 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 bring minerals up from deep beneath the crust. Hotspots in the deep ocean, resulting in islands and seamounts like the Hawaiian chain, have abundant minerals in their seas. Unknown forms of life, that we have barely begun to understand, exist in these places as well. (As an aside, if you assume that the preservation of such species is an entirely non-human concern, think about pharmaceuticals, and where most of them originate). I grew up in and around the Atlantic and continue to be in love with the ocean. As a kid, I have memories of coming home after a day at the beach and watching "The Undersea World of Jacque Cousteau" or "Flipper". So be gentle. **Homework 14:** After watching these videos, what (if anything) should be done to regulate the exploitation of the seabed for minerals? Use Wikipedia (at least) and tell me about the history and possible significance of so-called exclusive economic zones (EEZs)? What are their significance in this context? Should individual nations have such rights?
16	**5/13/2019**	Topic: **Land use** **Watch:** Eric Lambin: Land Use and Land Cover Change https://youtu.be/EuH_F_bGCAM **Access via CANVAS (Files):** (Lambin) global land use change, globalization, and land scarcity (Foley) global consequences of land use **Homework 15:** In the paper, Lambin claims that "Globalization can be harnessed to increase land use efficiency rather than leading to uncontrolled land use expansion". How does he propose this occur? Foley details differences between natural ecosystems, intensive cropland, and cropland with restored ecosystem services. Discuss these categories in terms of agricultural yield, economic globalization, other land uses, sustainability, and anything else that occurs to you.
	5/20/2019	Topic: **Final Evaluation** Choose one of the topics we've covered and expand your discussion into a well-written term paper that will serve as your final evaluation. Provide at least four citations, including at least one that you have found yourself. I suggest that you choose a topic most closely aligned with your career plans, or something about which you are interested in educating yourself further. Do NOT phone this in. The resulting paper should be at least four pages long, easily more. No upper limit.