Lesson Plan Background

Materials included here: lecture notes corresponding to powerpoint presentations, descriptions of 2 student-led activities, and a bibliography. Materials are designed to cover 4 class meetings of 75 minutes each. I have reassessed the time management of these materials based on the feedback of my advising committee and my experience presenting the lecture portions of this project to my current freshman course (fall 2014), described below.

For this lesson planning portion of my project, I took a much broader overview approach than in the project report due to the nature of the target audience. These materials are intended for a freshman-level, themed "First Year Seminar" course that is an option under General Education requirements at Appalachian State University.

The following is verbiage by the First Year Seminar program that we include in syllabi as a brief overview of the underlying purpose of these courses:

> **What is First Year Seminar?**
> First Year Seminar (UCO 1200) introduces first year and transfer students to the rigorous academic study at the University level through interdisciplinary engagement with a variety of disciplines and perspectives. It serves as the foundation of the university's General Education program. First Year Seminar students and faculty engage in a shared process of inquiry around a broad, interdisciplinary topic or question.

I have been teaching a course (Food Politics and Preservation) with this program for the past three semesters and successfully proposed a second course (Navigating the Food System) in the Spring. I may teach this course in a future semester if my schedule allows. The teaching materials developed for this project are intended to correspond with the goals and topic theme of this course:

Navigating the Food System, First Year Seminar (UCO 1200 ___)**, Course Description:**
In this course we will investigate some of the environmental, social, and economic impacts of our food system. From obesity to biodiversity, the outcomes of how we organize food production can have global ramifications over both the short and long terms. We will use the tools of various academic disciplines to examine our food infrastructure from the perspectives of producer, policy maker, and consumer. The ultimate goal of these inquiries is to enhance critical thinking skills, effective communication, and our understanding of community membership. The course will incorporate multiple modes of inquiry such as analytical reading, lectures, research, and in-class activities including visits to local food businesses.

Lesson Plan Outline

Class meeting 1 (75 minutes): Lecture 1, "Climate Change and Agriculture Introduction," including 5 minute CSPAN clip with 15 minute discussion of prompt questions (see lecture notes below).

Class meeting 2 (75 minutes): Class to meet in computer classroom to work on Activity 1 "Impacts of sea-level rise." Student groups will provide brief presentations in class on their work for the day.

Class meeting 3 (75 minutes): Food security lecture and work on Activity 2, "Adaptation Strategies." A written description of the students' work on this activity will be due as an assignment. Any work not completed by the end of the class period is to be done on the students' own time.

Class meeting 4 (75 minutes): Lecture 3, “Climate Change and Food Safety.” The longest of the three lectures, I anticipate presenting material to take the entire class time. Any additional time left in this class period will be used to review the climate change module overall and field student questions.

Lecture Notes 1: Climate Change and Agriculture Introduction

1. [Project Cover Slide]

2. [Climate Change and Agriculture Introduction]

3. Title page:
   - Today’s goal is to look at some of what is known about climate change and how that interacts with agriculture.

4. CSPAN 5 minute clip: 1:16 – 1:21 Lee Thomas, EPA Administrator for Reagan[includes link: http://www.c-span.org/video/?320038-1/addressing-climate-change]
   - Let’s start out with a brief overview of the issue from as neutral a source as we could ask for
   - Lee Thomas joined 3 other former EPA Administrators [named on slide] to testify in favor of governmental action to mitigate climate change.
   - Mr. Thomas fits a lot of information into this 5-minute clip. [For students:] In your notes, reflect on what he states about the following: [Discussion to follow video]
     - Why does he emphasize the “risk assessment” and “risk management” methodology?
     - What does he note as a major cause of climate change?
     - What environmental changes are occurring as a result of climate change?
     - The US is not the top global producer of CO2 emissions. Why does Lee Thomas emphasize the role of the US EPA in mitigating climate change?

5. Global temperature rise estimate graph:
   - This graph is adapted from the data published by the Intergovernmental Panel on Climate Change in its 2014 report.
   - The red line marks expected median global temperature rise through the 21st Century (in Celsius; multiply by 1.8 for Fahrenheit), while the grey bars illustrate the amount of decrease or increase in carbon dioxide emissions over the next 40 years.
   - If global emissions are static at current levels (no mitigation and no acceleration), the authors estimate a 2.65°C increase (4.77°F) by the end of the century. [following slide shows citation of original data]
   - From the Bulletin of the American Meteorological Society (2014): 15.3% of the earth’s surface experienced a 1st, 2nd, or 3rd warmest year on record, while no area experienced a 1st, 2nd, or 3rd coldest year in 2012

6. [Citation for IPCC data in previous graph]

7. Quick notes on emissions:
    - IPCC asserts that greenhouse gas (GHG) emissions are driving these changes
    - The level of anthropogenic GHG emissions from 2000 -2010 was the highest in human history, AND grew at a higher rate than in the three previous decades.
    - CO_2 emissions doubled during that time, accounting for 76% of total GHG emissions

8. How agriculture contributes:
    - 2010 data (IPCC): 35% of GHG emissions were released by the energy supply sector, 24% by Agriculture, Forestry and Other Land-Use (AFOLU), 21% in industry, 14% in transport, and 6.4% in buildings.
    - Cattle for meat is by far the least efficient food to grow, responsible for 600 times more emissions per kilogram produced than chicken, eggs, grains, or even milk
    - This includes CO_2 emissions from energy needs in production and methane released from animals and manure.

9. Effects on agriculture:
    - In addition to temperature change, extreme weather events are anticipated to increase in both frequency and severity in the future (think of the destructive power of floods, droughts, and hail on a field of crops).
    - Sea level rise has also begun to cause saltwater contamination in freshwater areas, which can decrease the area of land available for agricultural use. Caused by warming, thereby expanding, sea water and ice melt from land
    - According to NOAA, "global sea level has been steadily rising since 1900 at a rate of at least 0.04 to 0.1 inches per year."
    - Sea water warming and acidification affect biodiversity in the ocean including species important to the fishing industry
    - This will affect both food security (availability of food for a population) and food safety. We will look at both of these more in depth in upcoming class meetings.

10. Ocean acidification:
    - Oceans are also acidifying as a result of increased absorption of CO_2 into the water. This chemical reaction not only increases the abundance of hydrogen ions (thereby reducing pH), but also causes carbonate ions, which are used by corals and shelled sea-life to maintain their calcium carbonate structures, to be less abundant (NOAA, 2014).
    - Mathis et al., 2014: Case study risk assessment for Alaska's fishery sector. Author highlights from the study:

      "- The intensity, extent and duration of ocean acidification in the coastal areas around Alaska will increase.

      - Important commercial and subsistence fisheries in Alaska are co-located where enhanced ocean acidification will occur.

- Coastal human communities in southeast and southwest Alaska are highly reliant on fishery harvests.

- Coastal human communities in southeast and southwest Alaska face the highest risk from ocean acidification."

Activity Description 1: Impacts of Sea-Level Rise

Class will meet in a computer lab classroom for this activity.

Instructions for students:

Working in pairs, you will be given one of three maps developed by the University of Arizona department of Geology mapping anticipated impacts of sea level rise based on shoreline elevations. (If you want to go to the site yourself http://climategem.geo.arizona.edu/slr/world/index.html and create a map that is fine as well).

Using google maps, google earth, or a related system, pinpoint two specific cities or region within your map that are shown as being potentially directly impacted by sea level rise (the areas shown in red).

Search for information on your two areas and compare them in terms of:

- Population and demographics (how many people might be displaced?)
- Available resources (any information you can find out about the relevant government, economic status, or natural resources of the area).
- Which area will have a more difficult job in preparing for sea level rise? Why?
- What is one thing individuals or organizations in each area might do to prepare/adapt?

"ArcGIS Viewer for Flex." 2014. Accessed August 5. http://climategem.geo.arizona.edu/slr/world/index.html. Based on: Weiss JL, Overpeck JT, Strauss B (2011) Implications of recent sea level rise science for low-elevation areas in coastal cities of the conterminous U.S.A. Climatic Change DOI: 10.1007/s10584-011-0024-x. Esri provided basemaps.

http://www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/mapping_slr/

Lecture Notes 2: Food Security

11. [Day 2: Food Security]
12. [Title Slide]

13. Definition:
    - The USDA describes food security as "access by all people at all times to enough food for an active, healthy life."

- Food security is a separate issue from food safety and food biosecurity (safety of the food system from biological attacks)
- While this map from the World Bank shows that food insecurity to the point of child malnutrition is very rare in the United States, 14.5% of households are considered food insecure each year, including 17% of households in North Carolina (USDA 2013).
- By 2008, over 1 billion people worldwide were considered undernourished by the United Nations (UN Task Force Report, 2013).

14. What factors affect food security?
    - Things to think about in regards to food security: natural resources, population density, climate, global food price volatility, and socioeconomic barriers
    - Sparked by the global economic crisis, population growth, and an increased frequency of droughts and floods, staple food prices around the world rose by 30% within a few months in 2008 (UN Task Force Report, 2013).
    - Since that time, the UN created the The High-Level Task Force on Global Food Security, tasked with the following objectives:

i) Coordinated support for in-country action to improve food and nutrition security;
ii) Advocating for funds needed for urgent action and long-term investment;
iii) Inspiring a broad engagement by multiple stakeholders;
iv) Improving accountability of the international system as it makes commitments for food and nutrition security, and examining progress towards the realization of the CFA outcomes.

15. CO_2
    - In the EPA hearing from which we watched a clip last class, one of the objecting senators quips that CO_2 is not a poison but is "plant food," implying that increasing emissions may be good for agriculture. Some major crops could increase yield by 10% - 30% by in-taking twice as much CO_2 as currently available. However, increasing temperature, water availability, nutrition, and extreme weather events will mitigate the potential benefit, (EPA 2013).
    - In addition, weed plants will receive this same benefit, (EPA 2013).
    - Valerio et al., 2013 found that both weed species studied showed increased competition with the crop (tomato) even though species chosen were of two different photosynthetic pathway types (C_3 and C_4) and theoretically should have reacted differently
    - Ziska, 2012 found that relative loses of soybean crop due to weed competition did not change with increasing levels of CO_2, and that in the absence of weeds soybean yield increased with higher level of CO_2

16. Heat and droughts:
    - Drought and heat waves threaten livestock populations both directly and through the availability of pasture or feed
    - Droughts (as well as seawater intake) can also reduce the amount of water available for irrigation
    - Trade-offs: the number of "frost-free days" per year across the US is anticipated to increase. This could expand the range for growing certain crops, but also contribute to a drying effect in

the West, further stressing water resources. In addition, an increase in the number and intensity of warm nights can stress crops and livestock

- In the midst of a long-term heating, drying trend, the heavy rain events have increased over the past 30 years, contributing to soil erosion and flooding

17. Overwintering of pests and vectors for crop disease (expanded range)
    - Ziska (2014) studied soybean yield from 1999 – 2013 across 7 states with a 23.5°C (42.3°F) range in minimum daily temperature, and found:
        - "Although soybean yields (per hectare) did not vary by state, total pesticide applications (kg of active ingredient, ai, per hectare) increased from 4.3 to 6.5 over this temperature range. Significant correlations were observed between minimum daily temperatures and kg of ai for all pesticide classes. This suggested that minimum daily temperature could serve as a proxy for pesticide application. Longer term temperature data (1977–2013) indicated greater relative increases in minimum daily temperatures for northern relative to southern states. Using these longer-term trends to determine short-term projections of pesticide use (to 2023) showed a greater comparative increase in herbicide use for soybean in northern; but a greater increase in insecticide and fungicide use for southern states in a warmer climate. Overall, these data suggest that increases in pesticide application rates may be a means to maintain soybean production in response to rising minimum daily temperatures and potential increases in pest pressures."
    - Svobodová et al., 2014:
        - mapped climate suitability across Europe for 7 pest species from 4 families given expected changes in temperature and humidity
        - "Based on the ensemble-scenario mean for 2055, a **climate-driven northward shift of between 3° N (O. nubilalis) and 11° N (L. botrana) is expected**. The areas that are most sensitive to experiencing a significant increase in climate suitability for future pest persistence were identified. These areas include Central Europe, the higher altitudes of the Alps and Carpathians and areas above 55° N"
    - Insects are common crop pests, but also common carriers of crop—as well as animal and human—diseases. The increasing range of vector-borne diseases is a current public health problem as well as agricultural risk (we'll discuss that a bit more tomorrow).

18. Svobodová et al., 2014 mapped results:
    - Explanation of graphic: "Changes in climate suitability for selected pests according to low (left) and high (right) climate scenarios. Grey areas are areas where the species is present under current climate conditions and climate suitability is expected to be maintained or to increase slightly without generation growth. **Red areas indicate an increase in climate suitability, and blue areas indicate a decrease in climate suitability for pest development** in terms of an increase or decrease in generation number. The transparency of the colours expresses three levels of agreement between scenarios (agreement among scenarios 3, 4 or 5 in the increase/decrease predictions). CP—Cydia pomonella; LB—Lobesia botrana; ON—Ostrinia nubilalis; LD—Leptinotarsa decemlineata; OM—Oulema melanopus; RP—Ropalosiphum padi; SA—Sitobion avenae."

- Decreases shown in the southern regions of Europe are due to predicted lowering of humidity in that area.

19. Increasing vulnerability due to lack of biodiversity in modern agriculture:
    - link to FAO poster in the picture: [ftp://ftp.fao.org/docrep/fao/010/i0112e/i0112e00.pdf]
    - main points here are that agricultural biodiversity will be a key component of resilience and adaptability
    - [Have a student volunteer explain why biodiversity might be important in adapting agriculture to new climate conditions]
    - As a major land-use activity (accounting for 1/3 of all land in most countries) agriculture is as important to maintaining the Earth's biodiversity as biodiversity is important to maintaining agriculture in a changing climate.

Activity Description 2: Adaptation Strategies

Class will meet in a computer lab classroom for this activity.

Instructions for students:

Take the following link to the United Nation's Database on Local Coping Strategies under the Framework Convention on Climate Change: http://maindb.unfccc.int/public/adaptation/

Spend a few minutes browsing through the projects listed, and take notes on your three favorites (they don't have to be related).

[Once students have familiarized themselves with the database and their choices, they will be put into groups of three and presented with the following challenge:]

Chose a project from your collective group list that is not already directly related to agriculture, and adapt it to an agricultural setting, i.e. how could farmers, food distributors, retailers, or consumers participate in the coping strategy?

Alternatively your group can develop a novel strategy to counteract one of the hazards or impacts listed in the database.

Record the following about your project:

- Summarize the hazard or impact your project addresses and how it will work.
- Where (location) will this strategy be most useful?
- Is this based on a strategy in the database? (If so, which, and how are you adapting it?)
- What resources will be needed to carry out this strategy? Does the population in the target location have access to these resources?
- Will it be possible to measure the results of this strategy? If so, how? If not, how do you know it is working?

Lecture Notes 3: Climate Change and Food Safety

20. [Day 3: Food Safety]

21. [Title Slide]

22. Intro:
    - Last class we talked about food security - now we will cover food safety, which refers to ensuring that a food does not cause acute injury or illness in the eater.
    - Note that contaminated food is not the same as spoiled food. Many contaminants are truly undetectable by sight, smell, or food consistency. Spoiled foods may be contaminated, but physical damage of spoilage itself is not related to contamination by pathogens etc.

23. Food Contamination:
    - Contamination of food can occur at any point from the agricultural setting to retail or in the home.

24. Hazard categories
    - Biological hazards:
        - Bacterial, viral, parasitic (protozoa and worms)
    - Chemical
        - Naturally occurring or due to contamination
    - Physical
        - Basically objects or insects that could cause physical harm to eater. This one we won't focus on in regards to climate change.

25. Biological hazards:
    - Living (or kind-of living e.g. viruses), so the conditions of the food and reducing cross-contamination are best preventative measures
    - bacteria are the primary concern among microorganisms: can cause infection, intoxication, or both (toxin-mediated infection)
        - infection: ingestion of living organism that acts as a pathogen (*Salmonella, Listeria monocytogenes, Shigella*)
        - intoxication: microbe produces a toxin that is ingested (*Staphylococcus aureus, Clostridium botulinum, Bacillus cereus*)
        - toxin-mediated infection: ingestion of living organism that is pathogenic and produces a toxin within your body (*Clostridium perfringens, E. coli* 0157:H7)
    - Microbes require certain: pH, temperature (temp "danger zone" considered to be 40 – 140 F), oxygen, water, and food to grow and reproduce; requirement for viruses and parasites is: need a host, so food is a transmission medium for them
    - Parasites and viruses - best to reduce at source (ie contaminated water) and don't spread!
    - Pictured: *e. coli* bacterium, Norwalk virus capsid, giardia protozoa

26. Major bacterial concerns:
    - *Clostridium botulinum*: anaerobic, sporeforming rod bacteria that creates a neurotoxin – one of the "most potent substances known" can cause death among other symptoms ; found in soil, really not uncommon but combination of being aerobic and intolerant of low pH makes it mainly an issue in Low Acid Canned Foods (LACF). Its spore-forming capability makes it highly heat

resistant. Controlled by specific thermal processing procedure, pH < 4.6, aw < .95 and/or 5-10% salt concentration.

- *Listeria monocytogenes*: fairly ubiquitous microbe, causes serious illness (listerosis) especially in compromised individuals, newborns, pregnant women; flu-like symptoms in healthy people. Psychotrophic (can grow in fridge temps).
- *Salmonella:* found in most raw animal-based foods, causes salmonellosis (nausea, diarrhea, etc). Killed by pasteurization, illness usually caused by cross-contamination of raw product
- *Staphylococcus aureus*: can create heat-stable enterotoxin (prevention key!) found on hands and in nasal passages of humans. Growth in food typically due to temp abuse (abuse level: b/w 45 – 140 ^{o}F) causes nausea, diarrhea, etc

27. Major viral hazards: (viruses very small particles, cannot be seen w/ light microscope; do not reproduce in food but can be transmitted b/w hosts via food) viruses do not grow in foods, but will hang out there as a transportation method to get to you, where they can use your cells to reproduce
    - Hepatitis A – found sin raw shellfish from polluted water and feces of infected persons
    - Norwalk virus family,
    - Rotavirus

28. Parasitic protozoa and worms: tiny organisms that can be single celled (protozoa) or multi-celled and even disgustingly large (worms). Parasites depend on a host for nourishment.
    - *Giardia lamblia*, single-celled protozoa, causes giardiasis, fecal-oral route, associated typically with contaminated water
    - *Entamoeba histolytica*, single-celled protozoa fecal-oral route, associated typically with contaminated water or direct contact w/ dirty hands/objects
    - *Ascaris lumbricoides*, roundworm (nematode) – larvae migrate from your gut to lungs (yuk!!) then back down to gut – contaminated sewage used for fertilizer or direct contact from infected material to transmit.
    - *Trichinella spiralis*, small parasitic worm found in raw (i.e. undercooked) pork, causes disease Trichinosis – incidences in US have declined since feeding of pigs “uncooked garbage” was made illegal in 1980 and industry-led parasite prevention system put in place

29. Climate and Biological Hazards
- Concern: extreme weather events
    - Flooding and heavy rain can overwhelm water treatment systems and lead to contamination of crop fields and waterways
    - As discussed earlier, drying and heating of some regions paired with heavy rain events can lead not only to increased soil erosion, but also contamination of waterways by pathogens (or agricultural chemicals).
- Concern: changes in disease range
    - ex/ salmonellosis has been shown to increase in incidence at warmer temperatures, including a study showing 5 – 10% incidence increase for each one-degree (C) increase in weekly average temperature (Kovats et al 2004, cited in Tirado)
- Concern: vector-borne diseases:
    - Pathogens that are spread via blood-feeding arthropods (mosquitos, ticks, etc). These lifecycles can even include disease exchange from animals to humans (via the insect vector). Since these arthropod vectors are cold-blooded, populations are highly sensitive

to change in weather and climate. In addition, other factors such as viral replication within the vector species, for example dengue virus, have also been found to be effected by temperature (Gubler et al., 2001).
- Diseases of concern include malaria, yellow fever, dengue fever, West Nile Virus and other types of vector-borne viral encephalitis
- Interestingly, malaria was a common disease in the United States in the 19th C until it was basically eliminated by 1950: "The initial decline in malaria in the United States was attributed to a population shift from rural to urban areas, improved water management, improved housing and nutrition, better standards of living, and greater access to medical services. Vector control and improved case finding and treatment were important in eliminating malaria from the Continental United States by 1950." (Gubler et al., 2001). So, infrastructure and public health measures have significant roles to play in stemming disease spread in a new climate

30. Chemical hazards: can be naturally occurring or added, at certain level create toxic effect if ingested
    - Naturally occurring
        - Mycotoxins "secondary metabolites" of fungi (ex/ aflatoxins created by strains of Aspergillus) found mainly in corn and peanuts – unwanted mold growth is generally more of a food spoilage issue than safety issue, except for these mycotoxin-producing molds
        - Mushroom toxins - fruiting body of fungi, often toxic
        - Shellfish toxins – caused by planktonic algae that shellfish eat
    - Added chemicals
        - Agricultural: pesticide, fertilizers
        - Prohibited substances
        - Toxic elements (lead mercury arsenic) or compounds (zinc, cyanide) etc
        - Additives (over acceptable level)

31. Climate and chemical hazards
    - "Plant protection products" (wording from Boxall et al., 2009)
        - Pest and disease range and seasonal activity is anticipated to change (Boxall et al., 2009), which may lead to an increase in use of agricultural pesticides, herbicides, and fungicides. Drier water systems will also dilute contaminants less effectively.
        - Researchers predict pesticide exposure by humans will increase in terms of spray and transfer drift (aerial), drinking water, and from food. (Boxall et al., 2009)
    - Nutrient pollution
        - Increased agricultural runoff due to heavy rains leading to nutrient pollution – use of nutrient addition (fertilizer) is not anticipated to increase as is the case with plant protection products in response to climate change. However, runoff and concentration within waterways can increase the level of pollution caused by these applications (Boxall et al., 2009).
        - Nutrient pollution, in addition to factors such as sea temperature change, can also effect the abundance of toxic algae. [includes link to: http://www.bbc.com/news/world-us-canada-28644489] Note on Toledo – bloom has been connected to phosphorus runoff

from upriver agricultural land. This is not to say that climate change directly caused the toxic bloom, but to illustrate a potential side effect of nutrient pollution.

- Antibiotics: As weather conditions become warmer or more extreme, livestock will be increasingly stressed either outdoors or by being increasingly housed indoors. This could exacerbate widespread use of antibiotics in animal production. Although antibiotics are an important tool in animal and human health care, the overuse of antibiotics can select for antibiotic-resistant pathogens, which can be an issue in human disease as well as livestock disease (Cogliani et al., 2011; Oliver et al., 2011).

32. http://www.theonion.com/video/hungry-fda-official-orders-massive-pot-pie-recall,14223/

Lesson Plan Bibliography

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