Teaching Notes

1. **Title:** Do good seawalls make bad neighbors?

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3. **Abstract:**
This case is a dilemma or decision case focused on how coastal residents make decisions and balance trade-offs on whether to maintain or modify their shoreline, illustrating the value, vulnerability and challenges of managing coastal shoreline ecosystems. Our case begins by introducing students to the Caldwell family from Mobile Bay, Alabama and their dilemma of deciding among five options for dealing with erosion along their shoreline. The second section of our case provides small groups of students with a fact sheet on one of five criteria (i.e. Economic, Environmental, Hazards, Legal, Sociocultural) which the Caldwell's should consider when making their decision. This task asks students to rank each option for the specific criteria they've been assigned and provide a summary of how they made their decision during a brief discussion. Next, each group of students is assigned different criteria to consider, and the same activities are repeated. Finally, after all groups have rotated through all criteria, students are asked to use any approach they desire (i.e., quantitative or qualitative) to provide an overall ranking and ultimately form an argument for which shoreline option the Caldwell's should select. During the closing activity, an interactive discussion is used to consider the costs, benefits and trades-offs of the Caldwell's decision, as well as reinforce concepts of ecosystem management, ecosystem services and social-environmental synthesis.

4. **What course (s) is this case appropriate for?**
We expect that our case could be appropriate for a wide range of environmental courses, but would be particularly well suited for course such as:

Coastal Processes
Conservation Biology
Intro to Environmental Science / Studies
Environmental Ethics, Policy or Management
Sustainable Development

Students should have a general understanding of environmental science concepts pertaining to coastal ecosystems, human impacts, habitats, and how humans are dependent on ecosystem functions (i.e., for the ecosystem services they provide). For the intro to environmental sciences course, we anticipate this case study would used in the second half of the course as a capstone case study.

5. What level is the case appropriate for?

Advanced High School
Undergraduate

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Graduate

6. **SES Learning Goals**

This case study will address the following Socio-Environmental Synthesis learning goals:

1. Ability to describe a socio-environmental system, including the ecological and social components and their interactions
2. Ability to identify disciplines and approaches relevant to a socio-environmental problem
3. Ability to value different types of knowledge and knowledge sources
4. Ability to analyze (upper level course) and synthesize existing data
    a. Identify and understand different types of data used in the natural and social sciences
    b. Integrate different types of data (interdisciplinary integration)
    c. Assess quality and objectivity of information (peer-reviewed literature vs. technical reports vs. web info)

7. Learning Objectives:

1. Develop a greater understanding of environmental decisions, policy issues and the complexities involved
2. Gain knowledge of natural (e.g., habitat, ecosystem, ecosystem services, erosion) and social (e.g., values, beliefs, behaviors, cultural ecosystem services) science concepts
3. Grasp the concept that humans are central in ecosystems, or are part of a coupled social-ecological system where social factors affect ecosystem dynamics and vice versa
4. Ability to analyze and interpret social and natural science data at multiple scales, and understand how important issues of scale are for resolving environmental problems

8. Introduction/Background

Coastal habitats have been severely degraded by development and other human decisions. Along densely populated coasts, hardening shorelines with vertical walls is a pervasive cause of natural habitat loss and degradation. Vertical walls also disrupt land-water exchange and alter wave climates and depth profiles, potentially indirectly harming other natural habitats (Douglass and Pickel 1999, NRC 2007). Although the societal and ecological costs of degraded coastal habitats are becoming increasingly recognized (Barbier et al. 2011, Arkema et al. 2013, Barbier et al. 2013), coastal population size and development have continued to expand and the armoring of shorelines has continued to progress.

Our case focuses on how coastal residents make decisions and balance trade-offs on whether to maintain or modify their shoreline, illustrating the value, vulnerability and challenges of managing coastal shoreline ecosystems. Our case begins by introducing students to the Caldwell family from Mobile Bay, Alabama and their dilemma of deciding among five options for dealing with erosion along their shoreline. Our case forces students to consider the costs, benefits and trades-offs of the Caldwell's decision, while learning about fundamental concepts of ecosystem management, ecosystem services and social-environmental synthesis.

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9. Classroom Management

<u>*3 Hour - Full Module*</u>
0 to 10 min – *General class discussion*

- Introduce the case, have students read the intro, then introduce to them the five options the Caldwell’s much evaluate

10 to 25 min – *Breakout #1*

- Divide students into small groups of 4-6
- Task each group with reviewing the ‘Environmental Impact’ fact sheet and ranking the five shoreline options

25 to 35 min – *General class discussion*

- Review each group’s rankings on board and discuss briefly

35 to 50 min – *Breakout #2*

- Task each group with reviewing the ‘Economics’ fact sheet and ranking the five shoreline options

50 to 60 min – *General class discussion*

- Review each group’s rankings on board and discuss briefly

60 to 75 min – *Breakout #3*

- Task each group with reviewing the ‘Recreational and Sociocultural’ fact sheet ad ranking the five shoreline options

75 to 85 min – *General class discussion*

- Review each group’s rankings on board and discuss briefly

85 to 100 min – *Breakout #4*

- Task each group with reviewing the ‘Hazard’ fact sheet ad ranking the five shoreline options

100 to 110 min – *General class discussion*

- Review each group’s rankings on board and discuss briefly

110 to 125 min – *Breakout #5*

- Task each group with reviewing the ‘Hazard’ fact sheet ad ranking the five shoreline options

125 to 135 min – *General class discussion*

- Review each group’s rankings on board and discuss briefly

135 to 155 min – *Breakout into groups*

- Task each group with developing a ranking that integrates all three types of data

155 to 175 min – *General class discussion*

- Review each group’s rankings on board, discuss major points

175 to 180 min – *Individual assignment*

- Complete written assessment of case study

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<u>*2 Hour - Abbreviated Module*</u>

0 to 10 min – *General class discussion*

- Divide students into small groups of 4-6
- Introduce the case, have students read the intro, then introduce to them the 4 habitats briefly

10 to 25 min – *Breakout #1*

- Task each group with reviewing the 'Environmental Impact' fact sheet and ranking the five shoreline options

25 to 35 min – *General class discussion*

- Review each group's rankings on board and discuss briefly

35 to 50 min – *Breakout #2*

- Task each group with reviewing the 'Economics' fact sheet and ranking the five shoreline options

50 to 60 min – *General class discussion*

- Review each group's rankings on board and discuss briefly

60 to 75 min – *Breakout #3*

- Task each group with reviewing the 'Recreational and Sociocultural' fact sheet ad ranking the five shoreline options

75 to 85 min – *General class discussion*

- Review each group's rankings on board and discuss briefly

85 to 100 min – *Breakout into groups*

- Task each group with developing a ranking that integrates all three types of data

100 to 115 min – *General class discussion*

- Review each group's rankings on board, discuss major points

115 to 120 min – *Individual assignment*

- Complete written assessment of case study

<u>*Notes & Lessons Learned from First Implementation (HS Students)*</u>

The *Abbreviated Module* of this case was taught to high school students on August 20, 2013 in one 2-hr block session. Thus, they were provided each fact sheet one at a time, so that when they rated shoreline options based on Environmental Impact information, they had not seen the Economics or Recreational and Sociocultural fact sheets. Students were broken into groups of 4 and asked to rank shoreline stabilization options based on each type of data individually and then collectively. We included brief discussions after each type of data were reviewed to ask students how they developed ranking systems, which type of data they valued most/least, and then eventually to determine how they handled working with different types of data (quantitative/qualitative, economic/environmental/sociocultural). While the only assignments were to rank the shoreline options based one each type of data individually and then collectively, we included an assessment of the activity (see Section 13 below).

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Notes & Lessons Learned from Second Implementation (Undergraduate Environmental Science)
The *Abbreviated Module* of this case was taught to an undergraduate Environmental Science course at Northeastern University on November 1, 2013 in one 2-hr block session (~80 students). During this class, we conducted the course similarly to the first implementation, but we also utilized TOPHAT pedagogy-driven classroom technology. The TOPHAT technology allowed students to submit their rankings using an online website or by sending a text message from a mobile phone. While the TOPHAT technology allowed the class to see their cumulative rankings in real-time, we ultimately went back to also posting the rankings on the chalkboard to more clearly show the range of answers submitted by different groups. Overall, we felt like the technology was useful for recording and analyzing responses in the large course and the minor problems we encountered could be overcome with more experience with the software.

10. **Blocks of Analysis**

Estuaries: coupled social-ecological systems
The coastal regions of the world's oceans are among the most ecologically and economically valuable places on Earth because coastal marine ecosystems provide disproportionately high levels and a wide array of ecosystem services (MA 2005, Barbier et al. 2011). For instance, in temperate and subtropical estuaries, nearshore and shoreline habitats such as salt marshes, coral reefs, mangroves, seagrass meadows and oyster reefs collectively attenuate erosive wave energies, provide essential habitat, and support high levels of biodiversity, nutrient cycling, anthropogenic nitrogen removal, food production and recreation. Moreover, these habitats and the coastal fisheries they support have provided the foundation for coastal human societies for millennia (Beck et al. 2001, Jackson 2001). Unfortunately, concentrated human populations and resulting anthropogenic stressors in coastal regions have led to dramatic ecosystem degradation (Vitousek 1997, Halpern et al. 2008, Barbier et al. 2011). Achieving sustainability by restoring and maintaining the health of coastal ecosystems for present and future generations is now one of the top global environmental issues facing human societies (Dietz et al. 2003, MA 2005).

Shoreline stabilization
Shoreline habitats have been increasingly altered and developed as human populations continue migrating towards coastlines (Vitousek et al. 1997, Lotze et al. 2006), and traditional approaches to "protect" shorelines have introduced hardened structures such as seawalls, rocks, or bulkheads to dampen or reflect wave energy (NRC 2007, Douglass and Pickel 1999). Such structures may mitigate shoreline retreat and protect uplands, but the ecological damages that result from their presence can be especially damaging for coastal habitats (Pilkey and Wright 1988, Vitousek et al. 1997, Bilkovic and Roggero 2008). Coupled with projected rising sea levels, shoreline armoring could further harm submerged and emergent vegetation by preventing shoreward migration necessary to adapt to changing depth profiles (Duarte 2002, Feagin et al 2005). Although the societal and ecological costs of degraded coastal habitats are becoming increasingly recognized (Barbier et al. 2011, Arkema et al. 2013, Barbier et al. 2013), coastal population size and development have continued to expand and the armoring of shorelines has continued to progress.

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12. Answer Key

Our case study asks students to rank shoreline protection choices based on different types of socio-environmental data individually and then collectively using all of the datasets. For each of these activities, there is no right or wrong answer. We are more interested in seeing that the students develop their own qualitative and quantitative metrics to choose different options. Furthermore, there are several other lessons imbedded in the case study, from determining the quality of data sources to gaining a better understanding of how to integrate qualitative and quantitative data sources.

13. Assessment

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The following six questions were provided to our test case group on August 20th to assess learning and solicit feedback. Overall, our test case found the exercise to be highly interesting and useful.

1. Socio-environmental problems have been called ‘wicked’ because they are so complex. Why is it so difficult to resolve these issues?

2. You were exposed to data from several different disciplines. How did you rank shoreline options using all three datasets? Why is it relevant to assess different types of data when considering different environmental policy options?

3. We included information from a wide range of data sources in our fact sheets. Which types of information sources are most useful/which do you trust the most? Which are least useful?

4. Did you find this exercise useful?

5. What did you find to be the strengths of this exercise?

6. What were the weaknesses/what would you change?

Quantifying whether the case study meets its learning objectives:
Each of the first three questions will be graded as a 1 (met learning objective) or 0 (did not meet learning objective) based on the quality of the answer. Those that receive an overall score of 2 or 3 will be deemed to have met the majority of the learning objectives of this exercise. For those that score < 2, we will attempt to determine why they did not meet the majority of the learning objectives. We will also use questions 4-6 to determine if those that did not meet the learning objectives had different opinions of the activity than those that did meet the learning objectives.

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