

## CLIMATE-RESILIENT AGRICULTURAL CHOICES FOR SOUTHWEST BANGLADESH

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### **Abstract:**

Bangladesh is one of the most densely populated countries in the world (Streatfield and Karar, 2008). The majority of the population lives in rural areas, and they depend largely on agriculture and agricultural practice. Hence, in the country agriculture is a large and important sector in economy. It provides food to the people and at the same time is one of the major suppliers of local employments. However, in Bangladesh agriculture and agricultural production are usually under pressure due to the increasing demand of food for its huge population. Apart from that, in recent years, the country has exposed to differential impacts of climate change. Particularly, salinization of water and land, increasing phenomena with droughts and temperature variations, sea-level rise, increasing tropical cyclones – all have adverse impacts on agriculture and agriculture dependent communities. In this context of complex bio-physical and social environment, the country needs to adopt modern, climate-resilient agricultural practice, under the larger efforts of ecological modernization. Ecological modernization is a process of structural change in economy, politics and cultural institutions that can directly affect environmental outcomes. Therefore, ecologically modernized societies incorporate principles of environmentalism in the design of institutions to regulate human interactions with nature (Mol and Spaargaren, 2005).

However, it is very important how the countries in the Global South are realizing their efforts on ecological modernization. The concerns for Bangladesh might focus on the ultimate impact on food security and society, and how the local society responds to that.

This case study focuses on a local socio-environmental problem in the southwest Bangladesh to illustrate the coupled nature and interaction of socio-environmental systems. Students will develop their understanding on this localized socio-environmental problem by

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linking this local problem with issues to global environmental change. In this case, which combines the discussion and interrupted case techniques, students will be provided with an invented story about a farmer's family and real environmental, economic and social information about the problem. They will discuss in plenum and work in groups, taking different views in role plays. They will collect own data from provided and self-read up literature, collect arguments from different viewpoints and sketch a map to visualize the ecological and social interactions. At the end, the students should be able to synthesize the social and environmental information, which can help them further understanding of coupled human and natural system with a regional focus on a highly climate-sensitive region in Bangladesh.

**Topical areas:** Agriculture, Ecology, Climate Change, Socio-environmental Synthesis, Politics, Agroforestry, Water Management, Biodiversity, Adaptation Strategies,

**Education level:** Graduate level

**Type/method:** Discussion case and interrupted case

**Objectives:**

1. Understand and recognize the climate challenges and subsequent impacts on local agriculture.
2. Explore the impacts of agricultural intensification in society and environment
3. Recognize interactions between ecological and social factors in an environmental issue (agriculture practice in southwest Bangladesh).
4. Synthesize information from the natural and social sciences to understand the coupled human and natural systems with a focus on climate resilient agriculture strategies for southwest Bangladesh.

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

1. Ability to describe a socio-environmental system, including the environmental and social components and their interactions.
  - *Related activity:* Students diagram the social system that agriculture practice in southwest Bangladesh depends upon, climate challenges and factors driving population growth, and, in turn, discuss the linkages and interactions between these two systems: social systems and agriculture practice.
2. Ability to co-develop research questions and conceptual models in inter- or trans-disciplinary teams.
  - Value different ways of knowing and understand the value of different knowledge sources.
    - *Related activity:* Students examine the impacts on agriculture due to population pressure and/or climate challenges, and need to understand the entire phenomenon as a coupled human and natural system. Students discuss the difference between scientific knowledge and experiential or cultural knowledge, how they are valued, and the role they play in decision-making.
3. Ability to find, analyze, and synthesize existing social and environmental data.
  - Understand the different kinds of data and research methods used by relevant disciplines in the natural and social sciences.
    - *Related activity:* Students investigate provided literature and are asked to read up further literature via the internet from different disciplines/ different points of view (scientific, decision maker, NGO, farmers, etc.) to predict the current pressure on agricultural production. They will be also encouraged to consider the census data and the data from different international development agencies, such as FAO (Food and Agriculture Organization), World Bank etc.

4. Ability to consider the importance of scale and context in addressing socio-environmental problems.
  - Understand that ecological and social processes often vary across differing contexts, including space, time, and conditions (e.g. economic or political).
    - *Related activity*: Students examine the impacts of modern agriculture practice in the local context and the way of decision making. They investigate also the importance of indigenous agriculture practice as alternative practice facing climate change risks. Finally, the students will focus on how agriculture is embedded in the entire societal system and will come to decide about the problem.

### **Classroom Management Summary:**

**Total Estimated Time:** 12 hours; 3 hours/day

**Note:** As this case has not yet been tested, so our time estimates are guesses. These can substantially vary in the real situations.

PART 1: Understand and recognize the population and climate challenges in Southwest Bangladesh and their subsequent impacts on local agriculture

Total time estimate: 3 hours (60 min at home plus 120 minutes in classroom)

- Preparation before course/ homework: Students read some preliminary information sheet on Part 1 (see Students' Handout) (60 mins)
- Students listen some briefings from the instructors on the issues related to local population, culture, agricultural practice as well as climate challenges: a) *Story of Karim Gazi* (), b) Slide with Figure 1 (Potential Impacts of sea-level rise on Bangladesh, c) Slide with Figure 2 (Crop damage due to historical flood), d) some photographs of the region and visual problems/challenges (TBD)(30 mins)
- Students discuss the raised questions (see Students' Handout) in small groups (60 mins)
- Instructor-led discussion on Objective 1 (30 mins)

PART 2: Explore the impacts of agricultural modernization in society and environment.

Total time estimate: 3 hours (180 minutes)

- Students listen some briefings on the issue from the instructor (Background about use of fertilizers, impact on water, social tensions, see Students' Handout page 7, accompanied with slides/ photographs [need to be prepared by instructor]) (15 mins)
- Students discuss the issues in groups and try to develop their arguments on it. They develop a diagram. (120 mins)
- Representative from each group briefs their diagram to the class. The class will also have the opportunity to ask questions (30 mins)
- Instructor-led discussion of diagrams, (10 mins)

PART 3: Recognize the coupled relationship between local social and natural systems focusing on the issue of agricultural challenge in southwest Bangladesh.

Total time estimate: 3 hours (180 minutes)

- Students do some readings and discuss in small groups (60 mins)
- Instructor-led discussion on Objective 3 (60 mins)
  - Ask students: “What could be the possible interactions between ecological and social issues in the local context?”
- Students draw their understanding on the board and brief that to class (60 mins)
- Instructor summarizes main results and adds missing points (10 min).

PART 4: Synthesize information from the natural and social sciences.

Total time estimate: 3 hours (180 minutes)

- Instructor led discussion on the theoretical side of synthesizing information from the natural and social sciences (60 mins)
- Students led discussion on the practical/implication side of synthesizing information from the natural and social sciences (60 mins)
- Instructor led summary (60 mins)

**Background:**

*“Karim Gazi is looking up to the sky. There are heavy clouds and he can already feel the next monsoon rain arriving. The 52-year-old farmer in Southwest Bangladesh is worrying about how he and his son Ahmed, 13 years old, will be able to replant the rice seedlings in time. His biggest concerns are about feeding his family. Last year, he lost half of his yield due to heavy cyclones. His mother, living under the same roof, is constantly complaining about the storms which seem to touch the coast more often and heavier than in earlier times. He got relatively less lands from his father, who had to divide his land between 6 sons. For some other family issues, Karim also had to sell some parts of his land. With this limited land, he is already in trouble making enough food and support for his family. Recently, he faced new challenges. His lands became saltier, and he couldn’t get enough water for his irrigation from the well. Some people also told him a few days ago, the sea level will rise. Although his two younger kids go to school when not helping his wife Fatima, he himself never had the chance to learn how to read or write. Karim worries: If the rumors really turn out to be reality, - what is he supposed to do? Will he even have to sell all land of his ancestors and go to the big city to make a living?”*

**More background**

Bangladesh is a densely populated (2,600 per sq mile) and low-lying deltaic country (Streatfield and Karar, 2008). Even though now the country has a huge population, since its liberation as a sovereign country in 1971, the population rate has declined substantially from 2.9 percent in 1974 to 1.4 percent in 2006. The country demonstrated its progressive trajectories based on a number of development indicators, such as the Human Development Index, which has improved substantially in the recent years (BBS, 2007). However, the global environmental change, e.g. climate change, can jeopardize Bangladesh’s current social and economic progresses. Climate change has made the country one of the most vulnerable countries in the world (Rahman 2011). Due to climate change, the country is now extensively exposed to environmental threats as sea level rise, increasing frequency with floods, droughts, and cyclones, salinization in land and water, water logging etc. The prognosis says that 1 meter sea level rise can cost the landlessness of 14.8 million people and 40 million people will be internally

displaced forever due to the loss of 30,000 km<sup>2</sup> of land area in this land constrained country (Brown, 2011).

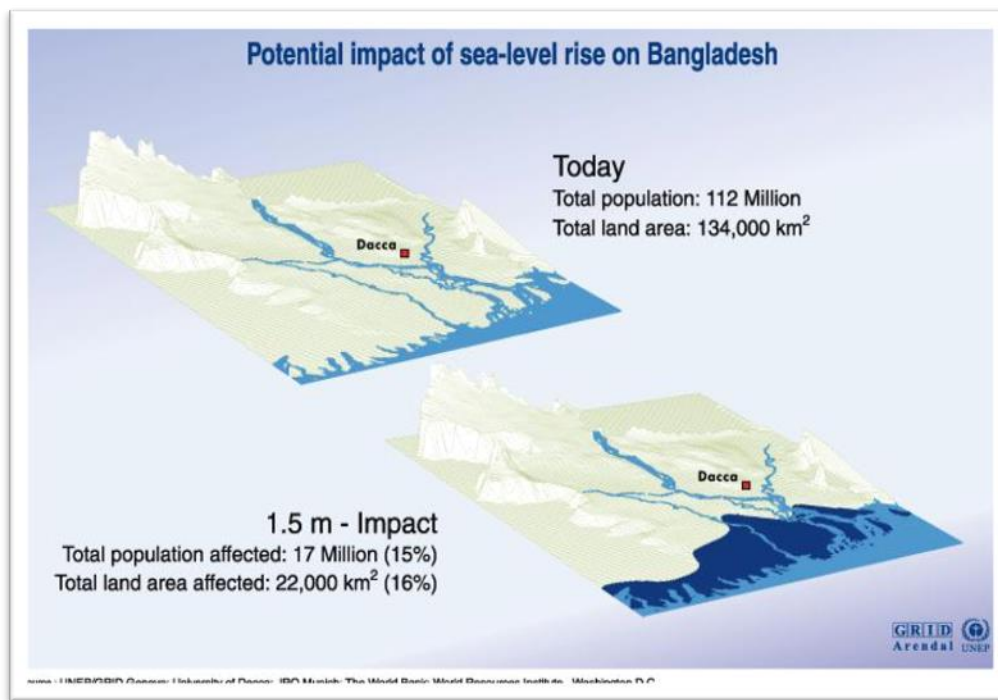


Figure 1: Potential impacts of sea-level rise on Bangladesh

Source: UNEP (2006)

In this situation, agriculture, which is one of the major economic bases of the majority of population, can be impacted severely, followed by damages to many other livelihood opportunities (Brown, 2011). In Bangladesh, rice production is predicted to fall by 8% and wheat production by 32% until 2050 (Ahmed, 2011).

For this case study, we will focus on the Southwestern region of the country. The region is the home of approximately 10 million people, housing 647 people per square kilometer (Bangladesh Bureau of Statistics, 2009). Often the regional poverty dynamics are shaped by the ecological conditions and requirements. The Sundarbans, world largest Mangrove forest, is one of the major suppliers of livelihood opportunities to majority of the coastal population, illustrating people's interactions with and dependencies on nature and natural resource as a whole (Pravda Bangladesh, 2009).

The climate impacts on agriculture will be enormous (Madhu and Jahid, 2010). Often Southwest Bangladesh is treated as the most disaster prone region in the country due to its exposure to extreme climate events in coastal areas, such as salinization, increased intensity and frequency of tropical cyclones, tidal surges, floods, repeated water logging etc. Overall, the country has extensive exposure to heavy monsoons almost every year. These monsoon rains or floods can affect agriculture considerably. Often it can delay the plantation of paddy, and subsequently with a significant loss of potential rice production. It is worth considering that the flood in 1998 caused the reduction of agriculture production by 45 percent, which is a huge food security challenge in this populous country (Fig. 2).

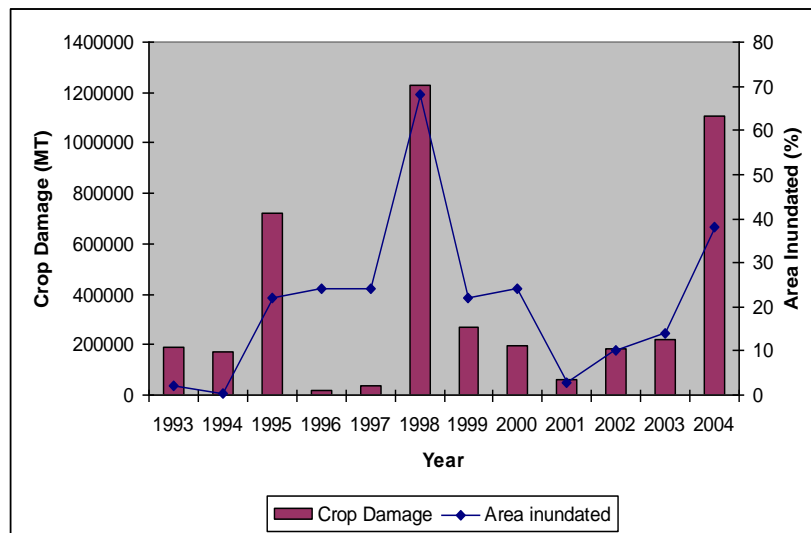


Figure 2: Crop damage (MT) due to historical flood

Source: Madhu and Jahid (2010)

Apart from floods, cyclones and storm surges can make substantial damage to region's agriculture. The Cyclone Sidr struck the region on 15 November 2007. The total cost of damages from this cyclone relating to crops was approximately 28.4 billion Bangladesh Taka (80 BDT = 1 US\$), and the total loss of production in all crops was 1.3 million metric tons (Madhu and Jahid, 2010).

Therefore if we just summarize the climate impacts on agricultural products in Bangladesh, such as seasonal crops, that could be as follows:



Table 1: The potential impact of Sea Level Rise and Flooding on Crop Yield in Bangladesh  
Source: Madhu and Jahid (2010)

Scenario	Crop Yields	Sea Level Rise	Flooding
Current Climate			In 1988, yields decreased to 45% because of flooding.
<b>2020</b>	Based on interpolation of published data to be consistent with climate change scenarios; rice yields have increases of up to 5%. With less optimistic assumptions about the CO <sub>2</sub> fertilization effect, generally have yield change -5% to +1%.	Based on interpolation, a 0.1 m SLR <sup>3</sup> would inundate 0.2 MMT <sup>4</sup> of production < 1% of current total.	Monsoonal floods increase yield loss.
<b>2050</b>	Based on interpolation of published data to be consistent with climate change scenarios; rice yields have increases of up to 10%. In Bangladesh: loss of 8%  With less optimistic assumptions about the CO <sub>2</sub> fertilization effect, generally yield changes from few percent increase to 10% decrease. Pests and crop disease could reduce yields further.	0.3 SLR inundate 0.5 MMT of production ~ 2% of current total.	Monsoonal floods increase yield loss.

The country is experiencing rapid decline of prime agricultural land, which is 1% per annum, and at the same time the population growth is 1.48% per annum (Ahmed, 2010). This tells a definite story, that in near future, the country might get a severe exposure with food shortage for its growing and largely poor population.

However, in this context the country is focusing more on climate resilient farming practice through some agricultural intensification as part of country's effort to achieve ecological modernization. Ecological modernization highlights a process of structural change in economic, political and cultural institutions that directly affect environmental outcomes. Therefore, ecologically modernized societies incorporate principles of environmentalism in the design of institutions to regulate human interactions with nature (Mol and Spaargaren, 2005). But this intensification or modernization efforts came with some ecological additions to and withdrawals

<sup>3</sup> SLR: Sea Level Rise

<sup>4</sup> MMT: Million Metric Tons

from nature, which is also the reasons for the loss of fertility of prime farm lands and additions of chemicals to the nature. Additionally, intensification practices can also cause social disorganization due to exposure of capital intensive or market oriented production systems, which often undermine local norms and practices of agriculture. Because society, livelihoods and agricultural practices are closely intertwined, the process of climate resilient farming/agricultural practice is a great example of a coupled human and natural system. Therefore, it is important to understand and integrate the importance of indigenous knowledge in this framework of climate change farming.

Briefly, as part of climate resilient farming, we can focus on the following aspects of agriculture and agricultural practice in the local context: (1) climate stress such as floods, droughts, salinity, heat, cold etc. tolerant crop varieties; (2) short duration of crops; (3) floating cultivation methods, which is a changing pattern of crop cultivation; (4) crop diversification and (5) alternative wetting and drying irrigation methods (Ahmed, 2010).

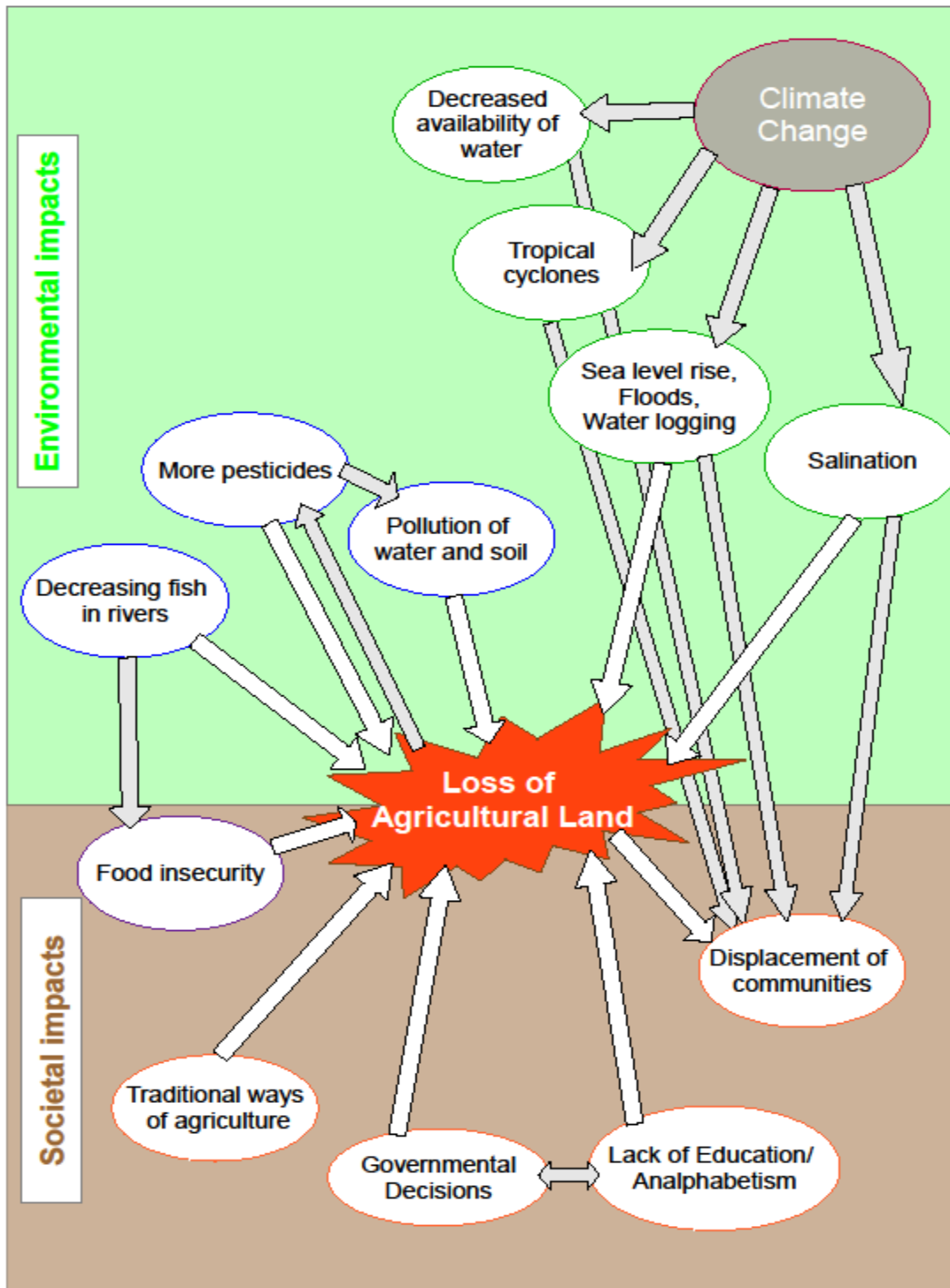


Figure 3: A selection of actual pressures on Agricultural land in S-W-Bangladesh. White arrows indicate direct pressures, grey arrows indicate indirect effects. E.g. climate change influences decreased availability of water via temperature stress.

## **Block of Analysis**

### **PART 1: Understand and recognize the climate challenges and subsequent impacts on local agriculture**

At this part student will get some briefings from the instructor. Bangladesh is a small, but densely-populated country. So there was always pressure for more agriculture production. But at recent times, climate change poses new challenges for the country. There is a rising trend with salinization in land and water, sea level rise etc. These have adverse impacts on available lands for agriculture practice. As a consequence, many people are changing their occupations and also migrating to the nearest big cities as part of their responses and adaptations to climate challenges. In this section, students will get expose by the instructors to the local social and environmental challenges, which can be contributive to their further understanding on coupled relationship of human and natural systems in times of climate change:

- (a) what could be the possible impacts of climate changes in the region?*
- (b) what could be the possible impacts of changing climate on local agriculture?*

These key points related to climate change and its impacts on the region and on agriculture will help the students to start thinking critically about the local context and challenges. This understanding and recognition of the issues can be the basis for student's critical thinking of socio-ecological synthesis of the issue. The estimated time for this block could be 180 minutes.

### **PART 2: Explore the impacts of agricultural modernization in society and environment**

Again, students will work in small groups to discuss the following questions, and then share their understanding and information with their colleagues and class. Total time estimate is 180 minutes.

In presence of population growth and climate change impacts the country adopted agriculture intensification; vertical expansion of agriculture productivity. But that added chemicals and fertilizers to the farm lands. This process added more production, but decreased

land fertility. There are also some social and economic implications of this agriculture modernization. Therefore, we would encourage the class to discuss the social, economic and environmental implications of agricultural production. The potential responses are highlighted in the section of answer key, at the back of this teaching note. However, for the students the following questions could be good starting points:

- (a) what are the overall impacts of modernization of agriculture?*
- (b) what are location based activities of modernization of agriculture?*
- (c) what are the social impacts of agriculture modernization?*
- (d) what are the economic impacts of agriculture modernization?*
- (e) what are the environmental impacts of agriculture modernization?*

**PART 3: Recognize the interactions between ecological and social factors in an environmental issue (agriculture practice in southwest Bangladesh).**

Like other parts, also at the Part 3 students will work in groups and try to recognize some of the major driving forces and relations between social and ecological issue, focusing on agriculture practice in Southwest Bangladesh. As mentioned already in part 2, the potential responses are highlighted in the section of answer key, which is at the back of this teaching note. The estimated time is approximately 180 minutes. However, the students are expected to discuss the following questions:

- (a) What are the coupled relationships between social and natural systems regarding agriculture practice in Bangladesh?*
- (b) Why do you think local agriculture challenge due to climate change could be an example of social and environmental interaction?*
- (c) What could be the forms of possible interactions between ecological and social factors in the local context? Group work: - Effects of water logging to the situation of women - agriculture adaptation strategies facing floods.*

#### **PART 4: Synthesize information from the natural and social sciences**

At this stage students will synthesize the social and ecological information, gained in part 1-3, to have a clear understanding of coupled human and natural systems. The estimate time for this exercise is approximately 180 minutes. The students will be encouraged to address the following questions:

- (a) How can you synthesize the information?*
- (b) What could be the possible challenges of synthesizing the information?*
- (c) Which information they can derive after synthesizing their available information?*
- (d) What further achievements do you get by synthesizing the data? Why is the synthesis more than just a sum of its different parts?*
- (d) What are the broader implications of synthesizing this location-based case study towards the better understanding of global environmental change dynamics?*

At the end, instructor will lead a summary and clarify the concepts and solutions if necessary.

## References:

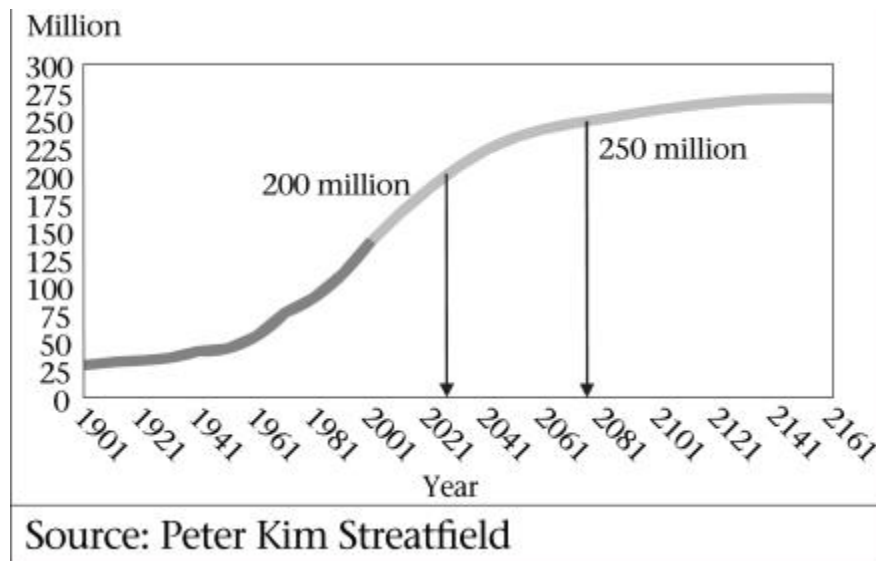
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- Links for Students' use:  
<http://practicalaction.org/reducing-vulnerability-bangladesh>

**Answer Keys:**

**PART 1: Understand and recognize the population and climate challenges and their subsequent impacts on challenges from population growth of local agriculture challenge**

*(a) what is the population growth scenario in Bangladesh?*

A:



*(b) what are the impacts of population growth on agriculture in Bangladesh?*

A: Less available space for farm activities; e.g. land use change.

*(c) what are the scenarios of climate change in Bangladesh?*

A: Sea level rise, salinization of land and water, peoples' occupation change etc.

*(d) what are the possible impacts of climate changes in Bangladesh?*

A: Less lands for agricultural practice.

*(e) what are the combined impacts of population growth and climate change in Bangladesh?*

A: Less available lands for agricultural practice.



**PART 2: Explore the impacts of agricultural modernization in society and environment**

*(a) what are the overall impacts of modernization of agriculture?*

A: more productive at the first level, but in the long run less production.

*(b) what are location based activities of modernization of agriculture?*

A: use of chemical fertilizers; over-grazing.

*(c) what are the social impacts of agriculture modernization?*

A: erosion of family farming; invasion of mechanical or commercial farming practice.

Change of occupation becomes a frequent phenomenon.

*(d) what are the economic impacts of agriculture modernization?*

A: At the short term there could be increase of productivity, by agricultural intensification. Some people might envision this as the economic impacts of agriculture.

*(e) what are the environmental impacts of agriculture modernization?*

Less productivity of lands and lack of farm lands.

**PART 3: Recognize interactions between ecological and social factors in an environmental issue (agriculture practice in Southwest Bangladesh).**

*(a) discuss the coupled nature of social and environmental system*

A: Students should identify that there is a relationship between

*(b) What and how could be the possible interactions between ecological and social interaction in the local context?*

A: Agriculture, and society are interlinked.

**PART 4: Synthesize information from the natural and social sciences**

*(a) how they can synthesize the information?*

A: Consider the social dimensions while thinking about natural (e.g. agriculture) systems.

*(b) what could be the possible challenges of synthesizing the information?*

A: It is particularly happen if the students face difficulty to make a proper linkage between social and natural world.

*(c) which information they can derive after synthesizing their available information?*

A: Then can think and consider the social issues while deciding any environment related solutions.

*(d) what are the broader implications of synthesizing this location-based case study towards the better understanding of global environmental change dynamics?*

A: If the students can understand one localized challenges and associated social and natural systems dynamics, they will at least have clues how to approach to a global issue.

**Assessment:**

We would focus more on the synergistic/ coupled relationships of social and natural dimensions of the system. We would grade based on their class discussions, arguments and logical flows of their decisions. There is no right or wrong answer in this case study. Therefore logical flows of arguments based on the improved understanding of coupled human and natural system will help to judge the students and grade them. We would also like to see how they can link this localized coupled system of human and natural system can be scaled up to regional or global scale for better understanding of the similar challenges in other geographical context.