Perceptions of Climate Change in Kaptai National Park

Suriya Ferdous[1]

Abstract

Bangladesh has always been vulnerable to climate variability due to its geographical features and location. This vulnerability is exacerbated by high population density, high levels of poverty, and people's reliance on climate-sensitive sectors, particularly rural agriculture. In this paper I describe the perceptions and observations of local tribal people living in Kaptai National Park, Bangladesh concerning climate change and its impacts on their livelihoods. My main purpose is not only to understand tribal people's perceptions about climate change and its effects on their livelihood, but also to look at how they are adapting to perceived changes. I argue that the recording of tribal knowledge and perceptions of climate change in Kaptai National Park is important for both understanding local livelihoods and developing climate change policies. Such understanding is of great value because it helps us to better understand the present and potential future impacts of climate change on people living in Kaptai National Park, while offering clues into adaptive measures that should be taken.

Introduction

Bangladesh is internationally renowned as a "mega delta" and is home to the world's largest mangrove forest. The nation is also categorized as one of the world's least developed countries. In recent years, Bangladesh has been increasingly featured in international news because it is considered to be one of the first places where the impacts of climate change and sea level rise will be evident. This susceptibility to climate change is due to the country's low elevation and its location at the convergence of three major rivers (the Ganges, Brahmaputra, and Meghna) and the Bay of Bengal.

According to the predictions of global circulation models, global climate change will result in an average temperature increase in Bangladesh of 1ºC by 2030 and 1.4ºC by 2050. In addition, by 2050 monsoon precipitation is likely to increase by 6.8% (Selvaraju *et al* 2006). Bangladesh has always been vulnerable to climate variability due to its geographical features and location. The country is highly influenced by monsoons and regional precipitation patterns, which result in floods during the monsoon season and droughts in the dry season. The impact of this weather variability on the Bangladeshi people is exacerbated by high population density, high levels of poverty, and people's reliance on climate-sensitive sectors, particularly agriculture (Climate Change Cell 2006).

[1]. 5/2 Blok-A Jaleshor, Sobhunbug, Savar, Dhaka, suriya_ferdous@yahoo.com

The impacts of climate change in Bangladesh are likely to be most severe in the southern coastal belt along the Bay of Bengal. People living in this area are also especially vulnerable to disasters related to climate change because they live on marginal lands and their livelihoods are highly dependent on natural resources. According to the Intergovernmental Panel on Climate Change (IPCC)'s Fourth Assessment Report, people such as these are among the most vulnerable to climate change (IPCC 2007a). Therefore, it is important that consideration of these coastal communities is always integrated into estimations of the impact of future climate change-related disasters.

In this paper I describe the perceptions and observations of local ethnic minority people in Kaptai National Park concerning climate change and its impacts on their livelihoods. I also demonstrate how people in the park have been adapting to climatic variations up to this point. The main purpose of the study is not only to understand tribal people's perceptions about climate change and its effects on their livelihood, but also to look at how they are adapting to perceived changes.

Importance of the study

Bangladesh is a disaster prone country, and the majority of the most damaging events have occurred in the southern part of the country. According to the IPCC, communities that reside in marginal lands and whose livelihoods are dependent on natural resources and forests belong to a "high risk" group in the context of climate change (IPCC 2007b). Thus, tribal communities in southern Bangladesh could be in an even more vulnerable situation in the future due to climate change.

In attempting to comprehend the livelihoods of tribal people, the knowledge of the people themselves contains a wealth of significant information. According to Byg and Salick (2009).

> Documenting local perceptions of climate change is also important from a policy point of view, since local perceptions reflect local concerns and focus on the actual impacts of climate change on people's lives, which are dependent on local factors and cannot be estimated through models. In addition, local knowledge and perceptions influence people's decisions both in deciding whether to act or not and what adaptive measures are taken over both short- and long-terms. Therefore, local observations and perceptions should be taken into account in efforts to understand climate change, its impacts, adaptation to it, and mitigation of it.

In this paper I argue that the recording of tribal knowledge and perceptions of climate change in Kaptai National Park is important both for understanding impacts on livelihoods and developing climate change policies. This research will help us to better understand the present and future effects that climate change may have on tribal people living in Kaptai National Park, while offering clues into adaptive measures that should be taken.

For this study I selected Kaptai National Park for the following reasons:

- The park is located in a part of Bangladesh that is susceptible to sea-level rise and that is heavily impacted by seasonal weather variability and flooding;
- The park is co-managed;
- Limited research has been done on the impacts of climate change in the area.

Background

The global climate is changing and it is likely to change further over coming decades due to increasing concentrations of "greenhouse gases" in the earth's atmosphere caused largely by human activities (Climate Change Cell 2006). Like the rest of the world, Bangladesh is also experiencing significant climatic changes. Changes in rainfall patterns, droughts during rainy seasons, late monsoons, recurring floods, and warm winters may be signs of these changes. It is well recognized that these weather variations have had significant impacts in southern Bangladesh, particularly in southwestern Bangladesh. For example, since catastrophic landslides struck Chittagong in June 2007, it has been recognized that the Chittagong Hill Tracts are likely to be significantly affected by climate change-induced disasters. While flash floods and landslides in the Chittagong Hill Tracts are related mostly to human-caused soil erosion and deforestation, it is probable that the frequency and severity of such disasters will increase sharply due to climate change-induced increases in precipitation and storm surges (Gunter *et al* 2008). In addition, Bangladesh is particularly susceptible to sea level rise due to its geographical position.

Bangladesh is located between 20^{o} and 26^{o} north latitude and 88^{o} and 92^{o} east longitude. The country is bordered by India to the west, north, and east; by Myanmar to the southeast; and by the Bay of Bengal to the south. Eighty percent of the country occupies floodplains and mean elevations range from one to six meters (IPAC 2009). Bangladesh is a densely populated country, with over 156,050,900 people living in an area of only 143,998 square kilometers. This is significant in that higher population densities increase vulnerability to climate change because more people are exposed to risks while opportunities for migration are limited. Straddling the Tropic of Cancer, Bangladesh has a typically humid and warm tropical climate. The country is susceptible to natural calamities such as floods, tropical cyclones, tornadoes, and tidal bores. Such phenomena occur almost yearly. In Bangladesh there are four prominent seasons: winter, pre-monsoon, monsoon and post-monsoon (Agarwala *et al* 2003). The general characteristics of the seasons of Bangladesh are shown in Table 1.

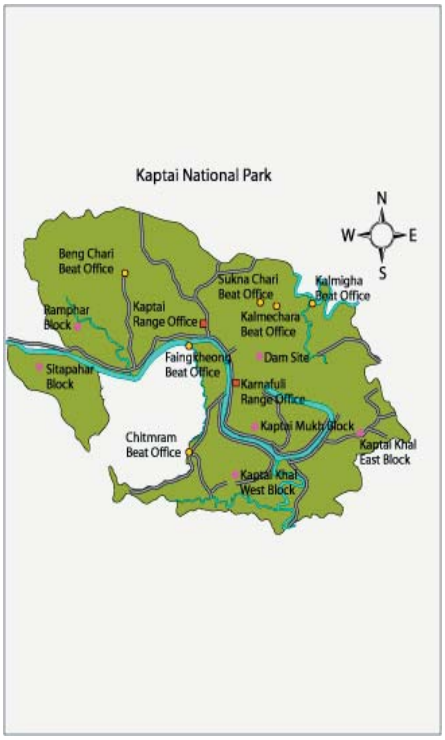
Table 1: General characteristics of seasons in Bangladesh (Agarwala *et al* 2003)

Season	Description
Winter	Period: December to February Type: relatively cooler and drier Temperature: 7.2 to 31.1°C
Pre-monsoon	Period: March to May Type: hot with high rate of evaporation and occasional rainfall Temperature: maximum of 36.7°C
Monsoon	Period: June to early-October Type: hot and humid with torrential rainfall Temperature: 22 to 40°C
Post-monsoon	Period: late October to November Type: reduced rainfall and lower night-time minimum temperature Temperature: 20 to 33°C

Kaptai is a hilly district situated in the southeastern part of Bangladesh. The area was declared a national park in 1999 by the Forest Department. The park is located in the Karnaphuly and Kaptai Ranges, part of the Rangamati Hill District, which is under the jurisdiction of the Chittagong Hill Tracts South Forest Division. Kaptai National Park covers 5,464 hectares and is about 57 kilometers east of Chittagong city (Table-2). The park, which is composed of evergreen deciduous and semi-deciduous tropical forest, is unique for its monumental teak plantations established in 1873, 1878, and 1879. These are the oldest plantations in Bangladesh and were the starting point of modern forest management in the Indian sub-continent. This type of natural forest[2] is found only in deep valleys where wet conditions exist. The canopy is irregular and the forest is multi-storied and unevenly aged.

[2]. Tree species include: gorjon (*Dipterocarpus sp.*), chompaful (*Michelia champaca.*), boilum (*Anisoptera scaphula*), gutguria (*Fortium serratum*), bohera (*Terminalia belerica*), civit (*Swintonia floribunda*), chakua (*Albizia chinensis*), narikeli (*Pterygota alata*), chapalis (*Artocarphus chapalus*), pitraj (*Aphanamixis polystachya*), nageshor (*Mesua nagessarium*), dharmara (*Stereospermum personatum*), bashpata (*Podocarpus neriifolia*), chulta (*Dillenia indica*), udal (*Sterculia villosa*), konok (*Schima wallichii*), and chikrashi (*Chickrassia tubulasis*).

Table 2: Characteristics and map of Kaptai National Park (Reza 2007, Khan 2007)

Area: 5464 hectares (13,498 acres)	
Geography: Hills covered in mixed - evergreen forests	
Coordinates: 22°30′ N latitude, 92°20′ E longitude	
Compartments: 50 (25 each in Kaptai & Karnaphully)	
Villages: 40	
Households: 1400 (approximately)	
Population: 9000 (approximately)	
Main Occupation: Jhum Cultivation	
Amphibian species: 11 Reptile species: 78	
Ethnic minorities: Chakma, Marma, Tanchainga	
Climate: Sub-tropical	
Temperature: 34°C - 12°C	
Rainfall: 2,200 to 3,600 mm	
Humidity: 35 -45% (November through March), 80% or higher (rainy season)	
Evaporation: average annual of about 500 mm	
Wind velocity: Maximum recorded is 96.54 km/h	

The first teak plantation was established at the site of present-day Kaptai National Park after teak seeds were imported from neighboring Myanmar in 1871. The growing of teak on a massive scale in the Sitapahar area began in 1873. The Sitapahar forest area was declared a forest reserve in 1945 and gazetted in 1946. In 1999, the Government of Bangladesh, with power authorized under section 23(3) of the Bangladesh Wildlife (Preservation) (Amendment) Act of 1974 (act number 17), declared the reserve forest "Kaptai National Park" and determined its boundary (IPAC 2009).

In addition to a wealth of wildlife[3], Kaptai National Park also supports a large number of tribal communities (e.g., Chakma, Marma, and Tanchangya) whose livelihoods mostly depend on *jhum*[4] cultivation and forest resources. Peoples from these three communities have continued to live in and near Kaptai National Park since its designation as a protected area. Two villages are located inside the park: Bangchori in the Kaptai Range and Kolabunia in the Karnaphuli Range. Marma, Chakma and Tanchangya peoples live in Bangchori, while only those of the Marma ethnicity live in Kolabunia.

Study area

Bangchori

Bangchori is located in the Kaptai Range forest administrative area. The village has eighty-four households located in five hamlets. The largest tribal group in Bangchori is the Marma, but the village is also home to Chakma and Tanchangya people. The main occupation in Bangchori is jhum cultivation, but people also engage in other occupations such as agriculture, retailing, day labor, fuelwood collection, business, teaching, logging, and government jobs. Typically males are the primary money-earners in the households and many females are housewives. Buddhism is the predominant religion of the villagers and their level of education is quite low. Bangchori has no primary school and only one preschool run by the NGO, Bangladesh Rural Advancement Committee (BRAC). I interviewed fifteen people in Bangchori, of which nine were males and six were females from different occupations.

Plate 1: Jhum Cultivation in Bangchori

According to the seasonal calendar of Bangchori (Table 3), jhum cultivation starts in the winter season (October to February) (Plate 1). A variety of crops are reaped during the time of jhum cultivation. Bangchori villagers grow and harvest rice, corn, long bean, bean, turmeric, banana, ginger, okra, sweet pumpkin, and spinach. The annual income of the villagers earned from jhum cultivation is approximately 25,000 to 30,000 BDT (362 to 434 USD). In the summer (June to October), locals engage in rice cultivation and tree logging. However, only a small portion of the villagers have their own land for rice cultivation, so a large portion of villagers engage in tree logging and other seasonal occupations during this time.

[3]. Wildlife includes: hati (*Elephus maximus*), maya horin (*Muntiacus muntjak*), para horin (*Cervus porcinus*), barsinga (*Cervus duvauceli*), Khorgous (*Lepus nigricolis*), honumun (*Presbytis entellus*), ulluk (*Hylobates hoolock*), Bon birul (*Felis chaus*), bonno sukor (*Sus scrofa*), sojaru (*Hystrix indica*), udh birul (*Lutra lutra*), bon chagol (*Capricornis sumatracnsis*), sumbur (*Cervus unicolor*), bunor (*Macaca sp.*), beji (*Herpestes sp.*) as well as many unknown birds, amphibians and reptiles.

[4]. A type of swidden agriculture

Table 3: The Seasonal Calendar of Bangchori

Seasons → / Occupations ↓	Summer					Winter				Pre-Summer		
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Jhum cultivation												
Rice cultivation												
Retailing												
Day labor												
Fuelwood collection												
Tree logging												
Business												
Teaching												

Kolabunia

Kolabunia is in the Karnaphuli Range forest administrative area. The village has eighteen households and is home to a population of approximately one hundred people belonging to the Marma tribal group. Like in Bangchori, the main occupation in Kolabunia is jhum cultivation. People also engage in other occupations, including fishing, day labor, boat operating, teaching, shop-keeping, and government jobs. In Kolabunia many of the women work in their own homes as housewives. The village has a low level of education. For this study, I interviewed ten people from the village, of which eight were males and two were females from different occupations.

According to the seasonal calendar of Kolabunia (Table 4), jhum cultivation starts in the winter season (December to February). A variety of crops are cultivated during this time, including rice, watermelon, bean, long bean, turmeric, banana, ginger, papaya and sweet pumpkin. The annual income earned by villagers from jhum cultivation is about 20,000 to 25,000 BDT (289 to 362 USD). In Kolabunia, the summer season lasts from June to October, during which time the villagers are engaged in day labor and fishing. The average monthly income of villagers engaged in fishing and day labor is about 4,000 to 5,000 BDT (58 to 72 USD) and 6,000 to 7,000 BDT (87 to 101 USD) respectively. In the past, during summer a large portion of the villagers provided day labor to the forest department for which they received fuelwood and wages.

Table 4: The Seasonal Calendar of Kolabunia

Seasons → / Occupations ↓	Summer			Pre-Winter		Winter				Pre-Summer	Summer	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Jhum cultivation												
Fishing												
Boatman												
Day labor												
Shop keeping												
Business												
Teaching												

One problem expressed by study participants in both villages was wildlife pestilence. Villagers in both communities have suffered badly from repeated intrusions of animals like elephants and monkeys into their jhum fields over the past several years. These animals uproot crops and damage fields. Increasingly animals do not get enough food from inside the forests because of severe degradation, and so they enter human settlements searching for food.

Methods

In order to identify perceptions of tribal people concerning the effects of climate change on their livelihoods in Kaptai National Park, I utilized both primary and secondary data. However, because I was particularly interested in people's perceptions, I relied mainly on primary data collected through interviews and focus group discussions. In particular, I focused on issues related to climate change such as environmental changes, variations in rainfall patterns, changes in agricultural practices, vector-borne diseases, biodiversity, culture change, natural disasters, and adaptation measures.

This research project spanned a six-month period from August 2009 to January 2010. I conducted field research from October to November 2009, and again in January 2010. In addition, I carried out informal discussions with NGO staff and government agency officials in Dhaka from September to December 2009. In total, I spent approximately thirty days collecting data in the villages and additional time reviewing relevant literature and analyzing findings.

I used an open-ended questionnaire for the semi-structured interviews with households. The questionnaire was designed to 1) gather information on livelihoods; and 2) to document opinions on and observations of impacts of climate change. The data from the questionnaire were used to draw conclusions about the socio-environmental condition of the villages.

I interviewed a total of twenty-five households in two villages. For the household survey, I did an ad hoc sampling of households in Bangchori and random sampling of households in Kolabunia. In Bangchori, I interviewed sixteen of eighty-one households in five hamlets. The breakdown of households in the hamlets of Bangchori is as follows: Old (22); Headman (14); Andalachara (11); Bogachori (10), and New (27). I interviewed five households each from New and Old hamlets, and two households from each of the other hamlets. In Kolabunia, I interviewed ten households out of eighteen.

For the household survey I interviewed either male or female respondents. I purposefully selected individuals 30 years of age or older as household respondents. Through preliminary discussions with villagers (both in Bangchori and Kolabunia), I found that female respondents did not have sufficient education, or were not conscious enough of the issues to respond appropriately. Most females were not interested in topics like environment, agriculture, rainfall, weather, food patterns, markets, or even, surprisingly, culture. Many female respondents simple answered, "I don't know anything." Therefore, the numbers of male respondents are comparatively higher than female.

Focus group discussions with villagers centered on perceived climate change impacts. They included questions about temperature fluctuation, rainfall changes, agricultural changes, biodiversity, vector borne diseases, and natural disasters. I conducted a total of two focus group discussions (one for each village). There were five respondents in each focus group discussion. The groups were composed of both males and females above thirty years of age and from various occupations.

For the key informant interviews I used an open-ended, in-depth questionnaire to ask questions about tribal people's experiences with the effects of climate change. My key informants were the two focal village's headmen.

With the help of villagers I prepared seasonal calendars for the two villages (Tables 3 and 4) in order to understand their agricultural practices with respect to the seasons of the year. These calendars contain time frames for crop production during different seasons, from which a considerable amount of information about villagers' livelihoods can be gleaned.

Results

This study sought to determine whether tribal people in two villages in Kaptai National Park perceive of climate change as affecting their environment and livelihoods; and if so, in what ways. Many respondents perceive that their environment is changing and that these changes are not the result of normal climatic variations or natural phenomena. They perceive enhanced anomalous changes in the climate, although most of them are not familiar with the term "climate change". In Bangchori village 40 percent of the participants (6 people) were familiar with the

term climate change and felt that the environmental changes they were experiencing in their own lives may be due to this. Of the six people who perceived changes, four were men and two were women. In Kolabunia village, none of the participants were aware of the term climate change but they perceived changes in rainfall, temperature, and other climate variables.

Table 5 summarizes the changes perceived by respondents in the two villages. Approximately 47% and 40% of respondents in Bangchori and Kolabunia respectively perceived that temperatures were increasing while the same percentage of respondents observed no changes in temperatures. In Bangchori 6% of respondents felt that winters were colder while in Kolabunia 20% perceived winter temperatures to be cooler. Most respondents in both villages felt that summers were getting longer and considerably hotter.

Approximately 47% and 70% of participants in Bangchori and Kolabunia respectively perceived rainfall to be decreasing at alarming rates, while 34% and 30% of participants perceived no changes in rainfall. In Bangchori, approximately 19% of participants perceive rainfall to be more irregular. Villagers could not recall the period and duration of rainfall patterns for the past four or five years but most of them perceived the changes in rainfall were affecting the cultivation and production of food crops.

Approximately 20% of participants in Bangchori and 60% in Kolabunia perceived that food production had decreased, while 47% and 20% perceived no change. Villagers were also aware of changes in the production of rice. An alternative rice variety had been introduced in both villages to improve yields. Rice varieties, such as "rice-10/11/panza" that had been grown in the past cannot be cultivated now. In Bangchori, 27% of respondents perceived that water availability was reduced. Villagers traditionally depended on spring water from nearby hills for irrigation and daily needs throughout the year, but for the last five or six years the springs have dried up in the winter and only begin to flow again in mid-summer. As water has become less available, farmers have started to use pumps to draw ground water for irrigation. Villagers also observed that the number of insect pests had increased and that consequently the application of pesticides had also increased. In addition, 20% of participants in Kolabunia felt that fewer fish were available in Kaptai Lake.

Table 5: Summary of perceived environmental changes in the two villages

Perceived effects	Bangchori % and number of respondents (n=15)	Kolabunia % and number of respondents (n=10)
Temperature changes		
Temperatures warmer	47% (7)	40% (4)
Winter much colder	6% (1)	20% (2)
No changes	47% (7)	40% (4)
Rainfall changes		
Rainfall has decreased alarmingly	--	70% (7)
Rainfall has decreased	47% (7)	--
Rainfall more irregular	19% (3)	--
No changes	34% (5)	30% (3)
Agricultural changes		
Agricultural production increased	--	60% (6)
Availability of fish more irregular	--	20% (2)
Availability of water to be reduced	27% (4)	--
Agricultural production decreased and alte rnative rice varieties introduced	20% (3)	--
Perceive pesticide use to have increased	6% (1)	--
Perceive no changes	47% (7)	20% (2)
Changes in vectors		
Increase in mosquito -borne infections	40% (6)	50% (5)
Increase in number of insects	20% (3)	30% (3)
No changes	40% (6)	20% (2)
Biodiversity changes		
Massive changes in biodiversity	74% (11)	50% (5)
No changes	26% (4)	50% (5)
Cultural changes		
No changes	100% (15)	100% (10)
Natural disaster		
Increase in irregularity of large storms	37% (6)	20% (2)
No changes	63% (9)	80% (8)
Adaptation measures		
Adaptation is occurring	20% (3)	20% (2)
No changes	80% (12)	80% (8)

In Bangchori and Kolabunia respectively, approximately 40% and 50% of participants perceive that vector borne diseases, especially diseases borne by mosquitoes, have increased. Approximately 20% and 30% of participants in the respective villages perceive that the number of insects has increased, while 40% and 20% of participants do not perceive any changes. Villagers identified a black mosquito as the main source of diseases such as malaria and believe that these mosquitoes are becoming more poisonous due to excessive use of pesticides. They hypothesize that mosquitoes exposed to the chemicals used in pesticides become more potent and consequently cause more severe disease in humans.

Villagers in both communities perceive massive changes in biodiversity (74% and 50% in Bangchori and Kolabunia respectively), while 26% and 50% of participants in the two villages did not perceive any changes in biodiversity. Twenty years ago a large variety of flora and fauna adorned Bangchori, but today people experience a village devoid of much of its biodiversity. In Kolabunia participants identified a loss of fish diversity and attributed it to deficient water transparency in Kaptai Lake. They suggested that big fish and shrimp face extinction while small fish are less available and are becoming seasonal (Plate 2). Migratory birds to Kaptai Lake were also more abundant in the past.

Plate 2: Shrimp from Kaptai Lake; half the size of a regular shrimp

Some respondents, approximately 37% in Bangchari and 20% in Kolabunia, perceived that tropical storms, cyclones, and floods were becoming more irregular, while a larger percentage, 63% and 80%, perceived no changes in natural disasters. Villagers expressed that they had less confidence in their ability to read the weather and said they could not forecast natural disasters. As they were not able to estimate when a disaster would strike they could not prepare themselves.

Approximately 20% of participants in each village perceived that they were taking measures to adapt to climatic and other changes, while 80% did not perceive any adaptation. Some of the ways in which people perceived that they were adapting were the increased use of pesticides to control insect pests, the use of water pumps to adjust to water shortages, and the protection of forests to safeguard water supplies.

Discussion

Few studies in Bangladesh have attempted to document people's perceptions of climate change or its affects on daily livelihoods; even less work has been done in the southeastern portion of the country. I could not find any studies in Bangladesh on the perceptions of tribal people living in protected areas concerning climate change and its effects. Selvaraju (2006) documented people's perceptions of climate change in drought prone areas of Bangladesh. He concluded that "People in the study area perceive that today's climate is different from the past - the seasonal cycle and rainfall pattern have changed, droughts have become more frequent, and pest and disease incidences have increased" (Selvaraju et al 2006:iv). In another paper, Gunter (2008) argues that both tribal and non-tribal populations in Chittagong Hill Tracts are highly vulnerable to climate change-induced increases in droughts, floods, landslides and cyclones (Gunter *et al* 2008).

A few recent research papers from other South Asian countries also report that people perceive climate change as affecting their daily lives. The author of a study of local perspectives on climate change in eastern Tibet interviewed people in villages that had never heard of the phenomenon of global climate change and asked them about their perceptions of the changes in air temperatures, snow cover, and glacial coverage. The findings showed that respondents had noticed declines in snowfall and rainfall, identified glacial retreat and decreased avalanches, perceived warming temperatures, begun early planting and harvesting, and experienced lower crop yields, increased crop diseases, and insect attacks. Interestingly, when villagers' perceptions of change were compared with scientific evidence, the climate records and models for the area supported their conclusions (Salick and Byg 2007).

In another recent study on local views of climate change in British Columbia, Canada-a region known for its cool, thick temperate rainforests-the author states that the impacts of climate change include shifts in species composition, anomalies in weather patterns, and declines in the health of forests and grasslands. British Columbia's local indigenous people rely heavily on the anticipated seasonal abundance of particular resources and depend on predictable rainfall, snowpack, and montane glaciers. Along the coast, people travel by boat and rely on generations-old knowledge of weather patterns, ocean currents, and tides to keep them safe on the water. Now, these features are changing and becoming less predictable and people feel more vulnerable and at greater risk despite modern weather prediction methods, improved communication, and enhanced technologies. Turner and Clifton (2009) stress the importance of appropriately recognizing and valuing the knowledge of local and indigenous peoples, and incorporating this knowledge into strategies for adapting to and reversing climate change (Turner and Clifton 2009).

This study found that tribal people residing in Kaptai National Park are aware of many differences in their environment, such as changes in temperature, rainfall, agricultural practices, vector-borne diseases, biodiversity, and the occurrence of natural disasters. While most respondents do not consider most of these differences

to be the result of normal variation, not all understand that these differences may be due to climatic variations and other environmental changes that are closely related to climate variables caused by anthropogenic sources.

Respondents recognize that some environmental modifications may be due to climate change but that other changes may have other causes. Changes they perceive as perhaps being caused by climate include variations in temperature and rainfall. Such changes affect agriculture (less water is available) as well as the abundance of insects, mosquitoes, and other pests that affect both agriculture and human health. In terms of agriculture, the communities experience a lack of water for irrigation due to lower flow from hill streams in the dry season and less rainfall (Plate 3). Respondents perceive an alarming decrease of rainfall and they feel rainfall patterns have not been normal for the past four or five years. The lack of water has placed pressure on the food production systems of these communities. Numbers of insects, mosquitoes, and other pests are also perceived to be at an all time high. People are suffering from black mosquitoes, which are said to be more poisonous and have boosted the number of malaria patients in the area.

Plate 3: Hilly streams became narrower in Bangchori

On the contrary, changes in biodiversity and fish abundance are not perceived by participants to be results of climate change. For example, fishers in Kolabunia have noticed changes in fishing patterns. Fish species they used to catch daily twelve to fifteen years ago can no longer be seen. Residents in both villages recognize extensive changes in biodiversity, which they attribute to excessive illegal tree felling and a shortage of agricultural lands (Plate 4). Alternatively, the loss of fish abundance and diversity in Kaptai Lake is considered to be a consequence of the establishment of the Kaptai Hydroelectric Project. This project is perceived to have caused the loss of many migratory birds and fishes.

Plate 4: Illegal logs collected by the Forest Department, Kaptai

Indigenous, traditional, and tribal peoples often depend immensely on their own knowledge, observations, and interpretations, which help them to improve their livelihoods and develop adaptive measures to variations in weather, seasons, natural disasters, agriculture, society, and other factors. Because of this great dependency, it is essential for local residents to understand climatic variation. Respondents in this study expressed that they had less confidence in their ability to read the weather than previously, and that they could not forecast natural disasters like tropical cyclones, storm surges, landslides, or floods that occur randomly in these areas. The IUCN (2008) has suggested that local observations and weather forecasting systems may in the future become less meaningful or even misleading for decision-making, due to more rapid and complex global climate change (IUCN 2008). As this study suggests, people in Kaptai National Park may become more vulnerable to future climatic deviations due to an inability to read with assuredness atypical climatic changes.

As elsewhere in the world, people in Bangladesh are adjusting to alterations in their environment caused by climate change without knowledge about how and why these changes are occurring. They are not helpless victims in the face of climate and other environmental changes, but rather active actors constantly looking for new ways to adapt and adjust to the changing environments they live in. Although most villagers are not familiar with the term "climate change", many of them are aware that they are living and working within a constantly changing environment that can affect their livelihoods for better or worse. Villagers are adopting all sorts of adaptive measures with respect to their changing environment without being completely aware of the causes of that change.

Various organizations have offered projections of climate change impacts that will affect Bangladesh. I compare some of these projected impacts with changes perceived by respondents in order to better triangulate the potential risks of climate change for local tribal people in Kaptai National Park (Table 6).

As can be seen from these comparisons, if projected changes become reality, Bangladesh will be exposed to higher temperatures, decreased precipitation leading

to crop failures, irregular natural disasters, and higher risk of lethal vector borne diseases. It is also important to note that people in the study area have long utilized local biodiversity and natural resources to adapt to alterations and protect themselves from climatic variations. It is tribal people that will experience environmental changes first hand, and it is their perceptions that can best inform the public about how climate change is happening and what its impacts are.

Table 6: Comparison of projected impacts and perceptions of change related to climate change.

Variable	Respondent perceptions	Projections
Temperature	Warmer	Bangladesh's temperature is projected to increase an average of 1ºC by 2030 and 1.4ºC by 2050 (Selvaraju, *et al* 2006)
Vector/borne diseases (malaria, dengue)	Increased	Assuming a global temperature increase of 2 - 3ºC, the number of people at risk of malaria in climatic terms is expected to rise by about 3 -5%, or several hundred million (WHO 2003).
Rainfall	Decreased	In Asia, the changing precipitation patterns are predicted to increase and are projected to affect local production negatively, possibly leading to crop failure, especially in subsistence sectors at low latitudes (IPCC 2007b)
Crop production	Decreased	
Natural disasters (tropical cyclones, floods, storm surges)	Irregular	Bangladesh is particularly vulnerable to tropical cyclones and storm surges. It is estimated that a 1.5 meter rise would affect 17 million people (about 15% of the population) and 22,000 km ^{2} of land.
Biodiversity	Massive exploitation and loss	Biodiversity is a primary tool of adaptation for indigenous peoples, w ho use diverse flora and fauna as a buffer against variation, change, and catastrophe. Throughout human history, climate change, societal change and biodiversity have been closely linked (Salick and Byg 2007)

Conclusion

The Intergovernmental Panel on Climate Change has confirmed that global climate change is already happening. The IPCC's 2007 report states that the determining factors of social and biophysical vulnerability of indigenous and traditional peoples are not well understood and require further investigations globally (IPCC 2007a). Bangladesh has been particularly impacted in the South by climate and weather phenomenon that has devastated the country's coastal livelihoods.

In this paper I examined perceptions of environmental variations possibly due to climate change among the Marma, Chakma, and Tanchainga peoples living in the village of Bangchori and the Marma of Kolabunia. I conclude that approximately half of the participants in Bangchori and Kolabunia perceive that temperatures are warmer than in the past and that the number of mosquitoes and mosquito borne diseases has increased. The World Health Organization (2003) suggests that vector borne diseases such as malaria are sensitive to long-term climate change and will likely increase. Malaria, today, is mostly confined to tropical and subtropical regions. However, assuming a global temperature increase of 2-3ºC, the number of people at risk of malaria in climatic terms is expected to rise by about 3-5%, or several hundred million (WHO 2003). Bangladesh's temperature is projected to increase an average of 1ºC by 2030 and 1.4ºC by 2050. If the projections of these variables become a reality, Bangladesh will be exposed to higher temperatures and the risk of lethal vector borne diseases will greatly increase. It is tribal people that will experience these changes first hand, and it is their perceptions that can best inform the public about how climate change is happening and what its impacts are.

Approximately half of the respondents in Bangchori and more than half in Kolabunia perceived that rainfall, and therefore food production, had decreased. Though changes in precipitation are more difficult to model, it has been projected that there will be less rain in areas adjacent to the tropics, while in the Asian monsoon region and other tropical areas more intense flooding is expected. There is evidence that future tropical cyclones may become more severe, with greater wind speeds and more intense precipitation. Changing precipitation patterns are predicted to increase the frequency of hazards such as droughts and floods and are projected to affect local production negatively, possibly leading to crop failure, especially in subsistence sectors at low latitudes (IPCC 2007b). So, the perceptions of the respondents in this study on rainfall and food production patterns associated with climate change may be true.

Approximately three-fourths of the participants in Bangchori and half of the participants in Kolabunia perceive that massive changes in biodiversity have taken place. Though respondents did not consider changes in biodiversity to be the consequence of a changing climate, and though there are many variables affecting the local ecosystem, adverse impacts on biodiversity as a result of climate change are predicted and the effects of this on local and ethnic minority people must be considered. Biodiversity is a primary tool for adaptation by indigenous peoples universally, who use diverse flora and fauna as a buffer against variation, change, and catastrophe. Tribal people are fighting the loss of biodiversity and adapting to climate change through migration, irrigation, water conservation techniques, land reclamation, changing where and at what elevation plants are cultivated, livelihood adaptation, and a myriad of other techniques. Throughout human history, climate change, societal change, and biodiversity have been closely linked (Salick and Byg 2007). So, it can be assumed that tribal people in the study area have long utilized their local biodiversity and natural resources to adapt to change and protect themselves from climatic variations.

A large portion of participants in Bangchori and in Kolabunia did not think that there had been an increase in the number or severity of natural hazards like tropical cyclones, storm surges, and floods. In this context, some projections for Bangladesh in terms of climate change, especially in the coastal zone, should be considered. Approximately twenty percent of the world's human population lives within thirty kilometers of the sea, and nearly double that number lives within one hundred kilometers of the coast. The main climate change impacts on Asian coastal zones will consist of sea-level rise and more frequent and severe storm events. Bangladesh is particularly vulnerable to tropical cyclones and storm surges. In the case of sea level rise, Bangladesh is expected to be one of the most heavily impacted as it is a flat deltaic land vulnerable to inundation. It is estimated that a 1.5 meter rise would affect seventeen million people (about 15% of the population) and 22,000 square kilometers of land (about 16% of total land surface).

When respondents discussed environmental changes such as changes in temperature, rainfall, agricultural practices and vector-borne diseases, they did not consider these differences to be merely the consequence of normal variations. They perceived these environmental changes as possibly being the result of climatic variations without any knowledge of the term climate change or its predicted effects. Moreover, they have already started to adopt some new adaptation techniques in response to the changing conditions. Regardless of whether or not people understand the term climate change and its causes and impacts, if the predictions of the climate change consortiums are correct, people will need to be able to adapt to survive. It is interesting that tribal people living in Kaptai National Park perceive the environmental alterations as possibly resulting from a changing climate and that they are actively adapting to these differences without having prior knowledge about what climate change is or recommendations on how to adjust to it.

Intensive research is needed to better understand tribal people's perceptions of climate change and to introduce applicable adaptation measures in these areas. It will be important to include the knowledge and perceptions of tribal peoples at the decision-making level, so that their experience and successful adaptative strategies can help shape new forms of governance and strengthen livelihoods to meet the challenges of climate change. In the words of Byg and Salick, "Mutual respect is indispensable to gain a better understanding of climate change and to tackle its many-facetted impacts" (Byg and Salick 2009:166).

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References

Agrawala, S., T. Ota, A. U. Ahmed, J. Smith, and M. V. Aalst 2003. Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans. Organisation for Economic Co-operation and Development: Paris, France.

Byg, A. and Salick, J. 2009. Local perspectives on a global phenomenon-climate change in Eastern Tibetan villages. *Global Environmental Change* 19 (2): 156-166.

Climate Change Cell. 2006. Key Facts: Climate Variability and Change in Bangladesh: Impacts, Vulnerability and Risks. Climate Change Cell, Comprehensive Disaster Management Program, Department of the Environment: Falls Church VA, USA.

Gunter, B. G., A. Rahman, and A. F. M. A. Rahman. 2008. How Vulnerable are Bangladesh's Indigenous People to Climate Change? Bangladesh Development Research Center: Dhaka, Bangladesh.

IPAC (Integrated Protected Area Co-Management). 2009. Site Level Field Appraisal for Integrated Protected Area Co-Management: Kaptai National Park, Chittagong Hill Tract. Integrated Protected Area Co-Management: Rangamati, Bangladesh.

IPCC (Intergovernmental Panel on Climate Change). 2007a. Climate Change 2007: Synthesis Report. Intergovernmental Panel on Climate Change: Valencia, Spain.

IPCC (Intergovernmental Panel on Climate Change). 2007b. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policymakers. Intergovernmental Panel on Climate Change: Brussels, Belgium.

IUCN (International Union for Conservation of Nature and Natural Resources). 2008. Indigenous and Traditional Peoples and Climate Change: Issues Paper. International Union for Conservation of Nature and Natural Resources: Gland, Switzerland.

Selvaraju R., Subbiah A.R., Baas S., Juergens I. 2006. Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh. Food and Agriculture Organization of the United Nations: Rome, Italy.

Salick, J. and Byg, A., eds. 2007. *Indigenous Peoples and Climate Change*. Tyndall Centre: Oxford, United Kingdom.

Turner, N. J. and Clifton, H. 2009. "It's so different today": Climate change and indigenous lifeways in British Columbia, Canada. *Global Environmental Change* 19(1):180-190.

WHO (World Health Organization). 2003. Climate Change and Human Health - Risks and Responses: Summary. World Health Organization: Geneva, Switzerland.

One of the poorest and most densely populated nations in the world, Bangladesh is also arguably the most vulnerable to the negative impacts of climate change. Increased salinity of soils in coastal regions as well as increased incidence and severity of cyclones and other natural disasters lend credence to the argument that the impacts of climate change are already here. Thus, Bangladesh must struggle in its efforts toward poverty alleviation and food security, and build a foundation of resilience to ensure gains made today can be sustained into the future. Increasingly, Bangladesh government officials and civil society recognize the importance of a healthy and integrated protected area system as a fundamental building block in its foundation of resilience. An integrated protected area system ensures that forests and wetlands are managed to conserve and sustain key environmental services. Based on the principles of co-management, government and communities are working together to ensure conservation of existing protected areas (PAs), to demonstrate the development benefits of conservation of protected areas, and to expand this network in size and complexity through the Nishorgo Network – 'Recognizing the need to save/conserve the most productive ecosystems of the country, the Government of Bangladesh materialized its concern by establishing the Nishorgo Network comprising of forest and wetland Protected Areas', http://www.nishorgo.org.

This book is a contribution to strengthening co-management of Bangladesh's PA system. Papers in this volume are based on research funded as part of the Nishorgo Network's IPAC program. Research funds were allotted to government officers from various departments, as well as to one post-graduate student, to support site-specific research pertaining to issues of community-based conservation. It is expected that the research findings reported in this book will illuminate new directions for policy and implementation strategies for creating arrangements that meet the goals conservation while not hindering the livelihoods of local community members. Spending time to investigate the realities of local resource users in both wetland and forest environments will help in tailoring conservation programs to the site-specific variables of socio-natural environments.

The Integrated Protected Area Co-Management (IPAC) project is a five-year USAID contract working with the Government and people of Bangladesh to establish a robust national protected area system based on the principle of co-management. IPAC is implemented by the Ministry of Environment and Forests (MoEF), and Ministry of Fisheries and Livestock (MoFL) involving directly the three line government agencies i.e., Forest Department (FD), Department of Fisheries (DoF) and the Department of Environment (DoE) , through a consortium of partners led by International Resources Group (IRG) and including the international organizations East-West Center, WorldFish Center and WWF-US as well as leading Bangladesh NGOs BELA, CODEC and CNRS. Components of the program have been designed to meet the needs of co-management arrangements at national, regional, and local levels. These include policy development, institutional capacity building, and support for site-specific implementation.

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