INTERNATIONAL
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IFPRI Discussion Paper 01322

February 2014

Exploring Local Perceptions of Climate Change Impact and Adaptation in Rural Bangladesh

Peter Davis

Snigdha Ali

Poverty Health and Nutrition Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Peter Davis (p.r.davis@sdri.org.uk) is the SDRI coordinator and research fellow at the Social Development Research Initiative, Bath, UK.

Snigdha Ali (singdha.ali@gmail.com) is the lead coordinator in the Communications Division of BRAC, Dhaka, Bangladesh.

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ABSTRACT

This paper reports on findings from 30 focus group discussions and 30 key informant interviews conducted in 12 districts of Bangladesh in May 2012. The discussions and interviews draw attention to perceptions of climate change and how climate-related trends influence people's lives, both directly and indirectly. The findings also identify how people adapt to and cope with these changes. This paper aims to improve our understanding of local people's perceptions of these changes, explore the ways they are affected by them, and how well they are adapting to them. In order for policymakers to plan responses to climate change in Bangladesh, it is essential to understand how people understand and cope with these trends.

The research showed that most respondents had a clear understanding of what was directly affecting their lives and livelihoods in terms of climate trends and the wider environment over the long term. Most respondents were also aware of the usually limited options available to them to adapt to the changes they experience. However, the respondents were less able to understand differences between climate variability and climate change or the causes of the trends they observed.

The respondents reported that adaptation allowed them to cope with declining groundwater levels for agriculture and domestic use, hotter weather, reduced and unpredictable rainfall at key times of the year, more intense extreme weather events such as storms, cyclones, floods, and tornados, and increased salinity of groundwater in coastal areas. Adaptation and coping varied according to location, livelihood, and the assets and endowments people have at their disposal.

Participants were particularly concerned that agricultural productivity is being undermined by increased input costs, increasingly scarce irrigation water, and diminished crop yields. They report changed cropping patterns and that many poorer households formerly supported by agriculture were moving into small, nonagricultural businesses or migrating to urban centers or internationally—mainly in the Middle East—for work.

Households with low incomes and few assets are the most vulnerable. The interviews and focus groups reports of this group showed poorer health due to problems associated with access to clean groundwater and higher temperatures and other unseasonable weather affecting dwellings, trees and crops. Women in low-income households were more concerned than men with accessing clean drinking water, the health of their families, livestock health, and food security. The research provides evidence that some vulnerable people are being excluded as clean water becomes more scarce and costly to extract.

There is a wide range of successful group activity in rural Bangladesh associated with nongovernmental organization microfinance and the management of irrigation. There are opportunities for strengthening group activities to help vulnerable households cope with new climate -related changes, particularly, new crops and cropping patterns, extreme climate events, ensuring access to domestic and agricultural water. Women are particularly vulnerable when households divide or livelihoods change—particularly with migration. Group-based activities are likely to help strengthen women's position when faced with these circumstances. For the most vulnerable with low incomes and few assets, programs that reduce risk and build up assets will provide more security, particularly in times of crisis.

Keywords: Bangladesh, climate change, poverty, gender, vulnerability

ACKNOWLEDGMENTS

The authors would like to thank Agnes Quisumbing, Ruth Meinzen-Dick, Claudia Ringler, Elizabeth Bryan, Timothy Thomas, and Noora-Lisa Aberman of IFPRI for support and helpful comments on a previous draft of this paper. We also thank Zahidul Hassan and Md. Zobair and the team at Data Analysis and Technical Assistance Ltd (DATA) Bangladesh for organizing and facilitating the discussion groups and interviews. This work is supported by the Federal Ministry for Economic Cooperation and Development, Germany under the project “Enhancing Women’s Assets to Manage Risk under Climate Change: Potential for Group-Based Approaches,” and forms part of the CGIAR Research Program on Policies Institutions and Markets (PIM).

1. INTRODUCTION

Bangladesh has been identified as one of the countries to be most adversely affected by global climate change. Bangladesh is a low-lying country with high population density and a large agricultural sector—which is vulnerable to environmental changes. In recent years, the economy has grown and diversified though intensified agricultural production, a burgeoning ready-made garments sector, large-scale international labor migration, and effective small-scale business development supported by microfinance. In the decades since becoming independent, Bangladesh has also been successful in improving most measures of human development and in halving the proportion of the population living in poverty (BBS 2011). At the same time, the country has improved strategies to cope with natural disasters such as flooding, storms, and cyclones—especially since the devastating cyclone of April 1991 (Chowdhury et al. 1993; Rana, Rajib, and Rahman 2011).

However, the rural population is largely dependent on agriculture, especially rain-fed and groundwater-irrigated rice production. Encroachment of salt water in coastal areas, depleting groundwater aquifers due to widespread expansion of tubewells for agriculture and domestic use, reduced replenishment due to declining river levels—especially in dry seasons—all jeopardize agricultural productivity and the livelihoods of the rural population (Mirza 1997, 2002, 2004). Dependence on high-yielding varieties of rice and other crops that rely on groundwater irrigation—especially during the dry winter months—has driven improved agricultural productivity since the 1970s. However, these improvements are vulnerable to changes in climate and water supply. Extreme weather events, such as storms, tornados, cyclones, flooding, and cold snaps, can further damage crops and undermine fragile livelihoods.

The effects of climate change in Bangladesh are still being understood, but it is likely that changes include higher temperatures throughout the year and problems with rainfall predictability leading to greater shortages in some seasons and flooding in others (Khan 2011; Rahman 2012; Rana, Rajib, and Rahman 2011; Shahid 2010a; Thurlow et al. 2012). Some studies predict that rainfall will increase in the wet monsoon season and decrease in the dry winter and spring months (Shahid 2010a; Thurlow et al. 2012), while other studies vary in predicting which months will be most affected by erratic rainfall (Thomas et al. 2013). Also, there is concern that reduction in melt water in the Brahmaputra Basin will further reduce river water available for irrigation (Immerzeel, van Beek, and Bierkens 2010). In coastal areas, it is likely that sea level rises will lead to increased salinity of groundwater. Moreover, greater frequency of cyclones and storm surges is likely (Karim and Mimura 2008). These complex changes interact with other trends not directly caused by climate change—particularly the impact of increased agricultural water extraction and potential adverse water availability impacts from diversion of rivers upstream in India—in depleting river flow and replenishment of ground water aquifers in Bangladesh.

This paper aims to improve our understanding of local people's perceptions of these changes, explore the ways they are affected by them, and how well they are adapting to them. In order for policymakers to plan responses to climate change in Bangladesh, it is essential to understand how people understand and cope with these trends.

2. CONTEXT AND METHODS

Thirty focus group discussions (15 female and 15 male) and 30 key informant interviews were carried out in May 2012 in 15 villages across 7 agroecological zones (AEZ) in rural Bangladesh (Table 2.1). The 15 villages were selected from a larger sample of villages in an associated quantitative survey, which re-interviewed households surveyed in an earlier study by Thomas et al. (2013). The locations of the research provide a range of different environments and a variety of climate change-related impacts (Figure 2.1 and Table 2.1).

The lowest rainfall areas in Bangladesh are in the northeast, where our Dinajpur, Rangpur and Naogaon sites were located. This area of Bangladesh has historically been the most vulnerable to drought and has the highest levels of poverty and food insecurity.

Coastal areas are vulnerable to cyclones sweeping in from the Bay of Bengal—usually in the pre- and post-monsoon months—with associated tidal surges and encroachment of saltwater. This area is characterized by extensive low fertility, flood and salinity prone *char* areas¹, which tend to have higher than average levels of poverty. The Barguna and Laxmipur sites were in these areas and the Chittagong site was nearby.

Hill and forest tract areas in Bangladesh also face specific problems because they are home to marginalized ethnic minorities, are often remote, and have poor infrastructure, public services and transportation access. Also, populations in these areas are dependent on hill agricultural practices and deforestation and soil erosion are common problems. The Chittagong, Narsingdi and Habiganj-Chunarughat, and Mymensingh-Madhupur sites were in such hill-tract areas.

The Habiganj-Sadar and Netrokona sites were on the Himalayan Piedmont (foothill) plain. The Mymensingh floodplain, Jessore, Khulna, Naogaon-Atrai sites were in floodplain areas, which also included *beel* and *haor* low-lying areas, typical of large parts of the country².

Table 2.1 Research sites

District	Subdistrict (<i>upazila</i>)	Agroecological zone	focus groups	Key informant interviews
Barguna	Amtali	Tidal flood plain	2	2
Chittagong	Banshkhali	Northern and Eastern Hills	2	2
Dinajpur	Ghoraghat	Barind Tract	2	2
Habiganj	Habiganj Sadar	Himalayan Piedmont Plain	2	2
	Chunarughat	Northern and Eastern Hills	2	2
Jessore	Bagherpara	Floodplain	2	2
Khulna	Dumuria	<i>Beel</i> and <i>Haor</i> Basin	2	2
Laxmipur	Raipur	Tidal Floodplain	2	2
Mymensingh	Fulbaria	Floodplain	2	2
	Fulbaria	Madhupur Tract	2	2
Naogaon	Atrai	<i>Beel</i> and <i>Haor</i> Basin	2	2
	Niyamotpur	Barind Tract	2	2
Narsingdi	Monohardi	Madhupur Tract	2	2
Netrokona	Kalmakanda	Himalayan Piedmont Plain	2	2
Rangpur	Taraganj	Floodplain	2	2

Source: Authors' analysis of interviews.

¹ New land formed by accretion from rivers and on coasts is referred to as a *char* in Bengali. *Chars* are often flood- and erosion prone.

² *Beels* and *haors* are types of freshwater wetlands in Bangladesh. *Beels* are generally smaller than *haors*. They are often dry depressions in the dry season and fill with freshwater during the monsoon.

Figure 2.1 Map showing location of research districts

Source: Adapted from NordNordWest/Wikipedia (2013).

Two focus group discussions (one for men and one for women) and two key informant interviews (one with a man and one with a woman) were carried out in each village site. Single-sex focus group discussions are useful in Bangladesh because patriarchal norms of female deference sometimes prevent women from openly discussing some subjects when men are present. Two teams from DATA³ worked simultaneously in different study locations. Female researchers conducted focus group discussions with women and interviewed female key informants, and male researchers conducted male focus group discussions and interviewed men. The focus group discussions consisted of eight to ten participants who were thirty years of age. A minimum age was decided to ensure that research participants were aware of long-term trends. Key informants for individual interviews were recommended by other villagers as people who were knowledgeable about the local area and had completed some formal education.

Prior to the fieldwork, a two and a half day training workshop took place in Dhaka with one of the authors to discuss the objectives of the project and develop a semi-structured interview checklist—which has been included in its entirety in the Appendix—to guide the focus group discussions and interviews. After conducting four focus group discussions and four key informant interviews, the field teams returned to Dhaka for a feedback session with one of the authors before returning to the field to complete the field research.

³ Data Analysis and Technical Assistance Ltd, Dhaka, Bangladesh.

Management of Data and Analysis

Interviews and focus group discussions were transcribed in Bengali and translated into English. The authors then used NVivo 9⁴ to analyze and explore this material. A checklist (in the Appendix) developed for the focus groups and interviews were grouped into three themes: climate history and adaptation, group-based approaches, and gender and assets.

Limitations of the Study

The fieldwork was carried out in May 2012 after being delayed from March 2012, due to logistical problems. Unfortunately, this corresponded with the main (*boro*) rice harvest time. During this time of year, rural Bangladeshis tend to be very busy and men are often away from home working in the fields. Women are also busy, but usually work processing the harvested rice closer to home. This made arranging discussions and interviews quite challenging and limited the time that discussants and respondents were able to participate in the study.

The final analysis and write-up of focus group and interview findings was done in part by an analyst who had not participated in the focus group discussions or interviews, so there were limitations due to the division of labor in the study. While this kind of arrangement is common in quantitative field survey work, it is not ideal for qualitative work. Fortunately, the field researchers were well organized and the written materials from the study were of high quality.

⁴ NVivo is a qualitative data analysis program developed by QSR International.

3. FINDINGS

Perceptions of Climate Change

It is difficult to assess the level of understanding that respondents had about global climate change trends. In general, respondents confused climate change and climate variability. Some focus group respondents reported that the frequency of earthquakes had increased. This demonstrated either a lack of understanding of the aims of the study, or the nature of climate change. Thus, meteorological data are more likely to reliably reflect climate trends in Bangladesh than local people's qualitative perceptions.

However, respondents were aware of the effects of climate on their lives and livelihoods—even if their assessments of climate change were problematic. This is not surprising because assessing climate change over the medium term is difficult and most respondents had a fairly limited scientific understanding regarding climate change.

Men and women from all districts and AEZs widely expressed concerns about drought, lack of rainfall, and lowered groundwater levels. This concern should be examined in context. The interviews and discussions took place in May, toward the end of the hot summer season (*grisho*⁵) when problems with water shortages were in recent memory. Though it is possible that the groundwater crisis in Bangladesh is related to climate change, research has shown that it is related to increased demand for groundwater for *boro* rice irrigation, domestic use, reduced river levels because of diversion of river flow for irrigation in India contamination of groundwater with arsenic, and salinity problems in groundwater in coastal areas (Mirza 1997, 2002, 2004). Thus, these trends are linked to climate change and also to other causes.

The effects of other climate change-related trends varied greatly. Respondents reported increased crop damage and crop diseases—mainly due to a lowered water table at critical times, more costly and difficult irrigation, changed cropping patterns, changes in livelihoods away from agriculture, increased illness—especially during the hotter months, reduced yields of crops and fruits from trees such as mangos and coconuts, more frequent and damaging hailstorms, more frequent cold and foggy (*kwasha*) weather—which farmers reported had damaged crops, and health problems in livestock.

Less direct impacts with social dimensions were reported, such as the most poor and powerless experiencing exacerbated difficulty accessing clean and convenient drinking water in dry months. This was attributed to the lowered water table and the control of water from deep tubewells⁶ by more powerful households. In general, there seems to be a trend towards the buying and selling of previously free clean water due to increased demand and cost of extraction—especially when deep tubewells are relied on when cheaper shallow tubewells run dry or are identified as being contaminated with arsenic.

There were differences between men and women in their main issues of concern. Men tended to talk much more about problems with arable agriculture: crop yields, changed cropping patterns, irrigation problems due to depleted groundwater, declining river levels and interrupted electricity supply for tubewells, soil salinity, and crop-damaging mists. Women were much more concerned with problems with accessing drinking and washing water, family health problems, food security, livestock health, and lack of social power.

It is possible that women were more concerned with problems associated with accessing clean drinking water and family health because managing domestic water is seen to be a woman's role in rural Bangladesh. It is also possible that NGO⁷-organized microfinance programs—which target women and include education on subjects such as clean water and hygiene—have been effective in raising women's awareness about these subjects.

⁵ The Bengali calendar is divided into twelve months and six seasons: summer (*grisho*); rainy/monsoon (*borsha*); autumn (*shorot*); dry season (*hemonto*); winter (*shit*); and spring (*bosonto*).

⁶ In Bangladesh a deep tube well is over 75 meters in depth.

⁷ Nongovernmental organization.

Few respondents were aware of the global scale of climate change problems and most were unable to distinguish between short-term climate variability and long-term climate change. Also, few respondents distinguished between *climate change mitigation*, the global need to reduce greenhouse gas emissions, and *adaptation*, changed agricultural practices, livelihoods, migration, irrigation practices and disaster management, as responses to climate change impact. Some respondents also drew attention to more frequent earthquakes as an outcome of climate change, revealing a lack of understanding of the nature of anthropogenic climate change.

Perceived Impacts on Lives and Livelihoods

Table 3.1 provides a list of concerns raised by research participants as percentages of the focus groups and focal person interviews.

Table 3.1 Percentage of groups or interviews citing perceived climate-change related problems

Perceived problem	Overall	Women	Men	Female focus groups	Female interviews	Male focus groups	Male interviews
Drought	97	97	97	100	93	100	93
Storms or wind	87	90	83	100	80	93	73
Unseasonal weather	85	80	90	93	67	100	80
Hot weather	85	87	83	87	87	93	73
Flooding	80	80	80	93	67	100	60
Groundwater problems	78	67	90	73	60	93	87
Crop damage	57	63	50	80	47	73	27
Tree damage	53	33	73	47	20	93	53
Cold weather	45	33	57	27	40	60	53
Health problems	42	63	20	73	53	33	7
Poor crop or fruit yields	37	27	47	47	7	60	33
Electricity supply problems	35	27	43	20	33	47	40
Domestic water problems	33	53	13	53	53	13	13
Hailstorms	33	43	23	53	33	13	33
Low river levels	32	20	43	40	0	53	33
Cyclones	27	27	27	40	13	20	33
Illness due to water scarcity	30	50	10	47	53	13	7
Poor fish availability	23	17	30	33	0	33	27
Crop disease due to lack of water	22	27	17	27	27	27	7
Crop damage due to mist or fog	20	13	27	20	7	27	27
Loss of water in ponds or swamps	20	7	33	13	0	40	27
Livestock health problems	15	17	13	27	7	27	0
Malnutrition	12	17	7	33	0	13	0
Animal diseases due to water shortage	7	10	3	7	13	7	0
Food quality problems	7	10	3	13	7	7	0
Air pollution	7	3	10	0	7	13	7
Salinity	7	3	10	0	7	13	7
Arsenic in groundwater	5	7	3	7	7	0	7
River erosion	3	3	3	7	0	0	7

Source: Authors' analysis of interviews.

Drought and Water Shortages

The most widespread area of concern raised in focus groups and individual interviews was the need for sufficient water for crops, trees, fish, livestock, and domestic use. In all focus groups, and all but two interviews, drought-related problems were raised by respondents or discussants. These concerns were articulated in terms of a falling groundwater table, reduced rainfall, declining river levels, reduced water in ponds and swamp areas, and groundwater contamination by arsenic and saltwater.

Responses about water shortages tended to conflate concerns about declining groundwater and river levels with perceptions of reduced rainfall, so it was difficult to separate the different perceived causes of drought. Studies of the hydrology of the Ganges system show that river flows have declined in dry seasons and increased in wet seasons, particularly on the western side of the country. This has been linked to diversion of river water in India due to the Farakka Barrage (Mirza 1997, 2004).

Problems with accessing groundwater were cited at a similar frequency across all AEZs and all districts. Men and women tended to cite problems accessing groundwater for crop irrigation in similar frequencies, with men citing groundwater problems slightly more frequently (Table 3.1). However, women cited problems with accessing groundwater for domestic use more frequently than men. Women seemed to be more concerned with household health problems (Table 3.2), due to water shortages, and possibly problems with livestock health, due to a lack of groundwater. This probably reflects the gendered division of labor in rural Bangladesh—where women are more responsible for managing domestic water and tend livestock near homesteads, while men are more likely to manage irrigated agriculture.

Table 3.2 Frequency of citation in focus groups and interviews of water problems and disease by gender

Water problem	Women overall	Men overall
	%	%
Groundwater problems overall	67	90
Problems with domestic water	53	13
Concerns with illness overall	63	20
Concerns with human diseases due to lack of water	50	10
Concerns with animal health due to lack of water	10	3
Concerns with crop diseases due to lack of water	27	17

Source: Authors' analysis of focus group interviews.

Declining river levels were most frequently cited as a problem in the western area of the country. This is presumably a significant problem in this area due to the importance of the Gorai River in providing irrigation water, and its falling levels in dry months due to the impact of the Farakka Barrage in India (Mirza 2004). All AEZs except the Northern and Eastern Hills and Madhupur Tract cited declining river levels as a problem. Participants in the floodplain areas in Rangpur, Jessore, Mymensingh, the *beel* and *haor* basin areas in Khulna and Naogaon, the Barind Tract areas in Naogaon, and Dinajpur, and tidal floodplain areas in Barguna and Laxmipur all cited declined river levels as a problem for water shortages.

Storms and Wind

After problems with drought and access to water, storms and wind were the next most frequently cited climate-related problem. However the findings were more ambiguous. Some respondents claimed that storms were increasing in number and force, while others claimed that they were occurring less frequently. There was more consensus that crop-damaging hailstorms were more frequent. There was also a widespread fear of lightning strikes—which are sometimes fatal. In the spring and early summer months, thunderstorms are common. Respondents reported that the timing of these storms had become less predictable.

Respondents in the southern coastal sites in Barguna were most affected by cyclones—the respondents reported that Cyclone Sidr in November 2007 and Cyclone Aila in May 2009 particularly

affected them. Those affected reported considerable loss of life and also longstanding salinity of groundwater in the area after the cyclones. The other impacts were damaged crops, houses, and trees and livestock losses all of which are important economic assets.

Unseasonal Temperatures

Fifty-one cases (focus groups and interviews), or 85 percent of respondents, discussed difficulty coping with what were perceived as higher temperatures in comparison with several decades ago. A smaller number (27 cases or 45 percent) reported being affected by unseasonably cold weather that affected crops—especially when accompanied by foggy weather. In general respondents were puzzled by atypical temperatures in particular months. Respondents coupled hot weather problems with water supply problems, even during the monsoon season. However, it is not possible to support these perceptions of temperature trends with trends in temperature data. It is also unlikely that these perceived changes are generally seen to be due to climate change given the general inability of respondents to distinguish long term climate change from short- or medium-term climate variability.

It is difficult to link predicted higher temperatures with increases in daily irrigation requirements. Shahid (2010b) predicted increases, particularly for dry season *boro* rice. Though Thomas et al. (2013) suggests that agricultural adaptations, such as changed planting dates, may allow farmers to avoid higher temperatures and increased demand for irrigation. Thus, it is not yet clear what impact increased temperatures will have on groundwater scarcity.

Flooding

Flooding is an annual phenomenon in Bangladesh with about 20 percent of the area of the country flooded in most years, but up to 70 percent in extreme floods (Mirza 2001). It is likely that serious flooding will increase with climate change, although this is by no means certain. Many of our study's participants considered that floods were occurring with less intensity and frequency than in the past. This may be due to embankments and other measures adopted in their local areas. Many participants shared stories they heard from parents or remembered as children about big floods that took place many years ago. Impacts of the floods included loss of many lives, severe damage to houses, roads, and other properties, death of poultry and domestic animals, and land for cultivation remaining inundated for long periods of time. Current floods were described as causing less damage, although diarrhea and other water-borne illnesses were still considered a problem.

Crop Damage

In some of the AEZs—especially in the floodplains, Barind Tract, Himalayan Piedmont Plain and *beel* and *haor* basin—thick fog or mist was mentioned in the discussions. This is slightly different from regular fog. It would appear suddenly and last longer than usual, sometimes through mid-morning of the next day or even for several days. This fog was blamed for causing insect infestation of crops, such as lentils and mustard, and for lowering crop yields. Crop damage also occurred due to storms, cyclones, hail and flooding. The greatest perceived threat to crops was caused by water shortages.

Illness

Focus groups and interviewees cited illness problems associated with the following causes in the order of frequency (Table 3.3).

Table 3.3 Causes of ill-health related to climate

Frequency	Cause
1.	Hot weather
2.	Domestic water problems
3.	Storms and wind
4.	Flooding
5.	Cold weather
6.	Cyclones
7.	Pollution
8.	Food availability
9.	Food quality

Source: Authors' analysis of focus group interviews.

It is possible that the environmental changes caused by climate change and related factors will adversely affect rural people's health. Our respondents cited increased temperatures in the hot season as causing health problems. This hotter weather can cause diarrheal diseases, dehydration, and aggravation of cardiovascular and respiratory diseases (Shahid 2010a). Lack of clean water for drinking and washing was also cited, as these can lead to infectious and diarrheal diseases, as does inundation by floodwater. Our respondents also reported that crop damage and crop diseases due to unseasonal weather were leading to problems of food quality and availability, sometimes causing illness.

Deaths and injuries during cyclones and storms were also cited. Throughout the years, the number of deaths and injuries has varied greatly. For example, mortality in the cyclone of April 1991 reached approximately 139,000 (Shahid 2010a). In 2007, during Cyclone Sidr nearly 3000 people lost their lives and a similar number were injured (Shahid 2010a). These lower casualty figures in recent times can, to some extent, be attributed to more effective early warning and the construction of a large number of cyclone shelters after 1991.

In addition to the direct problems caused by illness, the costs associated with treating illnesses can also damage households. For example, a study of 450 households in Khulna and Rajshahi districts estimated that on average households spent 9,323 Taka per year for the treatment of climate sensitive diseases and sickness (Haque et al. 2013). Less than half of the funds came from savings. The remainder came from various sources, including the sale of family assets. Losses of assets due to distress sales can cause irreparable damage to households and can lead to downward spirals into chronic poverty (Davis 2011).

It is possible that some aspects of climate change could improve health—especially if climate change leads to higher winter temperatures. However, in this study, no respondents commented on this possibility.

Salinity

Salt water encroachment was a particular problem in the southern coastal district of Barguna in the coastal floodplain area where the study site was located. There were also mentions of salinity problems in the Laxmipur and Chittagong sites. In Barguna, respondents claimed that the most serious saltwater encroachment problems occurred due to the flooding caused by Cyclone Sidr in November 2007. It is likely that salinity in groundwater will also lead to health problems, particularly for pregnant women (Vineis, Chan, and Khan 2011; Ehmar 2013).

Adaptation and Coping

Discussions about adaptation to climate change were dominated by concerns with water supplies for irrigation. Men were more likely to raise this as an adaptation strategy than women. Men were also more likely to talk about changing cropping patterns—in some cases not growing crops in seasons with water shortages or rainfall unpredictability (Table 3.4).

Table 3.4 Percentage of focus groups and interviews mentioning main types of potential or actual climate change adaptation

Adaption type	Overall	Women	Men	Female focus groups	Female interviews	Male focus groups	Male interviews
Improved irrigation	85	77	93	80	73	100	87
Changed cropping patterns	58	53	63	73	33	67	60
Changed livelihood	58	40	77	53	27	73	80
Loans or distress sales	20	37	3	40	33	0	7
Migration	17	13	20	20	7	20	20
Disaster relief	2	0	3	0	0	7	0

Source: Authors' analysis of focus group interviews.

Irrigation Strategies

Men were more interested than women in improved irrigation as an adaptive strategy. Discussants expressed the desire to have access to deeper tubewells and motorized pumps—often referred to as *shallow machines*—to pump water from ponds, rivers, and canals. Many discussants explained that they were often paying for irrigation water from deep tubewells controlled by the more powerful and wealthy in their villages. Also, unreliable electricity supplies were making irrigation difficult at key times. There was also concern that many shallow tubewells and some deep tubewells were drying up in the driest times of the year, hindering irrigation and reducing crop yields.

Cropping Patterns

Cropping patterns have changed considerably in Bangladesh since Green Revolution technologies were introduced from the 1970s. High-yielding varieties of cereals and new crops such as maize and potatoes have become widespread. These new crops have tended to be more dependent on irrigation water, which in the recent past has been readily available from groundwater aquifers and rivers across most of Bangladesh. In the monsoon season, *aus* and *aman* rice crops could be irrigated by rainwater, but as the winter *boro* rice crop has become more important, irrigation has become more critical.⁸ However, now many farmers are expressing concern about being able to afford to irrigate dry-season crops because of the lowering of the ground water table and the associated decline in river, pond and, swamp levels. They also cited increased electricity and diesel costs associated with pumping water. With these changes, as well as increased temperatures, it is likely that cropping patterns will change. Some of the increases in yield associated with Green Revolution technologies may also be placed in jeopardy. This is also a conclusion supported by Thurlow et al. (2012) who predict that climate change may reduce dry (winter) season (irrigated) *boro* production more than wet season *aus* and *aman*, and increase food insecurity overall.

⁸ *Aus* rice is direct-seeded or transplanted in the pre-monsoon period (April-July) and harvested in August; *aman* is transplanted at the onset of the monsoon in June-July and harvested in October-December; *boro* grows through the dry season (December-May).

The interviews and discussions highlighted some of these widespread problems. Some farmers explained that they used to rely on rainwater for *aman* rice but can no longer do so and that they no longer cultivate jute and sugarcane because of insufficient water. Other farmers explained that they could no longer grow potatoes for lack of irrigation water. In some cases, trees were being planted or land was being left fallow in areas used for arable crops in the past due to difficulties with irrigation water.

Livelihood Changes

Due to increased costs of agricultural production, primarily due to increased irrigation costs associated with the need to access water from deeper tubewells, many discussants reported that agricultural workers from their communities were changing their occupations. In the Chittagong hill tract area, people were cutting and selling firewood instead of growing crops. Others from the Chittagong and Laxmipur sites were moving to Chittagong city in search of urban-based jobs and others were working overseas—mainly in the Middle East. Those from the other sites were moving to Dhaka—usually for urban-based manual work. People who had assets, such as land or livestock, were better able to fund small businesses as they changed their livelihoods. Others who had few assets were more likely to work as agricultural day laborers on other people's land. Others were doing other forms of low-paid manual and transport work such as working in brick-making factories, cutting wood, or driving rickshaws.

Loans or Distress Sales

A smaller number of people—predominately women—discussed adapting to the changes they were facing by taking out loans in order to meet consumption requirements or selling assets such as livestock or land. NGO loans were widely available in all the research sites. While they are useful for those with the ability to use them as capital in income-generating small businesses or projects that have assets that appreciate, using loans to cope with crises can lead to a downward spiral of increasing debt and impoverishment. The use of loans for coping in crises draws attention to the need for other forms of support, which may enable people to maintain their households without damaging their future security by losing productive assets or incurring debt.

Migration

Migration of various kinds was mentioned as an adaptive strategy. In some cases, it consisted of temporary migrant labor to other districts for agricultural work during harvest times. This is a common practice in Bangladesh when daily wage rates are higher in some districts due to labor demand. In other cases, there seemed to be a trend toward moving away from agriculture altogether and migrating to urban centers, such as Dhaka and Chittagong, because labor rates were higher in urban centers. One common strategy was to send sons to work abroad—mainly to the Middle East—and then live on the remittances sent home. In these cases, relatively large investments were made to pay for the initial costs for arranging the overseas job, travel, and visa. Respondents reported that they had sold or mortgaged land in order to pay for those costs.

Migration patterns could not be clearly identified in this research. However, other studies (for example, Hassani-Mahmooui and Parris 2012) predict that the most likely pattern of domestic migration due to climate change in Bangladesh will be from the drought-prone northwest of the country and cyclone-prone south towards northern and eastern districts. Given the importance of drought as a problem identified in this study, this predicted pattern seems plausible.

Group Activities

There are a wide range of government-supported, NGO-sponsored, and community-level group activities in rural Bangladesh. Cooperatives (*samiti*) help to solve common property problems, such as managing irrigation projects, fisheries, and forests, and work with women providing microfinance and other services to the rural poor. Government and NGOs also work together to provide a wide range of social protection

programs. One of the problems with this array of programs is the large number of organizations, departments, and ministries involved in their implementation. This allows administrative overlap, waste, and opportunities for corruption, particularly in government-administered programs.

Interviewees and discussants outlined many of the group-based programs and projects that were present in their communities. The services provided by NGOs primarily included microfinance services but also health, social protection, education, social, and agricultural services. In addition, local governments were working with farmers on irrigation projects, providing public health services, social protection, and disaster relief. In spite of these interventions, few of these services and projects were explicitly identified by respondents as fostering climate change mitigation or adaptation.

From this research and other research in this area, it is likely that the lives and livelihoods of rural Bangladeshis are already being damaged by trends associated with climate change. However, this study depended on local perceptions of climate change impacts and many respondents confused climate variability with climate change. Thus it is difficult to clearly assess climate change impact from these interviews.

Given the nature of current and potential future impacts due to climate change, it is likely that many solutions will involve existing groups and programs. Most existing programs are currently dealing with the climate change-related problems of management of common property and natural resources, agriculture, access to drinking and washing water, irrigation, cyclones, poverty, and vulnerability. Bangladesh will need to expand its ability to manage water resources, agriculture, and disasters in response to climate change. There are presently many approaches and programs, including group-based programs, which have been successful in the past in addressing similar existing problems, albeit on a smaller scale. Therefore, it would be sensible to consider scaling up existing programs rather than supporting the creation of parallel programs that address climate change adaptation in name only. Replicating existing approaches to common property management, agriculture, poverty reduction, social protection, women's empowerment, and sustainable livelihoods that have already proved successful should be encouraged. New approaches should only be introduced when existing models are unable to address new problems.

Those who are usually most vulnerable to the types of crises caused by climate change are inevitably those with low incomes and few assets (Brouwer et al. 2007). Group-based interventions should therefore focus on including these more disadvantaged people—including female-headed households—to avoid commonly experienced problems of sequestration of valuable assets and common property resources by wealthy and powerful community members. Group-based interventions are well placed to achieve this.

4. DISCUSSION

There is broad understanding that some of the trends likely to continue due to anthropogenic climate change in rural Bangladesh: (1) it is likely that temperatures will continue to increase; (2) extreme weather events will become more frequent; (3) groundwater levels will continue to decline; and (4) rainfall patterns will change. Some changes are complex and less well-defined: for example, groundwater levels are affected by snow melt in key river basins originating in the Himalayas; diversion of rivers for productive uses in India, particularly through the Farakka Barrage; and changes in temperature and rainfall and water extraction in Bangladesh.

This research provides further evidence that climate change is currently affecting people's lives and livelihoods in rural Bangladesh. The most critical change is the groundwater crisis that is affecting most areas of the country. Though a number of other factors not directly caused by anthropogenic climate change also contribute to this crisis, it is probable that higher temperatures and changed rainfall patterns are exacerbating existing water shortages. In coastal areas, it is also likely that salinity of groundwater will also spread to new areas (Vineis, Chan, and Khan 2011).

Local people in rural Bangladesh are adapting to these changes with varied success, while also incurring damage to their lives, livelihoods, and future security. Because of climate change and groundwater problems, agriculture in Bangladesh will continue to change and some of the gains made in rural incomes and crop productivity during the Green Revolution years may be jeopardized.

There are a large number of existing group-based programs, which have made significant contributions in previous decades to poverty reduction, improved agriculture, support of small businesses, management of common property, social protection, education, health and family planning, and disaster management. These programs have succeeded with the support of NGOs, government, and international development organizations. As climate change adaptation is increasingly needed in Bangladesh, it is likely that these cooperatives, groups and organizations will become even more important in supporting rural people as they adapt to more acute water shortages, changed cropping patterns, livelihood disruption, and vulnerability to natural disasters.

APPENDIX: THEME CHECKLIST FOR FOCUS GROUP DISCUSSIONS AND KEY INFORMANT INTERVIEWS

Theme 1: Climate History and Adaptation

Conception

During your lifetime, have you noticed any changes in climate?
What do they understand by 'climate change (CC)', examples or occurrences of climate change they experienced Occurrences of annual flood or storms – do you think those are signs of climate change?
Has the frequency of storms, floods, droughts, heavy rains increased over time?
Have you heard stories of any such big natural disasters from your parents?
Are natural disasters or shocks any different now than what you had heard from your earlier generation? If so, how?

Adaptation

How does this change in climate affect you and your community? What kinds of problems do you have to face because of impacts of CC? Is there any benefit or advantage of CC as well? If so, what are those?
What do you do to cope or adapt to the impacts of CC?
Do you think that these coping measures will be effective in future? Or, will they have to be changed?
To adapt to the impacts of CC, do you take separate short-term and long-term measures?
Do you face any obstacle, challenge or constraints when undertaking the adaptive strategies or coping mechanisms to deal with the effects of CC?
What tools, resources, information, interventions are needed to adapt to the impacts of CC or overcome the barriers you mentioned?
Do women have to face more obstacles? Is it harder for women to have access to resources needed for coping with the impacts of CC or overcoming the obstacles you mentioned? If so, please explain how.
Are the impacts of CC comparatively more for people engaged in a particular profession, livelihood practices or group? If so, how?

Information

Where do you get your information about these changes in climate?
How reliable are these sources of information?
Do you get informed of imminent natural disasters? Who informs you, or where do you get that information from – *upazilla* weather office/ *upazilla* chairman/radio, TV/community people?
Do you need any CC related information for decision making in agricultural works? If you do, where do you get that information from?
Do women face any problem in getting that information?

Theme 2: Group-based Approaches

Groups

Information on groups active in the area
What are the most important or effective groups or organizations in this village?
How did this group form?
What are the main objectives or purpose of the group?
Which activities does this group undertake?
Who are members of the group?
How effective is the group at meeting its objectives?
How do you think this organization/group helps the community cope with or adapt to the climate changes discussed earlier?

Attitude

In the context of our past discussion, what do you feel is more effective in adapting to impacts of CC - individual initiatives or group based approach?

What more can be done by the government/local governance or Upazilla Chairman to make group based approaches to be more effective?

Is this group based approach in any way connected to increasing food security (by increasing agricultural production), increasing asset (by reducing loss and damage), increasing co-operation and exchange of information among community people? Can these be seen as the success of group-based approach?

How can women be encouraged to participate in such groups?

Strengthen their decision making power in the household and/or agricultural issues?

Theme 3: Gender and Assets

What are the most important types of assets in the village?

Where did this asset come from?

Who owns this asset?

Who controls this type of asset?

What happens to this asset in the case of death or divorce of household head?

Has this type of asset helped you cope with the aforementioned (see tool 1) climate shocks?

Are you aware of reforms in the existing policy by the government or interventions by the government that have affected your assets?

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2033 K Street, NW
Washington, DC 20006-1002 USA
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Fax: +1-202-467-4439
Email: ifpri@cgiar.org