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FINAL REPORT

USAID/BANGLADESH COMPREHENSIVE RISK AND RESILIENCE ASSESSMENT

September 2016

This document was prepared by TANGO International.

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Acronyms

ADB	Asian Development Bank
ANC	Antenatal care
ARI	Acute respiratory infection
BBS	Bangladesh Bureau of Statistics
BIGD	BRAC Institute of Governance and Development
BL	Baseline
BWDB	Bangladesh Water Development Board
CARE	Cooperative for Assistance and Relief Everywhere
CFPR-TUP	Challenging the Frontiers of Poverty Reduction – Targeting the Ultra-Poor
CHT	Chittagong Hill Tract
CLP	Chars Livelihood Programme
CP	Country Programme
CTG	Caretaker government
DHS	Demographic and Health Survey
DFID	Department for International Development
EWS	Early Warning System
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FFP	Food for Peace
ER	Enhancing Resilience
FTF	Feed the Future
GBD	Ganges-Brahmaputra Delta
GDP	Gross Domestic Product
GoB	Government of Bangladesh
IFPRI	International Food Policy Research Institute
IPCC	International Panel on Climate Change
IWGIA	International Work Group for Indigenous Affairs
IWRM	Integrated Water Resource Management
KWASA	Khulna Water Supply and Sewerage Authority
LCG	Local Consultancy Group
MYAP	Multi Year Assistance Program
NGO	Non-Governmental Organization
NSSS	National Social Security Strategy
ODI	Overseas Development Institute
OLS	Ordinary Least Squares
PROSHAR	Program for Strengthening Household Access to Resources
RC	Resilience capacity
SHOUHARDO II	Strengthening Household Ability to Respond to Development Opportunities II
TANGO	Technical Assistance to Non-Governmental Organizations
UNCHR	United Nations Commission on Human Rights
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund

USAID	United States Agency for International Development
USAID BFS	United States Agency for International Development Bureau of Food Security
WASA	Water Supply and Sewerage Authority
WB	World Bank
WEAI	Women's Empowerment in Agriculture Index
WFP	World Food Programme
WHO	World Health Organization
ZOI	Zone of Influence

Executive Summary

The last two decades in Bangladesh have seen progress in poverty reduction. Individual projects have demonstrated positive results in core areas of development in the country such as agriculture, health, and emergency planning. However, these positive outcomes have been insufficient in terms of geographic coverage, impact on different economic groups, effects on men versus women, and effects on different vulnerable groups. Moreover, the sustainability of impacts is continually threatened given Bangladesh's increasingly complex risk environment. Population growth, climate change, fluctuating global markets, political instability, inadequate governance mechanisms and human resource capacity to manage these risks are major challenges and merit a reexamination of current development strategies. Given Bangladesh's topography, long and complex coastline, high population, and increasing urbanization, of particular concern are climate projections of more frequent and intense drought, rainfall, sea-level rise, and cyclones over at least the next 20 years. These recurring shocks and stresses, already a substantial part of Bangladesh's risk profile, will demand significant resilience from Bangladeshi households, communities, and systems to prevent declines in development outcomes such as backsliding into poverty. USAID defines resilience as, "The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth."

This risk and resilience capacity assessment seeks to inform the USAID Bangladesh Country Development and Cooperation Strategy, future program design, and current program implementation. The intended audience is USAID Bangladesh, its partners, and other stakeholders. Using a resilience framework, the assessment aims to provide a comprehensive understanding of Bangladesh's complex risk environment and the capacities of people, households, and communities to mitigate, adapt to, and recover from the shocks and stresses they face. This approach assesses contextual factors such as social, political, ecological, and economic systems and identifies vulnerabilities in the local context. The assessment draws on literature provided by USAID; qualitative risk and resilience capacities data and narrative from the Food for Peace endline surveys; assessments and evaluations pertaining to risk and resilience in the Feed the Future (FTF) Zone of Influence (ZOI); IFPRI data on movements into and out of poverty; a study by the Overseas Development Institute on sustainable poverty escapes and backsliding in Bangladesh; maps developed by GeoCenter on the impacts of specific shocks and stresses; and other relevant reports and papers identified in online searches. The report covers areas considered most vulnerable to prevalent shocks and stresses, including but not limited to the FTF ZOI in the Khulna and Barisal divisions in southwest Bangladesh.

The main limitation to this review is the scope of academic and grey literature that is written from a resilience perspective in the Bangladesh context. There is a particular gap in terms of resilience-oriented impact evaluations of development projects. To mitigate this challenge, we have brought in more recent analyses conducted using resilience measurement methodology on existing data from select USAID-supported projects.

Main findings: shocks and stresses. Bangladesh's geographic features and location between the Himalayas and the Bay of Bengal leave it exposed to numerous natural shocks, particularly floods, flash floods, drought, salinity and cyclones. River and urban flooding have increased the spread of vector- and waterborne illness, especially as improper waste management clogs drain channels and water run-off, contributing to freshwater contamination. Increasing water salinity and drought are compounding the freshwater crisis. Other major impacts of flooding and drought are

large crop and asset losses that can stress food security and strain income and job opportunities in impoverished rural and disaster-prone regions.

Climate change aggravates Bangladesh's vulnerability to these extreme weather events: higher temperatures and melting glaciers are intensifying the occurrence and severity of cyclones, floods, and drought. Rising sea levels, increasing temperatures and melting glaciers are creating more erratic and unpredictable natural hazzards that contribute to overall vulnerability. Large climate shocks create massive damage and loss of assets that can place stress on household incomes and on national economic growth and stability. In addition, natural shocks have downstream health and economic consequences, forcing significant livelihood changes. For example, climate-related shocks are driving migration to urban centers. This rapid urbanization is poorly planned, taxing the urban infrastructure and environment. Slum dwellings are densely populated, without the necessary public services to prevent the spread of disease.

Growing political uncertainty and security risks are contributing to a weaker governance structure, placing economic and civil stability in question while potentially interfering with Bangladesh's ability to court future international investment and aid to help reduce poverty and build resilience.

Main findings: vulnerable groups. Chronically vulnerable groups in Bangladesh include people who are exposed to physical hazards such as natural disasters, the chronically poor, the rural poor, women and children, street children, people with disabilities, and Rohingya refugees. The poor are especially vulnerable to natural disasters due to their higher level of exposure, both physically and in terms of ecosystem- and climate-dependent livelihoods such as agriculture and fishing. Low levels of empowerment and cultural norms, such as those restricting women's mobility, increase women's vulnerability to disasters. Children are particularly vulnerable to food insecurity and the effects of malnutrition. Poverty escapes – and, conversely, poverty backsliding – are each correlated with different sets household characteristics and conditions.

Main findings: well-being outcomes. Resilience is linked to development outcomes, and both are influenced by absorptive, adaptive, and transformative capacity at individual, household, and community levels. Outcomes related to resilience include food security, poverty, and health and nutrition. Food security and nutrition outcomes have been shown to be improving in the FTF ZOI, as evidence from USAID Title II projects indicates; this may be attributed to program interventions but also to national trends. Systems-level outcomes have also seen progress, though enhanced attention is needed on building the capacities to support these outcomes, such as governance work and improvement and expansion of critical infrastructure (e.g., roads, water resource management infrastructure, the electric power grid, and emergency response infrastructure).

Main findings: resilience capacities. Absorptive capacity is the ability to minimize exposure to shocks and recover quickly. Interventions in building and strengthening absorptive capacity have made strong contributions to resilience at the household and community levels. Analysis of data from both PROSHAR and SHOUHARDO II shows a strong correlation between absorptive capacity and improved food security outcomes in the face of shocks. Interventions to strengthen disaster risk reduction and response capacity have reduced loss of lives and assets. Strengthening absorptive capacity through disaster risk reduction interventions is critical, especially in an area as disaster-prone as Bangladesh.

Adaptive capacity is the ability to make informed choices about alternative livelihood strategies based on changing conditions. Access to information, such as information about climate trends

and work availability, contributes to adaptive capacity, and has been weak in some areas. For example, studies have shown that farmers tend to receive inadequate weather and climate information, which would otherwise help them make short- and long-term decisions about what crops to plant and when. Research on SHOUHARDO II provided strong evidence that to suggest that adaptive capacity – specifically in the form of bridging social capital, asset ownership, livelihood diversification, human capital, and aspirations and confidence to adapt – was a significant factor in helping households to mitigate the impacts of severe flooding in 2014.

Based on the IFPRI studies in the FTF ZOI, another important factor shown to strengthen adaptive capacity is having higher-value assets such as land, and savings, both of which help households avoid falling into poverty and increase household diet diversity. In addition, those who have access to commercial loans are better able to invest in ways that will increase their future ability to adapt. For example, investments in mechanized irrigation can improve production and income level, which in turn can enable further beneficial practices such as fertilizer use, and open doors for more investment in human capital (education).

Transformative capacity is comprised of system-level enabling conditions such as governance mechanisms, policies/regulations, infrastructure, community networks, and formal and informal social protection mechanisms that create an enabling environment for systemic change. Women's empowerment contributes to transformative capacity and has improved dramatically in the FTF ZOI between 2011 and 2015. However, uneven power relationships related to gender and other social dynamics negatively influence the distribution of relief aid. Bridging and linking social capital are important and contribute to transformative capacity but need to be balanced with increased institutional accountability to protect the most vulnerable. In SHOUHARDO II, the most robust evidence was found for the following factors as supporting resilience: bridging social capital, access to services, exposure to information, women's empowerment, village governance, and informal safety nets.

Recommended investments: Evidence from the academic literature and from USAID Title II projects suggests several sectors where past development investments have had a positive impact on resilience capacities. There is also evidence from post-shock monitoring and studies that these capacities supported households to cope with and recover from actual shocks. A multi-pronged strategy including simultaneous, coordinated interventions in several sectors – and at multiple levels – is recommended, as this is likely to have a more powerful and longer-lasting impact on resilience than single-sector interventions.

Investments that enhance **absorptive capacity** have given the strongest positive results in terms of households' abilities to prepare for and cope with shocks. This validates further investment in areas such as emergency awareness and preparedness. Establishing, maintaining, and updating early warning systems is critical in this regard. These systems need to be designed with the awareness of, and complementary to, traditional, indigenous, mechanisms for early warning – tapping into and building on autonomous strategies for gathering, processing, and disseminating early warning information. A related focus area is emergency shelters. More work needs to be done to ensure shelters have the proper mechanisms and facilities to receive and accommodate vulnerable groups. This starts with ensuring transportation to the shelter is available for people who are far from the facility, and for those with limited mobility such as the elderly and disabled. It also includes making sure that the shelter is sensitive to gender, and age-specific protection needs, such as those related to privacy and cultural norms.

Investments that build **adaptive capacity should include educating** people about how to plan for future scenarios and help prepare them to modify their practices and behaviors in response to those scenarios. One key area on this regard is supporting smallholders to invest in and maintain physical assets and adopt agricultural technologies shown to increase farmer income and food security. Examples include increasing farmer access to mechanized irrigation and promoting crop diversification into higher-value and high-nutritive value varieties that farmers will ultimately be able to cultivate without project support (e.g., seeds and other needed inputs will be available and accessible). More attention is warranted on understanding the dynamics of traditional versus introduced farming technologies, and how to effectively promote smallholder adoption of improved practices.

Non-farm livelihoods are also an important area for increasing adaptive capacity. It is important to ensure that household livelihoods – even when diversified – are not all susceptible to the same risks. Having a higher share of non-farm income sources has been shown to help prevent backslides into poverty, as well as to increase income and household diet diversity.

Given the normalization of migration as an adaptive strategy in the face of shocks and stresses in Bangladesh, there is potential for work that supports migrants and their families to understand and mitigate the risks associated with migration, and to help them optimize the benefits of migration as a livelihood diversification strategy, such as by increasing connections in rural areas and developing export-oriented industries.

While microcredit interventions receive mixed reviews in terms of their impact on long-term resilience (e.g., households may use loan funds for immediate expenses rather than productive investments or investments in human capital), there is potential to tailor microcredit approaches so that they respond to specific scenarios. For example, some may be specifically recovery-oriented and thus structured so as not to further burden already-strained households, such as by offering contingent repayment systems and other measures that prevent the borrower from entering a debt cycle.. In all cases, consideration should also be taken of the most vulnerable groups, who often face barriers to entry such as the inability to pay membership fees, and who may have more difficulty keeping to an installment plan given the challenges they face in meeting basic needs.

Investments in human capital – namely, in education and health – have multiple short- and long-term benefits and should continue. Education helps people avoid poverty traps and poverty backslides. Similarly, health should continue to be a critical focus, given its importance to child development and well-being outcomes of both children and adults. This is especially true in light of escalating health challenges related to climate change impacts, such as waterborne illness and water contamination from flooding (as well as increased salinity) in the context of inadequate water and sanitation infrastructure, especially in overcrowded urban areas. Bangladesh's current level of health human resources is severely limited to meet the demand for services, especially in rural areas. In addition, health shocks compound the vulnerability of households affected by simultaneous or shocks and stresses, given the limited availability of health insurance and the financial strain that medical expenditures place on households.

Investments in **transformative capacity** are critical to building systems that can prepare for, respond, and govern in response to current and future shocks and in an inclusive way. Governance is an overarching area for investment, given the need to improve local institutions' capacity to respond to recurring shocks and stresses and plan for the future effectively. This

involves supporting technical and managerial knowledge and skill-building in institutions (traditional, village/local, district and national levels) in key sectors, as well as ensuring accountability mechanisms are in place and designed to ensure inclusiveness and participatory processes. Specific sectors where support should be directed include water resource management, emergency preparedness, and possibly agricultural and health extension.

Another realm of systems-level work – also related to governance – is civil infrastructure, particularly roads, water and sanitation infrastructure, emergency infrastructure (e.g., interconnectivity of multi-level early warning systems; shelters), electric power, and telecommunications). Bangladesh has many geographic areas of high vulnerability (e.g., coast, floodplains, urban slums) as well as populations with limited access to these types of infrastructure, or lives with poor-quality infrastructure, because of a range of geographic, social-economic, and cultural factors. Improving coverage of, quality of and equitable access to these systems is essential for long-term resilience. Regarding early warning specifically, the development of regional climate models to inform adaptation strategies and agricultural and economic policies will be essential analysis, particularly as climate change will have different effects on different regions within Bangladesh and thus different demand types of preparation, response, and adaptation.

The strength and connectivity of market infrastructure will be aided by work on roads, communications, governance, and other systems-level work, however continued and additional work on pre-market activities will remain critical to supporting resilience in Bangladesh. Work areas include improvements in the quality of agricultural inputs (already underway via the Feed the Future Agro-Inputs project), and especially the development and capacity building of marketing collectives.

Systems approaches designed to benefit the population as a whole, should not lose sight of the most vulnerable populations, who may not be able to take advantage of the full range of household- and community level resilience interventions. These include the elderly, orphans and vulnerable children, and people unable to work due to illness or other limitations. These subgroups may need temporary or permanent assistance not only to cope with shocks and stresses, but to meet basic needs. For this reason, resources need to be allocated to social safety nets. Development partners can work together to help to establish and improve social protection mechanisms through technical assistance, and in designing targeting strategies and graduation models.

Work in the transformative arena – as with all capacities – should continue to emphasize women's empowerment. There is substantial research indicating the centrality of women's role to positive development and resilience in Bangladesh. While there have been intervention-level successes in gender-sensitive programming and at the national policy level (e.g., national policy for the advancement of women), women still face strong sociocultural constraints to meaningful participation in decision-making in the household and in relation to governance structures.

Finally, the ability to know the extent to which current and future development investments build resilience capacities is contingent on planning, implementing, and measuring using a resilience lens. Resilience measures should be built into all investment M&E frameworks to capture positive changes related to building resilience.

1. Introduction

Poverty in Bangladesh has declined impressively from 60 percent (1991-92) to under 32 percent in 2010 (Bangladesh Bureau of Statistics [BBS] 2010). However, the large proportion of people who remain in poverty, hover around the poverty line, backslide, or become impoverished – about a quarter of the population examined in a national recent impact study[1] (Scott and Diwakar 2016) – is indicative of the complex risk environment in which Bangladeshis live and USAID programs are implemented. This underscores the importance of understanding the risk environment – and building resilience[2] to the recurrent shocks and stresses associated with it – to ending extreme poverty in the country.

The literature and data on risk and the impact of shocks and stresses on well-being in Bangladesh is extensive. However, the bulk of this literature and data is sectoral or focused on a sub-set of shocks and stresses. A comprehensive understanding of the complex risk environment and the compound (or cumulative) nature of the shocks and stresses associated with it is lacking, as is an understanding of the current capacities of individuals, households, and communities to mitigate, adapt to and recover from these shocks and stresses. The current review is designed to address these gaps: it aims "to provide the USAID/Bangladesh, its partners and other stakeholders with a comprehensive and consolidated risk and resilience capacity assessment to inform the USAID Bangladesh Country Development and Cooperation Strategy, future program design and current program implementation."[3] It focuses on the Feed the Future (FTF) Zone of Influence (ZOI) in the Khulna and Barisal divisions in southwest Bangladesh.

The review uses a resilience framework (Annex 1; component indicators in Annex 2) to assess contextual factors such as social, political, ecological, and economic systems and identify vulnerabilities, risks, and priorities for building resilience. Based on secondary sources, it draws on academic and grey literature provided by USAID; qualitative risk and resilience capacities information from the FFP surveys; IFPRI data on movements into and out of poverty; a USAID BFS-commissioned study from ODI on sustainable poverty escapes and backsliding in Bangladesh; GeoCenter maps of the impacts of specific shocks and stresses; and relevant assessments and reports identified through online searches.

This report is organized into sections that assess (1) the range of risks, shocks, and stresses that contribute to vulnerability and undermine resilience, (2) the vulnerability of different groups and geographic areas, (3) well-being outcomes, and (4) the absorptive, adaptive, and transformative resilience capacities that enable households and communities to prepare for and respond to shocks, and what can be done to strengthen those capacities. The last section recommends specific capacities and sectors for future resilience investments.

2. Shocks and stresses

2.1 Types of shocks

2.1.1 Natural

[1] Scott and Diwakar (2016) analyzed panel data from 1997-2010 survey rounds of the Bangladesh Chronic Poverty and Long Term Poverty and Impact study in order to investigate poverty dynamics. The study is not nationally representative; however, it is considered to "broadly characterize the variability of livelihoods found in rural Bangladesh" (Quisumbing 2007, cited in Scott and Diwakar 2016: 2).

[2] USAID defines resilience as "The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth."

[3] Scope of Work.

Geographical location is a tremendous influence on Bangladesh's vulnerability to shocks and stresses. Located between the Himalayas and the Indian Ocean, Bangladesh has a marshy tropical coastline, large floodplains and low sea elevation, which create constant exposure to natural shocks and disasters. The country is possibly the "single largest concentration of people in a highly disaster-prone environment" (Benson and Clay 2002: 19; Smith and Frankenberger 2016; Toufique and Islam 2014; Sarker et al. 2012). Globally, Bangladesh ranked as the sixth-most affected country on the Climate Risk Index for the 1994-2013 period, with 228 weather-related loss events (Kreft et al. 2014). (See Annex 7, **Figure 4**, for a map of flood and natural hazard shocks in Bangladesh).

Drought, flooding, water logging, cyclones, storm surges, coastal and riparian land erosion, salinity and sea-level rise comprise the more serious and regular natural shocks (Benson and Clay 2002; Toufique and Islam 2014; World Bank 2015). These shocks are not unique to any single region and often overlap, though Toufique and Islam (2014) note that certain regions or zones tend to be more prone to a specific type of shock. Projected climate change impacts have significant implications for natural shocks in the coming decades:

> "Extreme weather events are projected to become more frequent in South Asia, including heat waves and excessive rainfall. Tropical cyclone intensity is also expected to rise by 10–20 percent and sea surface temperature is expected to increase by 2–4°C. Glacial and sea-ice melt and the expansion of the oceans due to higher mean temperature suggest that sea-level rise is certain (the minimum rise of about 40 centimeters by the end of the century is projected based on the most conservative climate change estimates)" (Mani and Wang 2014: 30).

Drought-Prone Northwest/West Region: Drought affects 47 percent of the total area of Bangladesh and 53 percent of the population (Alauddin et al. 2014). The extent of drought effects can vary during the year, affecting almost "2.3 million hectares of cropland from April to September and 1.2 million hectares in the dry season from October to March" (Deb et al. 2013: 1). Monsoon season drought results in estimated losses of 1.5 million tons of rice production annually. Additionally, erratic rain patterns coupled with altered temperatures during the monsoon season can lead to a "perceived" extension of the dry season or to insufficient rainfall for agriculture, even in places threatened by floods, thereby placing a greater demand on irrigation and local water resources. Overexploitation of groundwater for irrigation, which might reach 58.6 percent of the total regional water supply, can also lead to more critical environmental problems such as heavy metal contamination and salinity (Deb et al. 2013; Toufique and Islam 2014). Unpredictable rainfall patterns during a drought regime are likely to shift the agricultural growth period and increase incidence of pests and vector-borne diseases in humans and crops. Drought's effect also extends to limited income and job opportunities, compromised future inputs and investments in agriculture for individual farmers, and impacts on regional food production and water resources.

Drought tends to be most prevalent in the Northwestern region of the country, directly affecting the agricultural sector and the livelihoods of rice farmers (Habiba et al. 2012; Sarker et al. 2012). Despite less exposure to other climate-change-related shocks, the northwest is considered to have a "lower adaptive capacity," demonstrated by its inability to produce wet-season Aman rice. Farmers depend solely on dry-season Boro rice, creating a predominance of mono-crop farming in the region and reflecting its limited agricultural opportunities (Toufique and Islam 2014). Such chronic crop failure has been linked to malnutrition, food insecurity, illness, famine, increased poverty, and conflict over limited drinking and irrigation sources (Habiba et al. 2012; Toufique and Islam 2014).

Coastal Region: With 600 km of coastline, the coastal belt comprises 30 percent of Bangladesh's geographical area and a third of its population (Fakruddin and Rahman 2015). A

study from 1972 to 2010 found both short-term (5-6 years) and long-term (10-16 years) changes in coastal land (Islam et al. 2011). Both land erosion and accretion were found along different islands and parts of the coastal areas, making permanent protections more challenging. Complicating matters along the coastline is Bangladesh's complex "geomorphologic location" and proximity to the Bay of Bengal, notorious for cyclone activity (Ahmed et al. 2013; Kahn et al. 2013; Toufique and Islam 2014). The destructive path of cyclones can be extensive and is often accompanied by tidal storm surges, flooding, and water logging. Cyclones can cause livestock losses, damage to housing, and inundation of farmland – leaving it carpeted with sand – and destroy mangrove trees critical to the Sundarbans ecosystem (Dastagir 2014; Ahmed et al. 2013; Jordan 2014). Storm and tidal surges can push saltwater further up Bangladesh's freshwater system, creating salinity issues almost 100 km inland. Cyclones can also aggravate water problems by damaging household latrines, thus increasing the risk of freshwater contamination and water-related illnesses (Shameem et al. 2014; Ahmeda et al. 2013).

The primarily rural coastal zone has 52 percent absolute poverty, and 25 percent extreme poverty (Fakruddin and Rahman 2015). The majority of coastline residents are low-income agricultural workers who live in structurally weak houses or are landless and relatively asset-poor (Akter and Mallick 2013; Pulla and Das 2015). The entire coastline is exposed to numerous natural hazards: cyclones, floods, tidal and storm surges, sea-level rise and salinity (Toufique and Islam 2014; Rahman and Kamal n.d.). About 830,000 million hectares of arable land and about 20 million people in Bangladesh's coastal areas are affected by soil and water salinity; this accounts for 70 percent of the total farmland in coastal and offshore regions (Shameem et al. 2014; Toufique and Islam 2014). Salinity can change the socio-ecological system "[manifesting] in scarcity of freshwater resources and transformation of agro-ecological system into [a] degraded state" (Shameem et al. 2014: 83). Increasing salinity along the coastline leaves inconsistent sources of water for drinking and irrigating croplands (see below). Upstream freshwater usage for irrigation and shrimp farming can further increase salinity intrusion, which can restrict crop preference and reduce grazing land, affecting farmers' agricultural and livestock income (Ahmed et al. 2013). For some, this has already resulted in livelihood changes, as farmers have shifted from rice farming to saltwater aquaculture, e.g., shrimp farming. This has increased coastal vulnerability as the region becomes more food insecure, now having to rely on in-country imports of rice and other produce.

Salinity is also a problem in western Bangladesh, where the Farakka Barrage[4] has caused a dramatic increase in soil and water salinity. Changes in water flow in the Farakka Barrage pose a major challenge for water flow in Bangladesh, particularly with upstream diversion of water during dry months, which increases salinity (Mahmuduzaman et al. 2014). Similar challenges lie with proposed upstream mega dams in India and China, expected to affect sediment levels and water availability (University of Minnesota 2016).

Urban Flooding /Waterlogging: Waterlogging, i.e., long-term inundation and soil saturation due to insufficient drainage, is an increasing problem due to changes in river flow, construction of river embankments, siltation of riverbeds rather than floodplains, and poor management of polder/embankment sluice gates (Awal 2014). Waterlogging is also affected by fluctuations of the Ganges-Brahmaputra Delta (GBD), in which most of Bangladesh lies (University of Minnesota 2016). The GBD is one of the largest deltas in the world and drains land from Bangladesh, Bhutan,

[4] The Farakka Barrage is across the Ganges River, located approximately 16 km west of the India-Bangladesh border in the Indian state of West Bengal.

China, India, and Nepal. Hence, a lot of water drains through Bangladesh, which is thereby affected by upstream events such as flooding, river diversion, and dam construction – all of which increase or decrease the amount of water and silt flowing into Bangladesh.

Urban areas within the GBD include Dhaka, Chittagong, and Khulna. Dhaka – with more than 16.4 million people in an area of approximately 300 km^2 (Shamsun et al. 2014).These urban areas have a long history of vulnerability to river and urban flooding, which has increased in recent years (Dasgupta et al. 2015; World Bank 2015). River flooding[5] in the eastern outskirts of Dhaka has affected informal settlements, while industrialization and illegal encroachment along city drainage systems, canals, lakes, and even rivers (e.g., Baku River) have congested runoff access and exposed the western portion of the city to greater and more regular urban flooding[6] (Dasgupta et al. 2015; World Bank, 2015).Cities in the coastal region, especially Khulna Division, experience serious waterlogging problems. In the 1990s, over 100,000 acres were waterlogged in Khulna, Jessore, and Satkhira districts, making agriculture impossible (Awal 2014). Satkhira (Khulna Division) experiences the most severe waterlogging and has experienced year-round waterlogging (Awal 2014). Khulna City is particularly vulnerable because of its low elevation just 2.5m above sea level and its location in a flat, poorly draining delta plain (ADB 2011). In 2011, Khulna City was experiencing worsening urban flooding/waterlogging, which could increase along with climate change-related rainfall and rising sea levels (ADB 2011: 4). ADB has implemented a drainage improvement sub-project in the city. Another factor contributing to flooding is strong storm surge, especially due to the narrowing of the Bay of Bengal at the north, near the city of Chittagong (ADB 2011: 2).

Urban flooding can be symptomatic of several issues and even occur from normal rainfall. Rapid urbanization can result in unplanned urban development, which can block both natural and constructed runoff points. Additionally, urban squatting and industrialization tend to occur in low-lying areas originally designated as rainwater retention ponds (World Bank 2015). The already-poor quality of aging drainage infrastructure is exacerbated by poor planning of new infrastructure made of impervious materials (particularly roads) and a "failure to implement activities that reduce urban flooding" (Dasgupta et al. 2015: 5). Inadequate garbage collection can cause waste to block city drainage, allowing street flooding, preventing water from draining, and extending the duration of waterlogging. Floodwaters can inundate sanitation systems, contaminating water and spreading disease (see Section 2.1.4). As in rural settings, urban flooding can place the environment, infrastructure, assets, income, and livelihoods at risk.

Flash-flood-prone areas: Flash floods are caused by excessive rainfall during a given period and are sudden and without warning. In 2016, flooding occurred in 16 districts in Rajshahi, Rangpur, Dhaka, Mymensingh, Khulna, and Sylhet divisions[7] (Davies 2016). As of the publication of this report, nine water stations reported warning levels, flood, or severe flood levels in Bangladesh, with the majority of these in the southwestern part of the country

[5] River flooding refers to the inundation that occurs when excessive runoff from upstream catchments leads to the river channel's capacity being exceeded, resulting in water spilling over the bank; thus, the floodplain is flooded by water spilling over from the river channel. (Dasgupta et al. 2015)

[6] Urban flooding refers to the inundation that occurs after heavy-rainfall events, which causes runoff to exceed the capacity of the local drainage system. As a result, water remains stagnant in the built-up area for extended periods. This type of flooding is also known as rain flooding or waterlogging; however, these terms can also apply to a rural setting. (Dasgupta et al. 2015)

[7] Bogra, Sirajgonj (Rajshahi Division); Gaibandha, Kurigram, Lalmonirhat, Nilphamary, Rangpur (Rangpur Division); Faridpur, Madaripur, Manikganj, Rajbari, Shariatpur, Tangail (Dhaka Division); Jamalpur (Mymensingh Division); Kushtia (Khulna Division); and Sunamgonj (Sylhet Division)

(Department of Disaster Management, Bangladesh, n.d.). In 2015, flash floods affected Khagrachhari and Bandarban districts in the southeast, as well as Sylhet and Sunamganj districts in the northeast. In Bandarban alone, nearly 30,000 families were affected by flooding by mid-June 2015 (Emergency Operations Center and the Department of Disaster Management, Bangladesh 2015, as cited in Disaster Management Information Centre 2015).

Floods are a regular occurrence in the northeast, considered by Toufique and Islam (2014) to be the country's most vulnerable region. Northeastern flash floods occur regularly from April-May and as late as June, and are often accompanied by landslides, river erosion, river flooding, soil degradation and the loss of fishing grounds due to siltation of riverbeds and other bodies of water (Toufique and Islam 2014). Flash floods have a devastating effect on livelihood systems and inundate vast tracts of cropland, limiting agricultural potential and creating greater potential for food insecurity and shortages (Toufique and Islam 2014; Deb et al. 2013). Toufique and Islam (2014) indicate that only six crop varietals grow in the region, compared to 17-20 types in other regions of Bangladesh.

Contributing to the area's vulnerability are limited opportunities for diversification; poor health services, exacerbated by a high dependency ratio and average household size; and the poor state of infrastructure, which often permanently erodes from long periods of water logging, making access to health facilities arduous and time consuming.

2.1.2 Political

Bangladesh gained independence in 1971; however, democracy did not occur until 1991, when it became a parliamentary democracy. Since then, the democracy has been evolving as the country tries to create a transparent and inclusive electoral system. In 1990, following the overthrow of the authoritarian regime of General Hussain Muhammad Ershad, three major political parties came to a consensus that parliamentary elections would be monitored by a non-partisan, neutral caretaker government (CTG) to ensure elections that were "peacefully, fairly, and impartially" conducted (BIGD 2014: 7). The CTG system was formalized through the 13th amendment to the constitution, and managed the predominantly two-party elections successfully until 2014, when the 13th amendment was declared void and the CTG system was abolished. The Bangladesh Nationalist Party, one of the major parties, boycotted the 2014 parliamentary elections, which were marred by deadly violence that included loss of many lives and burning of polling stations. This questioned the credibility of the electoral process and the independence of the election commission, as the current Awami-League-led government won many of its seats in the parliament uncontested, and resulted in heavy national and international criticism.

This criticism has led to greater scrutiny of the state-citizen relationship and of participation and representation at lower institutional levels. Underrepresentation can stress civil and economic conditions, resulting in a lack of national governance and democratic accountability mechanisms to solve local conflicts, such as disputes over water rights and land access. The absence of government oversight can require the local community's "existing social relations and mutual support networks" to determine matters of political economy (Shameem et al. 2014: 85). Shameem et al. (2014) note that "new configuration" or challenges to these informal governance structures can result in "chaos and conflicts." One example of this was in the early 1970s when local farmers along the coastline were forced to sell or lease their land to outside businessmen with an established large shrimp farm. The land-grabbing resulted in protest, violence and killing and although the land was eventually returned to the farmers, the new shrimp farms were maintained, creating a permanent tension with surrounding crop farmers over water rights and salinization of

adjoining agricultural land (Shameem et al. 2014). This highlights the necessity for "a major focus of government plans" to improving land-use management in the wake of an escalating "food-deficit crisis in the agricultural sector" (Younus 2014). The growing concern for Bangladesh is the need to establish more concrete and transparent policies on the rights of production and land use, while still allowing access and shared use of public resources for rural farmers faced with establishing alternative livelihood strategies in the face of climate change.

Matters of political ecology can also place a greater strain on vulnerable populations. For example, while drought-prone areas are in need of relief, the downstream consequences (e.g., increased salinity) from over-irrigation from the Ganges River on the southwest coastal region should not be ignored (Shameem et al. 2014). Another example is the "fierce" competition by the poorest Bangladeshis for the "publically free and available" government-owned *khas* lands (Litchfield 2010). Despite land rights' comprising over 60 percent of all legal disputes in Bangladeshi courts, governance, control, and ultimately distribution of these lands is controlled by local gangs (Litchfield 2010; BIGD 2014). This demonstrates the need for inter- and intra-regional issues to be addressed at a national level, placing more importance on a transparent and well-represented parliament. As the election process becomes more corrupt, it can create costs (not just monetary) that can "discourage[e] economically disadvantaged but politically committed people to take part in the election race" (BIGD 2014: 20).

Political conflict between government forces and indigenous communities has plagued the Chittagong Hill Tract (CHT) in southeastern Bangladesh for decades. The region, home to 11 multilingual indigenous *Jumma* groups, has seen a number of confrontations over the years. One of the most notable conflicts occurred in the early 1970s between the Parbatya Chattagram Jana Samhati Samiti, the political arm of the Jumma communities,[8] and the Awami-League-led government forces. This resulted in the establishment of 500 military camps and the settlement of 400,000 Bengali people in the CHT as a government "counter-insurgency measure" (International Work Group for Indigenous Affairs 2012:10). While this confrontation resulted in the signing of the CHT Peace Accord in 1997 (Local Consultancy Group Bangladesh 2004), land disputes between Bengali settlers and indigenous peoples have persisted. Even after the official signing of the Peace Accord, implementation remains problematic, with attacks from Bengali settlers and claims of attacks perpetrated by law enforcement agencies (Panday and Jamil 2009). Questions of land disputes have led to issues surrounding control of resources, communal violence, and violations of human rights. Peacekeeping measures have been taken in recent years to promote sustained cohesion across the region through the government-led CHT Development Board and the volunteer-run Local Trust-Builders Network, implemented with by international aid agencies and and United Nations organizations (UN Development Programme N.d; Government of Bangladesh [GoB] n.d.).

Recently, Bangladesh has shown greater signs of political and civil unrest, and murder and other crimes have been on the rise in the past decade (BIGD 2014). Thirty-three journalists were killed between 2001 and 2014 (BIGD 2014: 42), and there has been a "wave of deadly attacks on foreigners, religious minorities and secular bloggers, raising fears that religious extremists are gaining a foothold in the country, despite its traditions of secularism and tolerance" (Associated Press 2016). According to the Global Terrorism Database, terrorist attacks have gone up from 18 attacks in 2012, to 465 in 2015 (Tribune Business Desk 2016). These attacks, as well as disappearances and extrajudicial killings that are often politically motivated, have economic and

[8] Parbatya Chattagram Jana Samhati Samiti. http://www.pcjss-cht.org/. Accessed August 31, 2016.

political consequences that play significantly into the resources available to help alleviate poverty, as Bangladesh relies heavily on international aid and foreign direct investment to spur public and private development initiatives (Khatun 2016). Political instability and security risks have eroded investor confidence: "Given political volatility and uncertainty, along with low infrastructural development, the country could only attract a small amount of foreign investment, which hovered around one percent of GDP in the last ten years (BIGD 2014: 79)." Consequently, political uncertainty can play a major role in civil and economic stability, principally in how Bangladeshis solve conflict and in the resources needed to alleviate the tensions that create conflict.

2.1.3 Economic

Economic shocks and stresses prevalent in Bangladesh include price shocks and downstream economic impacts of natural hazard events on national debt and growth, and on livelihoods.

Price shocks: Changes in fiscal policy and global markets, inflation, and market system failure can cause price shocks such as increased prices for food and other daily essentials. In 2011-2012, seven percent of households in Bangladesh were affected by increased food prices (Annex 7, **Figure 6**). Food price shocks occurred in Chittagong, Rangpur and Dhaka districts, with the highest proportion of affected households in Chittagong. The more vulnerable households are those dependent on non-agrarian livelihoods, such as rickshaw pullers (15 percent affected by price shocks).

National-level economic losses due to natural shocks: Overall damage from extreme weather events can affect national debt and growth. With investment considered a pre-condition for national growth, regular and significant economic costs from natural disasters can restrict overall GDP growth and prevent both private and public investment in development and poverty reduction (Habiba et al. 2012). In 2007, Cyclone Sidr resulted in over 3400 deaths and US$1.7 billion in losses and affected over 8.9 million people (Jordan 2014). Estimates from extreme flood damage in 2007 were in excess of US$1.1 billion in lost assets, 1110 deaths and 14 million affected people (Dastagir 2014). In 2009, Cyclone Aila caused US$170 million in economic damage, claimed 190 lives and affected 11 of the 19 coastal districts (Akter and Mallick 2013). A severe drought can also be especially damaging, as agriculture accounts for 26 percent of Bangladesh's GDP. The 2006 drought reduced Aman rice crop production by about 25-30 percent in the northwestern part of Bangladesh, which caused abnormal increases in prices across the country (Habiba et al. 2012).

Economic shocks affecting livelihoods: Natural shocks can lead to downstream economic shocks that can have a greater effect on livelihood choices than the initial shock itself (Martin et al. 2014). Akter and Mallick (2013) postulate that an exogenous shock can exceed a household's resilience threshold by changing socio-economic conditions such as income and employment opportunities. Three typical downstream economic shocks are price increases (as noted above), poor or lost harvest, livestock death (Smith and Frankenberger 2016), and loss of other types of assets (e.g., damage and loss to homes, land and equipment due to natural disasters). Cyclones and floods often leave farms waterlogged for months, destroying crops and leaving cropland and aquifers salinized. Cyclone Aila created physical damage that had a statistically significant negative impact on individual income growth, particularly where male members were injured or killed. In many cases, both the average household income and income per person declined significantly after the cyclone (Akter and Mallick 2013). In addition, natural shocks that inundate roads and infrastructure can cripple market access, forcing livelihood changes that leave households more vulnerable and less resilient, such as by leading them to sell land and assets (Pulla and Das 2015).

Idiosyncratic economic shocks: While not unique to the Bangladesh context, household-specific economic shocks are also factors in vulnerability and resilience, such as loss of an income-earning family member (e.g., to death, illness, separation), or high expenses for treatment of serious illness (see Section 6.2.2).

2.1.4 Health and Nutrition

The 2011/2012 Bangladesh Integrated Household Survey found that Bangladesh's northwest, northeast, and south-central regions were hardest hit by health shocks relative to other regions (Annex 7, **Figure 5**). Vulnerability to health shocks was correlated with gender of household head, dependency ratio, and households with no land. These shocks can carry high financial costs, compelling households to resort to unsustainable coping strategies such as selling productive assets.

Health shocks are often downstream from exogenous shocks that increase vulnerability to disease or impede access to health services. Access to clean drinking water and adequate sewerage and sanitation systems are central challenges for Bangladesh. The interaction of poor child nutrition and water-related illness are a significant vulnerability, especially in hazard-prone areas. Prevalent care practices around child health, and access to professional health care, are additional challenges for health, compounding vulnerability in hazard-prone areas. This section discusses each of these issues in more detail.

Drinking water: Due to the prevalence of water-related shocks that increase water salinity or disrupt sewage and sanitation systems (potentially contaminating clean water resources), Bangladesh is considered to be in a "drinking water crisis" (Ahmed et al. 2013). The proper construction, maintenance, and regulation of boreholes and tube wells, which supply drinking water to more than 86 percent of households in Bangladesh, is particularly important to prevent contamination (National Institute of Population Research and Training et al. 2016). Especially vulnerable are urban areas and the northeastern flash flood zone. As of 2015, 32 percent of urban residents across Bangladesh had access to piped water (WHO/UNICEF 2015) (Annex 6, **Table 5**). In Khulna City, one of the largest cities in Bangladesh, only 18 percent of its 1 million residents had access to piped water (ADB 2010). In addition, 30-40 million people nationwide have been exposed to elevated levels of naturally occurring arsenic through 10 million tube wells (British Geological Survey 2001 as cited in Wasserman et al. 2004). As of 2011, an ADB project was underway to construct a water treatment plant and expand piped water access in Khulna City (ADB 2012).

Sanitation: At the national level, 36 percent of rural households use non-improved toilet facilities, and within that population, nearly 30 percent use open-pit latrines (National Institute of Population Research and Training et al. 2016). Dhaka's sewage system only services 25 percent of the city; the rest relies on more flood-vulnerable means such as septic tanks and latrines (Shamsun et al. 2014). Within the northeastern hills, it is much bleaker: 56 percent of households have no sanitary toilet facilities and the majority of households use hanging latrines. Coupled with general poor access to health services, these sanitation issues create extreme vulnerability to illness and disease.

Water-related illness: The waterlogging resulting from floods increases Bangladesh's vulnerability to vector- and waterborne illness. Excess water can remain for months after a flood, leaving breeding grounds for bacteria, parasites, and disease vectors (Mani and Wang 2014). Many outbreaks of waterborne diseases have been recorded during and after major floods, namely due to overcrowding in temporary shelters with inadequate drinking water and poor sanitation. Additionally, dengue fever, malaria, and kala-azar are projected to become more prevalent in the

coming decades due to a prolonged monsoon season and rising temperatures. However, waterborne diseases are still a more important health concern (Mani and Wang 2014).

Increased salinity has also led to illnesses – diarrhea, fever, high blood pressure, gastric and skin problems – due to a lack of freshwater for general consumption and household needs such as sanitation and cooking (Toufique and Islam 2014). Limited access to potable water and sanitation has also increased the prevalence of acute respiratory infections (ARIs), the leading cause of death among children in Bangladesh (National Institute of Population Research and Training et al. 2016).

Nutrition: Child malnutrition and undernutrition rates in Bangladesh are among the highest in the world (Mahmud and Mbuya 2016). In 2014, more than 36 percent of Bangladeshi children under five were stunted and more than 14 percent wasted. This includes richer segments of the population, suggesting a more complex problem beyond nutritional factors (National Institute of Population Research and Training et al. 2016). As reported by Mahmud and Mbuya 2016, the most important issues are food intake, household food security, poor maternal and childcare practices, disease, and limited access to safe water and sanitation. Multilevel models and recent studies have confirmed that climate variability is strongly linked with the incidence of illnesses, including in children, because of effects on temperature and humidity. One study found that during the pre-monsoon season (January–April), high temperature and humidity increased the incidence of fever and ARI. (Mani and Wang 2014). These and other childhood illnesses (e.g., diarrhea, pneumonia, malaria, and measles) are all major causes of under-five death and a child's reduced ability to absorb nutrients.

Another recent study sought to determine the link between six types of climate-related shocks and stresses on food security and nutrition status. Food price increased in communities affected by floods, droughts, and cyclones. For coastal areas in Bangladesh affected by salinity, households were found to increase food loans and spending on food, suggesting some food insecurity. The study found that while increased salinity in coastal areas affects essentially every aspect of people's lives, climate change events aggravated an already precarious situation during seasonal times. Post-shock coping strategies included decreasing the number of meals eaten, eating less per meal or skipping certain meals, eating less-preferred foods, and a decrease in dietary diversity. Intra-household inequalities were observed where women made sacrifices in their own nutritional wellbeing to protect children's nutritional wellbeing (Béné et al. 2015).

Care practices: Trends in maternal and newborn care practices have improved over time[9] in relation to the increasing number of antenatal care visits, births in medical facilities, and trends in the use of skilled medical personnel during deliveries. Despite these improvements, some challenges remain. At 70 percent, the use of maternal health services remains high in urban areas, while only 15 percent of women residing in rural areas enjoy such access. Nearly two-thirds of women do not receive post-natal care; antenatal care (ANC) visits in rural areas remain low, with 19.9 percent of women making one ANC visit and 25 percent making none (National Institute of Population Research and Training et al. 2016). Nearly 6 percent of children from households who participated in the 2014 DHS were reported to have had diarrhea, yet 35 percent of mothers with children experiencing diarrhea curtailed fluid intake during the episode of diarrhea, a practice that adds pressure on the child's recovery time (National Institute of Population Research and Training et al. 2016).

[9] Comparing DHS results from 2004, 2007, 2011, and 2014; see National Institute of Population Research and Training et al. 2016.

2.2 Long-term Stressors

2.2.1 Climate change

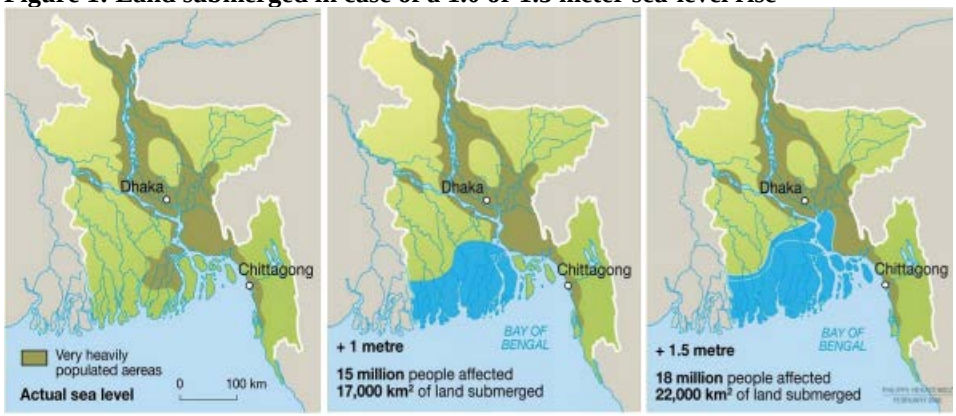
Bangladesh's low sea level and location in a major deltaic plain, combined with steadily increasing temperatures, an expected 5-6 percent increase in rainfall, melting glaciers, intensified and more erratic monsoon seasons and increasing severe weather events (particularly cyclones) exemplify why Bangladesh is considered one of the countries most vulnerable to climate change (Sarker et al. 2012; Deb et al. 2014; Martin et al. 2014; Khan et al. 2013). Climate change poses a threat to previous achievements and future efforts to reduce poverty in Bangladesh by reducing water and food security and damaging essential infrastructure during disasters (Dastagir 2014).

Part of this vulnerability lies in its high population density and predominant rural activity, with over 70 percent of its land used for agriculture. This makes climate threats such as the river floods, sea-level rise, increased drought and changing rainfall patterns particularly damaging and poses a "substantial challenge" for food production for the ninth-largest population in the world (Ruane et al. 2013: 338). Temperature rise (.5-2°C by 2050) and extreme weather events are predicted to decrease rice production 8-17 percent by 2050 (Younus 2014; Sarker et al. 2012). While rain has increased in coastal areas and northern Bangladesh in recent years (1969-2003), areas in the central part of the country have seen a decrease in rainfall, indicating uneven changes in the spatial distribution of rainfall (Shahid and Khairulmaini 2009). Rice, the predominant crop, is planted on 80 percent of the total cropland, and accounts for nearly 20 percent of the GDP and 66 percent of the employed labor force. The dependency on a single crop creates further vulnerability that can affect national food security as well as economic stability and growth (Sarker et al. 2012). Food shortages are particularly prevalent in low-lying areas, where land can remain inundated for three to four months after flooding, isolating them and limiting access to public services.

Droughts in Bangladesh will intensify due to reduced precipitation and increased evapotranspiration (Dastagir 2014); the resulting low rainfall runoff reduces river flows and allows salinity to penetrate further along the coastal rivers. Increased sea surface temperature, another impact of climate change, is linked to formation of category 3, 4 and 5 cyclones and could potentially create a "greater contrast between land and ocean" temperatures resulting in tropical cyclones (Ahmed et al. 2013: 225). Climate change will also cause more extreme floods due to heavier rainfall (despite the overall reduction in total precipitation) .

Sea-level rise is projected to be one of the most critical climate risks for Bangladesh due to its long coastline and high population density (Mani and Wang 2014). **Figure 1** illustrates the land projected to be inundated in a 1.0 – 1.5 meter sea-level rise scenario. The projected sea-level rise along the coastal areas of Bangladesh will be about 88 cm by the year 2100 (Dastagir 2014),. This sea level rise willcompletely inundate a majority of the low-lying, non-embanked coastal areas and increase the salinity of soil and surface water, including drinking water from wells. Land use suitability, particularly for current agricultural practices, will change: embanked coastal agricultural areas will be at higher risk of tidal surge and subsequent inundation with saline water. Sea-level rise will cause shoreline retreat, resulting in increased basin area, which lengthens the cyclone path length Cyclones will remain for a longer time in the water, acquiring and releasing more latent heat, which results in more energy, intensity and wind speed.

Figure 1: Land submerged in case of a 1.0 or 1.5 meter sea-level rise



Source: Dacca University and IPCC, via Wilson Center 2011

2.2.2 Population changes/Migration and population movement

Bangladesh is the third-most densely-populated country in the world. As of 2015, the World Bank recorded Bangladesh's population at 161 million,[10] with an annual growth rate of 1.2 percent[11] that will result in over 202 million people by 2025 (United Nations Population Division 2015). Overall population density figures are staggering at 1,237 people per km^2;[12] however, this varies substantially across the country. Bangladesh's most populated districts, which also house the largest urban centers, range from 3.4 to 12 million, while the least-populated districts range from a mere 390,000 to 918,000 (BBS census 2011, as cited in Mani and Wang 2014). Migration trends suggest that this disparity between districts will continue to grow. Urban migration is increasing as extreme weather events, natural disasters and poverty push Bangladeshis toward cities in search of jobs and better opportunities (Pulla et al. 2015; Martin et al. 2014; Uddin and Firoj 2013). An estimated 70 million new urban residents are expected by 2050 (Mani and Wang 2014).

Often urban migration begins with a livelihoods shock from an extreme environmental event that forces poor, rural Bangladeshis to sell land and assets after a crop loss. In areas prone to shock and hazards, alternative work opportunities are sparse, forcing migration to urban centers for food, shelter, and employment. These migrants end up in urban slums, where they exchange vulnerability in rural shock-prone areas for urban vulnerability (Mani and Wang 2014). However, it is not necessarily the environmental shock that causes long-term migration, but the loss of assets necessary to continue a livelihood system (Martin et al. 2014). Long-term migration is fueled by the need to improve economic opportunities, and increasingly results in the adoption of livelihood choices not dependent on natural resources. Urban centers are increasingly seen as a source for these opportunities: urban population growth rate is 3.4 percent (2015 figure) – nearly three times the growth rate for the whole country.[13] A rapid increase in migration can contribute to urban vulnerability as it can result in poorly planned urbanization (Mani and Wang 2014; Rahman 2014). An additional estimated 200,000 to 250,000 people will migrate in search of overseas job opportunities. While this provides an important source of remittances, it can also place additional stress on a household, especially if it transfers the burden of maintaining the household and village economy to women (Sikder 2012).

[10] World Bank Data, 2016. Population, total (2015). Accessed from: http://data.worldbank.org/indicator/SP.POP.TOTL?locations=BD
[11] World Bank Data, 2016. Population growth (annual %) (2015). Accessed from: http://data.worldbank.org/indicator/SP.POP.GROW?locations=BD
[12] World Bank Data (2015 figure) - 2016
[13] World Bank Web site. http://data.worldbank.org/indicator/SP.URB.GROW?locations=BD. Accessed August 24, 2016.

2.2.3 Pollution

Rapid urbanization and poor urban planning present enormous problems of water and air pollution and solid waste management. Inadequate planning leaves large urban centers without enough clean water to address the large influx of migrants and squatters. Increased industrialization and the agrochemical sector can also degrade surface water quality in nearby lakes and rivers. Poor waste management can cause chemical leaching into groundwater and is prominent in slum dwellings, which lack appropriate public services to prevent pollution and are located near unhygienic areas such as solid waste dumps, open drains and sewers, on embankments and along railroad tracks. Garbage is frequently dumped in low-lying areas of the city prone to flooding, which facilitates the spread of disease (Dewan 2012).

Air pollution is one of the most under-recognized health concerns in urban settings. Originating from vehicular emissions, industrial fumes and burning garbage, air pollution is related to severe respiratory disease, reported to claim at least 120,000 urban children annually. Compounding respiratory problems is indoor pollution created by the burning of biomass (e.g., used tires) for cooking (Dewan 2012).

2.2.4 Downstream Shocks/Food Insecurity

While estimated national levels of rice production (30,947 MT) for 2020 are expected to meet national demand (27,632 MT), large segments of the population remain food insecure (Younus 2014); the majority in rural and highly shock-prone areas, suggesting a greater role of downstream shocks – i.e., where one shock triggers another – on food insecurity. The downstream effects of cyclones and floods include salinity, waterborne disease, waterlogging, crop loss and displacement, and can play a significant role in livelihood decisions. While flooding is the most prevalent shock in Bangladesh, the strongest driver of significant livelihood change in rural areas is not flooding but crop failure, which can perpetuate a greater loss of assets and remove the ability to protect against other shocks (Martin et al. 2014). People can endure larger system shocks if coping and adaptive strategies are available to them, but downstream shocks and stresses can "erode traditional resilience" capacities and create current and future food insecurity: "[A]s they lose their crops and stored seeds they also lose their ability to afford seedlings, cultivation costs, watering costs, and agricultural input costs for the next cropping season" (Younus 2013: 6).

Key points on shocks

- Bangladesh's dense population and geographical makeup contribute to its vulnerability to a wide range of shocks, predominantly natural shocks such as floods, cyclone, salinity, drought and flash floods. Climate change is intensifying these shocks, causing sea-level rise, higher temperatures, glacier melt, and more erratic weather events. These environmental shocks create immense damage and loss of assets and have downstream health and economic effects at household and national levels.
- The increasing population creates great strain on food security, water resources and urban infrastructure, and greater pressure on overpopulated urban centers like Dhaka.
- Increased violence and political uncertainty have contributed to a politically volatile context that has affected economic and civil stability. Recent terrorist attacks have created security risks that could jeopardize international aid and investment.
- Pollution can lead to urban flooding and waterlogging by clogging drain channels and water run-off, which contributes to freshwater contamination and the spread of disease and illness.

3. Vulnerable groups

This assessment uses the definition of vulnerability provided by Cardona et al. (2012: 69): the extent to which elements such as human beings, their livelihoods, and assets are exposed to and suffer adverse effects from hazards. Vulnerability derives from historical and current cultural, social, environmental, political, and economic contexts; is related to sensitivity to conditions and level of ability to cope and adapt to hazards and stressors; and is situation-specific, meaning that vulnerability to flooding does not imply vulnerability to malaria or financial crisis. Factors such as poverty, weak social networks, lack of information, and global processes such as population growth, rapid urban development, and governance failures can aggravate vulnerability.

This section first describes chronically vulnerable populations in Bangladesh and then specifically in the FTF ZOI; second, it discusses changes in poverty levels over time and contributing factors; and third, it describes factors that contribute to people escaping or "backsliding" into poverty.[14]

3.1 Chronically vulnerable populations

3.1.1 Bangladesh Overall

People exposed to physical hazards: As described in Section 2, Bangladesh is exposed to many natural hazards. Toufique and Islam (2014) found that among 40 districts vulnerable to (primarily) one of four broad types of disasters – salinity, flood, drought, and flash flood – those exposed to flash floods, in the northeast of the country, had the highest livelihood vulnerability due to high reliance on rice farming and limited alternative livelihood opportunities. Other factors that increase vulnerability in the flash flood zone are poor roads, insufficient public health services, poor sanitary conditions, and long periods of food insecurity. The drought (northwest) and saline (coastal) areas are vulnerable to water scarcity and lack of safe drinking water. Drought-affected farmers are more likely to migrate for work, leaving wives and children behind (Habiba et al. 2012).

Chronically poor: Although poverty prevalence has declined over time, millions of Bangladeshis remain in poverty. Ahmed and colleagues (2016) found that households remaining in poverty between 2011/12 and 2015 had increased dependency ratios and household size, and low levels of savings and human capital (lack of education of the household head), limited physical assets (land, non-agricultural income), and poor women's empowerment. They also tended to have no access to electricity, did not own a cell phone, and if they received safety net transfers, these comprised less than 15 percent of household income. Areas lacking access to basic social services also had high prevalence of poverty as indicated by expenditures (UNICEF 2009 as cited by Mani and Wang 2014). Moreover, safety-net programs cover less than half of the 60 million food insecure Bangladeshis (WFP 2016), increasing vulnerability among the poor.

An analysis of 2009 data found that rural households experience more frequent shocks than urban ones and are therefore more vulnerable (Santos et al. 2011 as cited in World Bank 2013). Ahmed and colleagues (2016b) found that almost 19 percent of Bangladeshis have very low levels of spending, less than 1.25 times the upper national poverty line, indicating that they have low levels of assets and are thus vulnerable to slipping into poverty following a shock (NSSS 2015 as cited by Scott and Diwakar 2016). The country's two lean seasons contribute to reduced employment opportunities and food availability, and increased food insecurity and undernutrition, especially affecting the rural ultra-poor (WFP 2016).

[14] Backsliding refers to when a household escapes poverty but subsequently falls back into poverty.

Women: The socio-economic conditions and climate variability of Bangladesh have created a vulnerable and marginalized position for women. Women have fewer income-earning opportunities (WFP 2016), receive only about half the pay that men receive for the same work (Fakhruddin and Rahman 2015), and have little control over household productive resources. Dowry[15], a common practice in rural Bangladesh, further influences the woman's level of vulnerability: poor households often resort to selling or mortgaging land or taking out a loan, often resulting in a "trapped cycle" of loan taking and repayment (Scott and Diwakar 2016). Dowries have an even more significant economic impact on female-headed households. Another vulnerability factor is that women's and children's food needs are not prioritized within the household, which increases their food and nutrition insecurity, especially during pregnancy and after childbirth (WFP 2016).

Women are particularly vulnerable to disasters. A 1991 cyclone in Bangladesh killed five times more women than men (Fakhruddin and Rahman 2015). Cultural norms restrict women's mobility out of the homestead without a male relative, which prevents women from learning potentially life-saving behaviors such as swimming (Cannon 2000), gaining emergency preparedness or early warning information, or evacuating during a disaster (Ikeda 1995; Fakhruddin 2006). Women are also primarily responsible for children and the elderly, who may impede their movement or move slowly, and women's clothing, particularly the traditional *sari*, further inhibits their movement in disasters (Fakhruddin and Rahman 2015). Moreover, during disasters, women experience increased incidence of gender-based violence, intimidation, sexual harassment, and rape, and sometimes become victims of human trafficking. However, if they have access to early warning information, women have constructive coping strategies to prepare, save, and plan for floods and other emergencies.

Children and youth: Children are extremely vulnerable to food insecurity. Undernutrition, which contributes to lower productivity and increased morbidity, causes two out of three deaths among under-five children (WFP 2016). With almost half of children under five classified as chronically undernourished (stunted) and more than 14 percent acutely undernourished (wasted), Bangladesh has the highest prevalence of underweight children in South Asia. In 2014, the children of the poorest 20 percent of the population were most vulnerable to stunting, with more than 49 percent of children under five considered stunted (National Institute of Population Research and Training et al. 2016).

In the northwest, children of drought-affected farmers drop out of school at higher rates during drought periods than in other seasons (Habiba et al. 2012). The World Bank further suggests that, nationwide, teenagers from poor households are at higher risk for school drop-out and early marriage (World Bank 2013).

Vulnerable children and people with disabilities[16]: Scarce development financing has been allocated to addressing the needs of people with disabilities or at-risk children, defined as street children and those who have left their families (World Bank 2016). A World Bank project was implemented from 2008-2016 to expand and improve the quality of government services provided for these groups. The 2016 status report, however, details only the number of people with disabilities or at-risk children reached, not the scale of need (Cho 2016). This project helped the GoB establish and operate over 100 Disability Service Centers, which have served over

[15] Dowry is the property or money a woman brings to her husband upon marriage.
[16] Very limited information was found in the literature provided for this review and a limited online search on people with disabilities and other groups typically described as vulnerable, such as the elderly.

370,000 people; 11 Integrated Child Protection Service Centers have helped to reintegrate and protect 6,000 vulnerable children.

Minority ethnic and religious groups: Bangladesh is a predominantly Muslim country, with nearly 90 percent of people identifying as such. Hindus, Buddhists, Christian groups and other ethnic and religious groups make up an estimated 11 percent of the population (National Institute of Population Research and Training et al. 2016). While indigenous groups are found throughout the country, about one-third, including *Jumma* communities, live in three districts in the CHT region: Khagrachori, Bandarban and Rangamati (Iva 2011).

Minority ethnic, religious, and indigenous groups are targeted through harassment, violent attacks, sexual violence, killings, and forced displacement (Iva 2011). Despite the ratification of major international human rights treaties and constitutional protection for minority groups (Iva 2011), the GoB has been slow to respond to the protection of minorities and slow in investigating attacks (United States Department of State 2014).

Refugees: The Rohingya are a Muslim ethnic minority group from Myanmar that has been persecuted in Myanmar for decades (UNHCR 2013). About 33,000 registered Rohingya refugees live in Cox's Bazaar in southeast Bangladesh (Chittagong Division) and an additional 200,000 - 500,000 unregistered Rohingya are thought to live nearby in makeshift camps where they are vulnerable to human trafficking (especially women) and labor exploitation (UNHCR 2016; Sattar 2016). Counseling for sexual and gender-based violence was provided to 233 survivors in 2015 (UNHCR 2016).

Concerned about crime and the rapid growth of the refugee population, the Bangladesh government in 2013 recommended limiting rations, and in 2015, a government team recommended relocating refugees to an island that floods seasonally; the plan was met with anger from the United Nations and was not pursued (Sattar 2016). Current government efforts to conduct a census of undocumented Rohingya refugees are welcomed as a step toward helping refugees overcome statelessness; however, they have also led to fears of forced repatriation.

3.1.2 Khulna and Barisal Districts

People exposed to physical hazards: Khulna and Barisal divisions are in the coastal area and exposed to tropical cyclones, sea-level rise, salinity intrusion, and fishery declines (Fakhruddin and Rahman 2015). The main threat to the coastal region is sea-level rise, against which permanent protection is infeasible due to the complex coastline (Ruane et al. 2013). Changes in coastal areas, either through erosion or land accretion from silt and deposits, affect sea level rise along coastal zones (Ruane et al. 2013). A longitudinal study of changes in coastal areas from 1972 – 2010 found that while the Sundarbans mangrove forest in southern Khulna was in a phase of erosion, the Meghna Estuary – in the Noakhali District in southeastern Bangladesh – was in a gaining phase, indicating regional variations that complicate land protection measures (Islam et al. 2011).

In Shyamnagar, a sub-district of coastal Satkhira district (Khulna Division), the poor were found more vulnerable to cyclones due to increased likelihood of living farther away from emergency shelters, closer to the shoreline, and in structurally weak homes (*kacha* houses built with mud, bamboo, and local plant materials such as *golpata*) (Akter and Mallick 2013). Moreover, poorer households were less likely to attend cyclone preparedness training or receive early warning

information, and were significantly and systematically less prepared.[17,18] Research in Khulna has also highlighted the impact of waterlogging on a range of interconnected livelihoods: farmers, fish farmers (e.g., *gher*[19] farmers), fishers, livestock producers, input suppliers, and fish and rice processors (FAO and WFP 2014).

Women and children: Limited access to drinking water puts the largest time burden on women, as they are primarily responsible for fetching water and caring for household member health. Children's exposure to arsenic in drinking water has been associated with reduced intellectual function (Wasserman et al. 2004).

In the coastal Bagerhat district (Khulna Division), prawn post-larvae fisher households experience inadequate food and nutrition, especially due to the seasonality of their livelihood (Ahmed et al. 2013). Women and children in these households experience higher food insecurity generally and especially after Cyclone Aila, and more severe malnutrition-related consequences.

3.2 Movement of people in and out of poverty

Bangladesh: The national poverty headcount decreased from 60 percent in 1991-92 to 31.5 percent in 2010, and the proportion of the population in extreme poverty decreased from 50 percent to under 18 percent (Annex 7, Figure 7) (BBS 2010 and World Bank Health, as cited in Scott and Diwakar 2016). Prior to the 2000s, large poverty reductions were achieved through agricultural improvements to reach rice self-sufficiency (Scott and Diwakar 2016). Almost half (48 percent) of the population rely on agriculture as their main livelihood. More recent analysis by IFPRI indicates that 12 percent of non-poor rural households fell into poverty between 2011/12 and 2015 (Ahmed et al. 2016b).

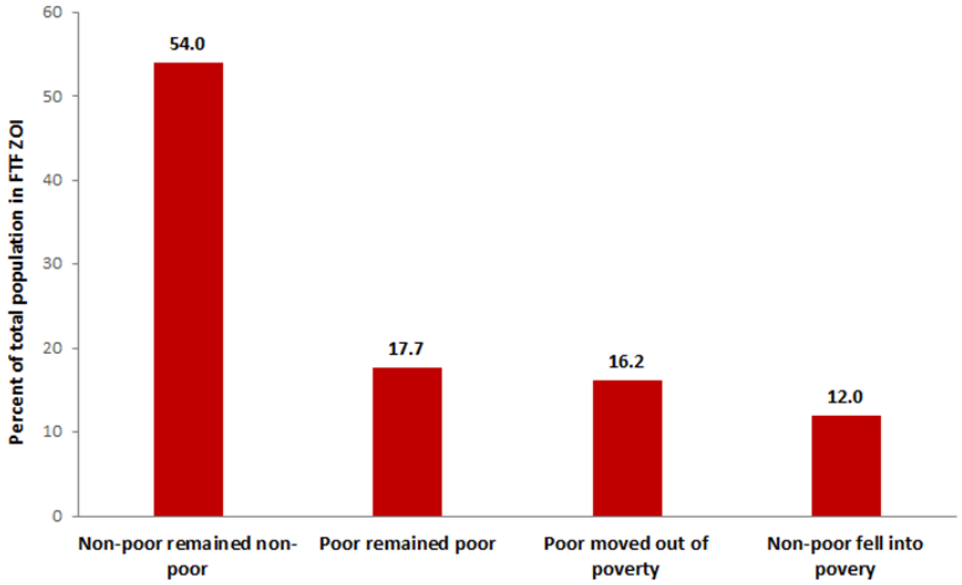
ZOI: Ahmed et al. (2016a) found that in the FTF ZOI, between 2010 and 2015, 54 percent of non-poor people remained non-poor and about 16 percent of people ascended out of poverty, but 12 percent were non-poor who descended into poverty (**Figure 2**). Poverty decreased by 16 percent from baseline to midline (34 percent in 2015), with larger reductions in extreme poverty (Ahmed et al. 2016a). Household incomes increased by 18 percent overall with greater increases for the poor, as indicated by per capita expenditures.

[17] This study did not specify the nature or source of efforts made to disseminate early warning information or training; it refers only to "existing cyclone preparedness programs (i.e., cyclone preparedness training, early warning system and evacuation plan)." (Akter and Mallick 2013: 123).

[18] Cyclone preparedness training exists through an early warning system in 13 coastal districts – a collaboration between the GoB and the Bangladesh Red Crescent Society (Bangladesh Red Crescent Society Web site. http://www.bdrcs.org/programs-and-projects/cyclone-preparedness-program, accessed August 31, 2016). A recent study on corruption on cyclone preparedness and relief efforts in Khulna before and after Cyclone Aila found "mild" corruption in pre-cyclone practices that resulted in household losses, i.e., negligence in providing warning messages, nepotism/ favoritism/ patronage in disaster preparedness training, and influence peddling in shelter access. Corruption was more severe in post-cyclone practices, primarily food aid distribution and public works. (Mahmoud and Prowse 2012). These governance challenges are also part of the risk landscape of these communities, particularly subgroups that are less socially and politically empowered.

[19] A *gher* is a traditional agricultural system in Bangladesh whereby a fish pond is dug into a rice field; vegetables are grown on the dykes created around the pond using the dug-out soil.

Figure 2: Dynamics of Poverty in Bangladesh FTF ZOI – changes from 2010-2015



Source: Ahmed et al. 2016

Factors found to increase the likelihood of falling into poverty include any increase in the number of household members or dependency ratio, and crop loss. Drivers of downward mobility over the past ten years include death of an income earner, illness, death of livestock, dowry, failed international migration, entrapment in a cycle of loan repayments, and lack of land ownership (Scott and Diwakar 2016). Factors central to helping households ascend from poverty include education, non-farm income, women's empowerment, access to electricity, physical asset holding, and savings (Ahmed et al. 2016). Increases in farmers' income were positively associated with non-farm income, education, mechanized irrigation, access to commercial loans and electricity, women's empowerment in agriculture, and ownership of a cell phone and solar panel. Increased incomes and reduced poverty contributed to improved household-level food security, as indicated by decreased prevalence of moderate or severe hunger.

3.3 Poverty escapes and backsliding

Households that ascend from poverty are more likely to have accumulated both land and non-land fixed assets, have fewer children, avoid shocks and large expenses, engage in at least one non-agricultural activity in addition to cultivating their own land, and earn income from crop intensification, diversified agriculture, irrigation, and non-farm activities (Scott and Diwakar 2016). Moreover, households with more human capital accumulate assets faster. Land ownership has agricultural value and also adds to social status and social capital; it can be sold in times of distress, though selling land often has negative long-term consequences such as reduced income.

A recent analysis of panel data from the Bangladesh Chronic Poverty and Long Term Poverty and Impact Study (1997-2010) found that backsliding occurred in about 10 percent of the study population (Scott and Diwakar 2016). In the last two years of the survey, 13 percent of households fell into poverty, and of these, 78 percent were backsliders. Among vulnerable populations –defined by the study authors as backsliders, the chronically poor, the (newly) impoverished, and "churners" (households just above and below the poverty line) – backsliders made up the largest segment. Factors associated with reduced risk of backsliding included increased household asset value; having a sanitary toilet, electricity, cultivable land, livestock, or

education (education level also playing a role in the magnitude of this reduction); employment or self-employment (especially non-agricultural employment) of the household head; asset sales; and obtaining a loan. Factors that increased risk of backsliding include higher numbers of children and dependents; experiencing a series of shocks in short succession; and access to improved water sources (due to arsenic exposure). Female-headed households where the woman has been abandoned, widowed, or divorced tend to be among the poorest in the country due to more limited income-earning options.

Key points on vulnerable groups

- Chronically vulnerable groups include people who are exposed to natural disasters, the chronically poor, rural poor, women, children, people with disabilities, and refugees.
- In the FTF ZOI, people are exposed to threats such as sea level rise and cyclones. Poor people are more likely to live farther away from emergency shelters, closer to shorelines, and in structurally weak homes.
- In urban areas, lack of safe drinking water puts a burden on women who fetch water, and on children, who are vulnerable to permanent reduced intellectual function.
- *Ascent out of poverty:* Factors central to helping households ascend from poverty include education, non-farm income, women's empowerment, access to electricity, physical asset holding, and savings.
- *Descent into poverty:* Factors that increase the likelihood of falling into poverty include any increase in the number of household members or dependency ratio, and crop losses.
- *Backsliding:* Factors associated with reduced backsliding risk include increased household asset value; having a sanitary toilet, electricity, cultivable land, and livestock; education level; employment or self-employment (especially non-agricultural); asset sales and obtaining a loan.

4. Well-being outcomes for which we are trying to build resilience

Among the abundant analyses of the effects of government and NGO interventions on development outcomes, a small but growing portion focuses on their linkages with resilience, especially as more data become available from post-shock monitoring and as resilience measurement becomes more refined and widely applied. This section discusses what is known or can be reasonably postulated regarding what outcomes we can expect to influence positively with resilience interventions, as well as what outcomes or conditions can be expected to influence resilience. We focus on food security but also discuss other common development areas, as well as systems-level outcomes and conditions. These outcomes are influenced by investments in certain resilience capacities, to be discussed in depth in Section 5.

4.1 Food security outcomes

Food security status is commonly understood as being an important resilience outcome and also contributing to resilience. Several studies in Bangladesh have posited and assessed a relationship between resilience to shocks and food security indicators. For example, a recent study of a World Food Programme project to address the vulnerability of populations exposed to natural disasters and the effects of climate change used an ex-post versus treatment framework to examine how the project affected household coping strategies and the extent to which it helped people recover from shocks and stresses (Béné et al. 2016b). The project, "Enhancing Resilience to Natural Disasters and the Effects of Climate Change" (ER), was implemented in areas of northwest Bangladesh and the southern coastal belt affected by river erosion. ER supported the construction

of rural infrastructure and provided emergency preparedness and life skills training to increase the capacity to respond to shocks and stresses, focusing on improved livelihoods and women's decision making and empowerment. The outcome measure for the study was based on the probability that households would respond to five main shocks – serious illness, cyclone, death of ducks/hens, loss of livestock, and flooding – by either reducing family expenses, taking loans, changing the type of food consumed, reducing food consumption, and/or seeking assistance from community members. Among the important results were that treatment households were statistically less likely to engage in these detrimental responses than control households. Of 20 combinations of shocks and shock responses tested, half show a statistically significant and positive impact from the project, three suggest a positive but not statistically significant effect, nine suggest no effect, and one – the reduction of food consumption as a response to flooding – indicates a significant negative effect (Béné et al. 2016b).

A one-year follow-on to ER, "ER+" gave women a cash grant, relevant training and follow-up support to invest in a productive asset or income-generation activity. An impact evaluation found very positive results of this relatively short intervention: significant improvements in poverty reduction, food consumption, wealth and asset accumulation, livelihood diversification through non-farm employment, women's decisionmaking, and savings (Hernandez et al. 2016). Project households had greater reductions in Coping Strategies Index scores than the control group: they resorted less to severe negative strategies in the face of food shortages.

Factors affecting food security in southern Bangladesh have been amply identified in academic literature and in large-scale interventions implemented in the region. Nobo Jibon, a Title II PL480 Multi-Year Assistance Program (2010-2014),[20] identified main causes of food insecurity in Barisal Division in south-central Bangladesh, including erratic and low-paying earning opportunities, especially for asset-poor households, and social exclusion and low status of women and children. Nobo Jibon thus aimed to strengthen the enabling environment for income generation and household economies and to promote women's engagement in household decisions. Project-promoted technologies and methodologies with the greatest producer uptake included maintenance of proper crop spacing; balanced fertilizer use; improved pits and heap systems; multistoried and relay cropping; aquaculture pond cleaning and liming; fish disease management; and poultry/livestock vaccination and de-worming (TANGO and Mitra 2015).

Another example of an intervention shown to contribute to food security in southern Bangladesh is brackish water shrimp aquaculture. The conversion of rice fields into shallow ponds, and connecting these to estuaries and canals, has had positive impacts on the agroecosystem in the southwestern coastal belt. The system facilitates the exchange of brackish water, which is important for trapping wild shrimp fry, supplying natural food, and maintaining salinity levels (Shameem et al 2014).

Overall, evidence from the three USAID Title II projects (Nobo Jibon, PROSHAR and SHOUHARDO II) and Ahmed et al. 2016 indicates that food and nutrition security outcomes have been improving over time in the FTF ZOI and vulnerable areas of interest in this review.

4.2 Poverty outcomes

Poverty status is correlated with certain aspects of resilience in the Bangladesh context. For example, in Satkhira district (Khulna Division) after Cyclone Aila, poorer households were found to be significantly and systematically less prepared to respond than less-poor ones (Akter

[20] Implemented by Save the Children Bangladesh

and Malick 2013).[21] Physical, economic, and structural damage were significantly and positively correlated with exposure and sensitivity, which are tied to poverty.

Having financial resources gives households more options for responding to shocks and decreasing their shock exposure. Those with fewer assets are less able to improve living conditions such as housing quality and choice of housing location in a way that decreases their vulnerability to natural disasters, (i.e., structurally sound housing located in secure areas, with construction materials and design adapted to mitigate risks particular to that area).[22] It stands to reason that increasing household wealth status – and educating people in the value of investing their resources in solid housing construction (e.g., *pucca* houses built with concrete and wood) – would be both an investment in (and an outcome of) their resilience.

4.3 Nutrition and health outcomes

Resilience is considered to be linked to nutrition and health outcomes. Bangladesh is on track to achieve most health-related Millennium Development Goal targets, even though only 3.5 percent of its GDP is for health expenditures (El-Saharty et al. 2015). However, disparities in health outcomes exist between rich and poor due to ineffective resource allocations and targeting (Mani and Wang 2014; World Bank 2013, 2010). In addition, Bangladesh still suffers from one of the highest levels of malnutrition (36.1 percent stunting in children under five) in South and Southeast Asia and has high neonatal mortality (National Institute of Population Research and Training et al. 2016). Child marriage and teenage pregnancy are prevalent, and skilled attendance at birth is low (Seventh Five Year Plan 2018-2021) (BIGD 2014).

USAID-supported efforts for improving health outcomes such as PROSHAR have focused on antenatal care, maternal and infant feeding practices, and child health care related to immunization and treatment of diarrhea and ARI (TANGO and Mitra 2015).

4.4 Social, ecological and economic systems

Civil infrastructure. Various systems-level outcomes can be both prerequisites and outcomes of resilience. Flood control infrastructure and flood risk mitigation systems are especially pertinent for resilience in many areas of Bangladesh, and many residents of flood-prone areas are aware of this. For example, a survey of residents in two villages of Jamalpur District, Mymensingh Division, central Bangladesh indicated support for building dams and strong embankments along the Jamuna River to prevent riverbank erosion, with even stronger support among dwellers of erosion-prone mainland compared to char land residents (Younus 2013).

A probable relationship exists between the adequacy of emergency infrastructure and resilience to natural hazards. For example, a study of poverty, vulnerability and resilience in Shyamnagar, Satkhira District (Khulna Division) after Cyclone Aila suggested that those who went to cyclone shelters but were not allowed entry due to a lack of space were more likely to incur death or injury (Akter and Mallick 2013).

Another desirable systems-level outcome is adequate electric power infrastructure. Approximately 55 percent of the population is connected to the electric grid (43 percent rural; 90 percent urban) (BBS 2010). The Bangladesh Government Power System Master Plan (2010) requires a generation capacity of 39,000 megawatts by 2030, emphasizing coal-based power given the Bangladesh context of low natural gas resources and the rising cost of oil. However,

[21] However poverty appeared to have a positive relationship with response capacity (rapidity): households living below the poverty line could access emergency food relief faster than those above the poverty line.
[22] Refer to discussion of housing under *Khulna and Barisal Districts* in Section 3.

there may be risks in implementing the plan, as it does not consider the impact of climate change on national power and transmission systems.

Economic systems. Microcredit seems a justified resource to offer households to prepare for or recover from shocks; however, it cannot be assumed that shock-exposed households will avail themselves of microcredit even if needs arise after a shock. Only one-tenth of Satkhira households in the Cyclone Aila study who experienced losses and damage took out microloans (Akter and Mallick 2013). Of those, all were "acquainted with local NGO workers" and half had borrowed before the cyclone. There was no statistically significant correlation between the likelihood of borrowing and pre-cyclone income or assets, nor between borrowing and the extent of household physical, economic or structural damage.

Remittances are another part of the socioeconomic system in Bangladesh. Studies on the use of remittances in high-migration areas of the country show that they form an important part of the economy and resilience of migrant households and villages, contributing to expenditure allocations, diversifying income, spreading risk, and improving living standards (Sikder 2012).

At the same time, it has been argued that because remittances tend to be spent on consumer goods rather than savings or building assets to improve livelihood, their long-term impacts are limited (Sikder 2012). The counterargument is that using remittances for consumption is not incompatible with investment – that remittances to address the food gap ultimately have a positive impact on household food and nutrition security. In the Bangladesh context, decisions regarding the effective use of remittances can be influenced by *gusthi* or *bongsher* (kin/lineage) or *rokter somporko* (bloodline) and village customs, especially for small amounts. Still, there is some evidence that remittances exacerbate income inequality and dependence in the receiving household or community.

Key points on well-being outcomes

- Resilience is linked to development outcomes that are influenced by the extent to which individuals, households, communities, and systems exhibit different resilience capacities (absorptive, adaptive and transformative).
- Several categories of outcomes are significant to resilience and thus relevant to resilience programming. Food security outcomes are highly relevant, as are other areas of traditional development programming, such as poverty outcomes and health and nutrition outcomes.
- Systems-level outcomes are strongly connected with outcomes at individual, household, and community levels; interaction and mutual influence occur across levels. Outcomes in household-level food security are partly a reflection of higher-level outcomes: they reflect the state of physical systems such as roads infrastructure, water management infrastructure, electric connectivity, emergency systems and social systems (migrant remittance networks).

5. Capacities needed to strengthen resilience

Resilience is comprised of three types of capacities that enable households to manage and recover from shocks: (1) absorptive capacity – the ability to minimize exposure to shocks and recover quickly when exposed; (2) adaptive capacity – the ability to make informed choices about alternative livelihood strategies based on changing conditions; and (3) transformative capacity – system-level enabling conditions such as governance mechanisms, policies/regulations, infrastructure, community networks, and formal and informal social protection mechanisms that create an enabling environment for systemic change (Frankenberger and Nelson 2013; Béné et al. 2016b; Smith and Frankenberger 2016).

Resilience capacities have been analyzed in two programs operating in Bangladesh from 2010-2015: PROSHAR and SHOUHARDO II. PROSHAR is especially relevant to this review because it was implemented in the FTF ZOI in the Khulna Division, in Batighata, Lohagara and Sarankhola upazilas. The PROSHAR analysis used endline data collected between January and February 2015 (N=2,218 households); the data are limited to absorptive capacity, as the variables needed to analyze adaptive and transformative capacity were not collected, so these indices could not be calculated. SHOUHARDO II was implemented in the northwest *haor*, Mid and North Char areas, and the southeast coast; it has a more robust sample size (N=8,415) and greater availability of resilience data than the PROSHAR study. Even though SHOUHARDO II is not in the FTF ZOI, it provides an excellent example of the kind of resilience measurement work that should be done in future FTF programs. This section first discusses study findings, then findings from the literature related to improvements needed in factors that contribute to resilience.

5.1 Study Findings

5.1.1. PROSHAR

The resilience capacity measurement approach used to analyze PROSHAR resilience data follows the theoretical groundwork of Smith and Frankenberger 2016, which was based on Barrett and Constas 2014 and the Food Security Information Network Resilience Measurement Technical Working Group (Constas et al. 2014a, 2014b).

Among PROSHAR households, exposure to disasters (shocks) in the previous 12 months had a negative impact on household food security (Annex 6, **Table 6**). This is the hypothesized and expected relationship between shock exposure and food security. The relationship is demonstrated in the analysis by the negative and significant coefficient on shock exposure: a household that experiences one or more shocks is likely to have fewer months of sufficient food provisioning. Similarly, the PROSHAR analysis indicates a correlation between exposure to shock and moderate to severe household hunger: households that have experienced one or more shocks are more likely to experience moderate and severe hunger.

Absorptive capacity, estimated in the PROSHAR study using a reduced-form index due to data availability, has the expected sign across both dependent outcome variables of interest – months of adequate food provision and household hunger – and is significant at the one-percent level. Absorptive capacity is correlated with more months of adequate food provisioning and positive household hunger scale outcomes. This demonstrates that a household with a higher absorptive capacity is more likely to have adequate food and less likely to go hungry. The finding of a significant correlation between absorptive resilience capacity and food security outcomes is further supported by SHOUHARDO II endline data (Smith and Frankenberger 2016).

5.1.2 SHOUHARDO II

Indices of resilience capacities in SHOUHARDO II at endline are based on the indicators in **Table 1** and constructed using factor analysis (Smith and Frankenberger 2016). Indicators in the absorptive and adaptive capacity indices are measured at the household level; those in the transformative capacity index are village level. An overall index of resilience capacity is calculated using factor analysis of the three indices. All four indices use a scale of zero (low) to 100 (high). The indices can be used for comparisons across geographic and demographic groups and provide variability across households needed to detect relationships in regression analyses; however, the indices are not comparable to one another, and specific ranges of values representing “low” or “high” resilience cannot be established.

Table 1: Indicators employed to measure resilience capacity

Absorptive capacity	Adaptive capacity	Transformative capacity
• Bonding social capital • Asset ownership • Cash savings • Access to informal safety nets • Availability of disaster preparedness and mitigation	• Bridging social capital • Linking social capital • Aspirations and confidence to adapt • Diversity of livelihoods • Asset ownership • Human capital • Exposure to information	• Bridging social capital • Linking social capital • Access to markets • Access to services • Women's empowerment • Governance

Source: Smith and Frankenberger 2016

In this study, the "Coast" area is in Cox's Bazaar in southeast Bangladesh. The area may share some similarities with coastal Khulna and Barisal divisions; key differences include a large refugee population in Cox's Bazaar, presence of urban centers in Khulna and Barisal, and a larger inland area in Khulna. The study found that Coast households have the lowest resilience capacity index means (**Table 2**). Absorptive capacity is roughly the same across regions. The greatest difference is in transformative capacity, which is especially low in the Coast area and high in North Char.

Table 2: Resilience capacity index means in SHOUHARDO II endline, by program area

		Program area			
	All	Coast	Haor	Mid-Char	North Char
Absorptive capacity	24.7	24.3	25.2	24.4	24.3
Adaptive capacity	41.3	34.1	43.4	38.9	41.0
Transformative capacity	50.8	28.7	51.3	44.9	55.1
Resilience capacity	**31.5**	**25.2**	**32.4**	**29.7**	**32.1**

Source: Smith and Frankenberger (2016) calculations using SHOUHARDO II endline data set.

The study found also that after the 2014 flood, households in the SHOUHARDO II program area that had higher resilience capacity (Annex 7, **Figure 8**) were better able to maintain their food security (measured as the number of months of adequate food), compared to households with the mean level resilience capacity or those with the least resilience capacity. SHOUHARDO II data were further analyzed to assess which sub-components helped mitigate flood impacts on food security (Annex 6, Table 7).[23] Supporting factors for which there is the strongest evidence[24] are bonding and bridging social capital,[25] access to services, exposure to information, women's empowerment, village governance, and informal safety nets. Those for which evidence is given from the cross-sectional regressions (which have the advantage of an ample sample size), but not the panel regressions, are aspirations and confidence to adapt; asset ownership; access to markets; and disaster preparedness and mitigation. Those for which evidence is given from the panel regressions (whose advantage is a more rigorous estimation technique), but not the cross-sectional regressions, are livelihood diversity and human capital. All of these factors likely helped mitigate the negative impact of the floods on household food security; moreover, this analysis provides evidence of specific factors that reduced the negative impact of a specific

[23] Annex 2 shows the component indicators used to measure each capacity.
[24] i.e., evidence from both the cross-sectional and panel regressions. The evidence is considered to be "strong" if the interaction term regression coefficient is of the expected sign and statistically significant at least at the 5 percent level in both the cross-sectional and panel regressions for one or more combinations of the shock exposure measures and food security indicators.
[25] When bridging social capital is measured at the community level, both regression methods provide supportive evidence (see results for transformative capacity).

shock (2014 extreme flooding in Northern Bangladesh).[26]

The SHOUHARDO II study found that while all three resilience capacities are strongly coordinated with households' resilience to shocks, in this case the 2014 floods, the evidence for the contribution of absorptive resilience capacity is the most robust (Smith and Frankenberger 2016). Households' absorptive capacity helped reduce the negative effect of flood exposure (measured using both self-reports and streamflow levels) on hunger (measured by hunger score) and food security (measured by the number of months in which households have adequate food). These findings are supported by results from the panel growth regressions when streamflow surplus is employed as the measure of flood exposure. The importance of absorptive capacity would be expected in a flood-prone area, when households need to prepare to reduce their exposure before, during, and after the flood, and to recover. One implication of this finding is in designing strategies to increase resilience for rapid-onset climate shocks, an appropriate focus would be on supporting households to build absorptive capacity.

5.2 Findings from the literature on resilience capacities

Absorptive capacity

Absorptive capacity is the ability to minimize exposure to shocks and recover quickly. Based on the literature, factors that contribute to absorptive capacity and need strengthening include:

- ***Greater inclusion of poorer households in disaster preparedness activities*:** Akter and Mallick (2013) found that cyclone preparedness activities in 2009 – including preparedness training, early warning systems, and evacuation plans – excluded poorer households, reducing their ability to plan for and respond effectively to Cyclone Aila. Poorer households were less likely to receive early warning and more likely to live farther away from cyclone shelters, some of which had insufficient space for evacuees. Nobo Jibon has increased disaster preparedness: across the program area, 22 percent of households had received training at the end of the program, compared to 5 percent at baseline (TANGO 2015). The proportion of households receiving training in Barisal increased from just 1 percent to 12 percent, indicating significant progress and an area of continued need.
- ***Structurally sound shelter*:** Poor people are more likely to live in *kacha* homes that are closer to shorelines and farther from disaster shelters and thus sustain high losses. Following Cyclone Aila, more than 20 percent of the *kacha* houses were rebuilt with wood, likely related to the central-government-led post-cyclone housing intervention "Build Back Better," leaving 80 percent to be rebuilt as *kacha* and therefore vulnerable (Akter and Mallick 2013).
- ***Access to emergency supplies and relief aid*:** Emergency supplies help people prepare for and mitigate the impact of a disaster. Relief aid, such as medical supplies, helps people recover in the aftermath. Following Cyclone Aila, relief and recovery aid in the southwest coastal area were well targeted but inadequate (Akter and Mallick 2013). Younus (2013) reported that local health care centers and NGO resource distribution centers are inadequate following floods and that insufficient aid supply exacerbates competition, with shortages creating opportunities for social elites to influence distribution.
- ***Post-cyclone loans*:** Although loans helped prevent unemployment among some people after Cyclone Aila, access to and availability of post-cyclone/disaster loans seemed to be limited

[26] Note that access to financial services and access to formal safety nets were not included in this study; also, it is known "…conceptually and from previous studies that some factors measured here that did not show up in the above lists—relying on savings and linking social capital—do potentially play a role in assisting households to cope with disasters like floods. They certainly should not be ruled out as possible contributing factors in future studies" (Smith and Frankenberger 2016).

(Akter and Mallick 2013). Increased access and availability of low-interest loans should be targeted towards self-employed individuals to help them restore their livelihoods.

- ***Access to sanitation, clean water and electricity after a cyclone*:** Households' access to sanitation, clean water and electricity was significantly reduced after Cyclone Aila (Akter and Mallick 2013).

Adaptive capacity

Adaptive capacity is the ability to make informed choices about alternative livelihood strategies based on changing conditions. Factors that contribute to adaptive capacity include bridging and linking social capital, aspirations and confidence to adapt, livelihood diversity, asset ownership, and human capital. People who have access to information about climate trends and work availability may be able to make better decisions affecting their future and therefore increase their resilience. This section highlights findings about adaptive capacity from USAID programs and the available relevant academic literature.

As with other areas in Bangladesh, in the Nobo Jibon program area in Barisal Division, agriculture is critical to livelihoods and food security, yet opportunities for training and information are limited. More than half (57 percent) of sample households in the Nobo Jibon program area were involved in agricultural production at endline, and almost 89 percent were involved in at least one form of food production (agriculture, livestock, or fish). However, only a small portion (13 percent) of households reported having received any agricultural training (TANGO 2015). Only 22 percent of households engaged in agricultural production in the previous year had received any training. Nobo Jibon was the most common source of agricultural training (62 percent), followed by government (30 percent), NGOs (16 percent) and seed companies (7 percent). Moreover, weather and climate information are very limited or not available, which further limits farmers' ability to make informed short- and long-term decisions.

A more comprehensive analysis of SHOUHARDO II findings links improved adaptive capacity to improved resilience to shock. Measured as a household's ability to maintain food security, evidence derived from either cross-sectional and/or panel regressions shows that aspirations and confidence to adapt, asset ownership, livelihood diversification and human capital are supporting factors of resilience. The evidence on aspiration has also been supported by studies from Ethiopia, Ghana, Fiji, Vietnam and Sri Lanka (Béné et al. 2016a).

While this study showed livelihood diversification to be important, it may also be context specific, as it will only improve resilience when "high return activities and significant non-climate-sensitive livelihood options exist (Smith and Frankenberger 2016, p. 36; Nelson et al. 2016)." Bridging and linking social capital are also noted to play important roles in building resilience.

Other factors that contribute to adaptive capacity and need strengthening include:

- ***Improved communication after a disaster, especially regarding jobs:*** Younus and Harvey's 2013 study found that half of survey respondents felt that if good communication between the unions and Islampur Upazila headquarters existed after extreme flooding events, people in the area would have an easier time finding temporary employment.
- ***Improved savings and access to commercial loans:*** Multinomial logit regression and panel data from IFPRI's FTF ZOI study indicates that higher value assets (e.g., land) and increased savings are shown to be correlated with helping households avoid dropping to poverty levels while also helping to increase household diet diversity (Ahmed et al. 2016). These findings also show that increased access to commercial loans allows for adaptive investments that can

help improve livelihood production, such as mechanized irrigation. These improvements can further facilitate greater income that can lead to other adaptive activities like greater fertilizer use and improved educational opportunities.

Transformative capacity

Transformative capacity is comprised of system-level enabling conditions such as governance mechanisms, policies/regulations, infrastructure, community networks, and formal and informal social protection mechanisms that create an enabling environment for systemic change. Other factors include bridging and linking social capital, access to markets and services, and women's empowerment.

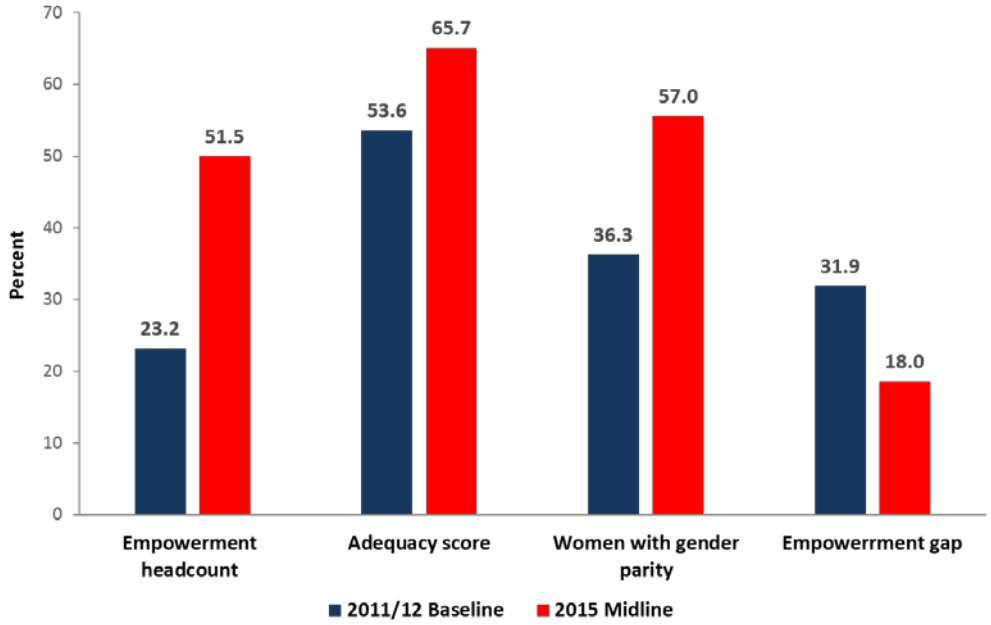
Based on the literature, factors that contribute to transformative capacity and need strengthening include:

- ***Climate information:*** Climate and natural hazard information is critical for early warning, disaster preparedness, and short- and long-term planning regarding which crops to plant each season. The World Bank recently approved US$113 million for a Weather and Climate Services Regional Project to "help Bangladesh provide reliable weather, water and climate forecasts and enable communities, especially farmers, to access weather information services easily" (World Bank 2016c). Further support may be needed to tailor information for various sectors, such as providing weather and climate information for Bangladesh's approximately 30 agro-ecological zones, integrating information into the agricultural extension curriculum, and adopting new technologies such as mobile phone messaging for information dissemination.
- ***Access to health services:*** One of the key factors influencing health outcomes in Bangladesh is the severe lack of human resource capacity in health (El-Saharty et al. 2015). Bangladesh spends just US$16 per capita for health annually, part of which comes from development partners (BIGD 2014). As of 2012, an estimated 35 physicians and 38 community health workers exist per 100,000 people. Contributing to this problem, most doctors do not like to be posted in the most critical flood-prone regions in the country. Consequently, in highly vulnerable regions, many Bangladeshis resort to traditional healers, resulting in more than 25 percent of households reporting chronic illness (Toufique and Islam 2014). While more and more women are entering the health profession, mostly in frontline positions, many become inactive in their careers after marriage, and due to lack of infrastructure and sociocultural reasons, it is difficult for women to work in remote areas.
- ***Local government capacity to manage and protect natural resources:*** A case study in Khulna Division indicates that local government institutions and NGOs lack capacity to create or implement natural resource management plans, such as for wetlands Reid and Alam (2014). Such a gap could contribute to over-exploitation of important resources, such as snails and fish, and subsequent ecosystem changes/decline. Improved management of natural resources such as fisheries and forests could provide a more robust natural resource base that would enhance long-term adaptive capacity.
- ***Women's empowerment:*** Bangladesh scored the lowest regionally and globally on the Women's Empowerment in Agriculture Index (WEAI), which prompted the implementation of FTF programming tailored for Bangladeshi women. Recent programs in the FTF ZOI have contributed to large improvements: in 2015, half of the women in the FTF ZOI were considered empowered, a major improvement from 23 percent in 2011 (**Figure 3**) (Ahmed et al. 2016). This improvement can directly lead to supporting increased resilience, as

demonstrated by more detailed regression analysis of SHOUHARDO II data (Smith and Frankenberger 2016).

- ***Improved access to market and services:*** Access to markets provides access to inputs and financial services, helping to improve adaptive and adsorptive capacities through diversification of assets and income-generation activities (Frankenberger et al. 2013; Frankenberger et al. 2012). Improved services can allow for access to infrastructure such as household and livestock safeguards, storage, irrigation, and drainage canals that helps "enable communities and households to better cope and to be less affected by natural shocks (WFP 2013)." This access can allow households to maintain both human capital and critical assets important to improving resilience capacities (Frankenberger et al. 2013).
- ***Governance:*** Representative, responsive, transparent and accountable governance is critical to "enable conditions that provide the foundation for households' access to resources, skills, technology, services, markets and information, thus helping them anticipate, prepare for, respond to, and recover from shocks (Smith and Frankenberger 2016: 22; Pasteur 2016)." A cross-sectional and panel regression analysis of findings from SHOUHARDO II offers strong evidence of village governance as a key supporting factor of resilience (Smith and Frankenberger 2016).

Figure 3: Women's empowerment status in the FTF ZOI in 2011 and 2015



Source: Ahmed et al. 2016

- *Power relations.* Bridging and linking social capital are critical for accessing resources and assistance from other communities or higher levels of authority such as NGOs and the government. Support from institutions/ organizations is especially important following a covariate shock where close friends and family are similarly resource-constrained. Uneven power relationships, though – such as those found in a case study in Khulna Division where local leaders delivered favors to friends, family or people who paid bribes – contribute to inequitable distribution of relief resources and limit people's coping strategies and adaptive capacity, especially the poor (Jordan 2014). Moreover, the fact that people do not report the bribery for fear of losing future relief points out weak governance and the need for increased

institutional accountability.

Key points on resilience capacities

- **Absorptive** capacity is the ability to minimize exposure to shocks and recover quickly Absorptive capacity contributes to resilience, through interventions that strengthen disaster risk reduction and response capacity that reduce loss of lives and assets. The proportion of households that has received disaster preparedness training in Barisal has increased but remains low (12 percent).
- **Adaptive** capacity is the ability to make informed choices about alternative livelihood strategies based on changing conditions. Factors that contribute to adaptive capacity include bridging and linking social capital, aspirations and confidence to adapt, livelihood diversity, asset ownership, and human capital. People who have access to information about climate trends and work availability may be able to make better decisions affecting their future and therefore increase their resilience.
- **Transformative** capacity is comprised of system-level enabling conditions such as governance mechanisms, policies/regulations, infrastructure, community networks, and formal and informal social protection mechanisms that create an enabling environment for systemic change. Other factors include bridging and linking social capital, access to markets and services, and women's empowerment.

6. Recommendations on key investments for improving resilience

This section recommends strategic areas for investment to improve resilience in Bangladesh. These have an evidentiary basis in the resilience research on recent development and resilience programming, and on the literature reviewed in this report. The discussion is organized by type of resilience capacity, indicating the corresponding USAID Bangladesh Mission Development Objective (DO) for each sector of investment: 1) Good Governance; 2) Economic Growth; 3) Health; and 4) Climate and Disaster Resilience.

6.1 Investments in absorptive capacity

To help households and communities prepare for and manage shocks and stresses in the short term, the following investments in absorptive capacity are important.

Climate and Disaster Resilience (DO4)

Disaster preparedness and mitigation

Evidence from projects such as PROSHAR strongly supports the importance of disaster preparedness training. This, as well as repeated messaging and follow-up training, could be further expanded to improve disaster awareness skills such as planning to protect human life, livestock and productive assets.

A community risk assessment undertaken for the WFP ER project identified embankments, household and livestock safeguards, storage, irrigation, and drainage canals as assets that contribute to the capacity to cope and decrease the harmful impacts of natural shocks (WFP 2013). These suggest areas of attention for disaster preparedness interventions.

EWS are a common and important element of disaster preparedness strategies. Yet even when EWS are in place, they should be reviewed and updated regularly. Indeed, one of the recommendations stemming from a study by Islam et al. (2013) on disaster risk in a coastal community (Matlab) in

Chittagong Division was to improve the functionality of its outdated system. The authors emphasize the importance of understanding traditional mechanisms used by local communities to relay disaster information– often a blind spot for external agencies, NGOs and the government – and integrating these with modern technological aspects of EWS for prevention, mitigation, and response (Islam et al. 2013). The significance of indigenous knowledge and practices in disaster preparedness is also highlighted in a study conducted on this topic in PROSHAR program areas (Rahman and Kamal, n.d.). For example, the report notes the traditional practice among local fishermen of predicting cyclones by observing wave size, wave direction and wind speed.

Ensuring that emergency shelters have adequate geographic coverage, capacity and facilities, and "making transportation available to encourage evacuation, especially for families with elderly household members and young children and for those who live further away from the cyclone shelters," are also important areas for attention (Akter and Mallik 2013).

6.2 Investments in adaptive capacity

To help households and communities manage, recover, and rebuild after shocks and stresses in the medium term, the following investments in adaptive capacity are important.

6.2.1 Economic Growth (DO2)

6.2.1.1 Agricultural and agro-aquaculture production

Supporting smallholders to invest in and maintain physical assets and adopt agricultural technologies shown to increase farmer income would be strategic areas of investment. Equipment and technologies should be affordable to small farmers, ecologically responsible, and adapted to the crops appropriate to local markets and the natural resource environment. Mechanized irrigation, such as fuel-efficient surface water irrigation pumps promoted by FTF, is one example; moreover, the use of mechanized irrigation has been shown to increase household diet diversity (Ahmed et al. 2016).[27]

Crop diversification is another important investment area. Improvements in household FCS have been attributed to increased diversity of agricultural production – specifically, to growing more non-rice crops and rearing dairy cows and poultry (Ahmed et al. 2016). In fact, increased rice cultivation in the FTF ZOI was associated with decreases in both farmer income and household-level diet quality, which suggests that non-rice alternatives such as higher-value and high-nutritive crops should be promoted. That said, results may be differ depending on the rice variety grown: certain varieties, like boro rice, are less desirable because they are input-intensive and thus less profitable. The FTF project has actually increased rice yields by 8.3 percent, despite a 3.2 percent reduction in the area cultivated – a result achieved presumably through using higher-performing rice varieties and improved agricultural technologies and practices such as fertilizer use. Sarker et al. (2012) call for more empirical study of the relationship between climatic variables and yields of specific crop varieties in Bangladesh, including rice yields, given the differential effects of those variables on different crops.

Regardless of the target knowledge or skill, it is important to better understand the factors that contribute to long-term behavior change in agricultural practices. Much has been invested to promote and support improved technologies and practices, yet there is evidence to indicate a

[27] A study of responses to the drought in 1994 and 1995 in northwestern Bangladesh found that for the lack of irrigation equipment, poor farmers could not apply adaptive responses that wealthy ones did, such as crop replacement, irrigation, gap filling and inter-cropping of wheat and Kaon (a local food crop) (Sarker et al. 2012).

prevailing preference for traditional methods – that may or may not make optimal use of resources or contribute to farmers' resilience (TANGO 2010).

6.2.1.2 Livelihood diversification

Livelihood diversification should include expansion and intensification of non-farm income opportunities. Having a higher share of non-farm income sources was shown in the FTF ZOI to help prevent households from backsliding into poverty; increases in non-farm income were also associated with increases in farm income and household-level diet diversity (Ahmed et al. 2016). Diversification is also important in light of resilience study findings in SHOUHARDO II program areas before and after flooding: laborers showed a heightened vulnerability to food insecurity compared to other forms of employment (Smith and Frankenberger 2016). Scott and Diwakar (2015) found that sustained poverty escapes are characterized by having a range of income sources including wage labor and microenterprise, such as crop agriculture and raising livestock. They suggest "reducing the risks associated with international migration: this could include making people aware of the economic returns from migration – in particular the salary required in order to make it an economically viable proposition, and increasing connections between rural areas and growing export-oriented industries, such as the ready-made garment sector" (p. 32).

6.2.1.3 Microcredit

Microcredit is a potentially useful area of support, especially when tailored for specific purposes such as helping households cope and recover from health shocks or make productive investments (Scott and Diwakar 2016). However, the limitations of current models need to be acknowledged; approaches need to be redesigned to overcome these shortcomings in order for microcredit to be effective in increasing households' absorptive and adaptive capacities. Microcredit can be available informally – via loans from one's family, neighbors, social network, and traditional moneylenders – and via the formal microfinance sector. The latter includes NGO-supported microcredit, where interest rates may be lower than traditional moneylenders: a case study of two villages in Bagerhat District (Khulna Division) found 10-12.5 percent total interest for NGO loans versus 10-20 percent monthly interest for traditional moneylenders (Jordan 2014). The case study, conducted in villages susceptible to salinity, cyclones, riverbank erosion and floods, suggested that microcredit can contribute to resilience in the face of climate stress by helping people diversify into non-climate sensitive economic activities and recuperate losses after a climate shock. However, taking one loan to pay for another and using loans for non-productive purposes limited their ability to use the funds for adaptive purposes more suitable for dealing with climate stresses. Indeed, the "vicious cycle of loan repayments" has been identified as a driver of poverty backsliding (Scott and Diwakar 2016: 33).

Taking loans can increase burdens at critical times, in cases where assets purchased are destroyed yet the borrower had to continue payments; this happened after Cyclone Sidr (Jordan 2014). This indicates the importance of the lending agency's capability to enact a contingent repayment system – such as suspending or cancelling the loan obligation – so that the household can recover. This is the case especially for covariate shocks that affect the social networks through which people would otherwise be able to receive loans or gifts immediately after a shock: since everyone is affected by the shock, everyone's resources are strained. Jordan's study thus recommends new credit mechanisms "…that can be grounded in longer-term concepts of resilience and … come into force at times of acute need when economic capital is required within a short time period" (p. 8).

Another cautionary note taken from the Bagerhat case study and elsewhere is that often microcredit schemes exclude the poorest; the ability to pay membership fees and monthly loan installments varies (Jordan 2014). A program implication highlighted in the Scott and Diwarat (2015) case study of poverty backsliding is that groups just above the extreme poverty line need access to finance mechanisms such as "soft loans with flexible repayment periods, training and linkages with markets (p. 31). This approach assists them to make adaptive investments once basic food security needs are satisfied and aspirations change. This recommendation is consistent with that of other researchers, e.g., Akter and Mallick (2013), who found "Although post-cyclone credit schemes appear to have prevented some people from becoming unemployed, access to and the availability of such credit programs does not seem to be widespread" (p. 123).

6.2.1.4 Education

Strengthening human capital is an important area for continued investment. The strong correlation between education level and several outcomes in the FTF ZOI suggests that support to education promises multiple benefits (Ahmed et al. 2016). More years of schooling of the household head and spouse of household head are suggested to prevent households from backsliding into poverty, increase farm income, and increase household diet quality as measured by the Food Consumption Score (FCS). This finding is consistent with other recent research on households' resilience to flooding in SHOUHARDO II villages: based on data before and after flooding in 2014, household head education level was significantly correlated with food security, increasing the number of months of adequate food and reducing the likelihood that a household will experience hunger (Smith and Frankenberger 2016). It is also consistent with the study on poverty backsliding in Bangladesh, which argues that education of school-age children is more effective than a focus on schooling of the household heads themselves, in that it is "… a means of continuing a virtuous cycle of sustainable poverty escapes, or preventing poverty traps in the long term" (Scott and Diwakar 2016: 17).

The policy context for education initiatives is favorable; it provides for monitoring of attendance and passing rates, and for rewarding achievements in these areas. Schools receive government educational stipends targeted to poorer households, and cash incentives exist for girls to attend and complete secondary school (WFP 2013).

6.2.2.2 Health (DO3)

Health and nutrition will continue to be a fundamental focus of development interventions given the precariousness of health outcomes in Bangladesh in the face of repeated shocks and stresses. **Table 3** shows the projected changes in selected climate factors and the burden on three childhood illnesses.

Table 3: Projected health burden by 2050 (Bangladesh)

		Estimation from DHS Data		Projection
Indicator		**2004**	**2007**	**2050**
Climate variable				
Average temperature (survey months)		23.5	27.8	29.0
Probability of flooding		22.6%	30.6%	40.0%
Disease incidence				
ARI	Incidence (%)	18.7	12.3	23.0
	Cases (thousands)	9,009	5,734	14.220
Diarrhea	Incidence (%)	7.0	9.2	7.3
	Cases (thousands)	3.376	4,296	4.529
Fever	Incidence (%)	39.2	36.1	46.3
	Cases (thousands)	18,916	16,787	28,605
Population ages 0-14 (thousands)		48,222	46.541	61,833

Note: The average temperature refers to the survey months. Flooding is defined as monthly rainfall above 1 standard deviation for a particular location and month.
Source: Mani and Wang 2014: 32

Prevalence of adult illnesses is also expected to increase, such as hypertension from water salinity and malnutrition from increased food insecurity and high disease incidence (Mani and Wang 2014). These findings underline the relevance of a continuing emphasis on health and nutrition in the next decades.

While continuing direct interventions in maternal and child health education and services is warranted, health and nutrition outcomes are influenced by a variety of factors and should be approached from multiple angles:

> The health impacts of increased climate variability and extreme weather events are projected to be significant by 2050, but well-targeted development investments can mitigate all of the excess health burden attributable to climate change. A simple message is that focusing resources in traditional areas of development, such as improving access of the population to safe drinking [water], sanitation, electricity, female education, and child nutrition, as well as strengthening the capacity to manage risks can be the best health adaptation option in the face of increased climate risk (Mani and Wang 2014: 7).

Table 4 speaks to this message, as it suggests both the scale of additional investment needed to have positive impacts on child illness and mortality, and how the impact of multi- sector investments is greater than investments in individual sectors.

Table 4: Simulation of the health impact of climate change (warming and flooding) by 2030 under two scenarios: current vs. higher levels of investment

	Scenario 1: current level of investment	Scenario 2: additional investment to promote development			
		Infrastructure	Education	Nutrition	All three combined
Impact					
Incidence of illness (baseline: 0.42 in 2011)	0.432-0.474	0.395	0.396	0.400	0.371
Averted deaths in children ages 0-14 (thousands)	464	-224	-215	-160	-605

Note: The incidence of childhood illness is projected based on regression estimation using the 2011 DHS, assuming that (a) average temperature increases by 1.5°C and (b) the probability of flooding increases from the current level of 0.225 to 0.35 by 2030 across the whole country. The population between the ages of 0 and 14 was 51 million in 2011(based on WHO figures) and is projected to be 66 million in 2020, and 61.8 million in 2030, based on U.S. projections. Overall development investment achieves (a) universal access to safe drinking water (that is, tube well in rural areas and piped water in urban areas), sanitary toilet facilities, and household access to electricity; (b) secondary female education attainment; and (c) elimination of child stunting in 2030.
Source: Mani and Wang (2014: 33)

As this report has shown, health shocks are an important contributor to poverty and poverty backsliding in Bangladesh, where health insurance is available only through a handful of NGO initiatives (Scott and Diwakar 2016; WFP CP Baseline 2013). Most people do not have insurance and must acquire cash quickly to pay medical costs, often by taking high-interest loans (Scott and Diwakar 2016). Developing the supply and demand for health insurance, including insurance subsidies, are possible areas for advocacy and intervention.

Promoting behavior change to improve child nutrition outcomes continues to be suggested as a critical investment area (Scott and Diwakar 2016). A personal approach – such as through door-to-door campaigns and local community champions – is viewed as among the more effective strategies (Scott and Diwakar 2016; Rahman and Kamal, n.d.).

6.3 Investments in transformative capacity

To develop and sustain households' and communities' abilities to prepare for, manage, recover from, and rebuild in the face of shocks and stresses in the long term, the following systems-level investments in transformative capacity are important.

6.3.1 Good Governance (DO1)

6.3.1.1 Governance in key institutions

An emphasis on governance and institutional accountability should be prioritized in various sectors. First, effective water resources management strategies will continue to be critical in Bangladesh, especially in the FTF ZOI where the impacts of climate change are hard-felt. Integrated Water Resources Management (IWRM) has been embraced globally and offers a framework for guiding work in this area: "IWRM is a process which promotes the coordinated development and management of water, land, and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."[28] It involves water managers and water users in assessment, management, planning, and decisionmaking processes, and thus has both a social dimension as well as an ecological one. Gain (2012) points out that with this approach, vulnerability assessments must

[28] Global Water Partnership. http://www.gwp.org. Accessed Jul 27, 2016.

include both of these "scales": the (bio-) physical water resources subsystem[29] and the social subsystem, and possibly a third scale to capture temporal and administrative aspects. Assessment- and governance-based IWRM are highly relevant emphases given gaps noted in the academic literature, such as a lack of ecosystem-based flood management (Reid and Alam 2014). An emphasis on water infrastructure in coastal areas, as promoted in the Bangladesh Climate Change Trust Fund, may be misdirected and even harmful to the ecosystem and

> "…important ecological processes; for example, sea walls affect the migration of mangroves as sea levels rise, and dykes and dams disrupt the annual flooding of floodplains. The IPCC reiterates that engineered defenses such as dams, sea walls and levees adversely affect biodiversity, potentially resulting in maladaptation due to damage to ecosystem regulating services" (Reid and Alam 2014: 35).

Ecosystem-based Adaptation approaches, including a combination of structural and non-structural approaches, are advised for water resource management (which extends to adaptation measures for flood control) (Reid and Alam 2014; Younus 2014), and used/developed in conjunction with early warning systems and means for real-time information exchange between upstream and downstream water users.

The management of water infrastructure needs to be well resourced, participatory, and transparent. Substantial work needs to be done to build public trust of institutions. A study of waterlogging in Khulna Division, and efforts to manage it in the context of its impact on *gher* farming, found

> …"widespread mistrust among different service-giving agencies, including NGOs, associated with lack of understanding amongst the working culture. All are working within their own boundary. There is virtually no coordination among the development and service-giving agencies. This may be addressed through establishment of separate central authority of the government (say, some form of Lower Ganges Delta Development authority). This has been suggested by many stakeholders" (FAO and WFP 2014: 28).

An additional argument for a continued focus on governance around water resources management is that there is evidence that governance is important to emergency response and recovery. For example, village governance was found to be a significant factor in helping SHOUHARDO II households to recover from floods (Smith and Frankenberger 2016).

There is also a need to develop capacity in government agencies involved in water resource management. For example, the Khulna Water Supply and Sewerage Authority (KWASA),[30] established in 2008 to ensure a safe water supply, manages a surface water treatment plant. KWASA requires "substantial work … to develop a modern water utility authority with proper corporate governance, organizational structure, human resource and financial management systems" (ADB 2010: 1). The Asian Development Bank and other donors have been supporting efforts to build institutional capacity in these areas, working with Water Supply and Sewerage Authorities through the Joint Partnership Framework for Urban Water Supply and Sanitation.

6.3.1.2 Infrastructure

At the systems level – the realm of transformative capacity – infrastructure is paramount in facilitating resilience to myriad shocks and stresses: "It becomes clear from a policy perspective that public goods have a major role to play in reducing livelihood vulnerabilities in the disaster zones in Bangladesh. Road infrastructure, particularly in the flash flood zone, drinking and irrigation water supplies, particularly in drought and saline zones and health services provided and promoted by the state can have a positive impact on enhancing the capacity of the households to withstand the shocks from natural disasters" (Toufique and Islam 2014: 248).

[29] e.g., from watershed, sub-basin, basin, or region to global hydrologic system, depending on the level of decisionmaking.
[30] Three Water Supply and Sewerage Authorities are established in Bangladesh: Dhaka, Chittagong and Khulna.

However, government efforts to develop rural roads and markets and to ensure a safe drinking water supply are underfunded. Public expenditures on sanitation, drinking water and health rank among the lowest in the world, with acute ramifications for disaster-prone and poor areas.

Access to electric power and to telecommunications infrastructure and hardware are additional specific areas suggested as linked to poverty outcomes and as such are potential areas for investment. In the FTF ZOI, lack of access to electricity and cell phone ownership were found to increase the likelihood of remaining in poverty; farmers' income increased when smallholders had electricity either via solar panels or the national grid, and owned a cell phone (Ahmed et al. 2016). These characteristics also had positive correlations with improvements in household diet quality.

6.3.1.3 Safety nets

Certain highly vulnerable populations may be unable to take advantage of the full range of resilience interventions. The elderly, orphans and vulnerable children, and people unable to work due to illness or other limitations, may temporarily or permanently need the assistance of formal safety nets to weather shocks and to maintain basic food security. Scott and Diwakar (2015) highlight the importance of tailoring program approaches to the needs of different wealth groups, namely the poor, extreme poor, and destitute, noting that highly labor-constrained households, such as those with elderly or disabled individuals, represent about five percent of the population and are likely to need continued assistance, which is an appropriate role for government safety nets. In contrast, a group such as the landless and extremely poor may be better served by one or a series of "economic pushes" – such as graduation models that combine asset transfers with stipends, training, participant monitoring and mentoring, and savings programs – en lieu of long-term safety nets.[31] Specific strategies are needed to define what amounts/ proportion of income, what duration, and what complementary services are most effective for different groups.

Informal safety nets were found to be a significant factor in helping SHOUHARDO II households recover from floods (Smith and Frankenberger 2016); this should be taken into consideration in program design.

6.3.1.4 Women's empowerment

Numerous studies point to the critical role of women's empowerment in development and resilience outcomes. Higher scores on the WEAI in the FTF ZOI (see Section 5) are associated with higher farm income and higher household-level diet quality (Ahmed et al. 2016). Women's empowerment was also found to be a significant factor in helping SHOUHARDO II households recover from the 2014 floods (Smith and Frankenberger 2016).

At the national level, policy frameworks exist for supporting women's empowerment, e.g., in 1997, the GoB adopted a national policy for the advancement of women. Moreover, community-based disaster management policies have embraced gender-sensitive approaches, recognizing women's social vulnerability and their role in disaster management, and seek "to minimize the vulnerability of women by promoting their participation in formal decision-making and to help meet their need to carry out responsibilities in line with the prevailing gender division of labor" (Fakhruddin and Rahman 2015: 117).

[31] Scott and Diwakar (2015) point to BRAC's Challenging the Frontiers of Poverty Reduction - Targeting the Ultra-Poor (CFPR-TUP) and DFID-funded extreme poverty programmes including the *Chars* Livelihoods Programme (CLP) and *Shiree* as useful models.

6.3.2 Economic Growth (DO2)

6.3.2.1 Marketing and pre-marketing activities

Alongside increasing agricultural productivity, improving knowledge and skills in agricultural marketing is an important supporting intervention (Scott and Diwakar 2016) – as are pre-market activities such as improving availability of and access to quality agricultural inputs, value-addition, quality improvement and control, packaging, and storage. There is likely significant work to be developed along this chain.

Improving the quality of agricultural inputs is an area where USAID has already placed substantial emphasis. For example, FTF has been working in the ZOI on an agro-inputs project that has created a network of certified agro-inputs retailers. The Agro-Inputs Project, implemented by Cultivating New Frontiers in Agriculture (CNFA), also seeks to improve inputs market information, enhance knowledge and quality of inputs standards, and strengthen the capacity of local organizations (CNFA 2016). This focus is consistent with analyses from past studies such as those identified in a 2012 study on WorldFish/FTF aquaculture project, which recommended to improve fish feed ingredients, feed formulation and processing, farm-level feed utilization (Mamun-Ur-Rashid et al. 2013). The study also recommended to work farmer access to financial and technical services, strengthen collaboration with the feed sector and animal health stakeholders (government, research institutions and development actors); and support policy measures that support aquaculture feed quality and safety such as the Feed Act.

Another indication of the importance of focusing on agricultural inputs is a study that found that a higher proportion of households in the disaster-prone areas in Bangladesh save seed (versus purchase it as market); possible reasons given for this are poor access to market or poor government extension (Toufique and Islam 2014). The study also notes, “If the market is less accessible and small, as is the case in the flash flood zone, quality of seed offered in the market may also turn out to be a serious concern.”

The organization and capacity building of marketing collectives is also a potential area for emphasis. This is suggested by data from the Nobo Jibon baseline: only 0.4 percent of households in the baseline bulked products for sale or sold to a cooperative or a collection point. A large majority of households (80 percent) relied on the local market to sell their agricultural produce, and local markets were also the most common source of agricultural inputs (TANGO 2010). Working with collectives is also a promising area for capacity development given that collective practices are emerging organically; Fakhruddin and Rahman 2015 found that farmers in coastal areas were adjusting and negotiating market prices jointly with fellow farmers as a coping strategy.

The need to develop marketing capacity also extends to aquaculture, e.g., building links between fish farmers and fish processors. Research in Khulna Division has highlighted opportunities in value-added aquaculture by-products in the pharmaceutical and cosmetics sectors, as well as in the use of silt: a study of waterlogging in the area found “brick fields have been established by the tidal rivers where Tidal Resource Management was in operation, which uses the silt of the river bed. The bricks are being used in the adjacent districts for construction and road works, and producers claim they are of good quality. Further study on it may help to develop the industrial use of huge sediment and agro-aquaculture by-product and potential marketing” (FAO and WFP 2014: 29).

6.3.3 Climate Change and Disaster Resilience (DO4)

It is important to be aware of autonomous adaptation strategies households employ to address environmental shocks and stresses, their effectiveness, and the value of integrating them into higher-level strategies for increasing resilience. Given that migration has become a normalized strategy in the context of perceived environmental change and climate variability – and is anticipated to continue into the future – it should be considered in development, climate change and environmental policies (Martin et al. 2014).

Support for the development of regional climate models to inform climate adaptation strategies and agricultural and economic policies is another area for investment. Accurate prediction of monsoons is critical to rain-fed agriculture and to early warning, yet in-country capacity to apply rigorous analysis and generate reliable data on rainfall, circulation, and regional-scale precipitation is limited, and there is low confidence in available projections (Dastagir 2014).

6.4 Closing remarks on future investments

This review has generated a sizeable list of contextual, theoretical and evidentiary considerations for planning a resilience strategy in Bangladesh for the next decade. There are multiple points of entry, many current interventions worth continuing and scaling up, and myriad opportunities for further strengthening and innovation. The USAID Title II projects whose results have been reviewed here in terms of what they teach us about resilience are a logical starting point. The studies on Nobo Jibon, PROSHAR, and SHOUHARDO II, as well as recent research on the USAID-supported ER projects, have shown that investing in certain kinds of capacities makes a difference. Absorptive capacity stands out in this regard, though we should keep in mind the benefit of experience here – traditionally, there has been a strong development focus in this area, with many established best practices at the household and community level. In contrast, working at the systems level (transformative capacity) is a highly complex undertaking, often larger in scale, requiring a more substantial investment, and slower to manifest measurable change. Nevertheless, the Title II projects have demonstrated positive results in systems-level areas such as governance, women's empowerment, and market linkages. This work should be expanded and reinforced; indeed, in the interest of sustainability, approaches to building resilience need to move increasingly in this direction, respecting and reinforcing the best efforts of native and traditional institutions and norms, and modelling and promoting inclusivity and transparency in analysis, planning, and decisionmaking regardless of sector.

Meanwhile, at the household and community levels, work in disaster risk reduction, health and nutrition, education, and agriculture should continue, though with more fine-tuning based on local contexts. This will require examining vulnerability assessments identifying risk exposure and existing capacity gaps in conjunction with available technical research on what works, where, when, for whom – and with what unintended adverse outcomes that may undermine resilience objectives and results. The role of social capital must be underscored in assessment and program design, given its proven role within and across absorptive, adaptive and transformative capacities. Program strategies need to be aware of the workings of traditional institutions and of the skills and knowledge of generations of community dwellers, as long-lasting behavior change favoring resilience outcomes stems from local perceptions and value systems.

Lastly, in order to improve the ability to analyze and understand the impacts of efforts to increase resilience, it is important that all future projects include a resilience module in baseline and endline evaluation exercises.

Key points on investments

- Future investments can be categorized into the three distinct resilience capacities: absorptive, adaptive, and transformative, and in alignment with USAID Bangladesh's Mission Development Objectives of Good Governance, Economic Growth, Health, and Climate and Disaster Resilience.
- **Absorptive capacities:** A traditional focus of relief and development interventions, investments in absorptive capacity have yielded the strongest results in terms of households' abilities to prepare for and manage shocks in the short term. This validates further investment in areas such as disaster and emergency awareness and preparedness.
- **Adaptive capacities:** Investments in adaptive capacity such as enhancing quality and productivity in agriculture and aquaculture, livelihood diversification, microcredit, and education, support positive resilience outcomes in the medium and long term. Such efforts focus in training and supporting vulnerable households to modify their practices and behaviors in response to future scenarios.
- **Transformative capacities:** Investments in transformative capacity are critical to building systems that can prepare for, respond, and govern in response to shocks and stresses. Emphasizing community, regional and national governance systems (e.g., water resource management, disaster risk management, safety nets, civil infrastructure), inclusiveness, safety nets, social systems and gender and power dynamics, marketing, and regional climate models is necessary to a holistic and sustainable approach to resilience.
- Many interventions in the named categories are already underway with the support of USAID, other development partners, the GoB, research partners and local institutions. The effectiveness of future work to build resilience is dependent on fine-tuning strategies to local context, linking these to best practices, and digging deeper into the more long-term and complex areas of change, such as social capital and governance at the systems-level both locally and nationally.
- To enable the analysis of the effectiveness of efforts to improve resilience, all future projects should include a resilience module in baseline and endline evaluation exercises.

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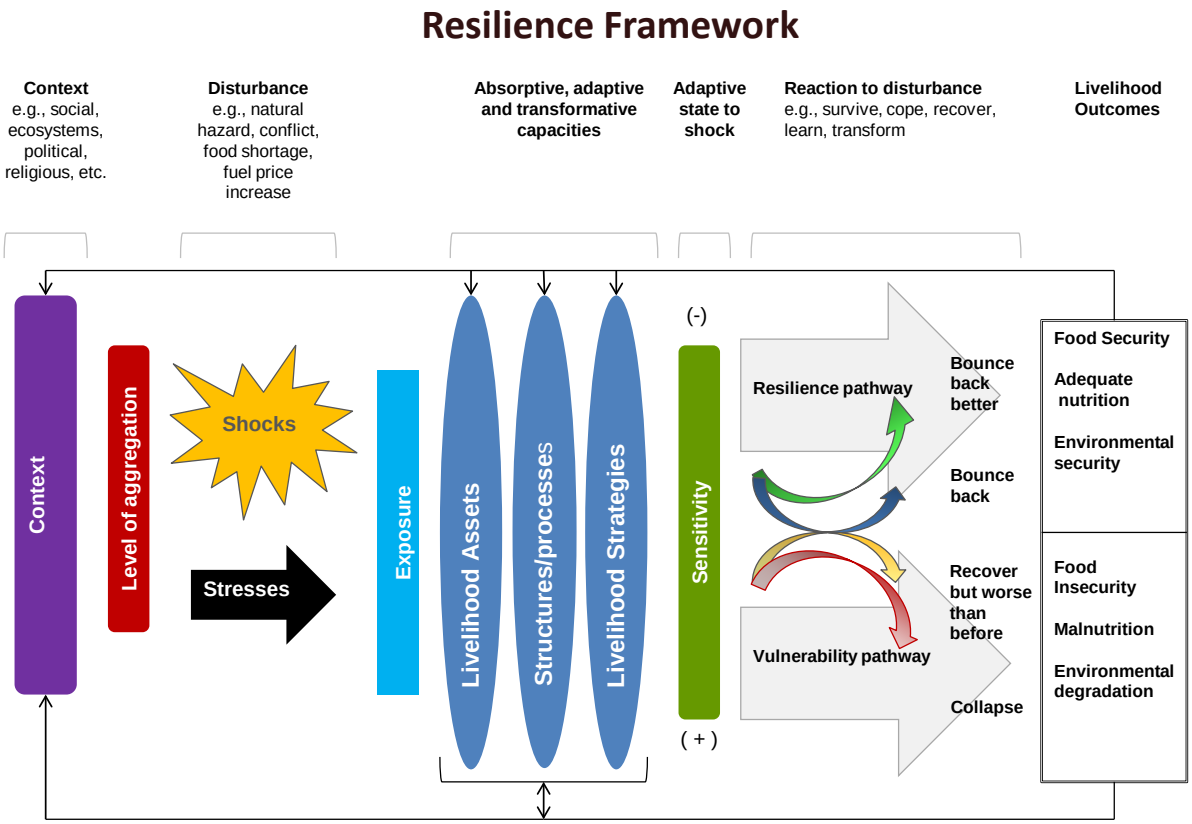
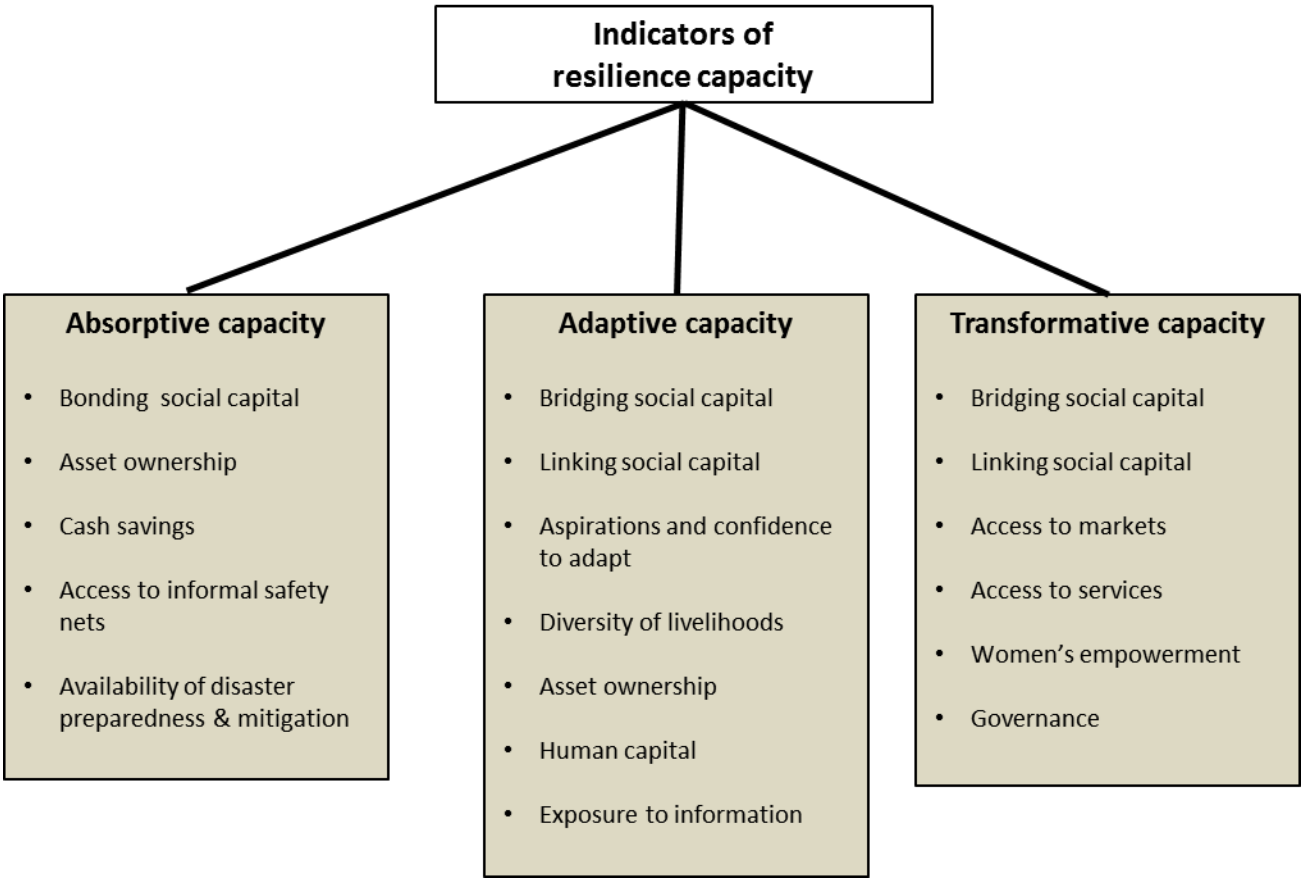
8. Annexes

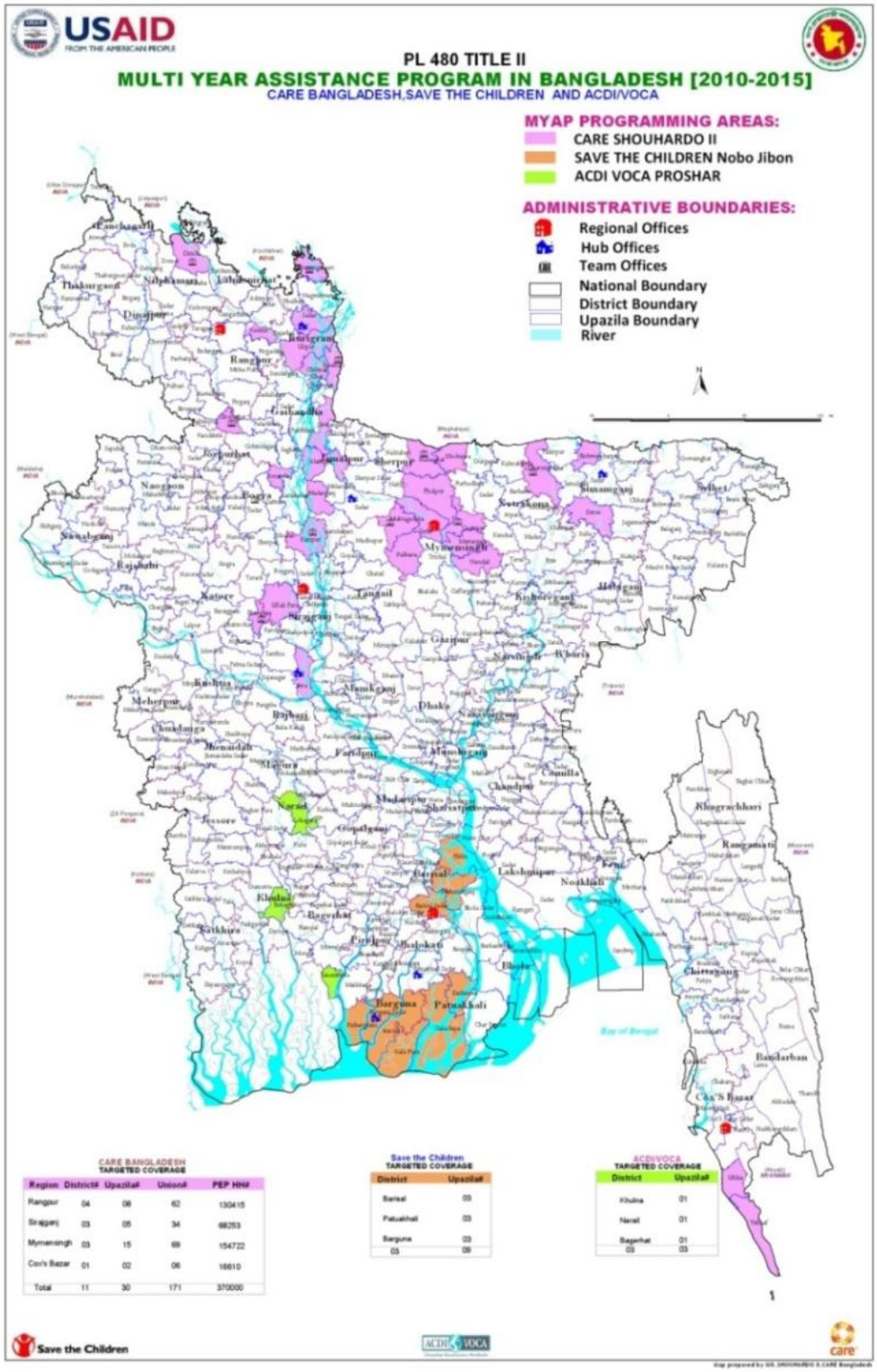
Annex 1: Resilience Framework



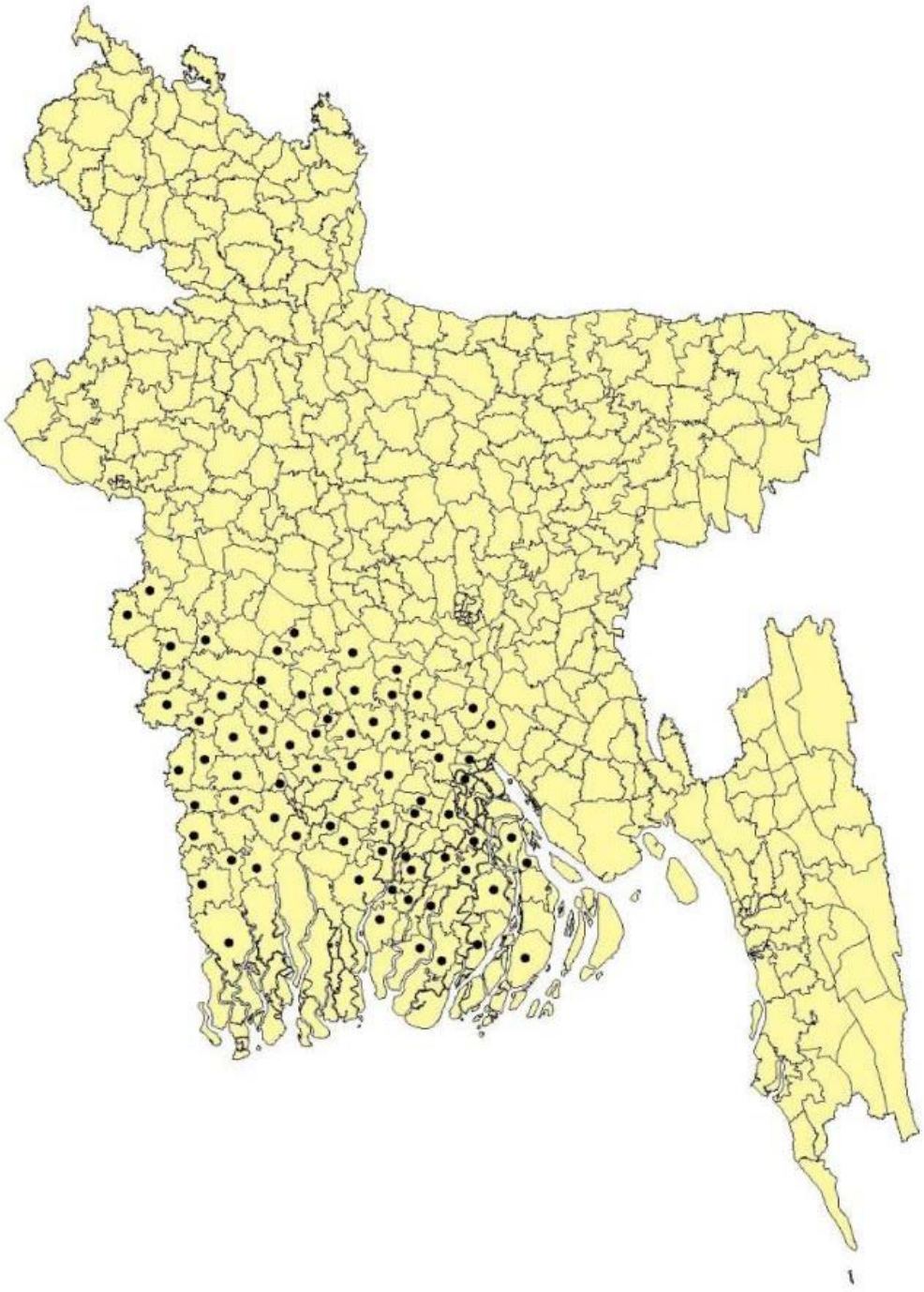
Annex 2: Indicators employed to measure resilience capacity



Annex 3: Map of USAID MYAP in Bangladesh 2010-2015



Annex 4: Map of FTF sub-section of IFPRI BIHS survey



Annex 5: Map of PROSHAR Program Area

Annex 6: Supplemental Tables

Table 5: Drinking water coverage estimates

Type of access	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Piped onto premises	23	32	0	1	5	12
Other improved source	58	55	65	86	63	75
Other unimproved	17	13	28	13	26	13
Surface water	2	0	7	0	6	0

Source: WHO/UNICEF JMP 2015

Table 6: Relationship between food security, shock exposure and absorptive resilience in PROSHAR program areas

OLS Fixed Effects at village level (cross-sectional)	(1)	(2)
Independent Variables: Dependent Variable:	Months of adequate food provisioning	Hunger Score
Shock exposure	-0.482***	0.027*
	(0.131)	(0.016)
Absorptive Capacity	15.902***	-1.124***
	(1.834)	(0.159)
Age of household head		-0.000
		(0.001)
Male household head		0.057
	(0.382)	(0.039)
Head of household education	0.034***	-0.001
	(0.012)	(0.002)
Occupation of head : Farming a/		
Agricultural laborer	-0.585***	0.038
	(0.133)	(0.024)
Non-agricultural laborer	-0.488***	0.045*
	(0.151)	(0.025)
Salaried employment	0.038	-0.010
	(0.160)	(0.020)
Self-employment	-0.232**	0.004
	(0.107)	(0.017)
Other	-0.288*	0.046**
	(0.171)	(0.022)
Household Size	-0.016	0.005
	(0.032)	(0.004)
Age-sex composition: % of females 0-16 a/		
Percent females 17-30	-0.068	0.008
	(0.105)	(0.016)
Percent females 31+	-0.254*	0.023
	(0.151)	
Percent males 0-16	-0.127	
	(0.125)	
Percent males 17-30	0.174	
	(0.108)	
Percent males 31+	0.419**	
	(0.174)	
Constant	6.687***	0.258***
	(0.528)	(0.061)
Observations	2,213	2,213
R-squared	0.278	0.142

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: TANGO calculations using PROSHAR endline data 2015

Table 7: The cross-sectional regression results are indicated with stars when the relevant interaction term is in the expected direction and statistically significant at least at the 10 percent level; number of stars represents significance levels. Cells are shaded if panel growth regression result coefficients indicate statistical significance at least at the 10 percent level. Cells that have stars and shading indicate results that were significant in both regressions and thus the most robust evidence.

Table 7: Does resilience capacity reduce the negative impact of shocks on food security? Results for index sub-components in SHOUHARDO II program areas facing flood risk

	Self-reported flood shock exposure		Streamflow surplus	
	Months of adequate food provisioning	Hunger Score	Months of adequate food provisioning	Hunger Score
Absorptive capacity				
Bonding social capital		***	***	***
Asset ownership	**	***	***	***
Savings a/		*		
Informal safety nets	***	*	***	***
Disaster preparation and mitigation			***	***
Adaptive capacity				
Linking social capital				
Bridging social capital			***	**
Aspirations and confidence to adapt			***	***
Livelihood diversity				
Asset ownership	**	***	***	***
Human capital				
Exposure to information			***	**
Transformative capacity				
Linking social capital in village b/				
Bridging social capital in village	***	***	***	***
Access to markets c/			***	***
Access to services	*	**	***	***
Women's empowerment in village		*	***	***
Quality of village governance			***	***

Notes: This table documents whether an interaction term between the factors supporting resilience capacity, listed in the left-most column, and the flooding exposure variables, the top column headings, has the expected sign and is statistically significant at least at the 10% level. Stars indicate the cross-sectional regression results, with *** indicating significance at the 1% level, ** at the 5% level, and * at the 10% level. Shaded cells indicate that the panel growth regression result coefficients have statistical significance at least at the 10% level. The independent variables controlled for in each regression are the same as those listed in Tables 6 and 7.

a/ The interaction term coefficient in both panel regressions is positive and statistically significant at least at the 5% level when the hunger score is the dependent variable.

b/ The interaction term coefficient in the cross-sectional regression is negative and statistically significant at the 10% level in the months of food regression.

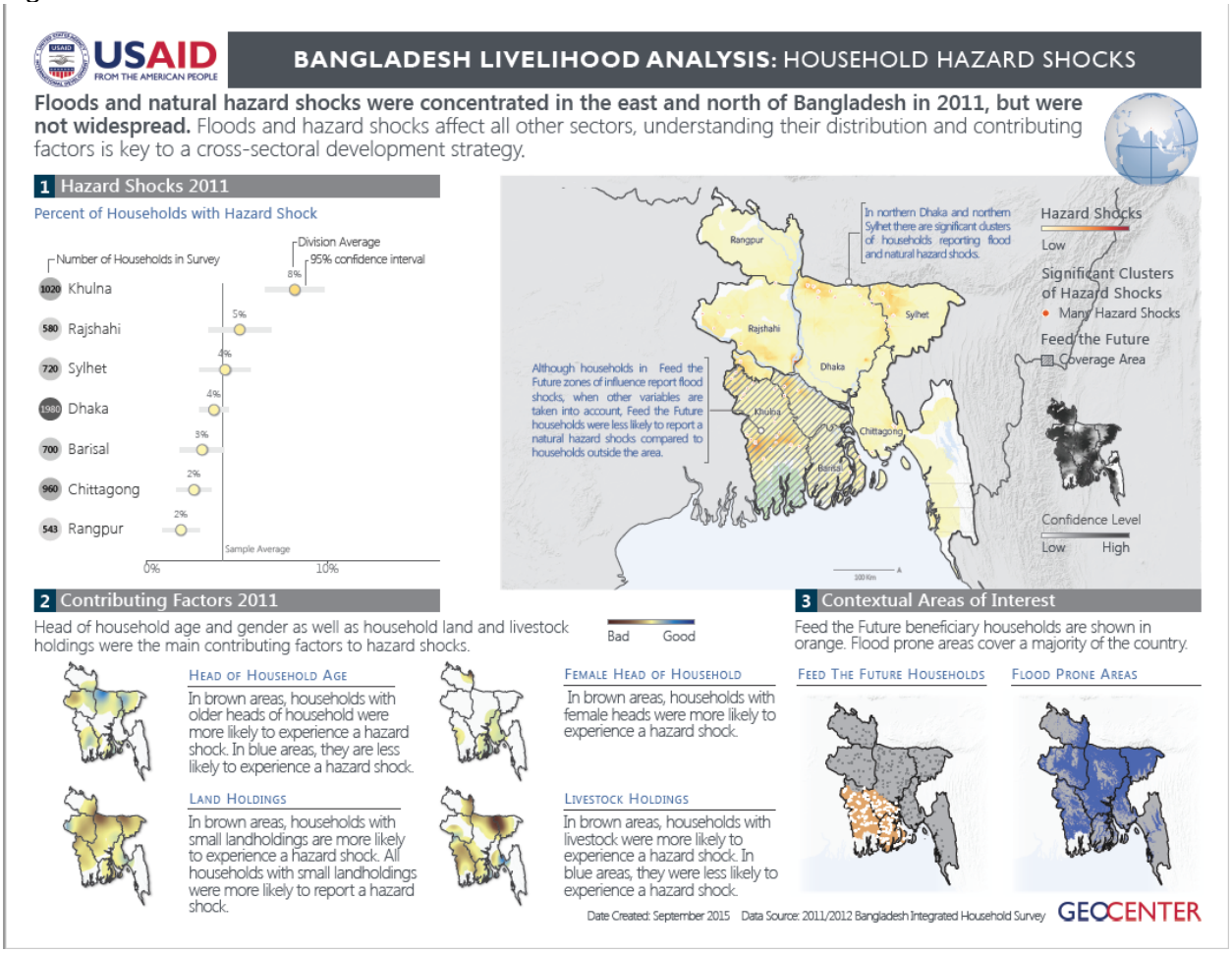
c/ The interaction term coefficient in the cross-sectional regression is negative and statistically significant at the 10% level in the months of food regression.

Source: Smith and Frankenberger 2016

Note: Separate regressions were run for each index sub-component rather than including all in a single regression. This modeling decision was in consideration of the substantial inter-correlations of the components and the fact that some are known to causally

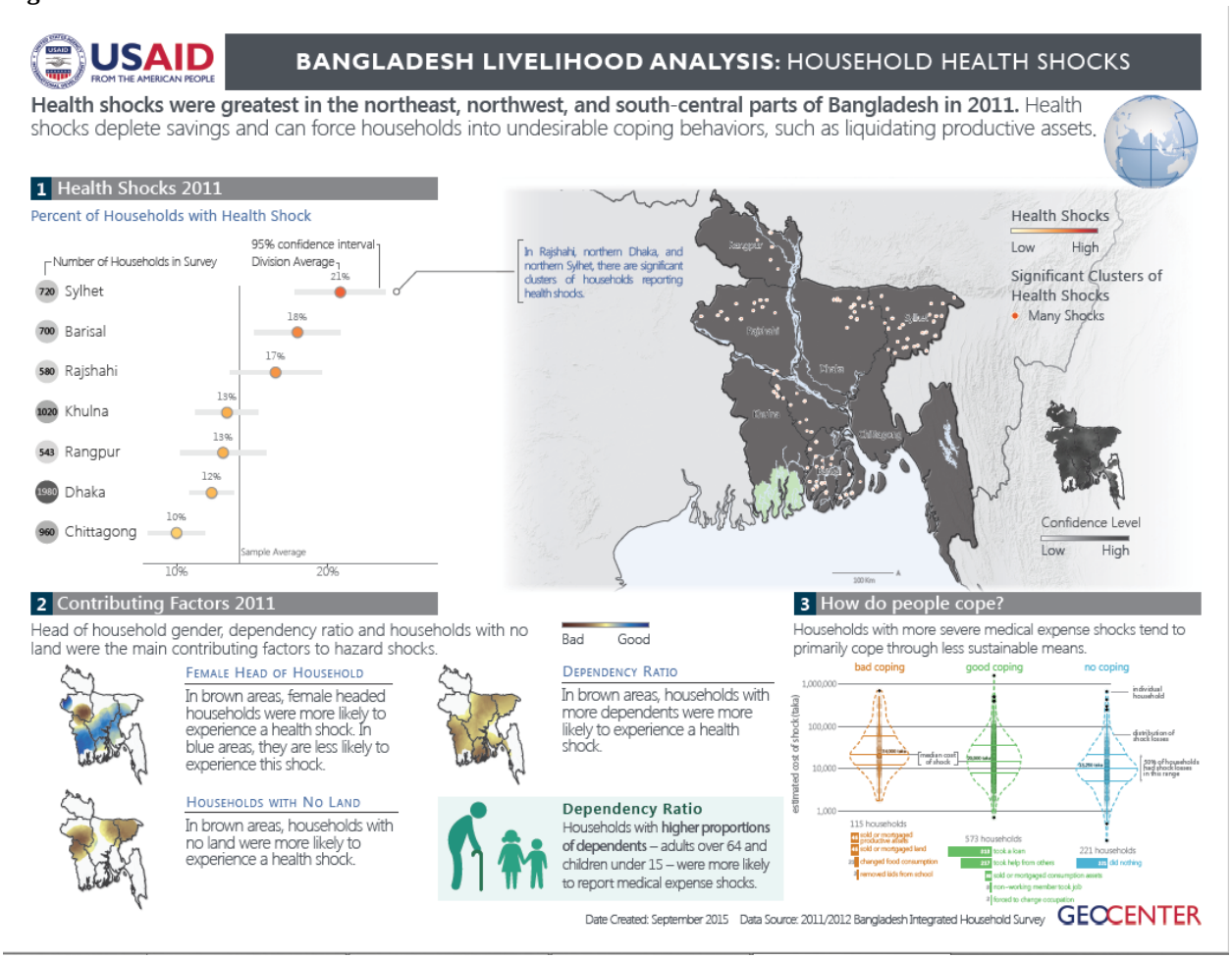
Annex 7: Supplemental Figures

Figure 4: Household hazard shocks



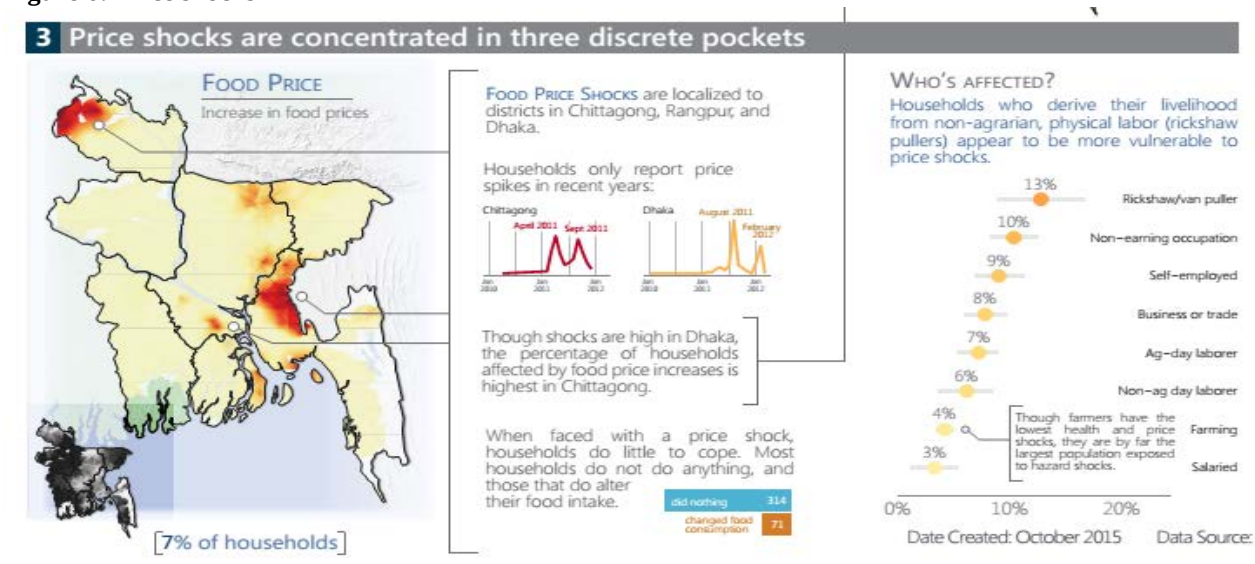
Source: USAID 2015. GeoCenter. Date created: September 2015. Data source: 2011/2012 Bangladesh Integrated Household Survey.

Figure 5: Household health shocks



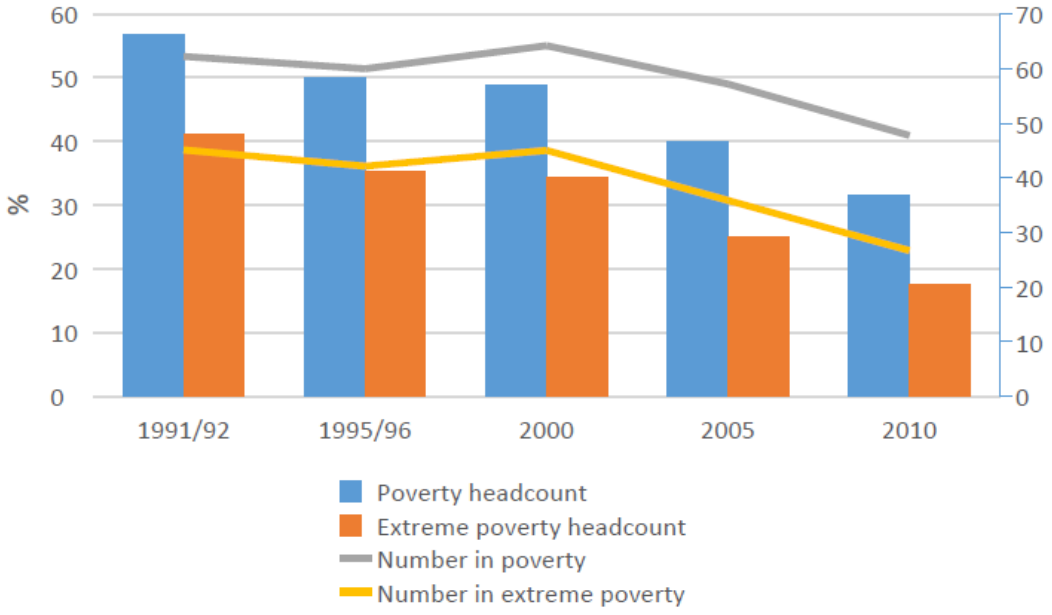
Source: USAID 2015. GeoCenter. Date created: September 2015. Data source: 2011/2012 Bangladesh Integrated Household Survey.

Figure 6: Price shocks



Source: USAID 2015. GeoCenter. Date created: October 2015. Data source: 2011/2012 Bangladesh Integrated Household Survey.

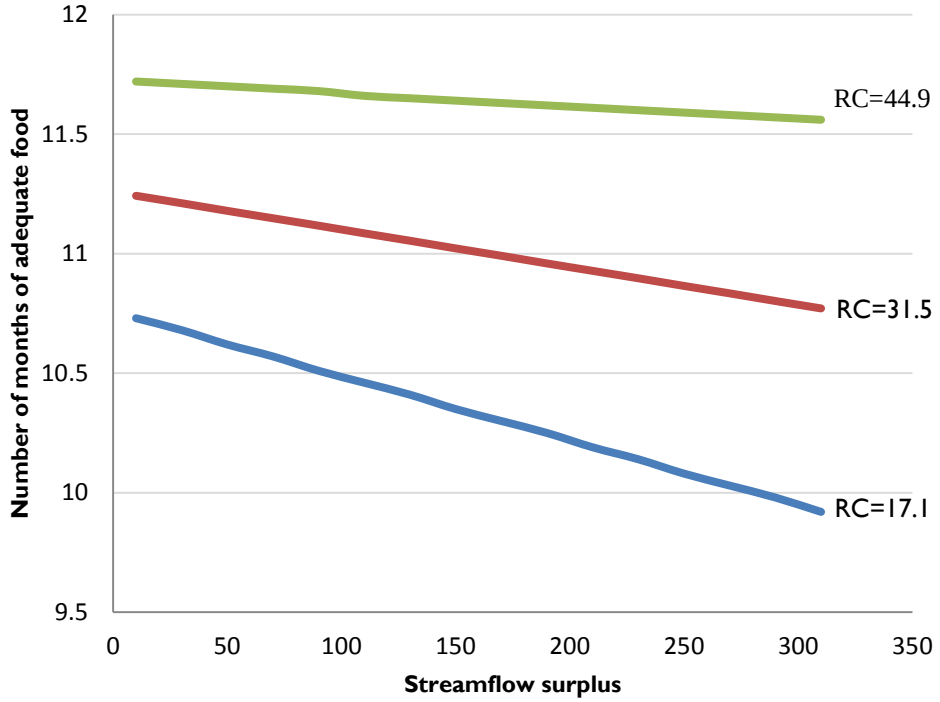
Figure 7: Poverty headcount ratio and number of people living in poverty in Bangladesh (1991-2010)



Source: BBS (2010) and World Bank Health, Nutrition and Population statistics as cited by Scott and Diwakar 2016

Figure 8: The study found that after the 2014 flood, households in the SHOUHARDO II program area that had higher resilience capacity (green line) were better able to maintain their food security (measured as the number of months of adequate food), compared to households with the mean level resilience capacity (red line) or those with the least resilience capacity (blue line).

Figure 8: Resilience capacity-mediated relationship between flood exposure and food security



Source: Smith and Frankenberger 2016.
Notes: This figure shows the implied impact of flood exposure (measured as streamflow surplus) on food security (measured as the number of months of adequate food), as implied by the regression results, at three values of the resilience capacity index: the mean (red line), the cut-off defining the bottom decile (blue line), and the cut-off defining the top decile (green line).