A Strategy to Engage the Private Sector in Climate Change Adaptation in Bangladesh

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Executive Summary

As noted in the Bangladesh Climate Change Strategy and Action Plan, the combination of frequent natural disasters, high population density, poor infrastructure and low resilience to economic shocks, makes Bangladesh especially vulnerable to climatic risks. The high incidence of poverty and heavy reliance of poor people on agriculture and natural resources increases their vulnerability to climate change.

The Government of Bangladesh (GOB) with the support of the major donor agencies has outlined a comprehensive strategy on tackling climate change. The effort has been spear-headed by a climate change cell set up within the Ministry of Environment and Forests.

On a global basis, while Adaptation is still seen as more of a public sector focus than mitigation, some increased focus has been evident. The private sector should also be seen as a "supplier of innovative goods and services". There is a clear need to meet the adaptation priorities of developing countries with expertise in technology and service delivery.

The private sector has particular competencies which can make a unique contribution to adaptation, through innovative technology, design of resilient infrastructure, development and implementation of improved information systems and the management of major projects.

There are future investment opportunities in adaptation in water resources, agriculture and environmental services. In agriculture, investment may be needed for developing irrigation equipment and technologies as well as fertilizers. Provision of clean water is another opportunity, requiring investment in water purification and treatment technologies such as desalination, and wastewater treatment technologies. Environmental services such as weather derivatives are also a possible area for investment

Fewer than 5 per cent of households and businesses in developing countries have insurance coverage for catastrophe risks. Instead, such risks are dealt with by a mix of social networks and informal post-event credit. The absence of insurance stunts development because smallholders cannot risk investing in fixed capital or concentrating on profitable activities and crops for fear of losing them, and falling into debt. Thus, a critical task for the public sector will be to support the private sector in creating financial risk sharing and management approaches and mechanisms that can be accessed by people in developing countries, especially LDCs, SIDS and countries in Africa, and help to reduce their vulnerability to the impacts of climate change. The greater involvement of the private sector is critical if Bangladesh is to prepare itself for both the challenges and opportunities of climate change. Relatively few companies in Bangladesh have yet considered both the impact of climate change on their existing activities, and perhaps as importantly, the new commercial opportunities that will emerge both domestically and globally.

While much of this report underlines the benefit and importance of private sector engagement in the battle against climate change, the reality is that that in Bangladesh, for 99% of corporate Climate Change is perceived to be either an irrelevance or at best an extension of their Corporate Social Responsibility (CSR). This perception has been re-enforced by the stakeholder consultations that were held as part of preparing this report. A key objective of this report is to assess why the private sector is so dis-engaged from the battle against Climate Change in Bangladesh and what policy measures, both by the Government of Bangladesh and also the development partners can be taken.

One important constraint in private sector engagement in Climate Change projects, for both mitigation and adaptation, is the lack of capacity of financial institutions in both public and private sectors to evaluate projects. This lack of understanding of specific types of climate change investments and their risk profiles means that banks often find it difficult to develop and structure appropriate financial products. Most of the commercial banks in Bangladesh rely on short term deposits, and an asset-liability mismatch also limits their ability and willingness to structure financial products with the longer tenure that is typically needed for climate change investments.

In terms of the initial feedback from different private sector stakeholders, a consensus theme was a concern that the bulk of climate change funding would be administered by the government with a lot of the implementation done by Non-Government Organisations (NGOs). Hence there was little incentive or motivation for companies to commit scarce and valuable senior management time to consider opportunities in tackling Climate Change. However, in that context, there was strong support for the IFC project to come up with a specific strategy and modalities to more effectively engage the private sector in the PPCR programme. There was strong

interest in concessional loans, grants, shared R&D expenditures. There was also little awareness of the massive market for service provision to the public sector as well in implementing adaptation projects.

Another potential factor is what can be termed a "Critical mismatch" of long term and short term perspectives. Developing countries need to attract investments, particularly in key sectors like infrastructure, which take account of the long-term impacts of climate change. Commercial financial institutions, driven by prudence, tend to want to achieve high returns quickly from investment in high-risk developing countries, and tend to finance for relatively short periods.

Another factor that came across in stakeholder discussions was the question of where responsibility lies for addressing climate change. Was it a public sector problem or should the private sector get more involved out of CSR objectives. The missing link remains a focus on the profit motive.

In terms of future policy steps in Bangladesh, A few general concepts from the UNFCCC emerge which are useful as guidance:

• The need to "pay the innovator": As the carbon market provides incentives and rewards for innovation, finding ways of rewarding private sector actions which enhance adaptation will be necessary to massively upscale private sector engagement.

• The need to fill information gaps and build awareness: An important first step in this regard has been supporting the efforts of developing countries to identify immediate adaptation priorities through the preparation of NAPAs. A next step may be to publicize these needs in a form that will encourage business engagement.

The meetings we have had with companies in preparing this report highlight three key areas that need to be addressed:

Overcoming Information Gaps: More effective communication of Climate Change issues and opportunities to key decision makers in Bangladeshi corporates. Senior management typically have not attended seminars that have been held and those that do find the information too generic. Broad based information dissemination needs to be supplemented by a more targeted approach. One on-on-one consulting and Technical assistance can be far more effective. A Climate Change Cell or strategy unit should be set up in leading corporates to develop capacity and expertise in addressing opportunities.

Regional and Global Success Stories: Another important potential tool to motivate the private sector is be more aware of successful and commercially viable investments and initiatives by other corporate in the region and indeed globally. The fact that well known Indian corporate are establishing large scale investments into climate change will give greater confidence as well as a template or business model that can be followed in BD.

Changing the Economics of Climate Change Investments: This can be done on a number of fronts including the tax regime, low cost debt financing, equity investments and even sharing of R& D costs.

We need a mindset shift in the corporate sector to understand that those companies that adapt to the profound impact of climate change will gain major competitive advantage versus those that don't.

One of the key messages to get across to both policymakers and corporates, is that the resources and strategies adopted to tackle climate change in both mitigation and adaptation can be a source of national and company level competitiveness. This was amply illustrated by a country such as Denmark that used the energy crisis triggered by a spike in oil prices in the 1970s to move away from the over-reliance on fossil energies. This in turn created new industries and export capabilities whereby now Danish companies are world leaders in products such as wind turbines.

The IFC, as the commercial lending arm of the World Bank Group, is naturally one of the more private sector focused organisations among the development partners. In Bangladesh, they play an addition relevant role in managing the Bangladesh Investment Climate Fund (BICF) as well as the South Asia Enterprise Development Fund (SEDF).

IFC already undertakes a number of Advisory Services initiatives that have (potential) climate resilience aspects. These include PPD (Private-Public Sector Dialogues), Cleaner Production, Sustainable Water Market Development, Water Foot-printing, Eco-standards and Inclusive Supply Chain, Forestry, Infrastructure Advisory, Green buildings/standards, Micro-finance, Insurance, Sustainable Investment, Community Investment, Investment Climate, Sustainable Energy.

IFC's focus is to address key market barriers that prevent the private sector from playing its required role in adapting to climate change. The key barriers consist of a lack of capacity to assess and manage climate risk within private supply chains, and a limited understanding amongst companies of the potential commercial opportunities that arise as others seek to become more resilient. The IFC role may therefore be seen in two ways:

- Increase the resilience of private sector companies to manage climate change impacts along their own supply chains.

- Encourage the market for the provision of resilience-oriented goods, finance and services.

Going forward, IFC is well positioned to convene and mobilize the wider private sector response. From an advisory perspective, the primary focus will be upon on the identification of sustainable business models that provide or encourage adaptive capacity, and encouraging commercial companies into the market through the provision of finance and capacity. It will also, however, involve supporting governments to create the correct regulatory environment for businesses to enter the market for adaptation services, much in the same way that IFC has addressed climate mitigation policy for the private sector. IFC is able to assess how climate change impacts upon business planning and investment cycles, and how to mobilize finance and knowledge for both large corporations and for those reliant on micro-finance scale solutions.

There is little doubt that that the initiatives such as PPCR can play an important role in engaging the private sector across the areas of knowledge building, shared R& D and concessional finance. However, one very clear piece of feedback that came back from the stakeholder meetings was a concern from corporates that if Climate Change funding was administered by a government ministry then the bureaucratic procedures would make the operational of funds and the process of obtaining either loans or grants unwieldy. They highlighted the fact that the much vaunted PPP programme announced by the Honourable Finance Minister in the June 09 Budget, had yet to be operationalized more than 12 months later.

In this context, it seems sensible to ear market and ring-fence separate funding for Climate Change Adaptation projects for the private separate distinct from broader public sector funding. Within a $ 100bn economy where the private sector is the major player, we believe an initial $ 10-12 mn investment fund should be set up within PPCR, administered by the IFC. This might expanded as the project portfolio increases much as the IPFF energy refinancing has recently been increased as it gained greater demand and traction. They would offer concessional debt financing and potentially equity for private sector project proposals in the area of Climate Change Adaptation. This will need additional technical assistance in the area of project development. A Climate Change Business Incubator service should also be established, possibly in conjunction with a leading research centre at BUET to facilitate the commercializing of primary science and new innovations in Climate Change in Bangladesh.

The IFC clearly have the potential to play an important catalytic role in the objective of engaging the private sector in Climate Change Adaptation by both managing a private sector focused fund as a sub-component of the PPCR as well as providing the critical technical assistance and project finance/development/management skills that will be important in ensuring funds are effectively utilized.

Overview

There is a growing scientific consensus on the impact of greenhouse gas (GHG) emissions on global warming as well agreement that it is causing increased weather volatility with the effects increasing in intensity in coming years. Warming may induce sudden shifts in regional weather patterns such as the monsoon rains in South Asia or the El Niño phenomenon - changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people. In addition, the melting or collapse of ice sheets would eventually threaten land which today is home to 1 in every 20 people.

On a global basis, while Adaptation is still seen as more of a public sector focus than mitigation, some increased focus has been evident. in their July 2008 *CEO Climate Policy Recommendations to G8 Leaders,* the World Business Council for Sustainable Development and the World Economic Forum recognized that "adaptation to climate change is a critical challenge for all countries, particularly for poor countries that will be hit hardest and earliest, and for all business sectors….The international business community is starting to develop products and services that can help with adaptation….In partnership with governments, international business can do much more in this space, particularly if the economic case for adaptation activities or markets for adaptation products is further developed"

The importance of private sector involvement in terms of "scaling up" or leveraging public sector capital has been summarized as follows: The World Business Council for Sustainable Development (WBCSD) and the World Economic Forum argue that "Even under the most optimistic scenario of donor commitments, public funds will be nowhere near sufficient to meet the investment requirements of a successful climate change strategy. The new framework must create mechanisms that catalyse much greater volumes of portfolio and direct private sector investment in climate change-related activities" (WBCSD and WEF 2008). "

Table 6.1: Current adaptation funding gap, million USD

	Cumulative (time period)	Nominal per year
PREDICTED COSTS		
Global adaptation cost estimates for developing countries		9,000–109,000
Total cost of identified NAPA projects, in 39 NAPAs	1,500 (to date)	
AVAILABLE FUNDING		
Disbursed to date:		
UNFCCC funds	183 (2001–2008)	23
ODA funds	610 (2000–2006)	43
Private sector and civil society funding	?	?
Pledged/announced for the near future:		
UNFCCC funds (including Adaptation Fund)a	530–1,630 (2008–2012)	106–326
ODA funds	1,557 (2008–2012)	28
Private sector and civil society funding	?	?
FUNDING GAP		
(Predicted costs – available funding)		Still tens of billions

[a]These figures are based on the difference between disbursed (183 million) and disbursed+pledged (313 million) funds as regards the existing UNFCCC funds, added to the projections made for the Adaptation Fund.

Leveraging Private Sector Innovation

The SEI (2009) report made the observation that the private sector should also be seen as a "supplier of innovative goods and services". They noted that there is a need to meet the adaptation priorities of developing countries with expertise in technology and service delivery. The World Business Council on Sustainable Development suggests that private enterprise has particular competencies which can make a unique contribution to adaptation, through innovative technology, design of resilient infrastructure, development and implementation of improved information systems and the management of major projects (WBCSD 2008). Adaptation efforts will generate new business opportunities for the private sector. There will, for instance, be increased demand for water saving expertise, new medicines, cooling systems and other major infrastructure, as well as the insurance and risk management expertise which was discussed above.

Actively encouraging this form of private sector engagement is of relevance to the UNFCCC because greater participation in the emerging adaptation "market" should foster innovation and theoretically lower the costs of adaptation. It should also increase the rate at which available adaptation funding is put to use.

Delivery channels and mechanisms

In terms of delivery, private suppliers pursuing commercial returns will seek out available markets. In this sense the adaptation funding channelled through the various GEF funds, the Adaptation Fund and other bilateral arrangements will provide the private sector with access to finance for designing, delivering and implementing goods and services that reduce climate risks. Finance to pay for private sector

expertise could also come from domestic budgets or large non-governmental organizations (NGOs) with their own financial capacity, usually backed by philanthropic capital.

The UNFCCC (2007) suggests that actual financing of innovation (i.e. research and development) will vary by source in different sectors. Some sectors and activities will be funded mostly by the private sector (e.g. information technology and pharmaceuticals), while others will not be a priority for the private sector and hence require public funding (e.g. disease research). Where the financial benefit is internalized and can be harvested as profit will be of primary interest to the private sector.

Private Sector Engagement in Climate Change in Bangladesh Remains Extremely Limited

While much of this report underlines the benefit and importance of private sector engagement in the battle against climate change, the reality is that that in Bangladesh, for 99% of corporate Climate Change is perceived to be either an irrelevance of at best an extension of their Corporate Social Responsibility (CSR). This perception has been re-enforced by the stakeholder consultations that were held as part of preparing this report. There have been some notable success stories in the area of mitigation, most notably the large scale roll out of rural solar systems which was a joint venture between Grameen Shakti, an NGO, and Rahimafrooz, a large local conglomerate as well as a CDM project by Waste Concern.

However, these are the exceptions, not the rule. A key objective of this report is to assess why the private sector is so dis-engaged from the battle against Climate Change in Bangladesh and what policy measures, both by the Government of Bangladesh and also the development partners, can be taken

Increased Need for Focus on Adaptation

While there is a greater focus, particularly in the private sector, on mitigation opportunities in Climate Change, that opportunities to reduce GHG emissions, there is a growing recognition that increased focus and investment needs to be made in adaptation. Carbon dioxide and other greenhouse gases can remain in the atmosphere for decades to many centuries after they are emitted, meaning that today's emissions will affect the climate far into the future. Due to this time lag, the Earth is committed to some additional warming no matter what actions are taken to reduce emissions now. With global emissions on the rise, adaptation efforts are necessary to reduce the cost and severity of climate change impacts for the next several decades.

The Pew Centre on Global Climate Change noted in their 2009 report that :

" Recent scientific research demonstrates that many aspects of climate change are happening earlier or more rapidly than climate models and experts initially projected. The rate of change projected for global surface temperatures, and related impacts such as ice melt and sea-level rise, is unprecedented in the history of civilization. Adapting to climate change will become that much harder and more expensive as changes happen faster, or on a larger scale, than expected."

The negative impacts of climate change will be disproportionately felt in the developing world in countries such as Bangladesh. This is because vulnerability to climate change is a factor of exposure, sensitivity and adaptive capacity.

Exposure - Developing countries are the most exposed to climate change because they are already warmer, on average, than developed regions, suffer from high rainfall variability, and, endure regular climate extremes given the location of many developing countries in tropical areas.

Vulnerability – Developing countries are heavily dependent on agriculture, the most climate-sensitive of all economic sectors, and suffer from inadequate health provision, low-quality public services, and build up of large slum areas. They have poor water-related infrastructure and management and often have inadequate early warning systems for extreme weather conditions.

Adaptive capacity – The low incomes and vulnerabilities of people in developing countries make adaptation to climate change particularly difficult.

Greater Clarity in Understanding Adaptation

One of the challenges in terms of engaging the private sector in Adaptation is a lack of clear understanding of the concept itself. Some useful definitions of adaptation were outlined by the IPCC 2007 as follows:

• **Adaptation:** "[a]adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation . . ."

• **Adaptive capacity:** "[t]he ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences".

• **Vulnerability:** "[t]he degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity".

The Stern Review emphasises that much adaptation will simply be an extension of good development practice. Promoting overall development will help reduce vulnerabilities and raise the adaptive capacity of poor people. In addition to good development practice, incremental measures and actions will need to be taken to address specific risks (such as building higher sea-defences) and reduce vulnerability to the impacts of climate change. But a major role of governments in tackling climate change will be to ensure that the private sector has the tools and incentives necessary to adapt autonomously.

The UNFCCC Report in 2008 (Investment and financial flows to address climate change: an update) noted that **"**The private sector, too, already invests significantly in many vulnerable sectors.

Ensuring that private-sector investments help to reduce vulnerability and exposure to climate risks an contribute to effective adaptation can channel a large source of funding towards climate-resilient outcomes. In addition, the private sector can be engaged in developing and implementing financial risk management mechanisms, including insurance, that encourage more adaptive behaviour."

However, the estimates for the scale of financing needed for Climate Change Adaptation is massive and clearly underlines the necessity of leveraging private sector resources. The UNFCCC secretariat estimated the additional investment and financial flows needed worldwide to be USD 60–182 billion in 2030 (UNFCCC 2007a), some USD 28–67 billion of which would be needed in developing countries. The largest uncertainty in these estimates is in the cost of adapting infrastructure, which may require anything between USD 8–130 billion in 2030, one-third of which would be for developing countries. The UNFCCC secretariat also estimated that an additional USD 52–62 billion would be needed for agriculture, water, health, ecosystem protection and coastal-zone protection, most of which would be used in developing countries (UNFCCC 2007a).

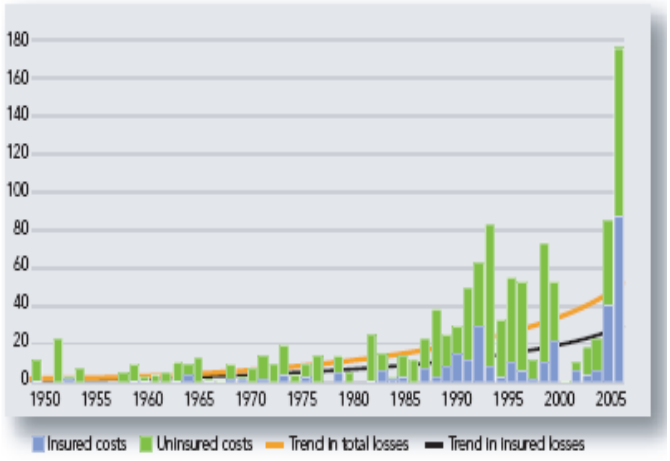
		Economics of Adaptation to Climate Change study	
Sector	United Nations Framework Convention on Climate Change (2007)	National Centre for Atmospheric Research (NCAR), wettest scenario	Commonwealth Scientific and Industrial Research Climate (CSIRO), driest scenario
Infrastructure	2-41	29.5	13.5
Coastal zones	5	30.1	29.6
Water supply and flood protection	9	13.7	19.2
Agriculture, forestry, fisheries	7	7.6	7.3
Human health	5	2	1.6
Extreme weather events	—	6.7	6.5
Total	28-67	89.6	77.7

Source: UNFCCC (2007) and Economics of Adaptation to Climate Change study team.

The World Bank (2006) concluded that the incremental costs of adapting to the projected impacts of climate change in developing countries are likely to be in the order of USD 9–41 billion per year, while Oxfam International (2007) estimated this number to be over USD 50 billion per year. UNDP made the most pessimistic estimate to date in suggesting that by 2015 the financing requirements for adaptation in developing countries could amount to USD 86–109 billion per year (Watkins 2007).

The Stern Report notes that at higher temperatures, the costs of adaptation will rise sharply and the residual damages remain large. The additional costs of making new infrastructure and buildings resilient to climate change in OECD countries could be $15 – 150 billion each year (0.05 – 0.5% of GDP). We can get a feel for the costs by looking at the statistics on damage that are published by Munich Re and Swiss Re. For example, the chart below shows the Munich Re figures for large weather disasters from 1950 to 2005.

Cost of great weather disasters 1950-2005
Costs in USD billion, 2005 values.

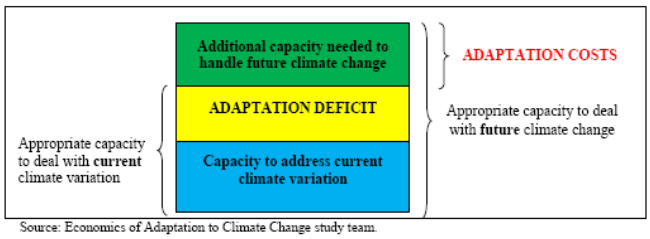


Source: Munich Re.

Defining the adaptation deficit

The EACC (2009) suggests that the Adaptation deficit has two meanings in the literature on climate change and development. One captures the notion that countries are underprepared for current climate conditions, much less for future climate change. Presumably, these shortfalls occur because people are under informed about climate uncertainty and therefore do not rationally allocate resources to adapt to current climate events. The shortfall is not the result of low levels of development but of less than optimal allocations of limited resources resulting in, say, insufficient urban drainage infrastructure. The cost of closing this shortfall and bringing countries up to an "acceptable" standard for dealing with current climate conditions given their level of development is one definition of the adaptation deficit (figure 2). The second, perhaps more common, use of the term captures the notion that poor countries have less capacity to adapt to change, whether induced by climate change or other factors, because of their lower stage of development. A country's adaptive capacity is thus expected to increase with development. This meaning is perhaps better captured by the term development deficit.

Figure 2. A simplified interpretation of *adaptation deficit*

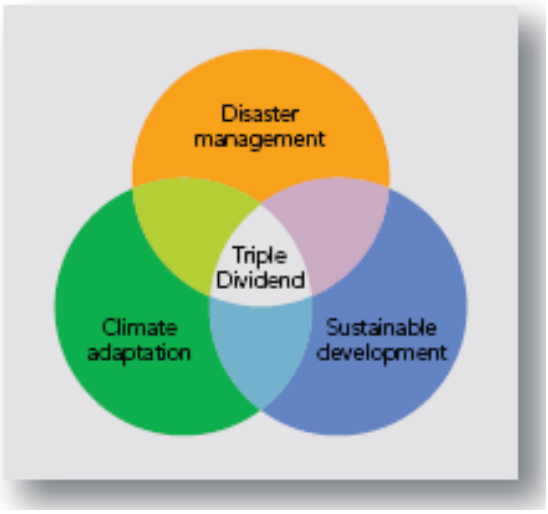


Source: Economics of Adaptation to Climate Change study team.

Mainstreaming Climate Change Adaptation

Mainstreaming climate change is key - managing climate change should be integrated into policy like water management, disaster preparedness, or land use planning at every level of decision-making.

to build local capacity and resilience in a way that links sustainable development, risk management, and adaptation for a win-win-win situation. This yields a "triple dividend" in the payback for the scarce resources that are available to invest, as shown in the chart below. Each dollar takes care of climate impacts, disaster recovery and economic growth. In addition, there may be opportunities to incorporate emissions reduction measures.



Source: Andalug Consulting

The Potential Role of the Private Sector in Climate Change Adaptation

There has also been a rapidly growing volume of research on the private sector implications of climate change, most notably by management consultancy firm McKinsey and Co, as well as a number of investment banks. It is critical that the private sector engage more fully and see the battle against climate change not as a burden or a form of taxation but rather the major economic opportunity of our generation.

Why has Private Sector Interest in CC Adaptation in BD been so Limited?

A Workshop Organized by DFID and the Forum for the Future in February 2007 ("Adapting to climate change in developing countries – what role for private sector finance? ") saw 60 delegates from the public and private sectors meet to debate the respective role of various stakeholders in tackling climate change. We believe it is valuable to review some of the feedback from the Workshop since there are also common themes relevant for all countries trying to increase private sector participation in the battle against climate change. We will then summarize some of the feedback we received in the stakeholder consultations in Bangladesh for this report.

Some of the highlights from the DFID workshop include:

"Critical mismatch" of long term and short term perspectives

Developing countries need to attract investments, particularly in key sectors like infrastructure, which take account of the long-term impacts of climate change. Commercial financial institutions, driven by prudence, tend to

want to achieve high returns quickly from investment in high-risk developing countries, and tend to finance for relatively short periods. While in some cases the private sector takes a longer-term perspective, the short term investment criteria that are normally adopted need to be reconciled in some way with the longer term perspective on the public good. By the time the risks become clear and imminent enough for private sector consideration, the costs of adaptation are likely to be substantially higher, for example in terms of retro-fitting protective measures.

"I'll do what I can, but it's not my problem"

Another interesting theme running through the discussions was the question of where responsibility lies for addressing climate change (and, more particularly in the context of this workshop, in adapting to climate change). Several of the private sector participants talked about "doing what we can to help out" and "supporting as far as possible within our profit-making mandate". Some public sector participants took the view that business should do more through a commitment to "corporate social responsibility". Others felt that, in terms of pure self-interest, business will need to evolve new business models which will deliver the best outcomes for the health of the global economy, to protect its long-term profitability. These different approaches depend to some extent on people's perceptions of the knock-on impacts of climate change.

Communication and coordination of efforts

The participants agreed that climate change needed now to be integral to public sector and private sector policy-making at all levels and in all areas. A climate change filter should therefore be applied to all decisions to test out their robustness in the face of climate change. The importance of integrating policies for economic development, adaptation to climate change and disaster risk reduction – to secure the "triple dividend" was also seen as key. The public sector also has an important role to play in generating data and developing models, and making those available to the private sector, and in leading by example by screening investments against climate change.

Protecting the most vulnerable

The public sector can create incentives for private sector intervention and market-based solutions to the delivery of insurance or credit to reduce vulnerability. But there will be many of the very poorest who will simply not be able to meet the requirements of the market. Central to a successful combination of public and private sector interventions may be a structure which supports the most vulnerable while not distorting the market incentives at higher income level and not preventing adaptation by the poorest where possible.

Some recommendations on Private Sector Involvement in Adaptation

UNFCCC (2008) made some of the following observations on potential private sector engagement in CC Adaptation:

"The private sector can provide financial resources for adaptation through investments, financial risk management, the commercial provision of capital and the philanthropic provision of resources through private foundations. Private investments may play an important role in adaptation to climate change. All privately owned assets (e.g. buildings and agriculture land) and business practices (e.g. insurance, water management and agriculture practices) that are sensitive to climate change will have to be adapted to climate change. In terms of scale, the gross fixed capital formation16 of these investments in 2007 was USD 12.25 trillion. Even though many investments in climate-sensitive sectors come from private sources, it is unlikely that adaptation to climate change is a significant consideration. "

They also highlighted that in a recent study, Deutsche Bank identified future investment opportunities in adaptation in water resources, agriculture and environmental services. In agriculture, investment may be needed for developing irrigation equipment and technologies as well as fertilizers. Provision of clean water is another opportunity, requiring investment in water purification and treatment technologies such as desalination, and wastewater treatment technologies. Environmental services such as weather derivatives are also a possible area for investment (DB Advisors, 2008).

Besides potential climate change impacts, baseline changes in the water and agriculture sectors will be very important for investors, as global water production is projected to increase by about 15 per cent over the next 20 years and cereal food production is projected to increase by about 25 per cent in the same period (DB Advisors, 2008).

Other sectors such as human health are also likely to present investment opportunities (and risks) from climate change.

However, the private sector will only provide investments for a specific rate of economic return. Below that rate, public investments remain essential. Furthermore, many of the investment opportunities are likely to occur in developed countries – in developing countries the public sector will remain paramount.

Financial risk management tools such as insurance schemes could provide an incentive for initiatives to reduce vulnerability before an event occurs, as well as provide economic relief after an event occurs. Any such insurance mechanism would need to reflect actual risks associated with specific locations and activities. It is possible to think of various types of insurance that could address climate change risks: insurance for investments (where the insured clients would be the private sector or governmental enterprises); insurance for property (clients: private or state property owners); and insurance for large-scale catastrophes (clients: national governments, private citizens or business.

The suite of financial risk management tools includes: commodity price hedging; economic shock funds; commodity price insurance; alternative risk transfer; hedge funds; alternative risk financing; structured risk financing mechanisms; effective use of developed captive insurance; credit and political risk coverage; hybrid insurance products; and catastrophe bonds.

However, fewer than 5 per cent of households and businesses in developing countries have insurance coverage for catastrophe risks. Instead, such risks are dealt with by a mix of social networks and informal post-event credit. The absence of insurance stunts development because smallholders cannot risk investing in fixed capital or concentrating on profitable activities and crops for fear of losing them, and falling into debt. Thus, a critical task for the public sector will be to support the private sector in creating financial risk sharing and management approaches and mechanisms that can be accessed by people in developing countries, especially LDCs, SIDS and countries in Africa, and help to reduce their vulnerability to the impacts of climate change.

Regarding the provision of capital for adaptation actions, market finance (including venture capital, commercial loans and revolving credits) could become a viable option in the future. In many instances, adaptation actions are already being undertaken by private actors, whether individuals o firms. However, at this point, in contrast with financing for mitigation, the public sector is expected t be the main source of funding for adaptation. Public funds for adaptation are important, because the benefits generated by adaptation actions often have the characteristics of public goods. For example, the benefits of coastal protection will typically be enjoyed by all the residents of the community at risk. Similarly, improved climate change projections and vulnerability assessments take the form of knowledge products, which are well recognized as public goods. To address an insufficiency of funds for developing and maintaining infrastructure, man governments are trying to involve private entities in sectoral management. Public–private partnerships may bring in financial resources as well as management practices that improve efficiency.

How can a new climate agreement stimulate private sector contribution to adaptation?

SEI (2009) also notes that in reality the many different roles of the private sector will come together at the project or programme level if adaptation is to be successfully implemented. For instance, financing major projects generally relies on both debt and equity as well as insurance, while implementing projects relies on technological expertise and an awareness of future climate risks. Importantly, in many cases there is also a complementary role which must be played by the public sector.

In considering how the UNFCCC process might create an enabling environment for harnessing private sector resources for adaptation, it is therefore useful to refer to a neat summary of "Public-private partnership roles in adaptation" from the UNEP Finance Initiative (2006) (see table below).

Table 7.1: Public private partnership roles in adaptation

Issue	Role of government	Role of the private sector
Hazard reduction	Basic data and research Awareness-raising	Risk modelling
Resilience enhancing measures	Regulation and enforcement	Incentives in product design
Vulnerable sectors/ communities	Infrastructure Pilot adaptation scheme funding Diminishing livelihood support	Micro-finance and insurance backed by reinsurance Pooled development funds
Risk transfer	Guarantee fund Volatility smoothing	Insurance if conditions of insurability are met Otherwise services for public schemes
Disaster relief	Restricted, using hazard reduction and pre-funding	Relaxed terms of business during emergency. Services for public schemes Claims under climatic impact insurance
Capacity-building	Funding	Technical assistance
Technology for adaptation	Basic research Incubator stage funding	Finance and insurance for consumers and operators Venture capital
Public goods – ecosystems, heritage	Conservation policy and funding	Technical advice, flagship funding
Economic stability	Security Sound financial policy	Availability and accessibility
Financial markets	Policy and governance	Product design, distribution and marketing "After-sale" customer service e.g. claims Administration

Source: UNEP (2006: 21)

Many of the roles envisaged here for the private sector are discussed above in this chapter. The contributions envisaged in the table provide a useful segue into conceptualizing the

role of the public sector and of international institutions in facilitating private sector activity.

General principles

The UNFCCC (2007) and others have suggested numerous actions which governments could take to encourage the private sector to contribute to adaptation. Some of these actions could also be applicable at the international level that is via the UNFCCC and / or future climate framework itself.

A few general concepts emerge which are useful as guidance:

• The need to "*pay the innovator*": As the carbon market provides incentives and rewards for innovation, finding ways of rewarding private sector actions which enhance adaptation will be necessary to massively upscale private sector engagement.

• The need to *fill information gaps and build awareness*: An important first step in this regard has been supporting the efforts of developing countries to identify immediate adaptation priorities through the preparation of NAPAs. A next step may be to publicize these needs in a form that will encourage business engagement.

• The need to *share the risks* associated with climate change impacts and with taking adaptive measures. For instance, finding ways of lowering the barriers for private insurers to making appropriate insurance products available for low income communities, and for developing countries at a national level could have significant benefits for reducing the vulnerability of individuals and communities to climate risks.

• The need to *build the capacity of developing countries* to engage as partners with the private sector in a way that improves the likelihood that the needs and interests of developing countries will be protected.

An important observation to make about private sector activity in developing countries is that the private sector has a clear track record of preferentially directing resources to certain countries or regions where it perceives risk to be lowest and the possible returns highest. Country risks play a major role in investment decisions by foreign investors and lenders. When choosing between investment locations, the private sector considers factors such as natural and social resources, market size, operating costs, taxation and regulatory frameworks, technology and information, infrastructure, institutions, and so on.

The UNFCCC (2007) points out those countries which are unable to attract private capital are therefore highly reliant on public capital for a wider range of investments. This problem is not unique to the issue of climate adaptation. This means that even if the private sector increases adaptation-related activity, it is reasonable to expect that some developing countries are unlikely to be involved – at least for some time – on the basis of perceived country risks.

The opportunities for private sector activity on adaptation to be fostered in the context of climate negotiations are discussed below.

Negotiating new finance for adaptation under a future climate agreement

The exception of insurance issues, fostering private sector activity seems unlikely to be a major focus for the climate negotiations. However, the SEI (2009) report that emphasizes that it is useful to be aware of a number of important links between adaptation financing discussions and the private sector:

• Annex I countries have mechanisms available to them to generate new finance for adaptation from the private sector as a mandatory requirement. The present share of proceeds on CDM transactions financing the Adaptation Fund is one example. These could be used as tools by Annex I countries to meet any agreed adaptation financing targets or obligations. Market mechanisms for generating new finance could be applied at the country level, at the discretion of an individual country, or at the international level.

• If national obligations for financing adaptation are agreed for Annex I countries, it is possible that some may seek to have any *voluntary* activities of their domestically based private sector that support adaptation in developing countries counted towards their national obligations. This would be inappropriate for several reasons. First, if the private sector is undertaking this activity of its own accord it represents "business as usual" activity and it is questionable whether this would meet the definition of new and additional, unless individual private entities formally agreed that their investments could be counted towards national public contributions – which would be an unlikely outcome. Second commercial private sector finance will primarily be delivered as debt and/or equity rather than grants or compensation, which is problematic from an equity perspective. Third, and most importantly, it would be almost impossible to verify the scale of actual financial flows or the components that could be considered to be contributing to adaptation.

The greater involvement of the private sector is critical if Bangladesh is to prepare itself for both the challenges and opportunities of climate change. Relatively few companies in Bangladesh have yet considered both the impact of climate

change on their existing activities, and perhaps as importantly, the new commercial opportunities that will emerge both domestically and globally. We need a mindset shift in the corporate sector to understand that those companies that adapt to the profound impact of climate change will gain major competitive advantage versus those that don't. New export markets will also open that currently don't exist as a result of the battle against global warming.

Public-Private Partnerships (PPPs) has become a new buzz phrase with respect to tacking Bangladesh's infrastructure crisis but we also need to ensure more PPPs in tacking climate change. Over coming years, tens, but more likely hundreds of billions of dollars of investment funds will be focused on the " Green Revolution ". How can Bangladesh attract such funding given the particular vulnerability of its economy to climate change?

One potential area of engagement is as a provider of risk management mechanisms, including insurance for the poor. The Bali Action Plan and many Submissions by Parties identify a central role for risk sharing and insurance instruments. Although the private insurance industry is already involved in climate-related risk, its access to and penetration of developing country markets could be enhanced through measures such as government subsidies for insurance products for vulnerable poor, better market infrastructure and better climate data. When local conditions hinder either the demand for or supply of insurance products, public sector resources could be used to overcome those barriers so that the final "delivery" stage can be implemented by the private sector.

As a designer, manufacturer and/or distributor of goods and services which can help communities reduce specific climate risks. The private sector has expertise in technology and service delivery and capacity to develop innovative solutions to climate risks. In this role it could be a recipient of public sector adaptation funding that can be leveraged with its own financial resources, and help deliver adaptation on the ground.

Fostering greater responses by the private sector to the adaptation priorities of developing countries, such as those expressed in the NAPAs, could facilitate greater competition for available multilateral or bilateral funding, and thereby theoretically lower the costs required to implement individual projects and measures. This would stretch existing funding further, and hence assist the UNFCCC's objective of optimizing the use of available financial resources.

The Government of Bangladesh has an important role to play in encouraging private sector participation by creating an "enabling environment" for Climate Change engagement. The Alliance of Small Island States (AOSIS) noted that: "*The creation of enabling environments, including through fiscal measures, regulatory policies, legislative changes, national capacity-building and environmental impact assessments must be twinned with actual implementation of adaptation activities on the ground. Policies in and of themselves will not resolve practical adaptation needs."*

Lack of Banks' Climate Change Knowledge a Major Constraint on Private Sector Involvement

One important constraint in private sector engagement in Climate Change projects, for both mitigation and adaptation, is the lack of capacity of financial institutions in both public and private sectors to evaluate projects. This lack of understanding of specific types of climate change investments and their risk profiles, means that banks often find it difficult to develop and structure appropriate financial products. Most of the commercial banks in Bangladesh rely on short term deposits, and an asset-liability mismatch also limits their ability and willingness to structure financial products with the longer tenure that is typically needed for climate change investments. Although some of the development agencies have funded some limited capacity building initiatives, the constraints remain substantial. Few appear to have sufficient technically competency in the area of climate change to be willing to offer the scale of financing new industries and projects need.

The World Bank and ADB, along with other development partners, have been working via IDCOL to provide loans for Solar, Biogas and other alternative energy projects. But a more defined mechanism needs to be established to finance Adaptation projects under PPCR. It is also important that any financing initiative in terms of a dedicated credit facility for banks is done in conjunction with capacity and knowledge building of climate change project finance/assessment capabilities.

Feedback from Bangladeshi Corporates on Climate Change Adaptation Opportunities

In terms of the initial feedback from different private sector stakeholders, a consensus theme was a concern that the bulk of climate change funding would be administered by the government with a lot of the implementation done by Non-Government Organisations (NGOs). Hence there was little incentive or motivation for companies to commit scarce and valuable senior management time to consider opportunities in tackling Climate Change. However, in that context, there was strong support for the IFC project to come up with a specific strategy and modalities to more effectively engage the private sector in the PPCR programme. There was strong interest in concessional loans, grants, shared R&D

expenditures. There was also little awareness of the massive market for service provision to the public sector as well in implementing adaptation projects.

Bangladesh Private sector interest in Agriculture and Climate Change Adaptation

Some of the specific areas of interest in the agriculture sector, interest was expressed by private sector players in developing Climate Change Adaptation was follows:

Research on new crop varieties

- Drought tolerant
- Flood tolerant
- Saline tolerant
- Shorter cycle
- Broadcast rice

Risk/ vulnerability mapping

- Fisheries
- Livestock (particularly in coastal areas)

Another area where there was interest in terms of collaborating on technology transfer and R%&D on adaptation was as follows:

- Coastal agricultural extension
- Coastal farming system
- Flexible water control system for shrimp and/or rice farming in coastal areas
- Alternative powered irrigation system
- Rooftop plantation in Dhaka city
- Fruit orchard in Chittagong Hill Tracts and Modhupur Barendra area
- Floating bed vegetables in water logging lands
- Fish cultivation system during flood

One corporate expressed an interest to look for areas of collaboration to take initiatives to reduce agricultural process loss by using alternative procurement mechanism and enhanced automation

There was also interest to work with development partners and the Government to develop infrastructure that enables the production, storage and distribution of seed and other agricultural input. There was also interest expressed to work to develop agricultural products that had a longer shelf life as a means of coping with more irregular weather patterns leading to less reliable crop cycles.

One of the largest purchasers of Mangoes in Bangladesh for their processed products expressed an interest to plant higher yielding mango trees and also participating in reforestation initiatives.

There was also interest from another corporate to Developing pumps that uses solar energy will make the country less dependent on the usual source of energy and less emission of Green House gasses.

Another large corporate expressed an interest to become more involved irrigation as they saw this as a relatively under developed field in Bangladesh and hence

The private sector corporates saw their wide networks within the farming community offering opportunities to leverage in areas such as Climate Change campaigns for awareness, disseminating information on Climate Change issues through a JV with the GOB and development partners in a climate cell/Agriculture helpline for farmers. A specific recommendation was Mass communication program on climate change through product packaging

There was also interest in a potential collaboration between agricultural companies, insurance companies and GOB in establishing crop insurance products.

The Private Sector and Climate Resilient Infrastructure

In the private sector stakeholder meetings an interesting proposal in the area of disaster resilience was the National Social Housing Council proposed by MDM architects, offers the potential for a scalable disaster- and climate-resilient housing programme in the rural villages that could be implemented under PPP.

Ahmed Mukta, principal of MDM architects has noted that About 73% of Bangladesh population lives in Rural Bangladesh. A large percentage of them are homeless. The reasons for becoming homeless in the rural areas are many; such as shortage of land, division of families, shrinking of agri-land, natural calamities such as river erosion, floods, cyclone, fire, drought, and defaulting mortgage payments to village touts and mohajons, and many more. Every year 25% of Bangladesh is flooded during the monsoon period, and it is anticipated that this will increase to 40% due to climate change impact.

He noted that several agencies have rolled out programs to mitigate sufferings of the affected people after the Cyclone 'SIDR' and 'AILA' in the coastal areas and Drought and "Monga" affected areas in some part of the country but the

challenges are enormous. The deliveries they receive, mostly emergency in nature, can barely meet their sustainable needs. The financially weaker people still remain homeless as they don't have enough money or a piece of land to build a home of their own.
Feature of the Proposed Houses include:

- Safe Housing (wind and flood Resistance).
- Weather Resistant, Energy Efficient and Environment friendly houses with hollow blocks walls and Bamboo reinforced concrete roof structure.
- Sanitation
- Solar Panel power
- Rain Water Harvesting
- Promote Local Landscaping
- Trained Local Population
- Low carbon footprint.

This is one example of where the private sector can work with the GOB and development partners in Climate Change Adaptation initiatives in the area of disaster resilient infrastructure.

Private Sector Involvement in river dredging, flood resilient roads, climate resilient infrastructure

We also spoke with Abdul Monem group, Bangladesh's largest builder of roads and one of the bigger construction companies. They stated that they had a number of river dredgers they were using in order to obtain soil for road construction. However, they were keen to understand global best practice and technologies from other more developed countries in river dredging techniques. They also mentioned that a major concern as they build new roads and bridges is in ensuring their resilience to increasing floods. They also welcomed technical assistance in that area. In fact, they admitted that they were not consciously targeting climate change projects but were not aware of all the technicalities and definitions. But they recognized that Climate Change was going to be of increased importance for Bangladesh, would have a larger effect on their existing business activities, and was likely to open up new markets and commercial opportunities for them. They were enthusiastic about the idea of a Climate Change audit of their existing activities.

Tarntari - Weather Resilient Boats

Another private sector initiative in the area of Climate Change Resilience is a project proposal from Bangladeshi firm Tartari to build fiberglass fishing boats. Yves Marre, the founder of Friendship, a well know local NGO, is the driver behind this project. As he has emphasized, all of the fishing boats in Bangladesh are made from wood. Although they cost BDT 50,000 (USD 700) versus BDT 300,000 (USD 4200) for a fiberglass boat, the latter lasts for 20 years. More significantly from a climate change adaptation perspective, the fiberglass fishing boats are much more stable in turbulent weather and significantly more resilient in flood conditions. Tartari were keen to receive R&D support in boat building to help manufacture boats which are more suited to volatile weather conditions but in as cost effective manner as possible. They were also looking for concessional financing given the challenges of getting bank financing for a project that Is in an industry and using technologies that local financial institutions are not familiar with.

BBG and Majher Chor Project

Another encouraging initiative from the private sector, in the area of Climate Change resilience, was the Majher Chor Project completed in 2008-10 by the British Business Group (BBG), an association of 54 UK companies operating in Bangladesh.

The British Business Group (BBG) following Cyclone Sidr decided to undertake a transformation project to benefit a community. In discussion with the Government of Bangladesh the island village of Majher Chor was identified. A substantial sum of money was donated by members of the British Business Group and working alongside the well established NGO-Friendship, the BBG undertook an ambitious programme of restoration and to transform the lives of those on the island.

In order to make sure that the Community was truly engaged, the BBG has worked closely with a long-established and well-known NGO, "Friendship", who have provided valuable advice and support.

Majher Chor was one of the hardest hit chors by the devastating cyclone Sidr which ripped through the country on15th November 2007. 16 feet high waves swept entire village and washed away almost all the homes, leaving only the plinth, the embankment surrounding the village was breached in many places.

The island lost all its crops and most of the trees were uprooted. With all the cattle and poultry washed away, the villagers were left without their livelihood. The villagers had no supply of fresh drinking water as there were no tube wells. Other sources of drinking water were not available because the ponds were salinated and loaded with debris.

Transformational Features

British Business Group (BBG) with a vision to "Build Back Better" began the restoration of the cyclone-hit Majher Chor with the aim to achieve the following transformational changes:

- Replace houses
- Build a cyclone shelter/ school / community centre and repair and upgrade the existing school
- Build a new ghat /jetty
- Replace lost livestock, fish, boats and crops
- Clean all the water supplies
- Raise the embankment that protects the paddy fields and houses
- Implement extensive re-forestation and planting of economically valuable trees.

Houses

A total of 164 houses have been constructed at Majher Chor. Each of the unit is 235 sq ft. An innovative design is used in the construction houses. The Walls use sand cement hollow blocks, strengthened by incorporation of reinforcing bars. The roof is made of ferro-cement sheets which are cast on-site using stone-dust, sand, cement and wire mesh. Each house has provision for rain water harvesting by collecting roof run-off in 1000 litre plastic tanks. Another transformational feature is the provision of solar panels for each house which supply 40 watts electricity with a life span of 20 years.

The houses have been constructed by Bangladesh's leading builders Mir Akhter Hossain Ltd. and project Builders Ltd. Hollow bricks and ferro-cement roofing construction methods provide increased thermal comfort and greater storm resistance than the usual GI Sheeting.

The ferro-cement roof sheeting corrodes less quickly than GI sheets hence maintains its strength and requires less maintenance and less frequent replacement. This type of roofing also provides more comfort of living for the families as these materials do not conduct heat.

With the solar panels, Majher Chor inhabitants have been able to enjoy light after sunset. The rain water harvesting system installed at the roof of the houses has not only ensured safe drinking water but also the convenience of having a water supply at each home.

Infrastructure

- A new boat ghat was built with a strikingly designed arch. The ghat is now a congregation point for the villagers as well as very impressive entry point to the island.
- The 3.75 km embankment was raised and repaired with a new paved road surface.
- Sluice culverts were built to allow the movement of tidal water.
- The mosque was reconstructed with the same technologies used for the dwellings.
- The old existing school was painted and books were provided for library.

One of the primary objectives of this transformation project was to restore the livelihood of the villagers and make them economically independent. The following livelihood restoration steps were taken based on the villagers' requirement as stated to the BBG:

- Replacement livestock including buffaloes and milking cows were given to 132 families.
- 32 families of fisherman were given 3 large boats and 8 fishing boats together with new fishing nets.
- Fish and fish-fry fauna were distributed to be released into the newly cleaned ponds.
- Agricultural support including seeds and fertilizers were distributed and training given in better crop management techniques.
- Community owned diesel power filters and fuel has been provided.
- Business report was given to set up a grocery store and pharmacy.

Environmental Impact

From the outset, the design of the dwellings and the choice of the construction methods used were selected to optimize the use of local labor and to minimize the environmental impact of the project. A study conducted by High point Rendel on behalf of the British Business Group established that these construction methods had less environmental impact than traditional methods. More specifically, it was found that this type of construction resulted in:

- Greater levels of comfort during hot weather.
- Lower maintenance time and costs compared to traditional galvanized iron (GI) and wood construction.
- Houses that will withstand storm-force winds of up to 150 km/hour (cyclone intensity) although the houses are not intended to be a substitute for the village cyclone shelters.
- A carbon footprint from the making of the building materials that is significantly lower than for the equivalent components of a traditional GI dwelling.

Sustainability

The primary aim of the BBG project was to bring immediate aid to the affected community and to create a basis for longer term livelihood development. UNDP will continue to monitor the longer term sustainability of these solutions and to track the changes in the lives of the villagers of Majher Chor in the years to come.

A value-for-money approach to transforming lives

Together with the strength and protection offered by the reinforced block construction, the ferro-cement roof, water harvesting solutions and solar panels, which are funded by UNDP, provide excellent value-for-money over the 30+ year predicted life-span of dwellings. As well as making a profound transformation to the lives of the villagers now, they represent a better long-term investment than more traditional construction methods.

While this was clearly a Corporate Social Responsibility activity done in response to a disaster, we believe that the project demonstrated some of the innovation, on-time-delivery, efficiency and on-time-delivery that the private sector involvement can bring to Bangladesh's Climate Change Adaptation efforts. There is no reason why some of the lessons learnt from the project cannot be applied and scaled up into pre-emptive climate change resilient projects.

The Potential Role of the IFC in Engaging the Private Sector in Climate Change Adaptation

The IFC, as the commercial lending arm of the World Bank Group, is naturally one of the more private sector focused organisations among the development partners. In Bangladesh, they play an addition relevant role in managing the Bangladesh Investment Climate Fund (BICF) as well as the South Asia Enterprise Development Facility (SEDF).

IFC already undertakes a number of Advisory Services initiatives that have (potential) climate resilience aspects. These include PPD (Private-Public Sector Dialogues), Cleaner Production, Sustainable Water Market Development, Water Foot-printing, Eco-standards and Inclusive Supply Chain, Forestry, Infrastructure Advisory, Green buildings/standards, Micro-finance, Insurance, Sustainable Investment, Community Investment, Investment Climate, Sustainable Energy.

IFC's focus is to address key market barriers that prevent the private sector from playing its required role in adapting to climate change. The key barriers consist of a lack of capacity to assess and manage climate risk within private supply chains, and a limited understanding amongst companies of the potential commercial opportunities that arise as others seek to become more resilient. The IFC role may therefore be seen in two ways:

- Increase the resilience of private sector companies to manage climate change impacts along their own supply chains
- Encourage the market for the provision of resilience-oriented goods, finance and services

Going forward, IFC is well positioned to convene and mobilize the wider private sector response. From an advisory perspective, the primary focus will be upon on the identification of sustainable business models that provide or encourage adaptive capacity, and encouraging commercial companies into the market through the provision of finance and capacity. It will also, however, involve supporting governments to create the correct regulatory environment for businesses to enter the market for adaptation services, much in the same way that IFC has addressed climate mitigation policy for the private sector. IFC is able to assess how climate change impacts upon business planning and investment cycles, and how to mobilize finance and knowledge for both large corporations and for those reliant on micro-finance scale solutions.

Agribusiness-Stress tolerant seed varieties

IFC is already working with private seed companies in Bangladesh to strengthen the production, distribution and adoption of stress tolerant seed varieties. IFC has also been spear heading multiple workshops, seminars and conferences over the last one year in conjunction with the Seed Wing of the Ministry of Agriculture and the Bangladesh Seed Association to create awareness around stress tolerant seed

varieties.

Adaptation pilot projects

IFC is developing its Climate Change Adaptation strategy for all major regions and shall be piloting some of the first adaptation initiatives in Bangladesh. A global workshop was held in June 2010 in Bangladesh with participation from IFC representatives from Africa, Middle East, South Asia, East Asia and Washington to identify the global strategies for resilient business advisory and to identify the critical sectors in the space of adaptation.

Sustainable Energy Finance Program, SEDF

For the Bangladesh Banking sector, environmental and social issues are increasingly becoming business issues and it is subsequently being recognized that banks can contribute to the improved environmental performance of the private sector. The SEDF's SEF initiative in Bangladesh has been working with the Central Bank and Financial institutions with the aim of combating climate change and enhancing the market for sustainable energy finance in Bangladesh by urging Financial Institutions to proactively consider environmental risk and at the same time encouraging financing in energy efficiency/renewable energy (EE/RE) projects that will cut down on GHG emissions.

Bangladesh is currently facing severe energy crisis, river pollutions, unplanned industrialization and housing which has reached a level where private sector is actively looking for ways to minimise energy cost and reduce losses. EE/RE project such as generating biogas from waste produced by a dairy farm or installing solar panels to reduce power consumption reduce operational costs of a business at the same time as promoting clean energy business development. Additionally, the IFC is building the capacity of a network of bankers, service providers such as energy auditing firms and private sector entrepreneurs who will be able to develop and support market awareness in EE/RE sectors.

SEDF has also partnered with the Bangladesh Bank, with valuable support from the Governor and a core working group focused sustainable energy finance, to develop an Environmental Risk Management Guideline for financial institutions urging them to consider environmental risk as a part of credit risk in their lending projects. Poor environmental due diligence has often resulted in poor lending projects with adverse impacts on the climate and these guidelines, once adopted by the financial sector, may go a long way in highlighting the causes of nonperforming loan projects at the same time as diminishing the effects of these projects on the climate.

Concluding Recommendations

However, they are very much the exception and there is still a significant amount of work to be done before private sector involvement becomes meaningful. The meetings we have had with companies in preparing this report highlight three key areas that need to be addressed:

1) **Overcoming Information Gaps:** More effective communication of Climate Change issues and opportunities to key decision makers in Bangladeshi corporates. Senior management typically have not attended seminars that have been held and those that do find the information too generic. Broad based information dissemination needs to be supplemented by a more targeted approach. One on-on-one consulting and Technical assistance can be far more effective. A Climate Change Cell or strategy unit should be set up in leading corporates to develop capacity and expertise in addressing opportunities.

2) **Regional and Global Success Stories:** Another important potential tool to motivate the private sector is be more aware of successful and commercially viable investments and initiatives by other corporate in the region and indeed globally. The fact that well known Indian corporate are establishing large scale investments into climate change will give greater confidence as well as a template or business model that can be followed in BD.

3) **Changing the Economics of Climate Change Investments:** This can be done on a number of fronts including the tax regime, low cost debt financing, equity investments and even sharing of R& D costs.

There is little doubt that that the initiatives such as PPCR can play an important role in engaging the private sector across the areas of knowledge building, shared R& D and concessional finance. However, one very clear piece of feedback that came back from the stakeholder meetings was a concern from corporates that if Climate Change funding was administered by a government ministry then the bureaucratic procedures would make the operational of funds and the process of obtaining either loans or grants unwieldy. They highlighted the fact that the much vaunted PPP programme announced by the Honourable Finance Minister in the June 09 Budget, had yet to be operationalized more than 12 months later.

In this context, it seems sensible to ear market and ring-fence separate funding for Climate Change Adaptation projects for the private separate distinct from broader public sector

funding. We discuss some of the potential modalities as well as some potential projects later in this report. We believe an initial $ 10-12 mn investment fund should be set up within PPCR, administered by the IFC. This might expanded as the project portfolio increases much as the IPFF energy refinancing has recently been increased as it gained greater demand and traction.

The IFC clearly has the potential to play an important catalytic role in the objective of engaging the private sector in Climate Change Adaptation by both managing a private sector focused fund as a sub-component of the PPCR as well as providing the critical technical assistance and project finance/development/management skills that will be important in ensuring funds are effectively utilized.

Purpose of the Report

The Pilot Program for Climate Resilience (PPCR) is part of the Strategic Climate Fund (SCF), a Multi-donor Trust Fund designed to pilot and demonstrate ways to mainstream climate vulnerability and resilience into national development policies and plans, consistent with poverty reduction and sustainable development goals. The key targets are to:

(i) Pilot and demonstrate approaches for integration of climate risk and resilience into development policies and planning;
(ii) Strengthen capacities at the national levels to integrate climate resilience into development planning;
(iii) Scale-up and leverage climate-resilient investments, capacity building and other ongoing initiatives;
(iv) Enable learning-by-doing and sharing of lessons learning at the country, regional and global levels; and
(v) For the PPCR pilot countries- Aim to strengthen cooperation and capacity at the regional level to integrate climate resilience into development planning and processes.

The Government of Bangladesh was nominated to participate in PPCR as one of the pilot countries.

In Bangladesh a joint mission (the Mission) led by the Government of Bangladesh (GOB) Ministry of Environment and Forest (MoEF) with the participation of the Asian Development Bank (ADB), the World Bank (WB), International Finance Corporation (IFC), United Nations Development Programme (UNDP), Department for International Development (DFID) and the Canadian International Development Agency (CIDA) was undertaken from 1-11 February 2010. Under the coordination and overall guidance of the MoEF, several participatory meetings were held with the relevant focal points in the various ministries involved in climate change activities.

Upon consultation 4 thematic areas were formed as below:

(i) Agriculture and Food Security
(ii) Extreme Climate Events and Climate Induced Disasters
(iii) Water Resource Management
(iv) Public Health, Migration and social Protection

A multi-stakeholder consultation workshop was then held to identify the sector impacts, vulnerability, and required priority actions. The Aide Memoire prepared from the findings has been agreed upon by the GOB. The Strategic Program for Climate Resilience (SPCR) paper which shall outline the hotspots and the sectors of focus is currently being developed and the first draft is expected to be ready by the 31st of May, 2010.

The objective now is to identify the challenges and opportunities of the private sector within the arena of PPCR and climate change adaptation initiatives in Bangladesh.

This report's objectives include:

- Assess the role and engagement potential of the private sector within the framework of PPCR initiatives in Bangladesh.
- Develop a specific set of recommendations that can be implemented.
- Outline the scale and modalities for funding from PPCR to go to the private sector
- Map out the potential role of IFC in steering this process through future projects

Assessment Methods/Stakeholder Consultations

A key element in preparing the report included consultations with key stakeholders within the private sector, the Government of Bangladesh (GOB) and the MDBs. The meetings held included:

1) ACI - 2 meetings with Mr Arif Dowla CEO and Mr Ansary COO Agri business
2) Pran – with Mr Ahsan Khan Choudhury DMD and Ms Uzma Choudhury, Director, who is looking after climate change
3) Mr Iqbal Ahmed, OBE, Chairman and CEO of Seamark Group
4) MD of SME foundation
5) Mr Ahmed Mukta, Principal, Mukta Dinwiddie Maclaren Architects – Climate Resilient Social Housing
6) Mr Yves Marre, CEO and Ms Ayeleen Saleh of Tartari, a boat building firm planning to build fibreglass fishing boats. Also Friendship NGO.
7) Min of Environment, GOB with Joint Sec and Dep Secy
8) Mr Jiangfeng Zhang, Senior Country Economist and PPCR C0-Mission Leader, ADB and Mr Arif Faisal, Environment Specialist ADB.
9) Rahimafrooz
10) Samdani Life Insurance
11) Pragati Life Insurance
12) Mr Haruhisa Ohtsuka, Senior Climate Change Specialist, IFC, Washington, William Beloe Head for Advisory Services & Program Manager for Sustainability – Philippines, Mr Mrinal Sircar, Program Manager SEDF Bangladesh, Ms Anika Ali, Operations Analyst, IFC Bangladesh.
13) Mr Saleemul Huq
14) Mainuddin Monem, DMD, Abdul Monem Group
15) Kevin Ringham, Head of UK Trade and Industry, British High Commission Dhaka and Secretary BBG.

Implications and Consequences of Climate Change for Bangladesh

"The combination of frequent natural disasters, high population density, poor infrastructure and low resilience to economic shocks, makes Bangladesh especially vulnerable to climatic risks. The high incidence of poverty and heavy reliance of poor people on agriculture and natural resources increases their vulnerability to climate change." **(Bangladesh Climate Change Strategy and Action Plan, 2008)**

The Government of Bangladesh (GOB) with the support of the major donor agencies, has outlined a comprehensive strategy on tackling climate change that culminated in a conference sponsored by DFID in the UK in September 2008 along with a detailed report "Bangladesh Climate Change Strategy and Action Plan" (BCCSAP 2008). The effort has been spear-headed by a climate change cell set up within the Ministry of Environment and Forests. We summarize some of the highlights of the report and in particular the climate change action plan programmes. The latter offer a clear road map as to how Bangladesh can evolve a strategy of both adaptation and mitigation of climate change.

Climate change will exacerbate many of the current problems and natural hazards the country faces. It is expected to result in:

1. **Increasingly frequent and severe tropical cyclones** with higher wind speeds and storm surges leading to more damage in the coastal region

2. **Heavier and more erratic rainfall** in the Ganges-Brahmaputra-Meghna system, including Bangladesh, during the monsoon resulting in:

3. **Higher river flows** - causing over-topping and breaching of embankments and widespread flooding in rural and urban areas

4. **River bank erosion** - resulting in loss of homes and agricultural land to the rivers;

5. **Increased sedimentation** - in riverbeds leading to drainage congestion and water logging;

6. **Melting of the Himalayan glaciers** - leading to higher river flows in the warmer months of the year, followed by lower river flows and increased saline intrusion after the glaciers have shrunk or disappeared;

7. **Lower and more erratic rainfall** - resulting in increasing droughts, especially in drier northern and western regions of the country;

8. **Sea level rises** - leading to submergence of low-lying coastal areas and saline water intrusion up coastal rivers and into groundwater aquifers, reducing freshwater availability; damage to the Sundarbans mangrove forest, a World Heritage site with rich biodiversity; and drainage congestion inside coastal polders, which will adversely affect agriculture;

9. **Warmer and more Humid Weather** - leading to increased prevalence of disease and disease vectors.

Each of these changes is likely to seriously affect agriculture (crops, livestock and fisheries). Although agriculture now accounts for only 20% of GDP, over 60% of people depend on agriculture directly or indirectly for their livelihoods. The higher temperatures and changing rainfall patterns, coupled with increased flooding, rising salinity in the coastal belt and droughts are likely to reduce crop yields and crop production. IPCC estimates that, by 2050, rice production in Bangladesh could decline by 8% and wheat by 32% (against a base year of 1990).

Shortage of safe drinking water is likely to become more pronounced, especially in the coastal belt and in drought-prone areas in the north-west of the country. This will impose hardship on women and children, who are responsible for collecting drinking water for their families. Increasingly saline drinking water may also result in health hazards, especially for pregnant women. Climate change is likely to adversely affect women more than men.

Increased river bank erosion and saline water intrusion in coastal areas are likely to displace hundreds of thousands of people who will be forced to migrate, often to slums in Dhaka and other big cities. If sea level rise is higher than currently expected and coastal polders are not strengthened and/or new ones built, six to eight million people could be displaced by 2050 and would have to be resettled.

All of these changes threaten the food security, livelihoods and health of the poor. People living on river islands ( ) and along the coastline (e.g. fishing families), are among the poorest people in the country. They will be seriously affected, as will others who lose their land to river erosion. Extremely poor households throughout the country, including many female-headed households, will suffer most from climate change.

Climate change is likely to increase the incidence of water-borne and air-borne diseases. Bacteria, parasites and disease

vectors breed faster in warmer and wetter conditions and where there is poor drainage and sanitation. In view of this, it will be important to implement public health measures (immunisation; improved drainage, sanitation and hygiene) to reduce the spread of these diseases and to improve access to health services for those communities likely to be worst affected by climate change. Unless these steps are taken, the health of many of the poorest and most vulnerable people will deteriorate. Acute illness is known to be one of the main triggers driving people into extreme poverty and destitution in Bangladesh.

Bangladesh has one of the highest population densities of any country in the world. By 2050, the population will have grown from approximately 150 million, in 2008, to more than 200 million, with almost half of the people living in cities and towns. Dhaka will have become a mega city with a population of over 40 million. The impact of higher and more intense rainfall will be felt in urban areas, where drainage is already a serious problem and sewers frequently back-up in the monsoon season. The poor, who live in slums and informal settlements, often in low-lying parts of cities, will be worst affected. With rapid and unplanned urbanisation in Bangladesh, this is going to become an even more urgent and pressing problem.

Initiatives taken to tackle the challenges of climate change

Over the last three decades, the Government of Bangladesh has invested over $10 billion (at constant 2007 prices) to make the country more climate resilient and less vulnerable to natural disasters. Flood management embankments, coastal polders and cyclone shelters have been built, and important lessons learnt on how to implement such projects successfully in the dynamic hydrological conditions in Bangladesh and with the active participation of communities.

A comprehensive system of disaster preparedness and management, including , *Standing Orders on Disaster* which details the responsibilities of Government officials and others at times of disaster, has also been put in place. The Government demonstrated its competence in dealing with disasters in 2007 when the country suffered two serious floods and a severe tropical cyclone (Cyclone Sidr) in the same year.

The BCCSAP 2008 is built on six pillars:

1. **Food security, social protection and health** to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programmes focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.

2. **Comprehensive disaster management** to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.

3. **Infrastructure** to ensure that existing assets (e.g., coastal and river embankments) are well-maintained and fit-for-purpose and that urgently needed infrastructure (e.g. cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.

4. **Research and knowledge management** to predict the likely scale and timing of climate change impacts on different sectors of the economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.

5. **Mitigation and low carbon development** to evolve low carbon development options and implement these as the country's economy grows over the coming decades.

6. **Capacity building and institutional** strengthening to enhance the capacity of government ministries and agencies, civil society and the private sector to meet the challenge of climate change

An equitable sharing of the burden of climate change adaptation

"In a world that is hot – a world that is more and more affected by global warming – guess who is going to suffer the most? It will be the people who caused it the least – the poorest people in the world who have no car, no power plants, and virtually no factories to emit CO2 into the atmosphere." (Thomas Friedman, "Hot, Flat and Crowded", 2008)

Climate change is a grave threat to the developing world and a major obstacle to continued poverty reduction across its many dimensions. First, developing regions are at a geographic disadvantage: they are already warmer, on average, than developed regions, and they also suffer from high rainfall variability. As a result, further warming will bring poor countries high costs and few benefits. Second, developing countries - in particular the poorest - are heavily dependent on agriculture, the most climate-sensitive of all economic sectors, and suffer from inadequate health provision and low-quality public services. Third, their low incomes and vulnerabilities make adaptation to climate change particularly difficult. Because of these vulnerabilities,

climate change is likely to reduce further already low incomes and increase illness and death rates in developing countries. Falling farm incomes will increase poverty and reduce the ability of households to invest in a better future, forcing them to use up meagre savings just to survive. At a national level, climate change will cut revenues and raise spending needs, worsening public finances.

Many developing countries are already struggling to cope with their current climate.

Climatic shocks cause setbacks to economic and social development in developing countries today even with temperature increases of less than 1°C. The impacts of unabated climate change, - that is, increases of 3 or 4°C and upwards - will be to increase the risks and costs of these events very powerfully.

Impacts on this scale could spill over national borders, exacerbating the damage further. Rising sea levels and other climate-driven changes could drive millions of people to migrate: more than a fifth of Bangladesh could be under water with a 1m rise in sea levels, which is a possibility by the end of the century.

Climate Change Adaptation as a Source of National/Corporate Competitiveness

"Confronting climate change is in the series of great opportunities disguised as insoluble problems" **(John Gardiner, Founder of Common Cause)**

The Green Economy is poised to become the mother of all markets, the economic opportunity of a lifetime, because it has become so fundamental…The challenge of global warming presents us with the greatest opportunity for return on investment and growth that any of us will ever see. To find any equivalent economic transformation, you have to go back to the Industrial Revolution. And in the industrial revolution there was a very clear before and after. "After" everything was different: Industries had come and gone, civic society changed, new social institutions were born, and every aspect of work and daily life had been changed. With that came the emergence of new global powers. This (clean technology transformation) will be an equivalent moment in history". **(Lois Quam, MD, Alternative Investments Piper Jaffey)**

One of the key messages that we need to get across to both policymakers and corporate, is that the resources and strategies adopted to tackle climate change in both mitigation and adaptation can be a source of national and company level competitiveness. This was amply illustrated by a country such as Denmark that used the energy crisis triggered by a spike in oil prices in the 1970s to move away from the over-reliance on fossil energies. This in turn created new industries and export capabilities whereby now Danish companies are world leaders in products such as wind turbines.

Similarly, Bangladeshi corporates can use resources and technologies that are available from PPCR, SPCR and the range of other Climate Change funding to move into new markets, both domestically and internationally increase their levels of productivity and hence profitability.

As Chapter 7 of the 2010 World Development Report has noted :" ***The capacity to tackle mitigation and adaptation will help build strong competitive economies...***Many advanced technologies, such as information and communication technologies, can help specifically with climate change yet are generic enough for use across a wide range of productivity-enhancing areas. Sensors are valuable in industrial automation but can also help waste managers limit pollution...Mobile phones... can also increase business productivity. In parts of Benin, Senegal, and Zambia mobile phones are used to disseminate information about food prices and innovations in farming techniques. Although climate-smart innovation is concentrated mostly in high-income countries, developing countries are starting to make important contributions. Developing countries accounted for 23 percent ($26 billion) of the new investments in energy efficiency and renewable energy in 2007, up from 13 percent in 2004.Eighty-two percent of those investments were concentrated in three countries—Brazil, China, and India."

However the WDR report goes on to note that "Developing countries are still lagging in innovation for adaptation. While it is more cost-effective to adopt technologies from abroad than to reinvent them, in some cases technological solutions for local problems do not exist. So innovation is not only relevant to high-income economies. For example, advances in biotechnology offer potential for adapting to climate-related events (droughts, heat waves, pests, and diseases) affecting agriculture and forestry. But patents from developing countries still represent a negligible fraction of global biotechnology patents. That will make it difficult to develop location-specific agricultural and health responses to climate change. Moreover, little spending on agricultural R&D—though on the rise since 1981—occurs in developing countries. High-income economies continue to account for more than 73 percent of investments in global agricultural R&D. In developing countries the public sector makes 93 percent of agricultural R&D investments, compared with 47 percent in high-income countries. But public sector organizations are typically less effective at commercializing research results than the private sector.

The capacity to tackle mitigation and adaptation will help build strong competitive economies

Many advanced technologies, such as information and communication technologies, can help specifically with climate change yet are generic enough for use across a wide range of productivity-enhancing areas. Sensors are valuable in industrial automation but can also help waste managers limit pollution. Mobile phones have helped in responding to impending disaster, as in the coastal village of Nallavadu, India, during the 2004 tsunami, but they can also increase business productivity. In parts of Benin, Senegal, and Zambia mobile phones are used to disseminate information about food prices and innovations in farming techniques.

Climate Change and Agricultural Sector Opportunities

Agriculture is the sector most vulnerable to climate change due to its high dependence on climate and weather and because people involved in agriculture tend to be poorer compared with urban residents. Consistent warming trends and more frequent and intense extreme weather events have been observed across Asia and the Pacific in recent decades.

Agriculture is important for all countries of Asia and the Pacific. More than 60% of the economically active population and their dependents—which amounts to 2.2 billion people—rely on agriculture for their livelihoods.

Bangladesh, especially in its coastal areas, is likely to face the triple threat of changing precipitation, temperature, and rising sea levels. Bangladesh is a cyclone- and flood-risk hotspot. Most of the country's elevation does not exceed 10 meters, and a 1-meter rise in sea level might well result in the flooding of 16% of the country's land area. Even a rise in sea level of 0.30 or 0.75 meters is expected to wreak havoc on the eastern coast of Bangladesh, flooding areas of 5.80 and 11.20 km2, respectively; 95% of which is agricultural land.

Although only 20% of Bangladesh' GDP is derived from the agriculture sector, according it employs more than half the country's total workforce. Furthermore, rural density is extremely high, with 1,249 people per square kilometre of arable land (World Bank 2005).

The ADB, in their comprehensive and insightful report ("Building Climate Change Resilience in the Agriculture Sector of Asia and Pacific" (2009)) noted that: "Developing countries in Asia and the Pacific are likely to face the highest reductions in agricultural potential in the world due to climate change. As a result, climate change will place an additional burden on efforts to meet long-term development goals in Asia and the Pacific. Slow agricultural productivity growth, declining income growth, and problems of maintaining food security already pose challenges to many countries in the region. "

Climate Change Impacts on Agriculture

Climate change alters temperature and precipitation patterns. These have both a direct effect on crop production and indirect effects through changes in irrigation water availability and evapotranspiration potential.

Climate change will also have a direct impact on regional hydrology and, therefore, affect agricultural production through its impact on water availability for crops. In addition, higher temperatures under climatic change will, for the most part, increase evapotranspiration, requirements of crops.

Climate Change Increases Food Prices

The ADB (2009) report states that world prices are the most useful single indicator of the effects of climate change on agriculture. The first table below shows results from the ADB team's modelling work on the price effects of various permutations of climate change, with and without the CO2 fertilization effect. Figure 3.5 and Figure 3.6 show the world price effects for livestock production and major grains respectively, assuming no CO2 fertilization effect.

Even with no climate change, world prices for the most important agricultural crops—rice, wheat, maize, and soybeans—will increase between 2000 and 2050. Climate change adds a significant price increase on top of higher prices under a no climate change scenario. Climate change adds 29% to 37% to the price of rice compared to the no climate change price in 2050. If CO2 fertilization is effective in the field, these price increases are cut roughly in half. Soybean, wheat, and maize price increases under no climate change are relatively small (26%, 17%, and 5%, respectively) but climate change causes larger price increases (additional 14%–49% for soybeans, 81%–102% for wheat, and 58%–97% for maize). The greatest price increases across crops do not occur in the same scenario. For example, the highest 2050 rice price is with the NCAR scenario while the highest 2050 wheat price is with the CSIRO scenario.

World Prices of Selected Crops and Livestock Products in 2000 and 2050

	No Climate Change		2050: With Climate Change					
			No CO_2 Fertilization ($/mt)			Difference between No and With CO_2 Fertilization (%)		
Product	2000 ($/mt)	2500 ($/mt)	NCAR	Hadley	CSIRO	NCAR	Hadley	CSIRO
Beef	1,926	1,907	2,017	2,026	2,024	(1.15)	(1.47)	(1.35)
Pork	911	1,009	1,070	1,084	1,074	(1.35)	(1.86)	(1.61)
Sheep and Goat	2,713	1,912	1,977	1,985	1,981	(0.71)	(0.93)	(0.85)
Poultry	1,203	1,228	1,334	1,356	1,342	(1.87)	(2.53)	(2.22)
Rice	190	305	419	392	414	(17.41)	(18.36)	(16.36)
Wheat	113	132	263	239	267	(10.39)	(10.67)	(11.37)
Maize	95	100	158	197	162	(11.41)	(16.64)	(13.50)
Soybeans	209	263	301	392	302	(65.85)	(75.05)	(64.33)

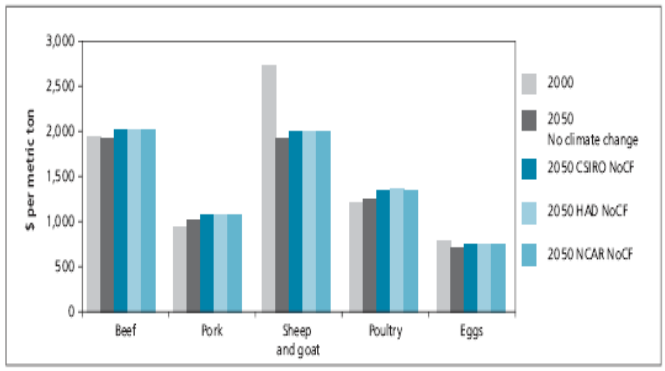
() = negative number, CSIRO = Commonwealth Scientific and Industrial Research Organization, NCAR = National Center for Atmospheric Research.

Note: Reference prices are in 2000 $. The last three columns in this table report the percentage difference between the price in 2050 with and without the CO_2 fertilization effect. For example, with the NCAR GCM, assuming CO_2 fertilization is effective in the field, results in a 17.41% decline in the world rice price. The change in prices of livestock products reflects only the reduced cost of feed.

Source: Compiled by authors.

Source: ADB (2009)

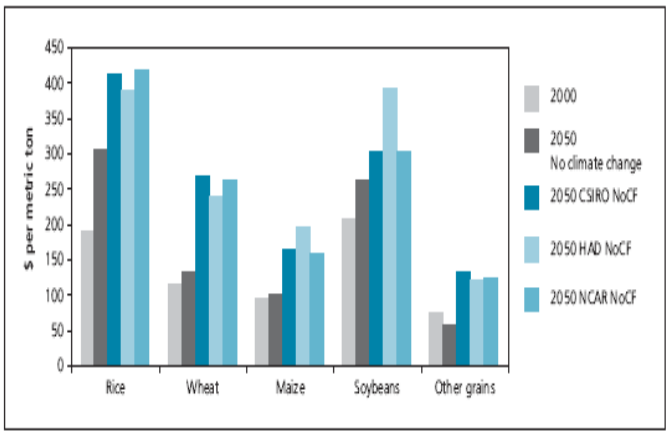
World Prices of Major Livestock Products in 2000 and 2050



Source: Authors.

Source: ADB (2009)

World Prices of Major Grains in 2000 and 2050



Source: Authors.

Source: ADB (2009)

Livestock are not directly affected by climate change in the IMPACT model but the effects of higher feed prices caused by climate change pass through to livestock, resulting in higher meat prices. For example, beef prices decline slightly by 2050 under the no climate change scenario but prices increase by 5% to 6% depending on GCM. With CO2 fertilization, crop price increases are less so the beef price increase is 1% less than under no CO2 fertilization.

Adaptation Recommendations

They also found that that aggressive investments into agricultural productivity enhancements are the key to reversing climate change impacts on both agriculture and food security—potentially reducing two-thirds of the increase in malnutrition levels arising from climate change.

Some of the suggestions the ADB make of new and innovative adaptation measures to climate change include:

(i) changes in agricultural practices to improve soil fertility and enhance carbon sequestration;
(ii) changes in agricultural water management for more efficient water use;
(iii) agricultural diversification toward enhanced climate resilience;
(iv) agricultural science and technology development, agricultural advisory services, and information systems; and
(v) risk management and crop insurance.

However, as the ADB also note: “Developing countries have chronically underinvested in science, technology, and innovation. However, crop breeding—using biotechnology and genetic modification—will be an essential component of adapting to key biotic and a biotic stresses related to climate change, including drought, heat, salinity, pests, and disease. These should be combined with tapping of traditional knowledge on crop varieties and adaptation.”

The World Bank’s World Development Report (WDR) 2010 recommended noted that Agricultural research and extension has been underfunded in the past decade. The share of official development assistance for agriculture dropped from 17 percent in 1980 to 4 percent in 2007, despite estimates that rates of return to investment in agricultural research and extension are high (30–50 percent). Public expenditures on agricultural research and development (R&D) in low- and middle-income countries have increased slowly since 1980, from $6 billion in 1981 to $10 billion in 2000 (measured in 2005 purchasing power dollars), and private investments remain a small share (6 percent) of agricultural R&D in those countries. Those trends will have to be reversed if societies are to meet their food needs.

The report goes on to note that The recently concluded Integrated Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD) showed that successful agricultural development under climate change will involve a combination of existing and new approaches. First, countries can build on the traditional knowledge of farmers. Such knowledge embodies a wealth of location-specific adaptation and risk management options that can be applied more widely. Second, policies that change the relative prices that farmers face have great potential to encourage practices that will help the world adapt to climate change (by increasing productivity) and mitigate it (by reducing agricultural emissions).

Third, new or unconventional farming practices can increase productivity and reduce carbon emissions. Farmers are beginning to adopt "conservation agriculture," which includes minimum tillage (where seeds are sowed with minimum soil disturbance and residue coverage on the soil surface is at least 30 percent), crop residue retention, and crop rotations. These tillage methods can increase yields, control soil erosion and runoff, increase water and nutrient-use efficiency, reduce production costs, and in many cases sequester carbon.

Increased importance for Aquaculture

Another issue highlighted in the WDR 2010 that is particularly relevant for Bangladesh is that Aquaculture will help meet growing demand for food. The report notes that fish and shellfish currently supply about 8 percent of the world animal protein consumed. With the world population growing by about 78 million people a year, fish and shellfish production must grow by about 2.2 million metric tons every year to maintain current consumption of 29 kilograms per person each year. If capture fish stocks fail to recover, only aquaculture will be able to fill the future demand.

Aquaculture contributed 46 percent of the world's fish food supply in 2006, with average annual growth (7 percent) outpacing population growth over the last decades. Productivity has increased by an order of magnitude for some species, driving down prices and expanding product markets.158 Developing countries, mostly in the Asia-Pacific region, dominate production. Of the fish eaten in China, 90 percent comes from aquaculture.

Demand for fish from aquaculture is projected to increase, but climate change will affect aquaculture operations worldwide. Rising seas, more severe storms, and saltwater intrusion in the main river deltas of the tropics will damage aquaculture, which is based on species with limited saline tolerance.

Private Sector Involvement in Agriculture critical

Policies that favour private sector investment in crop improvements targeted to climate change in the developed and developing world are critical. These policies include:

(i) decreasing the bureaucratic hurdles to business formation

(ii) developing infrastructure that enables the production and distribution of improved seeds and other agricultural inputs,

(iii) developing appropriate regulatory and bio safety protocols for the introduction of transgenic cultivars; and

(iv) Reforming intellectual property rights that could encourage private investment in crop improvement. A growing number of food companies are successfully adopting various sustainable pathways as new marketing strategies. This includes growing crops organically, offsetting GHG, sourcing fair-trade, and promoting biodiversity. These companies' experiences should be documented and lessons should be extracted on how the public sector can facilitate scaling up these initiatives.

Synergies between Mitigation and Adaptation

The ADB 2009 report underlines that the strategies for reducing emissions (mitigation) also have significant synergies with adaptation. Strategies to conserve soil and water resources, such as agro forestry, restoring degraded soils, and efficient water use in rice cultivation, also enhance ecosystem functioning, increase water availability, and provide resilience against droughts, pests, and other climatic threats. In general, the mismanagement of agro ecological systems generates emissions, degrades ecosystem functioning, and ultimately threatens food security. Therefore, measures to reduce emissions through integrated crop, grazing land, pest, and water management will build ecosystem resilience, thereby lessening sensitivity to climate change.

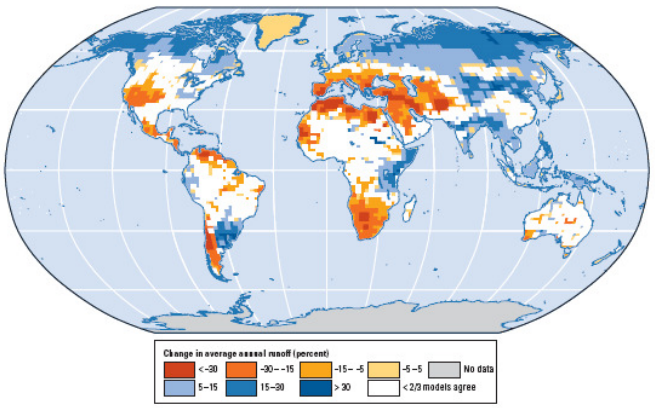
Two of the Bangladeshi corporates we met during the stakeholder consultations, ACI and Pran, have extensive exposure, networks and interactions with the farming community. Both have significant interest in working on a majority of the above areas.

Climate Change, Water Management and Disaster Defences

The ADB (2009) underlined that in irrigation and water resources, investments may be needed to expand large-scale storage to deal with the increased variability of rainfall and runoff. On the other hand, in regions where changes in precipitation are highly uncertain, investments might be better distributed in a variety of small catchments. Climate change and variability in water supply, together with potential long-term changes in the cost of energy, could also dramatically change the cost–benefit calculus for big dams for storage, irrigation, and hydropower, making these investments more attractive despite the environmental and human relocation issues that dams raise. The appropriate level and location of future irrigation investments could also change dramatically.

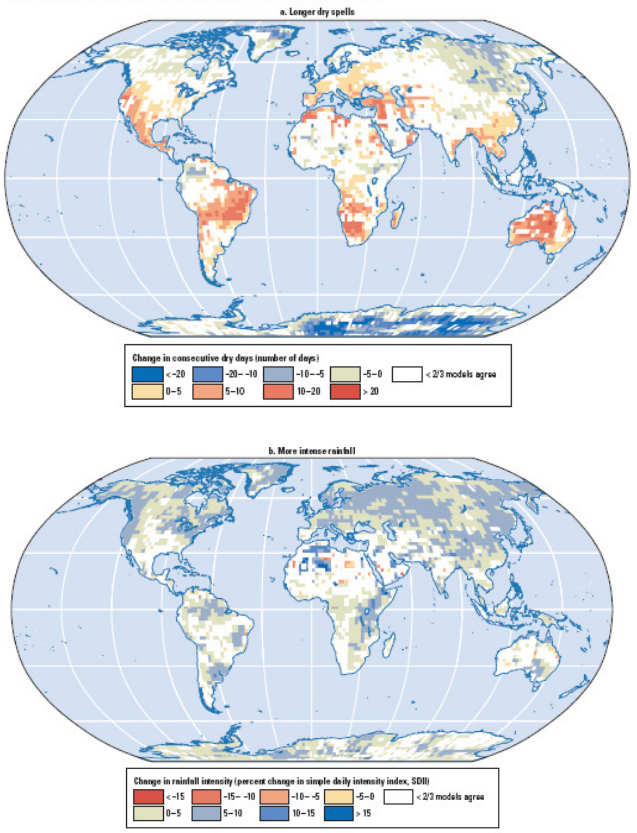
People will feel many of the effects of climate change through water. The entire water cycle will be affected (figure 3.1). While the world as a whole will get wetter as warming speeds up the hydrological cycle, increased evaporation will make drought conditions more prevalent (map 3.1). Most places will experience more intense and variable precipitation, often with longer dry periods in between (map 3.2). The effects on human activity and natural systems will be widespread. Areas that now depend on glaciers and snowmelt will have more fresh water initially, but supply will then decline over time. The shifts may be so rapid and unpredictable that traditional agricultural and water management practices are no longer useful. This is already the case for the indigenous communities in the Cordillera Blanca in Peru, where farmers are facing such rapid changes that their traditional practices are failing. The government and scientists are starting to work with them to try to find new solutions.

Map 3.1 Water availability is projected to change dramatically by the middle of the 21st century in many parts of the world



Sources: Milly and others 2005; Milly, Dunne, and Vecchia 2005.
Note: The colors indicate percentage changes in annual runoff values (based on the median of 12 global climate models using the IPCC SRES A1B scenario) from 2041–2060 compared with 1900–1970. The white denotes areas where less than two-thirds of the models agree on whether runoff will increase or decrease. Runoff is equal to precipitation minus evaporation, but the values shown here are annual averages, which could mask seasonal variability in precipitation such as an increase in both floods and droughts.

Map 3.2 The world will experience both longer dry spells and more intense rainfall events



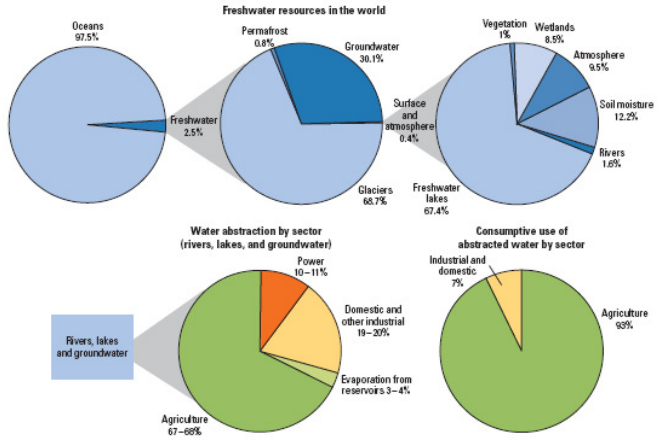
Source: The World Climate Research Program CMIP3 Multi-model Database (http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php). Analysis by the World Bank.
Note: The maps show the median change (based on 9 climate models using SRES A1B) in annual values in 2039–2048, compared with 1960–1999. A "dry" day is defined as one with precipitation less than 1ml/meter whereas a "rainy" day has more than 1 ml/meter. Precipitation intensity (SDII), or simple daily intensity index) is the total projected annual precipitation divided by the number of "rainy" days. White areas show areas of high model disagreement (fewer than two-thirds of the models agree on the sign of change).

Increasing knowledge about the world's water will improve management. To manage water well, it is critical to know how much water is available in any basin and what it is used for. This may sound straightforward, but it is not. The UN's World Water Development Report states: "Few countries know how much water is being used and for what purposes, the quantity and quality of water that is available and can be

withdrawn without serious environmental consequences, and how much is being invested in water infrastructure."Water accounting is complex. Definitions and methods vary, and confusion is common. For example, the Pacific Institute puts the Arab Republic of Egypt's annual renewable water resources in 2007 at 86.8 cubic kilometres, whereas Earth trends reports it at 58 cubic kilometres. Both reports cite the same source of information. The confusion stems from different interpretations of the term *use* (the higher figure includes water reuse within Egypt, while the lower figure does not).

The planet contains a fixed amount of water, with the form and location varying over space and time. Humans have little control over most of it—saltwater in oceans, freshwater in glaciers, water in the atmosphere. Most investment concentrates on water in rivers and lakes, but soil moisture and groundwater together account for 98 percent of the world's available freshwater (figure 3.2). Many people worry about how much drinking water is available,

Figure 3.2 Freshwater in rivers makes up a very small share of the water available on the planet—and agriculture dominates water use



Source: Shiklomanov 1999; Shiklomanov and Rodda 2003; Vassolo and Döll 2005.

Note: When humans use water, they affect the quantity, timing, or quality of water available for other users. Water for human use typically involves withdrawing water from lakes, rivers, or groundwater and either consuming it so that it reenters the atmospheric part of the hydrological cycle or returning it to the hydrological basin. When irrigated crops use water, it is a consumptive use—it becomes unavailable for use elsewhere in the basin. In contrast, releasing water from a dam to drive hydroelectric turbines is a nonconsumptive use because the water is available for downstream users but not necessarily at the appropriate time. Withdrawals by a city for municipal supplies are mainly nonconsumptive, but if the returning water is inadequately treated, the quality of water downstream is affected.

not realizing that agriculture dominates human water use. Each day, person drinks 2–4 litres of water but eats food that requires 2,000–5,000 litres of water in its production. These averages mask considerable variation. In some basins, industrial and urban use dominates, and more and more basins will be in that situation given the pace of urban growth.

Climate change will reduce the natural water storage of snow and glaciers, which will in turn affect aquifer storage and require water managers to design and operate reservoirs differently. Water managers will have to manage the entire water cycle. They can no longer afford to concentrate on the small share of water in rivers and lakes and leave groundwater and soil moisture to be managed by landowners. Many basins will experience increased demand, reduced availability, and increased variability all at the same time. Water managers in those places will have less room to manoeuvre if their decisions are not robust to a variety of outcomes. Tools are available to help societies cope with these changes. They range from policy reform to decision-making protocols, from data collection technologies to new infrastructure design.

The effects of climate change on hydrological patterns mean that the past can no longer be used as a guide for future hydrological conditions. So, like other natural resource managers, water engineers are developing new tools that consider impacts across a number of scales and time frames to help evaluate tradeoffs and make choices robust to an uncertain future (box 3.1).

Climate change will make applying and enforcing sound water policies even more important

Allocating water efficiently and limiting water consumption to safe levels will become increasingly important with climate change. When water is scarce, individual users can take too much, making water unavailable to others or harming ecosystems and the services they provide. When consumption in a basin exceeds the amount of water available, users must use less, and the water must be shared according to some process or principles.

BOX 3.1 *Robust decision making: Changing how water managers do business*

Traditional decision making under uncertainty uses probability distributions to rank different options for action, based on the envelope of risk from the past. But this approach is inadequate when decision makers do not know or cannot agree on how actions relate to consequences, how likely different events are, or how different outcomes should be evaluated. As chapter 2 shows, robust decision making is an alternative. Robust strategies are those that perform better than the alternatives across a wide range of plausible future circumstances. They are derived from computer simulation models that do not predict the future but create large ensembles of plausible futures to identify candidate robust strategies and systematically assess their performance. The process does not choose an optimal solution; instead, it finds the strategy that minimizes vulnerability to a range of possible risks.

Southern California's Inland Empire Utilities Agency has used this technique to respond to the effects of climate change on its long-term urban water management plan First, the agency derived probable regional climate projections by combining outputs from 21 climate models. Coupled with a water management simulation model, hundreds of scenarios explored assumptions about future climate change, the quantity and availability of groundwater, urban development, program costs, and the cost of importing water. Then the agency calculated the present value of costs of different ways to supply water under 200 scenarios. They rejected any strategy that gave costs above $3.75 billion over 35 years. Scenario discovery analysis concluded that the costs would be unacceptable if three things happened at the same time: large precipitation declines, large changes in the price of water imports, and reductions of natural percolation into the groundwater basin.

The goal of the process is to reduce the agency's vulnerability if those three things happen at the same time. The agency identified new management responses including increasing water-use efficiency, capturing more storm water for groundwater replenishment, water recycling, and importing more water in wet years so that in dry years more groundwater can be extracted. The agency found that, if all these actions were undertaken, the costs would almost never exceed the threshold of $3.75 billion.

Source: Groves and others 2008; Groves and Lempert 2007; Groves, Yates, and Tebaldi 2008.

Policy makers have two options: they can either set or enforce fixed quantities for specific users, or they can use prices to encourage users to cut back and even trade among themselves. Either way, designing and enforcing good policies require accurate information and strong institutions.

Quantitative allocations are most common, and it is difficult to do them well. South Africa has one of the most sophisticated schemes, though it is still a work in progress. Its 1998 National Water Act stipulates that water is public property and cannot be privately owned. All users must register and license their water use and pay for it, including river or groundwater extracted at their own expense. Stream flow reduction activity is a category of water use, which means that owners of plantation forests must apply for a license just like an irrigator or a town's water utility. Only plantation forestry has so far been categorized as a stream flow reduction activity, but rain fed agriculture or water harvesting techniques could follow. Counting forestry as a water user makes land use compete squarely with other water users. The only guaranteed rights to water are for ecological reserves and to ensure that each person has at least 25 litres daily for basic human needs.

Water is almost always priced below its value, giving users little incentive to use it efficiently. The literature is virtually unanimous in calling for economic instruments to reduce demand. Charging for water services (irrigation, drinking water, wastewater collection and treatment) can also recover the cost of providing the service and maintaining infrastructure.

The role of pricing to influence demand varies for different types of water use. For municipal water, pricing tends to be effective at reducing demand, especially when combined with user outreach. When the price is high, many utilities and users fix leaks and use only what they need. But because urban consumption accounts on average for only 20 percent of water abstractions, the effects on overall use are limited (figure 3.2). And because municipal use is basically no consumptive, the impact of reduced use in cities does little to increase availability elsewhere in the basin.

For irrigation, a consumptive use, pricing is more complex. First, the amount of water actually consumed is difficult to measure. Second, experience shows that farmers do not reduce consumption until the price is several multiples of the cost of providing the service. Yet most countries find it politically unacceptable to charge much more than is required to recover the operational costs. Third, too steep an increase in the price of surface water will encourage any farmer who can drill into an aquifer to switch to groundwater, shifting but not eliminating the problem of overuse.

In most countries the state or another owner of the water charges the city utility or irrigation agency for the water extracted from the river or aquifer. This is known as bulk water. For a host of technical and political reasons few countries charge enough for bulk water to affect the way resources are allocated between competing uses. Indeed, no country allocates surface water by price, although Australia is moving toward such a system. Although far from straightforward, fixed quotas on the combined quantity of surface and groundwater allocated to irrigation, or, better, the amount of water actually consumed (evapotranspiration), seem to be politically and administratively more realistic than pricing to limit overall consumptive use.

Adaptation Measures to Disaster Defences

As Michel and Pandya (2010) noted in their report on "Coastal Zones and Climate Change", adaptation based on innovative and existing management techniques and technologies is therefore a priority for Small Island Developing States (SIDS). One their observations that is particularly relevant for the coastal areas of Bangladesh that are prone to cyclones, and indeed broader areas of the country subject to flooding, is that : "Historically, much attention has focused on using hard structures such as seawalls to protect coastlines susceptible to sea level rise. A number of feasible "soft" protection and adaptation options are also possible, however. Integrated coastal zone management and ecosystem-based adaptation are proven frameworks that can facilitate the implementation of appropriate accommodation strategies. These strategies include measures such as coastal forest rehabilitation, beach dune restoration, and design structures that take the dynamic changes in the coastal zone into consideration. In many cases, these accommodation strategies—such as constructing homes on stilts rather than surrounding them with barriers — may provide a more cost-effective and resilient approach for adaptation. Where such measures are not possible, some communities may have to undertake a policy of retreat, relocating away from vulnerable areas. Needless to say, this alternative has serious implications for land ownership and compensation."

Climate Change and the Insurance Sector

Recent atmospheric extremes and record weather-related losses have demonstrated the potential link between climate change and the increasing frequency and intensity of extreme weather events. The developing world is especially vulnerable to the increasing economic losses resulting from these events. Between 1985 and 1999 alone, poorer countries lost 13.4% of their combined GDP (from severe storms and other natural catastrophes) versus a loss of only 2.5% of combined GDP in industrialized nations.

The increasing frequency and severity of natural disasters worldwide makes it more and more difficult for disaster-prone nations with smaller economies to finance economic losses from such events. A limited tax base and existing debt makes recovery especially challenging. Financing economic recovery in the aftermath of future natural disasters is severely constrained. In addition, an increasing share of international donor aid is spent on emergency relief and reconstruction, further limiting spending for social programs, health, and infrastructure.

Communities, governments, international organizations, industry, and NGOs that are at risk worldwide are seeking solutions for mitigating and adapting to the rapidly multiplying impacts of climate change and weather-related disasters. The financial management of natural disasters is a topic on the agendas of international financial organizations. Article 4.8 of the UNFCCC and the supporting Article 3.14 of the Kyoto Protocol urge developed countries to consider actions, including insurance, to meet the specific needs and concerns of developing countries in adapting to climate change.

While the industrialized countries enjoy a high level of insurance penetration, developing countries in general lack adequate catastrophe insurance. They simply lack the resources to purchase such insurance and, particularly in rural areas, are largely unaware of its benefits.

The business model of the global insurance industry dictates a price for products commensurate with the underlying risk. Although this has led to large amounts of natural-catastrophe risk coverage in the developed world, the product structures are not suited to the needs of the poorer rural dweller. Nevertheless, insurance and financial services businesses are developing some promising approaches aimed at making access to products and services more universal. Weather insurance is one example. In typical weather coverage, if a rainfall index, for example, falls below a certain level over a predefined period then an insurance payment is triggered. Because the benefit is paid on the basis of a statistical certainty, for instance the amount of rainfall in a 12-month period, the burden of administering claims payments is minimal in comparison to conventional insurance policies. This characteristic alone makes the weather-insurance concept well suited for covering risk in developing countries with widespread rural populations and limited insurance-relevant infrastructure. Farmers in rural communities in India can purchase this weather insurance for protection against the threat of crop failure resulting from drought – a potential consequence of climate change in some regions. Although individual coverage and premiums are low to remain affordable in developing countries, the potential number of clients is significant.

This potential new market for the insurance industry will likely provide much needed, and previously unavailable, protection. Further developments in this sector include the collaboration between the World Bank and insurance industry to form the Global Index Insurance Facility (GIIF). The GIIF is a reinsurance vehicle aiming to originate and underwrite indexed weather-insurance and commodity-pricing risk in developing countries (CMRG, 2006).

As highlighted by the DFID (2007) report, the agricultural sector remains the most critical in terms of providing a source of livelihood for the poorest communities: three quarters of the world's poorest people (those living on less than 1 dollar a day) live in rural areas. The focus of attention in terms of insurance products has been on this sector. It also presents the greatest opportunity to develop pro-poor insurance because the inputs and outputs are more clearly identifiable than, for example, in the case of informal employment by poor people in urban areas. The global agricultural insurance totals $7 billion, of which 2% is in Africa, 4% in Asia, and 3% in Latin America. North America has 58% of the market, while Western Europe has 28%.

A second example is micro insurance, which provides very small amounts of traditional insurance protection with very modest premiums, perhaps as little as $2 to $5 per year. While the protection could be as little as $100, this benefit could make the difference between success and failure for a small village shopkeeper who is unable to repay a loan due to illness or accident. Experts estimate that there could be more than 400 million potential micro insurance clients worldwide (Mills and Lecomte, 2006).

Providing insurance solutions in the developing world presents significant challenges and opportunities. In a larger sense, the role of insurers in protecting against the effects of climate change and assisting with mitigation efforts is vital to a successful worldwide strategy. Insurance is an enormous factor in the global economy, with $3.4 trillion in yearly premium revenue and another $1 trillion in investment income. Insurance is purchased by nearly every business in

the developed world. The prospect for the insurance industry's involvement in the development of climate-change mitigation strategies is an immense but largely untapped opportunity.

Considering its expertise in risk management and loss prevention, the insurance industry is uniquely positioned to advance creative solutions to minimize the impacts of climate change.

Operational Challenges in Developing Climate Change Insurance in Bangladesh

At the individual level, insurance needs to also be intermediated through institutions with rural outreach. Of the poorest countries, private sector scale-up has only happened in India, not elsewhere. Constraints for traditional products delivered at the individual level include poor rural infrastructure and capacity; operational difficulties of small farmer agriculture; lack of availability of farm level data; moral hazard; adverse selection; and high monitoring and administration costs. In order to be able to deliver these insurance products, a local financial institution needs to be able to have a large enough and diverse enough portfolio to spread its risk.

The insurance product must be linked with practical risk reduction activities if it is to be effective in promoting adaptation. So, for example, insurance needs to be conditional on better buildings, better flood defences and so on, which will require additional resources but will promote the critical changes in behaviour required.

Commercial financial institutions are best-placed to provide value in the areas of risk modelling and alternative risk transfer in the form of instruments such as weather derivatives and catastrophe bonds if they have the necessary data.

Some participants in the DFID workshop saw the need to transfer low probability, high impact indexed risks from developing countries to international markets. If climate change impacts are "reasonably foreseeable", as now argued by some observers including some law firms1, then private sector providers will be legally bound to assess the risks and liable if they do not. Others considered that the most devastating climate shocks were likely to be excluded by insurance policies as "Acts of God" and could only be covered by Governments.

Lack of Data and Forecasting

At a practical level, for climate change related insurance products to develop in Bangladesh, good data and forecasts and modelling capabilities are critical. Currently, the data are not available to enable insurers to assess the risks properly. The increasing frequency of climate-related events requires new models to interpret the data that is available and extrapolate forward. This lack of reliable data affects a number of different elements of the insurance system, including a critical part of indexed insurance products, the calculation of an appropriate level of basis risk.

The lack of domestic expertise to understand, model and price insurance products is the largest constraint. Even at a global basis, there is a limited pool of expertise structure solutions. Index insurance in particular, requires significant technical assistance in the identification, design and pilot phases. This can make products expensive with high front-end costs in particular. If products are not replicable or if there is a very narrow market then there may be the need for innovative financing models for the development of products.

It is an obvious point that insurers will not be willing to offer products if they cannot find people or institutions capable of paying the premiums. It is important to recognise that there are some risks that simply cannot be insured commercially and that there needs to be public sector provision in the form of a social fund or international development assistance. Insurers also need to be able to spread the risks adequately: this is currently constrained. The current range of microfinance institutions has quite a narrow client base, which is not attractive for an insurer: a multiple distribution network which pools risks is much more commercially fundable.

Factors constraining the demand for potential Climate Change Insurance Products

Awareness of changing risk

As the DFID workshop report highlighted: "Poor people are good risk managers and would readily take up a product that makes sense in their circumstances. However, the risks that they are currently facing cannot be assessed by reference to past experience, so the insurance that they are being offered to manage those risks may appear very costly." It is possible that in these circumstances, people's perception of risk is flawed because the probability of events happening is unclear. The key here is to provide greater information to increase awareness of risks and offer risk management tools.

How insurance products are distributed has obvious implications for their take-up. Microfinance institutions are a key partner here and their role – perhaps in cross-selling insurance products with credit – could be enhanced. Credit unions might be the most appropriate distribution channel in

East Africa although there are questions around transparency and protection for the consumer.

Case Study on Crop Insurance in India

The following case study is reproduced from Andalug (2006) and there is a strong case for a similar model to be replicated in Bangladesh.

Traditional crop insurance is not commercially viable anywhere. Farmers understand their risks so well that only high-risk ones insure (anti-selection), and the costs of monitoring crops at field level are high. In India, this is compounded by the slow settlement of claims under the public sector scheme - often a year or more after the loss, which forces the farmer to borrow at high interest rates, default on loans or sell assets. Natural disasters affect whole districts, so that traditional social networks cannot cope. The very poor cannot diversify, and may not be able to manage debt, so weather index insurance is well-suited to their needs.

Rainfall insurance was launched in India in 2003. Since then, there have been major improvements in the product design and delivery. A key development was the partnership between BASIX, an Indian micro-finance institution based in Hyderabad, The World Bank's Commodity Risk Management Group, and private insurers.

Gestation started in 2000 when the private sector was legislated into being. In 2003, the weather insurance pilot was very small and the products and systems rather simple, with payouts based on the entire seasonal rainfall recorded locally. In 2004, 10 rainfall products were trialled, but still on a small scale. A major expansion took place in 2005. The product was no longer crop-specific, but focused on district as the risk factor. Administration was streamlined, and the product was marketed in six Indian states in several languages.

Over 7,000 policies were sold, and other insurance companies and agents followed suit. The outlook for 2006 is further strong expansion, but growth may be limited by the availability of weather data.

As customers gain confidence with insurance products, BASIX believes there is scope to package it with other livelihood enhancement products, thereby monsoon-proofing loans. This would provide protection for BASIX as well as its clients. Insurance for non-farming activities could also take off.

The premium rates are not low, at between five and 12 percent of sum insured, but experience shows that insurers will not participate unless the scheme is viable, and clients are willing to pay if the claim settlement process is fast and fair. In fact the underwriter, ICICI Lombard, now sells weather insurance via BASIX, other intermediaries, and retail (direct), for crops, and also salt and brick manufacture. The insurer identified three barriers.

Better weather data will reduce basis risk for clients and encourage improved reinsurance rates. Automatic reinsurance is needed to permit greater flexibility in writing new contracts and portfolios. Third, the government should revise its subsidy policy for yield-insurance products, which undermines the weather insurance market.

This initiative has succeeded due to strong collaboration between all the partners, with doorstep delivery, and quick claim settlements – even before harvesting is over, compared with customary delays of twelve months in public schemes. It featured iterative and collective product development and innovation.

All the stakeholders gain: government by reduced relief payments and social problems, and easier budgeting; the insurer by more business; the microfinance institution BASIX complements its client services; the poor farmers receive reliable protection for their income and assets; and overseas development agencies avoid disruption from emergency relief calls, and can claim speedier assistance for clients. Wider schemes would benefit intermediaries, by generating more revenue; and banks by protecting their credit risk.

The World Bank intends to replicate this success in other developing countries e.g. Thailand and Mali. One question that remains to be explored is, what difference will this make long-term to the farmers – how will they exploit their new resilience to climatic variability as they gain confidence?

Potential Strategies to Engage the Private Sector in Climate Change Adaptation

Knowledge: Improving the link between CC Science and Commercial Opportunities

Despite the vast amounts of existing data and technical analyses on climate change, many in the private sector are still unclear what the mitigation and adaptation opportunities are. In part, that is because of the substantial divide between the cultures and languages of science and policy. As noted in a recent USAID report on establishing an Asian Regional Climate Change centre (see ARC (2010)): "Technical information is often functionally inaccessible to decision makers who expect and require rapidly digestible and actionable information. Strengthening the flow of information between the science and policy communities, to better target science and to better inform decision makers, could be truly transformative."

The USAID study team consulted 453 stakeholders across the region, including a mission to Bangladesh, and noted that stakeholders also highlighted the need for developing long-term technical capacity within organizations. Government and business leaders in particular expressed the need to have "information filtered and packaged into more digestible formats that are tailored to the audience."

Estimates for additional required investments for mitigation and adaptation range from $170 billion to $765 billion annually by 2030. But financial transfers alone will not be enough. Acquiring technology, far from easy, is a long, costly, and risky process ridden with market failures. Adaptation technologies depend on local technical skills and indigenous knowledge because they involve designing systems tailored to local needs

Even when technology can be imported, it involves a search process, prior technical knowledge, and the skills and resources necessary to use the technology efficiently. That capacity rests on various forms of knowledge, many of which are tacit and cannot be easily codified or transferred. Large-scale energy projects that can be contracted out to foreign firms, for example, require local capacity for policy makers to evaluate their merits, and for operation and maintenance. The European Union is developing legislation for managing risks associated with carbon capture and storage, but few countries have the technical capacity to design such legislation, another barrier to deploying the technology.

However, it is important to involve the private sector where possible. The WDR 2010 highlighted that iinstitutional reforms that give the private sector a greater voice in the governance of research institutions and that reward transfer of knowledge and technology to external clients can also help. In some cases "bridging institutions" such as business incubators can facilitate knowledge spillovers from research institutions. In 2007, 283 clean technology companies were under incubation worldwide (even before including China), twice as many as in 2005/6.

The UNFCCC (2008) have noted that "Technology plays an important role in reducing vulnerability to climate change and enabling adaptation and features in many types of adaptation action. Technologies can be distinguished between hard technologies, such as drought resistant crop varieties, seawalls and irrigation technologies, and soft technologies, such as crop rotation patterns. Many technologies have both hard and soft characteristics, and successful adaptation action would typically combine both.

Within these two broad categories (hard and soft), technologies have been further classified as traditional, modern, high technology or future technology. Traditional (indigenous) technologies that have been applied to adapt to weather hazards include technologies to build floating vegetable gardens, traditional housing designs and dykes. Examples of modern technologies include improved designs (e.g. of sanitation systems, housing and commercial buildings), technologies to produce new varieties of crop (e.g. hybrid corn) and new water-use technologies (e.g. drip irrigation).

High technology includes some of the more recently developed technologies resulting from scientific advances in recent decades, including in information and communications technology, earth observation systems and geographic information systems (GIS), and genetic modification. Future technologies are those that have yet to be invented or developed; examples include a malaria vaccine, various forms of geo-engineering to reduce climate impacts, and crops that need little or no water.

Many technologies for adaptation may be already readily available in developing countries, and the most-needed technologies in some cases may not be very capital-intensive.

Learning from Global and Regional Success Stories

Databases of adaptation initiatives

As outlined in SEI (2009) there are several databases with information on completed or ongoing adaptation projects and initiatives at the local and national levels which can inform an assessment of adaptation needs. The UNFCCC secretariat, for example, hosts an adaptation practices

interface which is a gateway to information on adaptation practices worldwide – the Local Coping Strategies Database.

It provides a summary of adaptation practices by a large range of organizations, agencies and businesses. Around 100 cases are categorized under: (a) type of hazard, for example, drought, erratic rainfall or sea-level rise; (b) type of impact, such as decreased food security, soil erosion and urban heat islands; (c) strategy, for example, alternative cultivation methods, land redistribution or improved housing design; and (d) adaptation action, such as sea dykes, seed selection and wells. The pattern of entries suggests that the most common types of adaptation action so far have been seed selection and storage, improved cropping systems and disaster preparedness. The picture provided by this database concurs very much with the NAPA summary above, that is, that thus far adaptation actions have been most common in the agriculture sector, although they may just have been more extensively reported. Mainly "hard" or technology-oriented activities have been reported so far, rather than, for example, economic diversification and other aspects related to vulnerability.

Another database was developed by the World Resources Institute for its 2007 report Weathering the Storm: Framing for Adaptation and Development (McGray et al. 2007).5 It includes 135 cases and categorizes them by region and country, scale, type of climate impact adapted to, objective, degree of targeting and the adaptation strategies employed. This database gives a somewhat different picture of adaptation needs than those of the
UNFCCC database and the NAPAs. Like the latter, most cases are from sub-Saharan Africa, followed by South and Central Asia and Latin America, but in addition it shows that the vast majority of projects have been undertaken in rural rather than urban settlements, and that almost half the projects were undertaken at community scale rather than sub national, national or multinational. This raises the question of, assuming that needs are most commonly defined and responded to at the community scale, whether the national government is the best placed actor to channel or manage adaptation finance for its communities.

Outsourcing R&D in CC Adaptation

A good example is cited in the WDR 2010. It highlights a JV between Bangladeshis and US researchers in innovating to improve coastal defences adaptation. Specifically, Bangladesh's coastal regions expect more frequent storm surges and tidal floods as a result of climate change. The University of Alabama at Birmingham is working with Bangladeshi researchers on home foundations and frames built of a lightweight composite material that bends—but does not break—in a hurricane and that can float on the rising tide of a coastal surge. Fibers from jute, one of Bangladesh's common plants, are woven with recycled plastics to form an ultrastrong building material. Jute does not require fertilizer, pesticides, or irrigation; is biodegradable; is inexpensive; and is already widely used to produce cloth, ropes, and other items in Bangladesh. Local architects are helping to incorporate the technology in local house designs. Bangladeshi researchers will contribute their expertise on the mass-manufacturing of jute products.

Building capacity and knowledge in the private sector is important. The most effective transfer of knowledge comes from real people working together. Many virtual networks exist that provide static resources and information on climate change. Such platforms are inadequate to provide the dynamic learning environment needed to engage and train managers and practitioners to understand and incorporate climate science results into practical policies and strategies. Increasing both baseline capacity and developing a cadre of thought leaders is critical to ensuring the sustainability of any other technical investments

Economic analyses and market-based solutions. Many emerging climate centres and networks are focused almost exclusively on assisting national governments in an effort to enable progress in the international negotiations. However, private sector investments and resources can be rapidly mobilized, dwarf the levels of public funding pledged in the international frameworks, and can be a driver of rapid and tremendous change. Wal-Mart and other major companies have shown the impact that the private sector can have in greening of supply chains and in developing market based solutions. In Asia, private sector leaders often do not have the information they need to make decisions and are eager for information on global best practices for mitigation and adaptation approaches. While there can be challenges in working with the private sector, the significant benefits from motivating and enabling them to take action should not be ignored.

Consulting /TA resources to develop institutional capacity on CC issues in the private sector

Concessional Financing for CC Projects

Grants and Concessional Loans

Both grants and concessional loans will be available to finance the additional costs necessary to make a development activity resilient to the impacts of climate change. Countries may choose to only access PPCR grant resources. When concessional loans are provided, the grant element of the loan will be sufficient to cover the additional costs of integrating climate risk and resilience into development activities. Financing terms for concessional loans are more concessional than standard IDA terms

PPCR financing will address the additional costs and risks associated with integrating climate risk and resilience in core development activities, which adversely affect the viability of investments. Financing modalities will be designed and deployed to meet the specific requirements of removing financial and institutional barriers. The key drivers of additional costs and risks for climate resilient development are the following:

a) ***Higher investment costs***: Even though development activities receive national and international financing, the integration of climate risk and resilience into these activities tend to have higher initial capital costs. This makes the cost of climate resilient development activities more dependent on the cost of capital than conventional development activities.

b) ***Lack of access to capital*****:** Developers of climate resilient development activities may lack access to capital to invest and finance a development project that integrates climate risk and resilience considerations because of typically more complex requirements relative to conventional sector-oriented development projects, poor creditworthiness, and uncertainty about mid-and long-term climate variability and vulnerability.

c) ***Real and perceived risks associated with climate change*****:** Climate change and variability increase the risk or the perception of risk for conventional development interventions, if there is limited information and experience with them how to integrate climate-related factors. These perceptions may increase required rates of return and result in less capital available.

d) ***Lack of technical or commercial skills and information*****:** Skilled personnel who can integrate climate risks and resilience considerations into development activities may not exist in large numbers, while lenders and government officials often lack information about characteristics associated with climate change and variability. The lack of skills and information may increase perceived uncertainties and block decisions.

e) ***Constrained ability to pay*****:** The upfront cost of making development interventions climate resilient is a serious barrier as the success of those interventions remains uncertain in the context of climate change, in particular climate variability.

Financing Modalities for Private Sector Involvement

MDBs will seek to use PPCR funds in private sector markets where the risk/reward profile of initial project entrants are not balanced (i.e. when the investment return on the initial projects do not compensate sponsors for the risks they experience) but where the risk/reward profile for future projects are eventually expected to be sufficient to encourage private investment without future subsidies (i.e. where risks come down because of the track record established from the early projects and where costs go down – and returns go up - because precedents are set which facilitate project implementation). Given the probability that some PPCR interventions will start at an earlier stage of development, the time lag from initial interventions to achieving long term sustainability will likely take longer in the PPCR.

Because each country, sector and project faces a unique set of barriers, PPCR financing will not be uniformly offered to all private sector companies but will be tailored to address the specific barriers identified in each project and intervention. Below is a description of the main types of PPCR instruments that may be structured to address development barriers as well as the principles for use of PPCR funds in private sector investments to address the specific barriers identified in each project and intervention.

It is expected that concessional finance will be preferred in funding revenue-generating projects. The level of concessionality should be adjusted according to the projected project revenue which partly depends on commercial and technical risks.

Principles for using PPCR funds in private sector investments

PPCR funds used in private sector investments will adhere to the principles outlined below.

Minimum concessionality**:** MDBs will seek to provide the minimum concessionality needed to catalyze projects and programs within a sector. In order to honour this principle, PPCR funds will be structured on a case-by-case basis to

address the specific barriers identified in each project/program. The amount and terms of PPCR funding offered to an individual client will be determined between the MDB and the client on the basis of efficient and effective use of PPCR and MDB resources. While an attempt will be made to quantify the additional costs faced by early entrants and compare that with the subsidy element implicit in the financing terms being offered, country, industry and individual company dynamics will impact the amount of concessionality a company will accept in order to undertake a project. Finding the right amount of concessionality5 is largely a matter of client needs, market conditions and negotiation, and is dependent on information not flowing between the companies or being available in the market. MDB's will always seek the minimum concessionality necessary to enable projects to happen and will justify the amount of concessionality requested in each PPCR proposal.

Avoiding distortion and crowding out: PPCR funds will not be priced or structured to displace commercial financing or set unsustainable expectations in a market. PPCR funds will be used to "crowd in" the private sector by enabling projects and investments to happen that otherwise would not by catalyzing those investments with their concessionality.

Leverage**:** PPCR funds will seek to catalyze and maximize the amount of MDB and other bilateral financing as well as commercial financing available for its projects and programs. A key feature of the PPCR will be its ability to unlock both MDB and other private sector financing for climate adaptation investments and catalyze ongoing sustainable investments in these sectors beyond the initial PPCR investments.

Financial Sustainability**:** PPCR programs will be developed to maximize the probability of long-term financial sustainability once the PPCR funds are no longer available/have been used. The project or program should at a minimum have the potential to achieve a substantial reduction in the need for subsidies in similar future projects beyond the initial few projects supported by PPCR.

Private Sector PPCR Instruments

Private sector engagement will generate both private and public benefits. For example, grants for the private sector may be justified when the intervention has clear demonstration effects that provide benefits beyond the company itself. Such public benefits could accrue to communities or advance market development. PPCR funding to the private sector will encompass both grant and concessional finance.

Below is a description of the types of PPCR instruments (list is not exhaustive) that may be structured to address the barriers identified in each case and justify the use of PPCR funds in private sector investments.

Grants

Grants for investment may be used for private sector investments to decrease costs through buy-downs and to increase revenue or reduce volatility through performance based payments to make a project climate resilient.

Concessional Loans

PPCR will offer concessional finance to support private sector projects and programs that have the potential of being replicated in the future without further subsidies. The terms and structures of each financial investment would be determined on a case by case basis to address the specific barriers identified in each case. These barriers could include:

a) High costs of early entrants (the additional costs associated with being among the first players to implement a project in a given sector, under new regulations or work through unprecedented systems); they could also include higher input costs because economies of scale have not been achieved for the technology;
b) Concessional pricing and repayment structures can offset these costs and make early stage projects with cash flow uncertainty bankable;

Equity Financing through a BD Cleantech Fund

Individual investors can provide equity by the direct purchase of stocks. This is most common for large institutional investors such as pension funds. Alternatively, investors may transfer responsibility for purchasing and holding stocks to some form of "pooled investment vehicle" (e.g. a "climate fund"), which manages the finance raised from an array of investors simultaneously.

Another form of providing equity is on a project basis, using the "project finance" model. The implementation of major projects, particularly infrastructure- and resource related projects, generally requires equity (in combination with debt and insurance). The private sector may contribute some or all of these forms of finance depending on the project. Where both public and private finance are used, the term public-private partnership is often used.

Delivery

A key feature of equity investments is that they are most appropriate for activities which are expected to generate a profitable revenue stream. In practice, this means that the economic value of the project is internalized within a market. Investments in energy production such as hydro electric power plants, for instance, earn money which repays the investment. Investments in carbon reduction projects create carbon credits which have a market value and so generate revenue to the owner. This means that the

Usefulness of equity as finance for climate adaptation will not always be high. Some projects, such as new water or energy supplies, may generate internal revenue while others, for example, inert infrastructure projects such as a sea wall, will only accrue value through avoided costs to society, such as by preventing flooding. These latter cases are therefore unlikely to be targets for equity investors.

From the perspective of developing countries, private equity may still be of interest because, in instances where it replaces investment that would otherwise have come from the public sector, it frees up domestic public resources to be spent on other needs.

Using bonds to generate finance for "Climate Funds"

This model of finance generation could be used specifically to raise new capital for supporting adaptation in developing countries. The key barrier, at least initially, is likely to be generating awareness of and support among large investors for the benefits of "ethical investment" of this kind. There has been considerable growth in climate funds targeting mitigation in recent years as a result of growing investor awareness and, since carbon is now a commodity, of profit opportunities. This provides encouragement that significant finance could also be raised to assist with adaptation. However, the economic benefits associated with adaptation will sometimes not accrue to the proponent of the activity itself (e.g. in the case of a sea wall built to prevent flooding, the benefits are not to the entity building the sea wall but to the wider community – the economic value accrues outside the "market").

In such cases, we may expect lower financial returns compared to those available in the carbon market. Since profit alone is unlikely to attract investors to adaptation over alternative investment options, some commitment to the principles of ethical investment will also be required. Investors primarily choose the form of investment (e.g. bonds) but are also able to choose between the different kinds of bonds offered in the market, that is, they can state a preference for what their investment money is used for.

Delivery

As is mentioned above, finance raised through bonds will be delivered ultimately to developing countries as loans – that is, debt – albeit at potentially lower interest rates than these countries would otherwise have access to on the commercial borrowing markets. These are sometimes referred to as "soft loans". It may be possible to structure the overall lending programme of an individual climate fund so that some borrowers – those in LDCs, for instance – could be given access to especially cheap finance (e.g. low- or no-interest loans, as the International Development Association of the World Bank does). The trade-off in such an approach is that the interest charged to other borrowers accessing the same funding pool, in this case other developing countries, will necessarily be higher than if interest were charged equally on all lending, in order to maintain the commercial rate of return of the overall lending activity.

Climate funds based on private sector finance

Finance raised by the above measures will often be pooled into some form of managed fund. There is already a range of what can broadly be considered climate funds financed by private investors. Some primarily use debt as the delivery mechanism to developing countries, others equity and, in a few philanthropic cases, grants. Managed funds may be administered by either the private sector or international institutions such as the World Bank.

Box 7.1: Case study in private sector financing: World Bank-SEB Green Bonds

In 2008, the World Bank partnered with Swedish Bank SEB to issue "Green Bonds" in order to raise capital specifically for climate change projects. The product was initiated in response to demand from a group of Scandinavian investors, predominantly pension funds and insurance companies, which identified that while there are opportunities to invest in climate change (mainly mitigation) at the venture capital or private equity level there is "a dearth of products into which they can easily direct tens or hundreds of millions of dollars of investment".[50]

Bonds are issued by the World Bank, which also administers the lending to projects, while SEB acts as a financial intermediary with investors. It is understood that SEB also took a lead role in defining the criteria for determining which projects would be eligible for lending. The first bond issue raised approximately USD 300m, and there have been several subsequent bond releases – the most recent in 2009 purchased by the Californian state treasury.

SEB has indicated to SEI that approximately 20 per cent of the total finance raised from the initial release is earmarked for adaptation projects. The broad criteria for adaptation projects are:[51]

- protection against floods, including reforestation and watershed management;
- food security improvement and stress-resilient crops, which slow deforestation;
- sustainable forest management and avoided deforestation.

It is unclear whether specific adaptation projects have already received funding. The World Bank website cites a "climate change development policy loan" to Mexico of around USD 500m to "mainstream climate change considerations into public policy".[4] Although the specific tasks described for this project appear to focus predominantly on mitigation, reducing deforestation could also have adaptation benefits.

To date, the array of climate funds are focused heavily on financing mitigation activities, such as investments in clean energy projects. However, the mechanism itself is equally applicable as a tool for raising finance which could contribute to adaptation outcomes. In discussions with SEI, the Swedish Bank SEB has suggested that there is likely to be considerable scope for adaptation-specific funds to emerge as the profile of adaptation increases in the community. Apparently, the various investors in their Green Bond product (see box 7.1) neither differentiate between mitigation and adaptation nor prioritize one over the other in making investment decisions. SEB's decision to focus mostly on mitigation projects for the first bond release was influenced mainly by the fact that mitigation was easier to explain to investors.

New finance in the case study above is entirely sourced from the private sector. Meanwhile, the World Bank has established a series of "carbon funds" – focused mostly on mitigation – that are sourced from partly public and partly private contributors. The *Community Development Carbon Fund*, for instance, is a "Multi-Donor Trust Fund" partly capitalized by 16 European corporations. Participants in the fund acquire a pro-rata share of emission reductions generated by the investment.53 This means the motivation for the private sector is commercial rather than philanthropic and, importantly, the investment relies on the existence of a market value for the good or service being produced – in this case, carbon emission credits. This hybrid public-private carbon fund illustrates another potential model for generating and administering new finance from the private sector for adaptation. However, as is discussed above, any fund which delivers finance as equity into projects will only be relevant where the economic value arising from the project is internalized. Where this is not the case the equity model is not likely to attract private interest.

The SEI (2009) report summarizes multiple sources of Climate Change Financing. It notes that if funding streams are consolidated at the international level, the use of multiple sources of adaptation finance does not need to result in further fragmentation. Adaptation finance can comprise both voluntary and mandatory financing. Mandatory financing can be provided through: (i) assessed national contributions; (ii) international levies; or (iii) obligations passed on to the private sector, as well as through a combination of these. Mandatory contributions need to be new and additional beyond existing ODA levels, and be certified for verification of compliance. Note also that while resources can be mobilized through the various channels, they should be disbursed in an integrative fashion. Delivering on adaptation, regardless of whether a vulnerability-based or a more impact-focused approach is adopted, will be more efficient and effective through the pooling of available resources for development and adaptation, and the strengthening of existing development processes and mechanisms. The issue of additionality is best addressed at the finance generation stage.

In order to illustrate this last message, figure 9.1 below provides a crude overview of the key financial flows for adaptation finance, and their interrelationships.

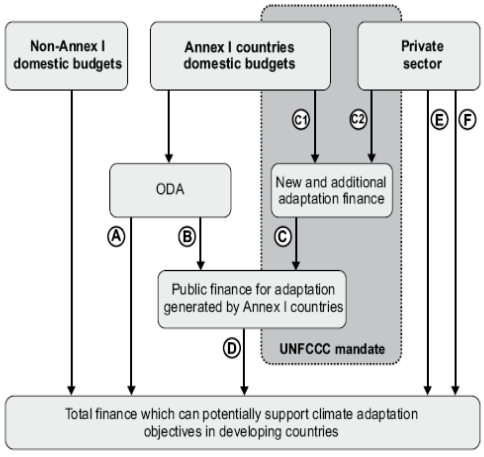


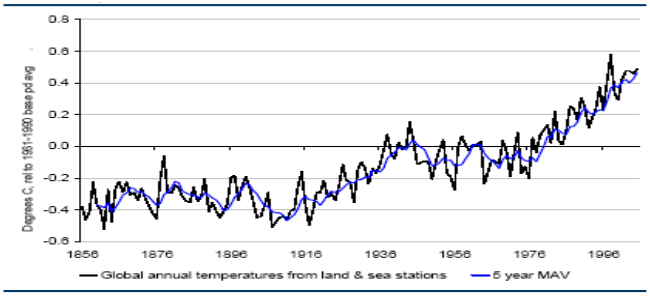
Figure 9.1: Channels for adaptation finance to developing countries

Appendix 1: The Global Backdrop to Climate Change Adaptation Challenges

"The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response" **(Stern Report on the Economics of Climate Change, 2006)**

The causes and consequences of global warming

Human activities have changed the climate of the Earth, with significant impacts on ecosystems and human society, and the pace of change is increasing. The global-average surface temperature is now about 0.8°C above its level in 1750, with most of the increase having occurred in the 20th century and the most rapid rise occurring since 1970. Temperature changes over the continents have been greater than the global average and the changes over the continents at high latitudes have been greater still.



Source: NASA GISS Surface Temperature (GISTEMP) Analysis.

The pattern of the observed changes matches closely what climate science predicts from the buildup in the atmospheric concentrations of carbon dioxide (CO2), methane (CH4), and other greenhouse gases (GHGs), taking into account other known influences on the temperature. The largest of all of the human and natural influences on climate over the past 250 years has been the increase in the atmospheric CO2 concentration resulting from deforestation and fossil fuel burning. The CO2 emissions in recent decades, which have been responsible for the largest part of this build-up, have come 75% to 85% from fossil fuels (largely in the industrialized countries) and 15% to 25% from deforestation and other land-cover change (largely from developing countries in the tropics).

As the Stern Report noted The current level or stock of greenhouse gases in the atmosphere is equivalent to around 430 parts per million (ppm) CO2 1, compared with only 280ppm before the Industrial Revolution. These concentrations have already caused the world to warm by more than half a degree Celsius and will lead to at least a further half degree warming over the next few decades, because of the inertia in the climate system.

Even if the annual flow of emissions did not increase beyond today's rate, the stock of greenhouse gases in the atmosphere would reach double pre-industrial levels by 2050 - that is 550ppm CO2e - and would continue growing thereafter. But the annual flow of emissions is accelerating, as fast-growing economies invest in high carbon infrastructure and as demand for energy and transport increases around the world. The level of 550ppm CO2e could be reached as early as 2035. At this level there is at least a 77% chance - and perhaps up to a 99% chance, depending on the climate model used - of a global average temperature rise exceeding 2°C.

Currently, 21% of the world's population lives within 30 km of the coast (Gommes et al., 1998) and the coastal population is growing at twice the average rate of global population (Bijlsma et al., 1996; references 3 and 4 cited in Nicholls et al. 1999). In 1995, some 60 million people lived at elevations of 1 m or less above sea level, and some 275 million people lived within 5 m or less of mean sea level. A sea level rise of 1 m or 5 m by 2100 would displace roughly 130 and 410 million people, respectively (Nicholls et al., 2004).

Source of sea level rise	Rate of sea level rise (mm per year) 1961—2003	1993—2003
Thermal expansion	0.42 ± 0.12	1.6 ± 0.5
Glaciers and ice caps*	0.50 ± 0.18	0.77 ± 0.22
Greenland ice sheet	0.05 ± 0.12	0.21 ± 0.07
Antarctic ice sheet	0.14 ± 0.41	0.21 ± 0.35
Sum of individual climate contributions to sea level rise	1.1 ± 0.5	2.8 ± 0.7
Observed total sea level rise**	1.8 ± 0.5	3.1 ± 0.7

**excluding Greenland and Antarctica.*
*** Data prior to 1993 are from tide gauges and after 1993 are from satellite altimetry.*
Source: IPCC.

A complete collapse of the Greenland Ice Sheet, projected to take roughly 1,000 years once local warming reaches about 3°C (which is expected by late this century), would increase global mean sea level by about 7 m. The collapse of the West Antarctic Ice Sheet (WAIS), which would likely take a comparable amount of time, would add another 4 to 6 m. While the IPCC's 2001 estimates do not anticipate significant loss of ice mass from either ice sheet during the 21st century, accelerated retreat of some ice streams has recently begun in Greenland, and some parts of the WAIS also seem to be nearing destabilization

	Recent trends and forecast
Temperature	Up 0.76°C over the last 150 years. High latitude areas such as Canada, Russia, and the Arctic are warming more rapidly than the tropics. The IPCC calculates a rise of 2.0-4.5°C in global surface temperature over the rest of this century.
Precipitation	Increases in the level of precipitation are expected in high latitudes, while decreases are likely in most subtropical land regions. Within each land mass it is generally expected that the West Coast will see lower levels of precipitation while the East Coast will be wetter.
Snow cover	Projected to contract. Thaw depth over most permafrost regions is projected to increase. Melting glaciers increase flood risk and then reduce water supplies. Areas particularly at risk are in the Indian subcontinent, China, and the Andes.
Sea-ice	Projected to shrink in both the Arctic and Antarctic under all scenarios. In some projections, Arctic late-summer sea ice disappears entirely by the end of 21st century.
Hurricanes and tropical storms	Intensity and frequency of hurricanes appears to have increased in the Gulf of Mexico (although the data is not conclusive). The IPCC predict storms are likely to become more intense with higher wind speeds and heavier precipitation.
Vegetation	Crop yields in subtropical regions look set to decline. Worst affected may be Africa and parts of Southern Europe. (Crop yields in S Europe are expected to decline 20% with a 2°C increase in temperatures.) At high latitudes, crop yields may increase with moderate temperature rises. Beyond 4.5°C, all crop yields look set to suffer.
Eco-systems	Around 15-40% of species face long-term negative effects after only 2°C in warming.
Ocean acidification	Increasing CO_2 concentrations leads to increasing acidification of the ocean. Since the start of the 20th century, ocean pH has decreased by 0.1 units. Forecasts suggest a further fall in ocean pH of 0.14 and 0.35 units over 21st century. This is likely to have major effects on marine life, with adverse effects on fishing stocks.

Source: IPCC, Stern Review, Nature.

Warming will have many severe impacts, often mediated through water:

• Melting glaciers will initially increase flood risk and then strongly reduce water supplies, eventually threatening one-sixth of the world's population, predominantly in the Indian sub-continent, parts of China, and the Andes in South America.

• Declining crop yields, especially in Africa, could leave hundreds of millions without the ability to produce or purchase sufficient food. At mid to high latitudes, crop yields may increase for moderate temperature rises (2 - 3°C), but then decline with greater amounts of warming. At 4°C and above, global food production is likely to be seriously affected.

• In higher latitudes, cold-related deaths will decrease. But climate change will increase worldwide deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place.

• Rising sea levels will result in tens to hundreds of millions more people flooded each year with warming of 3 or 4°C.

There will be serious risks and increasing pressures for coastal protection in South East Asia (Bangladesh and Vietnam), small islands in the Caribbean and the Pacific, and large coastal cities, such as Tokyo, New York, Cairo and London. According to one estimate, by the middle of the century, 200 million people may become permanently displaced due to rising sea levels, heavier floods, and more intense droughts.

• Ecosystems will be particularly vulnerable to climate change, with around 15 - 40% of species potentially facing extinction after only 2°C of warming. And ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks.

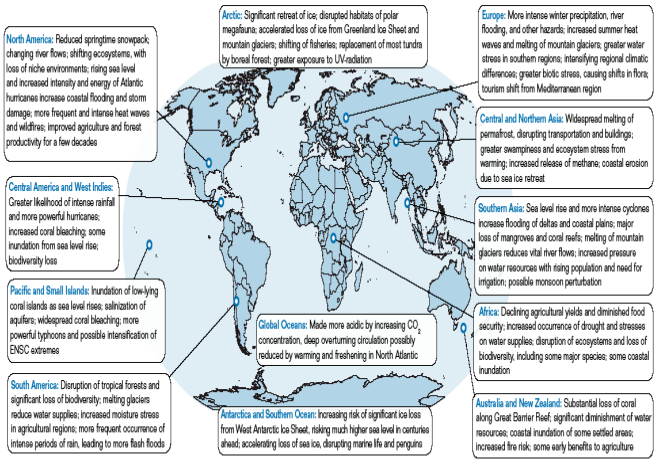
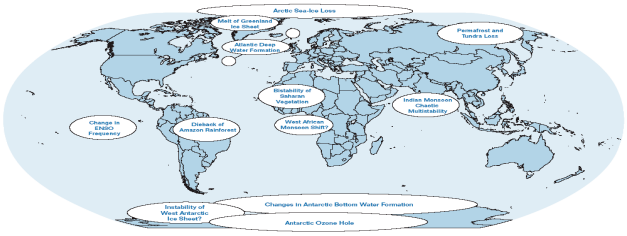


Figure ES.2. Significant impacts of climate change that will likely occur across the globe in the 21st century.



The Earth's "Tipping Points"

Figure 1.5. A preliminary "tipping points" map indicating a selection of the climatic and eco-dynamical properties of the Earth system that are at least of subcontinental scale and that would be expected to change abruptly at some time in the future as a result of gradually increasing climate change. See Table 1.3 for additional information. [Source: Schellnhuber and Held, 2002; Lenton et al., in prep.]

Risk of Extreme Environmental Risks if global temperatures rise too far

In the judgment of the Sigma Xi group pf scientists, and that of a growing number of other analysts and groups, , increases beyond 2°C to 2.5°C above the 1750 level will entail sharply rising risks of crossing a climate "tipping point" that could lead to intolerable impacts on human wellbeing, in spite of all feasible attempts at adaptation.

The damages from climate change will accelerate as the world gets warmer.

Higher temperatures will increase the chance of triggering abrupt and large-scale changes.

• Warming may induce sudden shifts in regional weather patterns such as the monsoon rains in South Asia or the El Niño phenomenon - changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people.

• A number of studies suggest that the Amazon rainforest could be vulnerable to climate change, with models projecting significant drying in this region. One model, for example, finds that the Amazon rainforest could be significantly, and possibly irrevocably, damaged by a warming of 2 - 3°C.

To stabilise at 450ppm CO2e, without overshooting, global emissions would need to peak in the next 10 years and then fall at more than 5% per year, reaching 70% below current levels by 2050.

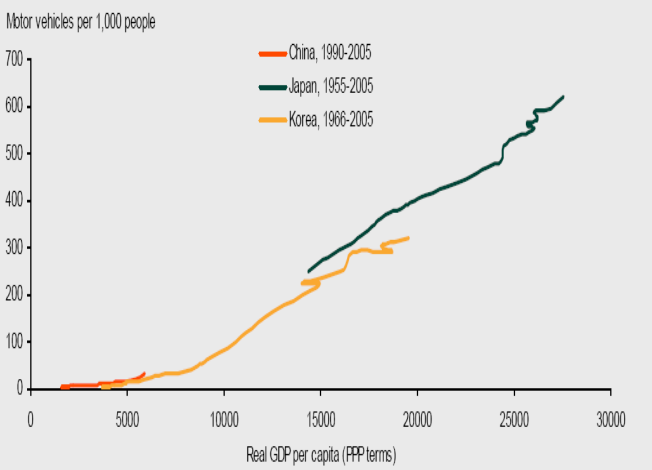
Stabilisation at 450ppm CO2e is already almost out of reach, given that we are likely to reach this level within ten years and that there are real difficulties of making the sharp reductions required with current and foreseeable technologies. Costs rise significantly as mitigation efforts become more ambitious or sudden. Efforts to reduce emissions rapidly are likely to be very costly.

An important corollary is that there is a high price to delay. Delay in taking action on climate change would make it necessary to accept both more climate change and, eventually, higher mitigation costs. Weak action in the next 10-20 years would put stabilisation even at 550ppm CO2e beyond reach – and this level is already associated with significant risks.

Rapid population growth will exacerbate climate change pressures

The UN Population report in 2007 forecast that the world population will likely increase by 2.5bn over the next 43 years from 6.7bn to 9.2bn by 2050…This is equivalent to the total world population in 1950 and it will be absorbed mostly by the less developed regions, whose population is projected to rise from 5.4bn in 2007 to 7.9bn in 2050." (UN Population division 2007)

While the total world population will increase by 1bn in the next 12 years, the world's middle class will rise by 1.8bn (Moses Naim, Foreign Policy, 2008). The Sigma Xi report noted that Most of the world's population growth is taking place in developing nations, which have relatively low per capita carbon emissions. This correlation between growing populations and low per capita emissions tends to obscure what will be, in the future, a linear relationship between population size and CO2 emissions. In the coming decades, people within developing countries will aspire to the level of material and economic well-being that is currently enjoyed in the industrialized countries. Once these economic aspirations have been achieved, population size will have a large and linear effect on global CO2 emissions.



In 2007 China, India and the Middle East spent $ 50bn subsidizing fuel and power. Indonesia spent 30% of its national budget on fuel subsidies and only 6% on education. Chinese developers are laying more than 52,700 miles of new highways throughout the country. Some 14,000 new cars hit China's roads each day. By 2020 China is expected to have 130mn cars and by 2050 more than the US.

Appendix 2: The Bangladesh Climate Change Action Plan

The Climate Change Action Plan is a 10-year programme (2009-2018) to build the capacity and resilience of the country to meet the challenge of climate change. The needs of the poor and vulnerable, including women and children, will be mainstreamed in all activities under the Action Plan. In the first five year period (2009-13), the programme will comprise six pillars:

1.Food security, social protection and health

Climate change is likely to impact most severely on the poorest and most vulnerable in society. Every effort will made to ensure that they are protected and that all programmes focus on the needs of this group for food security, safe housing, employment and access to basic services, including health. Under this pillar we will:

1.1 Increase the resilience of vulnerable groups, including women and children, through development of community-level adaptation, livelihood diversification, better access to basic services and social protection (e.g., safety nets, insurance) and scaling up

1.2 Develop climate change resilient cropping systems (e.g., agricultural research to develop crop varieties, which are tolerant of flooding, drought and salinity, and based on indigenous and other varieties suited to the needs of resource poor farmers), fisheries and livestock systems to ensure local and national food security

1.3 Implement surveillance systems for existing and new disease risks and ensure health systems are geared up to meet future demands

1.4 Implement drinking water and sanitation programmes in areas at risk from climate change (e.g., coastal areas, flood-and drought-prone areas)

2. Comprehensive Disaster Management

Comprehensive Disaster Management systems will be further strengthened to deal with the increasingly frequent and severe natural catastrophes as a result of climate change. We will build on and extend our proven experience in this area. Under this pillar we will:

2.1 Strengthen the government's capacity and that of civil society partners and communities to manage natural disasters, and ensure that appropriate policies, laws and regulations are in place

2.2 Strengthen community-based adaptation programmes and establish them in each of the disaster-prone parts of the country

2.3 Strengthen our cyclone, storm surge and flood early warning systems to enable more accurate short, medium and long-term forecasts

3. Infrastructure

It is imperative that existing infrastructure (e.g., coastal and river embankments) is well-maintained and fit-for-purpose and that urgently needed infrastructure (e.g., cyclone shelters, urban drainage) is put in place to deal with the likely short and medium-term impacts of climate change. Under this pillar we will:

3.1 Repair and rehabilitate existing infrastructure (e.g., coastal embankments, river embankments and drainage systems, urban drainage systems) and ensure effective operation and maintenance systems

3.2 Plan, design and construct urgently needed new infrastructure (e.g., cyclone shelters, coastal and river embankments and water management systems; urban drainage systems, river erosion control works, flood shelters) to meet the changing conditions expected with climate change

3.3 Undertake strategic planning of future infrastructure needs, taking into account the likely (a) future patterns of urbanisation and socio-economic development; and (b) the changing hydrology of the country, because of climate change

4. Research and knowledge management

Research will be undertaken to estimate the likely scale and timing of climate change impacts on different sectors of the economy, to inform planning of future investment strategies. We will also ensure that Bangladesh is effectively linked to regional and national knowledge networks, so that Bangladeshi organisations and the general public are aware of the latest research, lessons and technologies available in other countries. Under this pillar we will:

4.1 Model climate change scenarios for Bangladesh by applying global climate change models and methodologies at regional and national levels

4.2 Model the likely hydrological impacts of climate change on the Ganges-Brahmaputra-Meghna system to assess likely future system discharges and river levels in order to derive design criteria for flood protection embankments

4.3 Monitor and research the impacts of climate change on ecosystems and biodiversity

4.4 Research the likely impacts of climate change on the macro-economy of Bangladesh (a Bangladesh 'Stern Report') and key sectors (e.g., livelihoods and food security) and contribute to developing a climate-proof national development plan

4.5 Research the linkages between (a) climate change, poverty and vulnerability and (b) climate change, poverty and health (disease incidence, nutrition, water, sanitation) in order to identify possible interventions to increase the resilience of poor and vulnerable households to climate change

4.6 Establish a Centre for Research and Knowledge Management on Climate Change (or a network of centres) to ensure Bangladesh has access to the latest ideas and technologies from around the world, and ensure that data is widely and freely available to researchers

5. Mitigation and low carbon development

Even though Bangladesh's contribution to the generation of greenhouse gases is very low, we wish to play our part in reducing emissions now and in the future. Under this pillar we will:

5.1 Develop a strategic energy plan and investment portfolio to ensure national energy security and lower greenhouse gas emissions

5.2 Expand the social forestry programme on government and community lands throughout the country

5.3 Expand the 'greenbelt' coastal afforestation programme with mangrove planting along the shoreline

5.4 Seek the transfer of state-of the art technologies from developed countries to ensure that we follow a low-carbon growth path (e.g., 'clean coal' and other technologies)

5.5 Review energy and technology policies and incentives and revise these, where necessary, to promote efficient production, consumption, distribution and use of energy

6. Capacity building and institutional strengthening

To meet the challenge of climate change, the capacity of government ministries and agencies, civil society and the private sector will be strengthened. Under this pillar, we will:

6.1 Review and revise, where appropriate, all government policies (sector by sector) to ensure that they take full account of climate change and its impacts

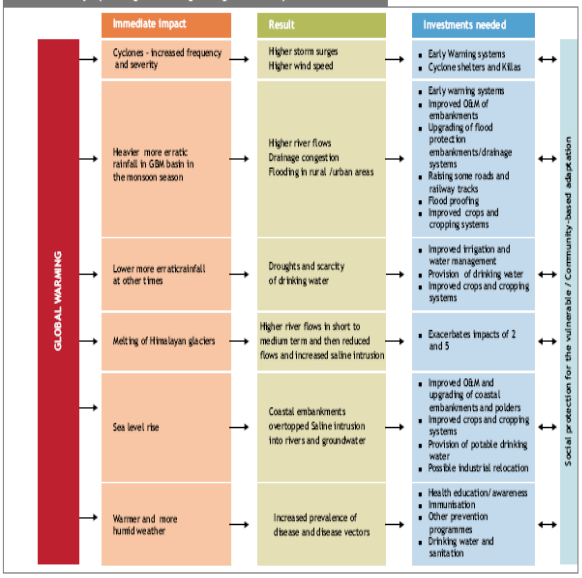
6.2 Mainstream climate change in national, sectoral and spatial development planning (in government ministries and agencies, local government, the private sector, civil society and communities) and ensure that impacts on vulnerable groups and women are prioritised in plans

6.3 Build the capacity of key government ministries and agencies to take forward climate change adaptation (e.g., Ministry of Food and Disaster Management, Bangladesh Water Development Board, Local Government Engineering Department; National Agricultural Research System, the health system, the Ministry of Women's and Children's Affairs)

6.4 Build the capacity of the government to undertake international and regional negotiations on climate change. Regional and international cooperation is essential in order to build necessary capacity and resilience

6.6 Build the capacity of the government, civil society and the private sector on carbon financing to access various global climate funds

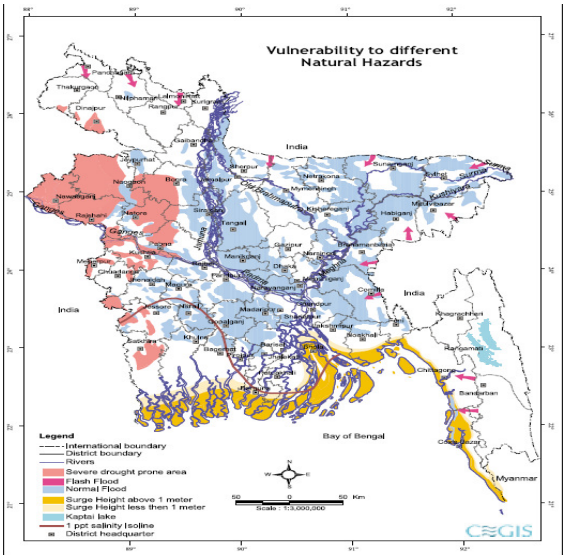
Box 7: Likely impacts of global warming on Bangladesh and required investments



Note: The arrows in this diagram are not meant to denote linear relationships between boxes. The relationships between and within boxes are very complex and are not captured by this diagram

Appendix 3 – Flood Vulnerability in Bangladesh

Areas affected by different types of climate-related disaster

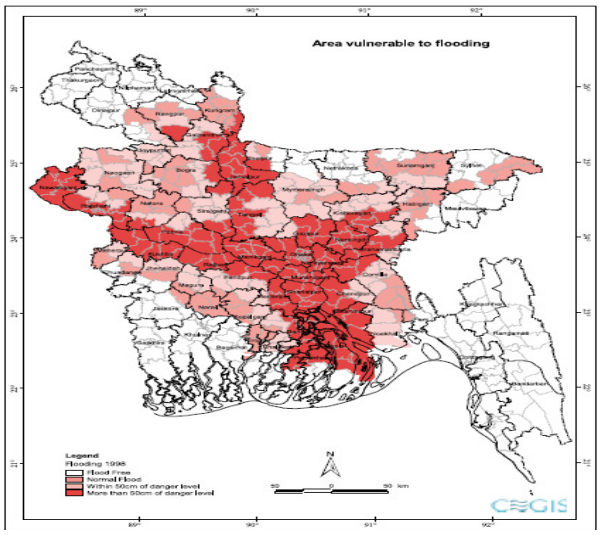


Source: CEGIS, Dhaka.

Floods

Most of Bangladesh lies in the delta of three of the largest rivers in the world – the Brahmaputra, the Ganges and the Meghna. These rivers have a combined peak discharge in the flood season of 180,000 m /sec. (the second highest in the world, after the Amazon) and carry about two billion tonnes of sediment each year. The topography of the country is mostly low and flat. Two-thirds of the country is less than 5 metres above sea level and is susceptible to river and rainwater flooding and, in lower lying coastal areas, to tidal flooding during storms (See chart below)

Areas vulnerable to flooding:



Tropical cyclones and storm surges

A severe tropical cyclone hits Bangladesh, on average, every 3 years. These storms generally form in the months just before and after the monsoon and intensify as they move north over the warm waters of the Bay of Bengal. They are accompanied by high winds of over 150 kph and can result in storm surges up to seven metres high, resulting in extensive damage to houses and high loss of life to humans and livestock in coastal communities. The tropical cyclones in 1970 and 1991 are estimated to have killed 500,000 and 140,000 people, respectively. The storm surges are higher in Bangladesh than in Map 3. Tracks of cyclones over last 50 years neighbouring countries because the Bay of Bengal narrows towards the north, where Bangladesh is located (See Map 3 – cyclone tracks). In recent years, general cyclonic activity in the Bay of Bengal has become more frequent, causing rougher seas that can make it difficult for fishermen and small craft to put to sea.

Bangladesh has a world-renowned community based early warning system and has built cyclone shelters on stilts, so that the storm surge can flow underneath (see Box 4). These shelters typically provide refuge to over 700 people and have separate spaces for women and men. However, people are often reluctant to go to the shelters, leaving their livestock and other assets behind.

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