Climate Change and Bangladesh
Annotated Bibliography

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About the Climate Change Cell

The Climate Change Cell has been established in the Department of Environment in 2004 under the Comprehensive Disaster Management Program (CDMP) of the Government. It responds to the recognition that Bangladesh is particularly vulnerable to the effects of climate change, and that the number and scale of climate-related disasters is likely to increase.

Climate change will have far-reaching effects across many sectors. The Cell provides the central focus for the Government's climate change related work, operating as a unit of the Department of Environment (DoE) under the Ministry of Environment and Forests (MoEF).

Its objective is to enable the management of long term climate risks and uncertainties as an integral part of national development planning. This will contribute to the primary objective of the wider Comprehensive Disaster Management Programme, which aims to strengthen the capacity of the Bangladesh disaster management system to reduce unacceptable risks and improve response and recovery activities.

Meeting these objectives will enable more effective and sustained poverty reduction through the reduction of disaster and climate risks within the overall development process.

About the Bangladesh Development Research Center (BDRC)

The BDRC is a non-profit research organization, incorporated with the specific purpose to undertake and disseminate research on development issues relevant for Bangladesh in order to foster the peaceful development of nations. The BDRC is formally recognized as a tax exempt public charity under Section 501(c)(3) of the Internal Revenue Code of the United States of America. The BDRC has been incorporated in January 2007.

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Last but not least, we want to thank all authors listed in this bibliography for contributing to the knowledge on climate change in Bangladesh as well as all publishers of such knowledge, including among others, A. A. Balkema Publishers; Bangladesh Centre for Advanced Studies; Bangladesh Unnayan Parishad; Blackwell Publishing Ltd.; Cambridge University Press, Elsevier B.V.; John Wiley & Sons, Ltd.; Kluwer Academic Publishers; Macmillan; Overseas Development Institute; Oxford University Press; SAGE Publications; Springer; St. Martin's Press; Taylor & Francis Group; The University Press Ltd.; United Nations University Press, and The World Bank. The copyrights of abstracts/summaries remain with the copyright holder of those abstracts/summaries as indicated in this bibliography.

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Part III contains the names of and links to some 70 website resources, structured into four sections: (a) main international organizations working on climate change; (b) research centers/institutes that focus on climate change; (c) websites of networks and/or websites with specific tools, projects, etc.; and (d) climate change related newsletters specifically on Bangladesh.

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Yusuf, Harun K. M.; Subash Dasgupta; and M. A. Halim Khan (2008) Climate Change: An Emerging Threat to Agriculture and Food security in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html.

Part – II: Annotated Bibliography

Abdullah, M. (2008) Influence of Climatic Changes on the abundance of Major Insect Pests of Sugarcane; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation is based on investigations made at the Bangladesh Sugarcane Research Institute (BSRI) from 1980 to 2007, whereby planted sugarcane varieties/clones were subjected to natural infestation. It examines various factors influencing the growth of sugarcane and its infestation and how climate change impacts these factors. Copyright © 2008 by the author(s).

Adger, W. Neil; Nigel W. Arnell; and Emma L. Tompkins (2005) "Successful adaptation to climate change across scales", *Global Environmental Change*, Vol. 15, pp. 77-86. **Abstract/Summary:** Climate change impacts and responses are presently observed in physical and ecological systems. Adaptation to these impacts is increasingly being observed in both physical and ecological systems as well as in human adjustments to resource availability and risk at different spatial and societal scales. We review the nature of adaptation and the implications of different spatial scales for these processes. We outline a set of normative evaluative criteria for judging the success of adaptations at different scales. We argue that elements of effectiveness, efficiency, equity and legitimacy are important in judging success in terms of the sustainability of development pathways into an uncertain future. We further argue that each of these elements of decision-making is implicit within presently formulated scenarios of socio-economic futures of both emission trajectories and adaptation, though with different weighting. The process by which adaptations are to be judged at different scales will involve new and challenging institutional processes. Copyright © 2005 by Elsevier B.V.

Adger, W. Neil; S. Agrawala; M. Monirul Qader Mirza; C. Conde; K. O'Brien; J. Pulhin; R. Pulwarty; B. Smit; and K. Takahashi (2007) "Assessment of adaptation practices, options, constraints and capacity", in: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability -- Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, UK: Cambridge University Press, pp. 717-743 (Chapter 17); available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter17.pdf. **Abstract/Summary:** This chapter of the IPCC's 2007 assessment examines the practices, options, constraints, and capacity of climate change adaptation and includes various examples from Bangladesh. Copyright © 2007 by IPCC.

Adger, W. Neil; Saleemul Huq; Katrina Brown; Declan Conway; and Mike Hulme (2003) "Adaptation to climate change in the developing world", *Progress in Development Studies*, Vol. 3, No. 3, pp. 179-195. **Abstract/Summary:** The world's climate is changing and will continue to change into the coming century at rates projected to be unprecedented in recent human history. The risks associated with these changes are real but highly uncertain. Societal vulnerability to the risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for those parts of societies dependent on resources that are sensitive to changes in climate. Risks are apparent in agriculture, fisheries and many other components that constitute the livelihood of rural populations in developing countries. In this paper we explore the nature of risk and vulnerability in the context of climate change and review the evidence on present-day

adaptation in developing countries and on coordinated international action on future adaptation. We argue that all societies are fundamentally adaptive and there are many situations in the past where societies have adapted to changes in climate and to similar risks. But some sectors are more sensitive and some groups in society more vulnerable to the risks posed by climate change than others. Yet all societies need to enhance their adaptive capacity to face both present and future climate change outside their experienced coping range. The challenges of climate change for development are in the present. Observed climate change, present-day climate variability and future expectations of change are changing the course of development strategies – development agencies and governments are now planning for this adaptation challenge. The primary challenge, therefore, posed at both the scale of local natural resource management and at the scale of international agreements and actions, is to promote adaptive capacity in the context of competing sustainable development objectives. Copyright © 2008 by SAGE Publications.

Aerts, Jeroen (1997) *Spatial Tools for River Basins and Environment and Analysis of Management options (STREAM), Applications for Sea Level Rise* (Amsterdam, The Netherlands: Vrije Universiteit, December). **Abstract/Summary:** STREAM has been used in Bangladesh and India for analysis of climate change scenarios and saltwater intrusion issues in the delta such as Mangrove habitat suitability studies in the Sundarbans, fish and shrimp productivity, and drinking water suitability. [STREAM is an instrument for river basin studies with emphasis on management aspects. It can be used to assess the present water availability in the basin and compare these to future demands of water resources. It furthermore enables the analysis of water resource related 'issues and processes' in a river basin by identifying the key interrelated water resource issues. STREAM is built around a spatial distributed hydrological model for simulating the water balance in larger river basins. Current modules comprise saltwater intrusion in the delta, an ecological module for mangrove habitats and socio-economic scenario development. This GIS based model allows for the analysis of vulnerability to exogenous influences like climate change and human interventions such as de- and afforestation, irrigation and dredging. STREAM is used to assess the impacts of these changes on the natural resources of the basin and the use of these resources by the population within the basin. STREAM enables rapid water resources assessment and is designed to be applied on any river basin.] Copyright © 1997 by the author(s).

Ågerup, Martin; Thompson Ayodele, Jose Cordeiro, Franklin Cudjoe, Juan Ricardo Fernandez, Juan Carlos Hidalgo, Martin Krause, Leon Louw, Barun Mitra, Julian Morris, Kendra Okonski, and Michael Oluwatuyi (2004) *Climate change and sustainable development: A Blueprint from the Sustainable Development Network* (London: International Policy Network); available at: http://www.policynetwork.net/uploaded/pdf/cc_sd_final.pdf. **Abstract/Summary:** This paper argues that good institutions are critical steps to achieve human well-being and environmental protection. They have been developed by human beings to enable us to cope better with uncertainty and are our best hope for addressing climate change and myriad other problems. Given the institutional focus, the paper also argues—which represents a rare minority view—that policies intended to mitigate climate change through restrictions on atmospheric carbon are almost certainly unsustainable; they are costly, would have little impact on the climate, and will most likely perpetuate poverty, making it more difficult for the poor to adapt to change. Meanwhile, foreign aid targeted at technological ‘adaptation’ is unlikely to do anything to prevent problems in the distant future and may even be counterproductive. Bangladesh is

mentioned various times as an example of problems existing in poor countries. Copyright © 2004 by International Policy Network.

Aggarwal, P. K.; P. K. Joshi; J. S. I. Ingram; and R. K. Gupta (2004) "Adapting food systems of the Indo-Gangetic plains to global environmental change: key information needs to improve policy formulation", *Environmental Science & Policy*, Vol. 7, No. 2, pp. 487-498. **Abstract/Summary:** The Indo-Gangetic plain (IGP; including regions of Pakistan, India, Nepal, and Bangladesh) is generally characterized by fertile soils, favorable climate and an abundant supply of water. Nevertheless, the challenge of increasing food production in the IGP in line with demand grows ever greater; any perturbation in agriculture will considerably affect the food systems of the region and increase the vulnerability of the resource-poor population. Increasing regional production is already complicated by increasing competition for land resources by nonagricultural sectors and by the deterioration of agri-environments and water resources. Global environmental change (GEC), especially changes in climate mean values and variability, will further complicate the agricultural situation and will therefore, have serious implications for food systems of the region. Strategies to reduce the vulnerability of the region's food systems to GEC need to be based on a combination of technical and policy options, and developed in recognition of the concurrent changes in socioeconomic stresses. Adaptation options need to be assessed with regard to their socioeconomic and environmental efficacy, but a greater understanding of the interactions of food systems with GEC is needed to be able to do this with confidence. This paper discusses information needs relating to resource management and policy support to guide the development of research planning for increasing the robustness of IGP food systems to GEC. Further information is needed to develop a range of adaptation strategies including augmenting production and its sustainability, increasing income from agricultural enterprises, diversification from rice–wheat systems, improving land use and natural resource management, and instigating more flexible policies and institutions. Copyright © 2004 by Elsevier B.V.

Agrawala, Shardul (ed.) (2005) *Bridge over Troubled Waters: Linking Climate Change and Development* (Paris: Organization for Economic Co-Operation and Development (OECD)); available at: http://www.oecd.org/document/18/0,3343,en_2649_34361_36172306_1_1_1_1,00.html. **Abstract/Summary:** This volume synthesizes insights from six country case studies that reviewed climate change impacts and vulnerabilities, analyzed relevant national plans and aid investments in terms of their exposure and attention to climate risks, and examined in depth key systems where climate change is closely intertwined with development and natural resource management. These include the Nepal Himalayas, Mount Kilimanjaro in Tanzania, the Nile in Egypt, the Bangladesh Sundarbans, coastal mangroves in Fiji, and agriculture and forestry sectors in Uruguay. Overall, the volume suggests a rich agenda for research and policy action which should be of considerable interest to donor agencies, sectoral planners and development practioners, as well as climate change experts and policy makers. Copyright © 2005 by Organization for Economic Co-Operation and Development.

Agrawala, Shardul; Tomoko Ota; Ahsan Uddin Ahmed; Joel Smith; and Maarten van Aalst (2003) *Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans* (Paris: Organisation for Economic Co-operation and Development (OECD)); available at: http://www.oecd.org/dataoecd/46/55/21055658.pdf. **Abstract/Summary:** This report presents the integrated case study for Bangladesh carried out under an OECD project on Development and Climate Change. The report is structured around a three-tiered framework.

First, recent climate trends and climate change scenarios for Bangladesh are assessed and key sectoral impacts are identified and ranked along multiple indicators to establish priorities for adaptation. Second, donor portfolios in Bangladesh are analyzed to examine the proportion of development assistance activities affected by climate risks. A desk analysis of donor strategies and project documents as well as national plans is conducted to assess the degree of attention to climate change concerns in development planning and assistance. Third, an in-depth analysis is conducted for coastal zones, particularly the coastal mangroves - the Sundarbans - which have been identified as particularly vulnerable to climate change. Copyright © 2003 by Organisation for Economic Co-operation and Development.

Ahmad, Qazi Kholiquzzaman (2003) "Regional Cooperation in Flood Management in the Ganges-Brahmaputra-Meghna Region: Bangladesh Perspective", *Natural Hazards*, Vol. 28, No. 1 (January), pp. 191-198. **Abstract/Summary:** Bangladesh is known to be highly vulnerable to floods. Frequent floods have put enormous constraints on its development potential. Unfortunately, the frequency of high intensity floods is on the rise. So far the country has struggled to put a sizeable infrastructure in place to prevent flooding in many parts of the country with limited success. In recent times, it was found that losses of lives and valuable assets could be significantly minimized by implementing non-structural measures including the improvement of flood forecasting and warning system. The existing flood forecasting and warning capacity of Bangladesh could be more effective if real-time data could be acquired from upstream areas within the Ganges-Brahmaputra-Meghna (GBM) catchment, where runoff is generated. In order to do so, Bangladesh needs to foster an effective regional cooperation with the other GBM regional countries of India, Nepal, and Bhutan. This article examines how GBM regional cooperation could be useful towards managing floods in Bangladesh in particular and the region in general. Copyright © 2003 by Springer.

Ahmad, Qazi Kholiquzzaman (2006) "Changement climatique, inondations et gestion des crues: le cas du Bangladesh", *Hérodote, Revue de géographie et de géopolitique*, No. 121, pp. 73-94. **Abstract/Summary:** Bangladesh is located at the bottom of three great river systems: the Ganges, the Brahmaputra, and the Meghna (GBM). The combined catchment area of the GBM river systems is 1.75 million sq km, of which Bangladesh accounts for only about 7 percent. But, the country drains to the sea over 92 percent of the total run-off generated in the combined catchment area, 80 percent during the five monsoon months, June-October. The country is, therefore, particularly liable to flooding due to run-off from upper river segments, but also, to an extent, as a result of precipitation within the country. Flooding of 20-30 percent of the country occurs with monotonous regularity; but the people have learnt to respond to these floods reasonably well as they have been living with such floods all their lives. However, varying extents of damages and losses are certainly caused by these floods, although not usually displacement of people. From time to time, disastrous floods occur in the country. When all the three river systems rise together, the flood becomes hugely devastating. The climate change phenomenon has been adding fuel to the fire. The frequency of major floods has been increasing over recent decades; and, as a consequence of climate change, there may, in future, be more intense, longer-duration, and more frequent floods in the country. Effective flood management calls for a three pronged approach: (i) purposeful government policies including both structural and non-structural measures; (ii) regional cooperation in flood management in terms of information and experience sharing and joint action where feasible, and (iii) community approaches to flood management in terms of increasing the capacity of the flood-affected people

to undertake effective action towards minimizing losses, damages, and sufferings caused by floods. The existing realities, potentials, prospects, and problems concerning these approaches are discussed. Copyright © 2006 by the author(s).

Ahmad, Qazi Kholiquzzaman (2006) "Sustainable Development: From Community Approaches to Flood Vulnerability Reduction to Climate Change Adaptation in South Asia", Presentation made at the Climate Change and Sustainable Development Workshop (Delhi); available at: http://www.un.org/esa/sustdev/sdissues/energy/op/new_dehli_workshop/UNDESA%20presentations/Day1/Session3/UN_DESA_New%20Delhi_2006_QK%20Ahmad.ppt. **Abstract/Summary:** This presentation focuses on the Challenges South Asia faces to achieve sustainable development, with and without climate change. It first reviews how to construct a sustainable development pathway, it then summarizes the challenges South Asia faces even without climate change. The presentation then explores linkages between community approaches to disaster (flood) management on the one hand and sustainable development in general and climate change adaptation in particular, on the other - based on a pilot study conducted in Bangladesh, India, and Nepal on Community Approaches to Flood Management (CAFM) during 2002-2005. Copyright © 2008 by the author(s).

Ahmad, Qazi Kholiquzzaman and Ahsan Uddin Ahmed (2004) "Regional Cooperation in Flood Management in the Ganges Basin: Bangladesh Perspective", in: M. Monirul Qader Mirza (ed.) *The Ganges Water Diversion: Environmental Effects and Implications* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 305-325 (Chapter 14)**. Abstract/Summary:** This chapter argues that the benefits accruable from cooperation in the Ganges basin among the co-riparians are positive-sum and win-win for all the participants. The available studies on the Ganges-Brahmaputra-Meghna (GBM) regional cooperation (explained in detail in the chapter) have been reviewed to set the background and highlight the possibilities. Both prospects and constraints on cooperation in the basin have been identified and discussed. The adverse implications for Bangladesh of the Indian scheme of inter-linking rivers have been discussed. It has been argued that the regionally non-cooperative manner in which the scheme is being developed by India can constitute to a new, major setback for regional cooperation. That can be avoided only if India takes necessary steps to initiate regional consultations and forge regional agreements by making necessary adjustments to the extent that the scheme adversely affects other co-riparians. The chapter also argues that need for more cooperation becomes even more urgent in the light of the implications resulting from climate change. Copyright © 2004 by Kluwer Academic Publishers.

Ahmad, Qazi Kholiquzzaman; R. A. Warrick; Neil J. Ericksen; and M. Q. Mirza (1994) *The Implications of Climate Change for Bangladesh: A Synthesis* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 7); also published in: Richard A. Warrick and Q. K. Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 1-34**. Abstract/Summary:** This is a synthesis of the findings of an interdisciplinary, collaborative assessment of what is known, and needs to be known, about the possible effects of climate and sea-level change on Bangladesh. The assessment focused on six major questions: How might climate change? How might sea level change in the Bay of Bengal? What are the possible effects on natural resources? What are the possible socio-economic effects? What are the: legal implications of climate and sea-level change? How might the coast of Bangladesh be affected? In this chapter, the salient features

relating to each question are summarized. The report also includes the scientific basis for the concern about global warming and scientific assessments, and the global context for understanding the possible regional changes in climate and sea level and their potential impacts on the resources and people of Bangladesh. Copyright © 1994 by Kluwer Academic Publishers.

Ahmed, Ahsan Uddin (2000) "Adaptability of Bangladesh's Crop Agriculture to Climate Change: Possibilities and Limitations", *Asia Pacific Journal on Environment and Development*, Vol. 7, No 1 (June) pp. 71-93. **Abstract/Summary:** Crop agriculture in Bangladesh is highly susceptible to variations in the climate system. It is prognosticated that crop production will be extremely vulnerable under climate change scenarios, and as a result, the food security of the country will be threatened. An attempt has been made to analyze the adaptation potential of the country's crop agriculture in a warmer world. The general IPCC adaptation types have been examined and suitable adaptation measures are identified. It is found that modifying the threat of crop loss and prevention of adverse effects on crop production are the most feasible adaptation options, while bearing crop loss and change of location of agricultural activities are least likely to be feasible given the socio-economic, cultural and agro-ecological realities in Bangladesh. The limitations of the adaptation types are also identified and possible modalities for removal of the obstacles are discussed. The article has identified possible actors for implementing adaptation in agriculture. It is found that adaptation on the part of the farmers would be facilitated to a considerable extent by offering a number of services such as research and training, education on disaster management, introduction of crop insurance and early warning system, adequate arrangement for crop protection, etc. Copyright © 2000 by Bangladesh Unnayan Parishad.

Ahmed, Ahsan Uddin (2003) "Climate Variability and Flood: Climate Variability and Flood: Observed Coping Mechanisms in Bangladesh" Presentation made at the 13th Stockholm Water Symposium (August 11-14)**. Abstract/Summary:** The poor people of Bangladesh have coped with climate related disasters many times Understanding such local and national level coping mechanisms provides valuable insights into management of future high intensity extreme climatic events. Living in a flood-prone area is a risky affair that requires a high degree of adaptation to climate variability. Traditionally, the Bangladeshi poor people have learned to live with floods. Rural population no longer considers a moderate flood as a cause of concern. With limited institutional support, they have successfully coped with very high intensity floods in the recent past. Management of during- and post-flood situations in Bangladesh during the deluge of 1998 - an event that lasted for about 70 days, engulfing over two-thirds of the land and rendering over 30 million people temporarily homeless - provides a glaring example of successful coping with floods. The lessons learnt during the 1998 flood offer many good examples which will be of great help when flood intensity is likely to increase in Bangladesh as a consequence of climate change. Copyright © 2008 by the author(s).

Ahmed, Ahsan Uddin (2004) *A Review of the Current Policy Regime in Bangladesh in Relation to Climate Change Adaptation* (Khulna, Bangladesh: CARE-RVCC Project). **Abstract/Summary:** The RVCC Project is being implemented by CARE Canada/CARE Bangladesh with the support of the Canadian International Development Agency (CIDA) through the Canada Climate Change Development Fund (CCDF). The project envisaged that vulnerability could be reduced via the promotion of sustainable development and the building of local-level capacity to adapt to the changes induced by climate change (RVCC, 2002). The policy review document provided the following recommendations: • A Climate Change Policy

(CCP) regime should be established, giving adequate emphasis on inter-ministerial coordination; inter-policy coherence as well as cont1ict resolution; creation of an institutional arrangement for the implementation of the CCP and mainstreaming adaptation to climate variability and change. The institutionalization of Coastal Zone Policy (CZP) may be considered as an example and the process may be replicated for handling the issues concerning climate change. • The current knowledge gaps in relation to adverse impacts of climate change in water resources management should be addressed as a priority and the implementation of the National Water Management. Plan (NWMP) should incorporate concerns related to climate change. • The current policy regime may reconsider the concerns of climate variability and change and create room for adaptation to climate change at various tiers, taking into account community-led initiatives. • The Standing Order on Disasters (SoD) may be extended to include management of disasters such as riverbank and coastal erosion, drought, salinity intrusion, etc. • The National Policy for Safe Water Supply and Sanitation (NPSWSS) must pay specific attention to providing saline-free drinking water, in addition to strengthening management of in-stream salinity. • The intention of the NPSWSS to ensure storm-water drainage in urban areas needs to be extended for the same in embanked and water-logged areas. • The promotion of shrimp along the coastal areas, as stated in the National Fisheries Policy (NFiP), needs to be re-examined in view of policy directives offered by the National Land Use Policy (NLUP), the National Action Programme (NAP) and Coastal Zone Policy (CZP). • Issues concerning climate variability and change need to be spearheaded and coordinated both nationally and internationally by one designated institution rather than more than one institution.

Ahmed, Ahsan Uddin (2005) “Adaptation Options for Managing Water-Related Extreme Events under Climate Change Regime: Bangladesh Perspectives” in: M. Monirul Qader Mirza and Q. K. Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers); pp. 255-278. **Abstract/Summary:** The population of the country has been coping with extreme water-related events since ages. The focus of all response measures, however, has been on survival coping. People's survival coping strategies have so far been effective, although not robust. Resilience of both human and natural systems of the country can be enhanced if adaptation options for management of the water resource sector are designed and implemented throughout the country. Bangladesh is already highly prone to water-related extreme events. Any significant change in the climate system would exacerbate water-related problems. Vulnerability due to monsoon floods will be increased in terms of both extent and frequency, while moisture stress due to high evapo-transpiration will put additional constraints to crop production, particularly during the Rabi season. Potential for reduction of surface flows in rivers during dry season will cause salinity ingress throughout the coastal areas. Current vulnerability due to cyclonic storm-surge and riverbank erosion is also likely to increase. Climate change will have far reaching impacts on biophysical environment of the country, people's livelihood, and national economy. Over the past millennia, people of Bangladesh have been showing indomitable courage to cope with extreme events driven by climate variability. Indigenous survival coping strategies are critical to overcome adverse situations, which have been complemented in recent decades with application of technologies and institutional response measures. To face anticipated high intensity events under climate change, one cannot rely only on 'survival coping strategies'. Time has come to re-evaluate both available and potential ways and means to cope with extreme events, make people aware of anticipated adverse climatic events, facilitate their preparedness responses, and simultaneously, try to implement institutionally supported appropriate response measures so that the threat to human and

ecological security is minimized, if not totally eliminated. People-centric anticipatory and planned adaptation measures, implemented phase-wise through institutional facilitation and supplemented by conducive policy and regulatory regime will be the keys to reduce vulnerability to climate change in the water resource sector for Bangladesh. Copyright © 2005 by A. A. Balkema Publishers.

Ahmed, Ahsan Uddin (2005) "Application of Solar Energy for Mitigation of Greenhouse Gases in Bangladesh" in: M. Eusuf (ed.) Solar Photovoltaic Systems in Bangladesh- Experiences and Opportunities (Dhaka: The University Press Ltd. and Bangladesh Center for Advanced Studies), pp. 171-181. **Abstract/Summary:** It is widely known that Bangladesh would have to suffer the most in a warmer world despite the fact that it is one of the least contributor to the annual load of greenhouse gases to the atmosphere. Global warming and its consequent effects would have devastating impacts on Bangladesh. There are several ways to reduce greenhouse gas emissions from Bangladesh, but only a few options are available involving use of solar (renewable) energy technologies. This article gives a general description of some potential mitigation options and discusses options concerning solar-powered technologies. Given the high initial investments for solar photo-voltaic technologies and poor socio-economic conditions of the majority of the population, it appears that the feasibility of large-scale greenhouse gas (GHG) mitigation by use of solar photo-voltaic systems is low in Bangladesh at the moment. Copyright © 2005 by The University Press Ltd.

Ahmed, Ahsan Uddin (2005) "Toward integrating adaptation to climate change in current policy regime: perspectives on Bangladesh's water resources and associated sectors", *Asia Pacific Journal on Environment and Development*, Vol. 12, No.1, pp. 35-54. **Abstract/Summary:** Bangladesh is known to be a deltaic country with very high vulnerability to climate change. Water resources and associated sectors compound the vulnerability of vast masses of the country's poor by significantly affecting their lives and livelihoods. Exacerbation of water related hazards and disasters will have far-reaching impacts on the social, economic and environmental aspects of people's lives, which warrant long-term planned adaptation capacity building. The current policy regime, despite being sector specific, offers a good number of elements that enhance the country's adaptation potentials. People have been practicing survival coping since millennia, which needs to be strengthened through infusion of modern but culturally sensitive technologies, continuous training and capacity building and appropriate investments at various tiers. It is argued that, in order to address future needs for adaptation to climate change, an appropriate policy regime must be put in place which will ensure sector-wise and inter-tier institutional integration for designing and implementing various adaptation activities. Making development efforts 'climate-safe' is a priority area. The article provides a rationale for integrating adaptation measures in the current policy regime in relation to water resources and associated sectors of the country. Copyright © 2005 by Bangladesh Unnayan Parishad.

Ahmed, Ahsan Uddin (2006) "Bangladesh: Climate Change Impacts and Vulnerability - A Synthesis" (Dhaka: GoB, MoEF, Department of Environment, Climate Change Cell, July); available at: http://www.climatechangecell-bd.org/publications/06ccimpactvulnerability.pdf. **Abstract/Summary:** The specific objective of the study was to prepare a synthesis for the general readership on climate change issues for Bangladesh. The modality of achieving this objective is to take note of all the important findings in published literature and put it in a form so that the product helps the readership to clearly understand the dynamics of climate change and

relate it within the contexts of various relevant sectoral developments. The publication helps to create awareness among the stakeholders and in near future, lead to an 'informed decision making' while considering development decisions in vulnerable areas and/or sectors. The synthesis is, therefore, envisaged as a tool to mainstream adaptation to climate change in Bangladesh, in order to achieve the goals and targets of Bangladesh's Initial National Communication1 and the National Adaptation Programme of Action process. Copyright © 2006 by GoB.

Ahmed, Ahsan Uddin and A. Atiq Rahman (2000) "Review of Activities Towards the National Communication of Bangladesh to the UNFCCC" in: Ahsan Uddin Ahmed, W. Chantanakome, Y. Jung, A. Karyadi, S. Mulandar, T. Onchan, J. Parikh, A. Rahman, K. Ramakrishna, R. Sharma, G. Singh, Y. T. Velasco, and Z. Zhang (eds.) *Asia Looking Ahead. Initial Stages of National Communications Reporting* (Washington, DC: The Wood Hole Research Center; also published by BCAS in 1999 as an advanced version). **Abstract/Summary:** This document provides an initial assessment of the process for developing Bangladesh's first National Communication under the United Nations Framework Convention on Climate Change (UNFCCC). The final version of Bangladesh's initial national communication under the UNFCCC was submitted by the Ministry of Environment and Forest on 12. November 2002. Copyright © 2000 by The World Hole Research Center).

Ahmed, Ahsan Uddin and Mozaharul Alam (1999) "Development of Climate Change Scenarios with General Circulation Models", in: Saleemul Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 13-20. **Abstract/Summary:** The vulnerability to climate change for different sectors was assessed based on climate scenarios for two projection years 2030 and 2075. These climate scenarios were developed by using General Circulation Models. Models were run to find correlation with the observed time-series data for 10 particular points distributed all over the country both for base and projection years. The model estimated monthly average rate of change in temperature and precipitation. The results revealed that the average increase in temperature would be 1.30C and 2.60C for the years 2030 and 2070, respectively. It was found that there would be a seasonal variation in changed temperature: 1.40C change in the winter and 0.70C in the monsoon months in 2030. For 2070 the variation would be 2.10C and 1.70C for winter and monsoon, respectively. For precipitation it was found that the winter precipitation would decrease at a negligible rate in 2030, while in 2075 there would not be any appreciable rainfall in winter. On the other hand, monsoon precipitation would increase at a rate of 12 percent and 27 percent for the two projection years, respectively. It was found that there would be excessive rainfall in the monsoon causing flooding and very little to no rainfall in the winter forcing drought. It was also found that there would be drastic changes in evaporation in both winter and monsoon seasons in the projection year 2075. It was inferred from the GCM output that moderate changes regarding climate parameters would take place for the projection year 2030, while for the projection year 2075 severe changes would occur. Copyright © 1999 by Kluwer Academic Publishers.

Ahmed, Ahsan Uddin and N. Haque (2002) "Managing Climate Change", in: Qazi Kholiquzzaman Ahmad and Ahsan Uddin Ahmed (eds.) *Bangladesh: Citizens' Perspectives on Sustainable Development* (Dhaka: Bangladesh Unnayan Parishad, August), pp. 143-151 (Chapter 19)**. Abstract/Summary:** According to the conclusions reached by the global scientific

community Bangladesh will be one of the worst victims of the anticipated adverse impacts of climate change. Since adaptation capacity of Bangladesh is poor, given the weak economic and institutional capabilities, adverse impacts of climate change will tend to reduce the potential for achieving sustainable development. This article deals heavily with the possibilities and necessities of adaptation. Contextualizing the country as a whole, including its natural institutional and social setting, the article makes a set of concrete recommendations for mainstreaming adaptation. Copyright © 2002 by Bangladesh Unnayan Parishad.

Ahmed, Ahsan Uddin; M. Reazuddin; and K. Islam (1996) "Bangladesh Emissions of Greenhouse Gases –Preliminary Findings", in: B. V. Braatz, B. P. Jallow, S. Molnar, D. Murdiyarso, M. Perdomo, and J. F. Fitzgerald (eds.) *Greenhouse Gas Emission Inventories: Interim Results from the US Country Studies Program* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 161-170**. Abstract/Summary:** This paper presents the inventory of greenhouse gas emissions and sinks for Bangladesh, with 1990 as the base year. The inventory consists of carbon dioxide emissions from energy consumption and forestry and land-use change, and methane emissions from flooded rice cultivation, livestock, and landfills. The energy sector, which includes fossil fuel combustion, has contributed emissions of 14,680 Gg carbon dioxide, and land-use change emitted about 43,963 Gg carbon dioxide. Reforestation has served as a carbon sink by sequestering some 45,173 Gg carbon dioxide. Hence, net emissions of carbon dioxide in 1990 were 13,470 Gg carbon dioxide. Carbon dioxide emissions from biomass burned to generate energy was not considered in the carbon budget, because the agricultural residues used were fully regenerated at the same rates. Methane emissions from flooded rice cultivation ranged between 257 Gg and 622 Gg, with a median of 439 Gg methane, while emissions from the livestock sector contributed about 453 Gg CH4. From energy production, approximately 6.31 Gg methane was emitted as a result of venting, flaring, transmission and distribution. Emissions from wastes contributed 76 Gg methane from both land filled wastes and wastewater generated in the major urban areas in Bangladesh. Hence, the total methane emissions in 1990 were estimated to be 974 Gg methane. Copyright © 1996 by Kluwer Academic Publishers.

Ahmed, Ahsan Uddin; Mozaharul Alam, and A. Atiq Rahman (1999) "Adaptation to climate change in Bangladesh: future outlook", in: S. Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (eds.) *Vulnerability and adaptation to climate change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 125-143. **Abstract/Summary:** The chapter examines the possibilities, opportunities and challenges of adaptation to climate change for the people of Bangladesh. It discusses the vulnerability to climate change; response to climate change (types of adaptation; anticipatory adaptation measures; possible actors and their respective domains. It also provides an assessment of opportunities for Bangladesh and challenges of managing adaptation, before concluding with suggestions for the way ahead. It points out that Bangladesh has very limited scope in order to respond to imminent danger. Since its per capita greenhouse gas emission is one of the lowest in the world while the total annual emission is insignificant to the global annual load, it cannot offer any appreciable mitigation at the global level. On the other hand, since its people would suffer the worst due to high level of vulnerability, it has no other choice but to consider some adaptation options and examine whether those might result in any significant reduction of anticipated vulnerability. Copyright © 1999 by Kluwer Academic Publishers.

Ahmed, Ahsan Uddin; N. A. Siddiqi; and R. A. Choudhuri (1999) "Vulnerability of Forest Ecosystems of Bangladesh to Climate Change", in: Saleemul Huq, Z. Karim, M. Asaduzzaman, and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 93-113. **Abstract/Summary:** Bangladesh is endowed with a number of natural forest ecosystems including inland Sal forest, dipterocarp forest, savanna, bamboo bushes in the hilly regions and freshwater swamp forests. It also has littoral mangrove ecosystems. An attempt was made to qualitatively analyze the impact of climate change on forest resources of Bangladesh. It was found that increased rainfall during monsoon would cause increased runoff in forest floor instead of infiltration into the soil. As a result there would be enhanced soil erosion from the forest floor. The erosion problem would be more pronounced in poorly dense hill forest areas. Prolonged floods would severely affect growth of many timber species, while it would cause high incidence of mortality for artocarpus species. In contrast, enhanced evapotranspiration in winter would cause increased moisture stress, especially in the Barind and Madhupur Tract areas, affecting the Sal forest ecosystem. The tea plantations in the north-east would also suffer due to moisture stress. It was found that the Sundarbans mangrove forest would be the worst victim of climate change. Due to a combination of high evapotranspiration and low-flow in winter, the salinity of the soil would increase. As a result the growth of freshwater loving species would be severely affected. Eventually the species offering dense canopy cover would be replaced by non-woody shrubs and bushes, while the overall forest productivity would decline significantly. The degradation of forest quality might cause a gradual depletion of rich diversity of the forest flora and fauna of the Sundarbans ecosystem.

Ahmed, Ahsan Uddin; Saleemul Huq; Z. Karim; M. Asaduzzaman; A. Atiq Rahman; Mozaharul Alam; Y. Ali and R. A. Chowdhury (1996) "Vulnerability and Adaptation Assessments for Bangladesh", in: Joel B. Smith, Saleemul Huq, S. Lenhart, L. J. Mata, I. Nemesova, and S. Toure (eds.) *Vulnerability and Adaptation to Climate Change: Interim Results from the US Country Studies Program* (Dordrecht, The Netherlands: Kluwer Academic Publishers). **Abstract/Summary:** In Bangladesh, vulnerability and adaptation assessments are being performed for the following sectors: agriculture, water resources, and coastal resources. More limited assessments are also being performed for the fisheries and forestry sectors. This paper explores vulnerabilities with regard to climate change, economic development, sea level rise, and watershed development. Preliminary analysis indicates that for Bangladesh the most affected sector in terms of climate change impacts is the water resources. Impacts could include devastating floods, severe droughts, and changes in salinity levels in the surface and groundwater systems as well as in soil. Further, the vulnerability of the water resources sector would affect the vulnerability of the agriculture production, coastal resources, forestry, and livestock sectors.

Ahmed, Sabbir; Salma Begum; and Sajjad Zohir; in association with Khan Zohirul Islam (2006) *Assessing Macro Impacts of Community-Based Fishery Management (CBFM) in the Inland Open Water Fishery Sector: An Analytical Exercise with Projections* (Dhaka: Economic Research Group (ERG), December). **Abstract/Summary:** The study estimates a reduced form supply function (of inland capture fishery) using CBFM monitoring data; and uses regression estimates and parameter estimates from secondary sources to generate a ten-year (2006-2015) projection of capture fish production. Various alternative scenarios are defined in terms of changes in relative price of fish to non-fish food items, gear usage, size of water bodies as well

as scale of operation of CBFM practices. Changes in the contribution of the fishery sector in GDP, and economy-wide impacts in the forms of national output, factor payments and household expenditure as well as changes in poverty situations are also projected under alternative scenarios. The paper summarizes the methods and presents the results of projection and its implications within the broader national context. Copyright © 2006 by Economic Research Group.

Ahsan, S.; M. R. Hoque; M. S. Osman; M. J. Babar; M. Shawkat; S. A. Begum; M. Rahman; and K. R. Islam (2008) Agricultural and Environmental Change in Bangladesh in Response to Global Warming; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation provides first an overview of global climate change sources and impacts and discusses then the experience of Bangladesh in terms of long term climatic changes and its impact on agriculture. Copyright © 2008 by the author(s).

Alam, A. M. Shafiqul (2008) Effect of Global Warming with Arsenic Mobilization in Sediments of the River Padma in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation is based on the study of sediments collected by the borehole technique at various locations along the Padma river. The critical result with regards to climate change is that global warming has been linked to an increase in arsenic concentration as the observed increase in temperature reduced the redox potential of water which helped to produce more As(III) from arsenic containing pyrites in sediments. Copyright © 2008 by the author(s).

Alam, Mozaharul (2004) "Adverse Impacts of Climate Change on Development of Bangladesh: Integrating Adaptation into Policies and Activities", *Capacity Strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)* Working Paper No. 1 (London: International Institute for Environment and Development (IIED), and Dhaka: Bangladesh Centre for Advanced Studies (BCAS)); available at: http://www.iied.org/pubs/pdf/full/10016IIED.pdf. **Abstract/Summary:** Bangladesh is one of the largest deltas, second to the Amazon, in the world formed mainly by the Ganges-Brahmaputra-Meghna (GBM) river system, except for the hilly regions in the northeast and southeast, and terrace land in northwest and central region. The total land area of Bangladesh is 147,570 sq. km and consists of low and flat land. Economic emancipation of large population through poverty alleviation is one of the primary targets of development planning and programme of Bangladesh. The national development strategy documents state that Bangladesh has one of the most vulnerable economics, characterized by extremely high population density, low resource base, and high incidence of natural disasters. These have implications for long-term savings, investment, and growth. There are many driving forces compelling people in Bangladesh to over-exploit natural resources. The main ones are poverty with rapid population growth, improper land use, absence of a land use policy, and ineffective implementation of existing laws and guidelines. Unplanned agricultural practices, and encroachment on forest areas for agriculture and settlements, also put pressure on scarce land resources. Unplanned or inadequate rural infrastructure development and the growing demands of increasing urbanization are also devouring productive land. Apart from existing challenges, most damaging effects of climate

change are floods and droughts that are found to drastically affect crop productivity almost every year. Climate change induced challenges are, a) scarcity of fresh water due to less rain and higher evapotranspiration, b) drainage congestion due to higher water levels in the confluence with the rise of sea level, c) river bank erosion, d) frequent floods and prolonged and widespread drought, e) wider salinity in the surface, ground and soil. Although Bangladesh is significantly impacted by current climate variability, and is among the countries most vulnerable to climate change, there is no national policy in place yet to comprehensively address climate related risks. However, it is revealed that many government plans and donor project documents in Bangladesh mentioned adverse impact of extreme weather events particularly floods, droughts and cyclones. For example, the National Water Policy (NWP) and National Water Management Plan (NWMP) have suggested measures such as to develop early warning and flood proofing systems to manage flood and drought that are expected to increase under climate change. The need for a National Policy on Climate Change has been expressed time and again by the civil society of the country since early 1990s. National Dialogue on Water and Climate Change held in 2003, formulation of a Climate Change Policy for the country was highly recommended. The National Adaptation Programme of Action (NAPA) appears to be the first attempt to bring different stakeholders, including the government and the civil society for preparing a national adaptation strategy to address immediate and urgent need. The involvement of donors and development agencies from the very beginning along with other sectoral agencies will help in mainstreaming adaptation to climate change. In addition, up scaling of the win-win measures that are already being implemented in Bangladesh and continuous persuasion with policy makers would help Bangladesh in mainstreaming adaptation to climate change.

Alam, Mozaharul (2008) "Current Climate Change Adaptation Research in Bangladesh" Presentation made at the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh, Bellagio, Italy (May 20-22); available at: http://www.bangladeshstudies.org/files/Presentation_Alam.pdf. **Abstract/Summary:** Following the provision of a definition and context of climate change adaptation, the presentation provides examples of (1) research on identification of adaptation options, (2) the identification of adaptation options in the National Adaptation Program of Action (NAPA). It also provides examples for adaptations in the agriculture and water sectors. It then outlines three climate change research categories: action research, policy research, and knowledge generation/gap filling, before closing with a variety of suggestions for next steps.

Alam, Mozaharul and Atiq Rahman (2008) "Adaptation to climate change: Beyond 2012", in: Yasuko Kameyama, Agus P. Sari, Moekti H. Soejahmoen, and Norichika Kanie (eds.), *Climate Change in Asia: Perspectives on the Future Climate Regime* (Tokyo: United Nations University Press), pp. 195-209 (Chapter 13). **Abstract/Summary:** This chapter reviews a number of future proposals, discussion papers and submissions by parties for formal discussion under the Kyoto Protocol and UNFCCC. The focus is on highlighting the need for adaptation in the future regime, along with equity and fairness, adequacy of funding, and technologies for adaptation. While this chapter does not focus on Bangladesh, the issues discussed are at least partly influenced by the Bangladesh experience.

Alam, Mozaharul and Atiq Rahman (2008) "Development and climate change policy-making process in Bangladesh", in: Yasuko Kameyama, Agus P. Sari, Moekti H. Soejahmoen, and Norichika Kanie (eds.), *Climate Change in Asia: Perspectives on the Future Climate Regime* (Tokyo: United Nations University Press), pp. 51-65 (Chapter 4). **Abstract/Summary:** This chapter highlights findings of the Bangladesh case study of a project called the "Capacity Building in Asia and the Pacific: On Issues Related to the Kyoto Protocol Beyond 2012", which reviewed the existing situation in six Asia-Pacific countries. The Bangladesh case study provides the key climate change features of Bangladesh, the key characteristics of the climate change policy-making process, Bangladesh's national climate change policy and the issues beyond 2012. It concludes among others that vulnerability is a major issue for countries like Bangladesh, that bargaining power in this area is increasing, and needs to be strengthened further through knowledge, research and training so that the message can be communicated better and international collaboration can be enhanced. Copyright © 2008 by United Nations University Press.

Alam, Mozaharul and Laurel A. Murray (2005) "Facing Up to Climate Change in South Asia", London, UK: International Institute for Environment and Development (IIED), *Gatekeeper Series*, No. 118 (April); available at: http://www.iied.org/NR/agbioliv/gatekeepers/gk_abs/documents/GK118.pdf. **Abstract/Summary:** This paper provides an overview of the likely impacts of climate change in three least developed countries in South Asia: Bangladesh, Bhutan and Nepal. In these countries, climate change will include changes in temperature, distribution of rainfall, sea-level rise and increase in the frequency and intensity of extreme weather events. These least developed countries are at risk because of their high vulnerability and low adaptive capacity. Weak economies, inadequate infrastructure, poor social development, lack of institutional capacity and high dependence on natural resources all contribute to this vulnerability. In addition to mainstreaming adaptation to national and sectoral development policies and measures, other recommendations include: strengthening community-based adaptation measures which build on local experiences and existing strategies for coping with extreme events; enhancing early warning systems and preparedness; developing new agricultural varieties; adopting efficient water resource management both in the winter and monsoon seasons; and improving inter-agency coordination and cooperation. Copyright © 2005 by International Institute for Environment and Development.

Alam, Mozaharul and M. D. Golam Rabbani (2007) "Vulnerabilities and responses to climate change for Dhaka", *Environment and Urbanization*, Vol. 19, No. 1, pp. 81-97. **Abstract/Summary:** The relationship between climate change and cities is complex. City-based activities contribute significant amounts of greenhouse gases and, simultaneously, are often more vulnerable to the impacts of climate change. Dhaka is now the world's eighth largest city and a significant proportion of Bangladesh's greenhouse gases are generated there although, relative to total emissions worldwide, the contribution is negligible. But this contribution is likely to increase rapidly with the continuing growth of the city's population, economy and electricity consumption, as well as increased motor vehicle use. At the same time, Dhaka is prone to damaging and costly flooding, both from the rivers that bound it and from rainfall that generates runoff that is beyond the capacity of the drains. In less than 20 years, the city has faced three major floods, each causing huge damage and economic loss. Although the government has taken a number of measures to improve both Dhaka's air quality and its capacity to withstand floods, there are further opportunities in both areas. This paper discusses, in specific terms, the scale of

the threats, the measures taken to address them and the potential for more effective action. Copyright © 2008 by SAGE Publications.

Alam, Mozaharul; A. Atiq Rahman; Nasimul Huq; and Sughra Arasta Kabir (2000) *In confronting climate change: economic priorities and climate protection in developing countries* (Washington, DC: National Environmental Trust, and Dhaka: Bangladesh Centre for Advanced Studies (BCAS); available at: http://www.eldis.org/fulltext/bcas3.pdf. **Abstract/Summary:** The paper examines Bangladesh's moves to address environmental degradation and natural resource management. It stresses that although the first imperative of any organized socio-economic activity at any level should be to eradicate poverty, economic growth and environmental protection do not necessarily conflict. The paper examines environmental aspects of the energy, transport, agriculture and forestry sectors with special emphasis on present and future greenhouse gas emissions. Although it stresses that Bangladesh is under no obligation under the UNFCC to cut back on GHG emissions it believes there could be win-win situations arising from mitigation in the following areas: Industry: through increased energy efficiency; Power generation: by updating inefficient existing technology and utilizing domestic gas supplies; Transport: significant potential for improving efficiency which would also have positive implications for public health; Cooling systems: encouraging use of more efficient systems would have a small impact; Forestry: firstly, large potential for afforestation both by the government and by as part of the emerging social forestry movement with important socio-economic and nutritional benefits for the rural poor. Secondly, improved biomass cooking stoves in commercial and domestic sectors will reduce deforestation and provide benefits to women and the rural poor. Copyright © 2000 by National Environmental Trust, and Bangladesh Centre for Advanced Studies.

Alam, Mozaharul; Ain-Un Nishat; and Saad M. Siddiqui (1999) “Water Resources Vulnerability to Climate Change with Special Reference to Inundation”, in: Saleemul Huq; Z. Karim; M. Asaduzzaman; and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 21-38**. Abstract/Summary:** Vulnerability assessment of water resources considered changes in flooding conditions due to a combination of increased discharge of river water during monsoon period and sea level rise for the two projection years, 2030 and 2075. MIKE-ll, a fixed bed hydrodynamic model was used for the estimation of changes in river water levels which was coupled with Geographic Information System (GIS) for the estimation of extent of flooding. The climatic parameters for the base year 1990 were obtained from secondary sources and the changes of climatic parameters for the two projection years were obtained from the General Circulation Model (GCM) output. Values of these parameters were taken as input for MIKE-ll model runs. Discharge values for 8 upstream boundary stations were calculated from a general relationship between changes in rainfall and runoff. The MIKE-ll model also includes other parameters for example a development scenario that included embanking of major rivers. Model runs gave water level values for over 4,000 output stations along the rivers all over the country except Chittagong and Chittagong Hill Tracts area. These water levels were interpolated by using GIS techniques to generate a water depth spatial database for the study area. The water depth spatial database for each of the projection years was compared with that of the base year to find changes in water depth. These values were then superimposed on a "land type database" to estimate extent of flooding in terms of water depth. A combination of development and climate change scenarios revealed that the Lower Ganges and Surma floodplains would become more

vulnerable compared to the rest of the study area. On the other hand, the north-central region would become flood free due to embankment in the major rivers. Copyright © 1999 by Kluwer Academic Publishers.

Alam, Sarfaraz (2003) "Environmentally Induced Migration from Bangladesh to India", *Strategic Analysis*, Vol. 27, No. 3 (Jul-Sep); revised paper available at: http://www.idsa.in/publications/strategic-analysis/2003/jul/Sarfaraz.pdf. **Abstract/Summary:** Environmental disasters destroy livelihoods in Bangladesh, causing mass migration to India. Environmental crisis in the rural areas of developing countries is increasingly becoming an important cause of cross-border migration of population and South Asia is no exception to this phenomenon. Such movement of population in the Indo- Bangladesh context is generating a range of destabilizing socio-political, economic, ethnic and communal tensions in India. It has embittered Indo-Bangladesh relations, causing tensions between the two countries. This paper focuses on environmental crisis as a reason for the continued migration of people from Bangladesh to India. It shows that scarcity of land and water in the rural areas of Bangladesh, caused by rapid population growth, environmental change and unequal resource distribution and development, are causing widespread landlessness, unemployment, declining wages and income, growing income disparities and degradation of human habitat. The affected people, unable to satisfy their needs in an economically less-developed Bangladesh, are increasingly moving to India where the prospect of life appears to be better. The study suggests that this flow of population would continue unabated, perhaps at a greater rate, unless remedial measures are taken in the places of origin of the migrants. Copyright © 2003 by Institute for Defence Studies and Analyses.

Alauddin, Mohammad and Clement Allan Tisdell (1998) *The Environment and Economic Development in South Asia: An Overview Concentrating on Bangladesh* (New York: St. Martin's Press). **Abstract/Summary:** This study investigates the major challenges facing South Asia to achieve sustainable development. It incorporates cases studies and applies new views in economics about the interdependence between development and the environment and discusses the major issues and challenges involved in achieving ecologically sustainable development in South Asia. Copyright © 1998 by St. Martin's Press.

Alauddin, Mohammad and Hasan Samiul (eds.) (1999) *Development, Governance and the Environment in South Asia: A Focus on Bangladesh* (London: Macmillan). **Abstract/Summary:** Problems of low social and economic development, grinding poverty and environmental degradation are widespread throughout the developing world. However, few regions have taken a more severe toll than South Asia. The absence of a plural and open political system compounds the problems of overall socio-economic development. The book uses case studies to analyze different aspects of the economics-environment nexus. The issue of climate change is only addressed marginally. Copyright © 1999 by Macmillan.

Ali, Anwar (1996) "Vulnerability of Bangladesh to Climate Change and Sea Level Rise through Tropical Cyclones and Storm Surges, *Water, Air, & Soil Pollution*, Vol. 92, No. 1-2 (November), pp. 171-179. **Abstract/Summary:** Bangladesh is frequently visited by natural disasters such as tropical cyclones, storm surges, floods, droughts, tornadoes, and norwesters. Of these, tropical cyclones originating in the Bay of Bengal and associated storm surges are the most disastrous. There are various reasons for the disastrous effects of cyclones and storm surges in Bangladesh.

Superimposed on these disastrous effects, climate change and any consequent sea level rise are likely to add fuel to the fire. A rise in temperature is likely to change cyclone activity: cyclone intensity, if not cyclone frequency, may increase. As a result, storm surges may also increase substantially. Sea level rise, an increase in cyclone intensity, and consequent increases in storm surge heights will have disastrous effects on a deltaic country like Bangladesh, which is not much above the mean sea level. This paper examines the climatology of cyclones in the Bay of Bengal for the last 110 years and trends in cyclone frequency and intensity. The phenomenon of storm surges in the Bay of Bengal is examined along with the primary reasons for the severity of storm surges in Bangladesh. The paper discusses both qualitatively and quantitatively the impacts of rises in temperature on tropical cyclone intensity in Bangladesh. With the use of a mathematical model developed for the simulation of storm surges along the Bangladesh coast; various scenarios of storm surges are developed. Using lower and upper bounds of sea surface temperature rise of 2 and 4°C and of sea level rise of 0.3 and 1.0 m (according to the Intergovernmental Panel on Climate Change standard), the model simulates the maximum possible surges that are likely to occur under these conditions. Copyright © 1996 by Springer.

Ali, Anwar (1999) "Climate change impacts and adaptation assessment in Bangladesh", *Climate Research*, CR Special 6, Vol. 12, No. 2/3, pp. 109-116; available at: http://www.int-res.com/articles/cr/12/c012p109.pdf. **Abstract/Summary:** Bangladesh is likely to be one of the most vulnerable countries in the world to climate change. This paper discusses the possible impacts of climate change in Bangladesh through tropical cyclones, storm surges, coastal erosion and back water effect. The possible increase in cyclone frequency in the Bay of Bengal, lying south of Bangladesh, due to climate change is looked at by analyzing the cyclone data for 119 yr. Both qualitative and quantitative discussions are made on cyclone intensity increase for a sea surface temperature rise of 2 and 4°C. Different scenarios of storm surges under different climate change conditions are developed by using a numerical model of storm surges for the Bay of Bengal. Possible loss of land through beach erosion due to sea level rise on the eastern coast of Bangladesh is examined. Some discussions are also made on the impacts of back water effect due to sea level rise on flood situations in the country. Finally, a few remarks are made on the adaptation options for Bangladesh in the event of climate change. Copyright © 1999 by Inter-Research.

Ali, Anwar (2000) *Vulnerability of Bangladesh Coastal Region to Climate Change with Adaptation Options* (Dhaka: Bangladesh Space Research and Remote Sensing Organisation (SPARRSO)); available at: http://www.survas.mdx.ac.uk/pdfs/3anwaral.pdf; **Abstract/Summary:** The paper has given some climate change and sea level rise scenarios for Bangladesh. The vulnerability assessment due to the CCSLR for Bangladesh has been made on the basis of existing literature and the best judgment. But still there remain a lot of uncertainties in the assessment which is understandable in the light of the non-availability of long period data, limitations of models and the lack of full understanding of the climatic parameters and their variation, etc. The assessment results need to be updated continuously and hence more in-depth research efforts should be put into this. The process of awareness raising should be geared up. This will help undertake adaptation and mitigation measures. Even if the climate change of alarming magnitude does not occur, the adaptation and mitigation options will pay in the long run to keep the future environment congenial. Copyright © 2000 by Bangladesh Space Research and Remote Sensing Organisation.

Ali, Anwar (2003) "Impacts of Climate Change on Tropical Cyclones and Storm Surges in Bangladesh", in: D. A. Quadir, K. Prasad, and M. A. Hussain (eds.) *Proceedings of SAARC Seminar on Climate Variability in the South Asian Region and its Impacts* (held on 10-12 December 2002) (Dhaka: SAARC Meteorological Research Center (SMRC)). **Abstract/Summary:** Tropical cyclones forming in the Bay of Bengal (to the south of Bangladesh) and the associated storm surges bring catastrophic ravages to Bangladesh. One count shows that about 50% of all major human deaths due to tropical cyclones in the world occurred in Bangladesh. Storm surge heights associated with cyclones hitting Bangladesh occasionally exceed 10m and easily inundate the coastal area which is hardly a few meters above the mean sea levels. The paper looks at the possible impacts of climate change on tropical cyclones in the Bay of Bengal and the storm surges with special reference to Bangladesh. The possible increase in cyclone frequency in the Bay of Bengal due to climate change is examined by analyzing more than 100 years' of cyclone data. Cyclone intensity is sure to increase due to rise in sea surface temperature (SST). Both qualitative and quantitative discussions are made on cyclone intensity increase for an SST rise of 2oC and 4oC. Different scenarios of storm surges under two different levels of SLR (0.3m and 1.0m) and temperature increase (2oC and 4oC) are developed by using a hydrodynamic model of storm surges for the Bay of Bengal.

Ali, Ayub; A. E. Mynett; and Mir Hammadul Azam (2007) "Sediment Dynamics in the Meghna Estuary, Bangladesh: A Model Study", *Journal of Waterway Port Coastal and Ocean Engineering*, Vol. 133, No. 4, pp. 255-263. **Abstract/Summary:** A depth integrated two-dimensional numerical modeling was carried out to study the sediment dynamics within the Meghna estuary. The sediment–water dynamics within this estuary are very complex due to its irregular shape, wide seasonal variation, and the changing role of the tide. Both cohesive and non-cohesive sediment transport formulations were used to estimate the total transport. An interactive morphological computation was also used to verify the bed level changes over 2 years. Sediment transports of both monsoon and dry seasons (the two most hydrologically pronounced periods in this region) were modeled, and a large seasonal variation in sediment transport pattern was observed. Land reclamation dams were tested by the model and found to be effective in enhancing the accretion in its vicinity.

Ali, M. Y. (1999) "Fish Resources Vulnerability and Adaptation to Climate Change in Bangladesh", in: Saleemul Huq; Z. Karim; M. Asaduzzaman; and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 113-124. **Abstract/Summary:** Fish and Fisheries have been playing a very significant role in nutrition, culture and economy of Bangladesh from time immemorial. Currently, about 80 percent of the animal protein intake in the daily diet of the people comes from fish. The fisheries sector, it is estimated, contributes 3.5 percent of the GDP of Bangladesh. From habitat point of view, three principal habitat forms exist from which fish are harvested. These are pure freshwater habitats in the rivers and their floodplains. These water bodies are inhabited by 260 species of fin fish, 25 species of prawn and 25 species of turtles. In addition, 11 exotic species of fin fish have been introduced for the purpose of aquaculture. In portions of the freshwater rivers near their confluence with the sea i.e., Bay of Bengal, the water changes from fresh to saline conditions, with a wide range of salinity gradient both spatially and temporally. These tidal parts of the rivers constitute the estuaries with brackish water conditions. Many

freshwater species of fish and prawn visit the estuaries and brackish water habitats at different stages of their life cycle. Similarly post-larvae of many coastal and marine prawns come to the brackish water habitat to feed and grow into adults. In the Upper Bay of Bengal bordering Bangladesh, 475 species of fin fish are known to occur of which about 65 are of commercial importance. The marine waters also contain about 38 species of marine prawn. In Bangladesh very little or no work on the physiology and ecology of indigenous species of fin fish or prawn has been done. As a result, it is difficult to state or predict likely effects of climate change on different fish / prawn populations and the fisheries based on them. However, some likely effects of climate change on fish habitats are presented in this article. Copyright © 1999 by Kluwer Academic Publishers.

Ali, S. I. and Saleemul Huq (1990) *International Sea Level Rise: National Assessment of Effects and Possible Responses for Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies (BCAS))**. Abstract/Summary:** The possibility of a rise in mean sea level due to global warming (or the greenhouse effect) has caused considerable interest amongst the international scientific community for some time and more recently amongst scientists, government officials and the general public in Bangladesh. The interest in sea level rise as a consequence the Greenhouse Effect has coincided with a major concern about environmental issues in general in Bangladesh which was triggered by the devastating floods of 1988 and cyclones of 1988 and 1989. This article discussed possible consequences of SLR on Bangladesh and its consequences. Copyright © 1990 by Bangladesh Centre for Advanced Studies.

Amadore, L., W. C. Bolhofer, R. V. Cruz, R. B. Feir, C. A. Freysinger, S. Guill, K. F. Jalal, A. Iglesias, A. Jose, S. Leatherman, S. Lenhart, S. Mukherjee, J. B. Smith, and J. Wisniewski (1996) "Climate change vulnerability and adaptation in Asia and the Pacific: Workshop summary" *Water, Air, & Soil Pollution*, Vol. 92, Nos. 1-2 (November), pp. 1-12. **Abstract/Summary:** The Regional Workshop on Climate Change Vulnerability and Adaptation Assessment in Asia and the Pacific metto present and discuss assessments of vulnerability and adaptation to climate change in agriculture, forests, coastal resources, and water resources. Discussions were held in breakout and plenary sessions about the state of the science for vulnerability and adaptation assessment, conclusions that can be drawn about the vulnerability of the region to climate change, and where future research efforts should be directed. The workshop concluded that sea level rise is of greatest concern to island and coastal nations in the region, climate change will have a significant effect on agriculture, water resources are sensitive to changes in average climate conditions and to tropical monsoons and cyclones, and forests could be significantly affected by climate change. The workshop recommended that efforts to improve general circulation models continue and that countries in the region cooperate on the analyses of vulnerability and addressing adaptation measures. The workshop also concluded that results of vulnerability and adaptation assessments should be presented to policy makers and the public and that assessments continue to be undertaken to improve our understanding of the issue. Copyright © 1996 by Springer.

Arnold, Margaret; Robert S. Chen; Uwe Deichmann; Maxx Dilley; Arthur L. Lerner-Lam; Randolph E. Pullen; and Zoe Trohanis (eds.) (2006) *Natural Disaster Hotspots Case Studies*, (Washington, DC: The World Bank, Hazard Management Unit); available at: http://siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf?&resourceurlname=0821363328.pdf. **Abstract/Summary:** These case studies complement the earlier

groundbreaking work of Natural Disaster Hotspots: A Global Risk Analysis published in April 2005. Three case studies address specific hazards: landslides, storm surges and drought. An additional, three case studies address regional multi-hazard situations in Sri Lanka, the Tana River basin in Kenya, and the city of Caracas, Venezuela. Copyright © 2006 by The World Bank.

Asada, H.; J. Matsumoto; and R. Rahman (2005) "Impact of Recent Severe Floods on Rice Production in Bangladesh", *Geographical Review of Japan*, Vol. 78, No. 12, pp. 783-793. **Abstract/Summary:** The long-term variations of rice production in Bangladesh are examined in the latter half of the 20th century and the impact of recent severe floods is discussed. Unprecedented severe floods, which submerged nearly two thirds of the country, occurred recently in Bangladesh in 1988 and 1998, and the effects of these severe floods to rice cropping are revealed. In these severe flood years, the rainy season crop aman drastically declined in production due to the decrease of the cultivated area and yield. On the other hand, the dry season crop boro, which is planted after the flood withdrawal, increased its production much higher than that of the previous year, mainly because of utilization of the residual flood water. In terms of total annual rice production, it turns out that severe floods have even a positive effect on rice production in Bangladesh. Furthermore, rice production after these severe flood years is higher than that of the previous years, suggesting that severe floods may act as a trigger for increasing rice production level through the change of the hydrological environment and farmers' reaction to it. Copyright © 2005 by The Association of Japanese Geographers.

Asaduzzaman, M. (1994) "Bangladesh Country Report", *Climate Alert*, Vol. 7, No. 4 (July-August). **Abstract/Summary:** This is one of the first comprehensive contributions describing and analyzing climate change on Bangladesh. Beyond insights into the impacts, it also addresses developmental consequences and provides tentative policy suggestions. Copyright © 1994 by Columbia earthscape.

Asaduzzaman, M. (2008) Policy Response of Bangladesh to Climate Change; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation focuses on the Bangladeshi policy responses as well as Bangladesh's submissions to recent climate change conferences in Bali, Bonn and Accra. It shows that the relatively advanced climate change research in Bangladesh contributed to the issues discussed at these conferences, while also stressing that adaptation is mostly a national issue which Bangladesh tries to address through various initiatives for which financial resources will need to be provided by the international community. Copyright © 2008 by the author(s).

Asaduzzaman, M.; M. Reazuddin; and Ahsan Uddin Ahmed (eds.) (1997) *Global Climate Change -- Bangladesh Episode* (Dhaka: Government of the People's Republic of Bangladesh, Ministry of Environment and Forest (MoEF), Department of Environment (DoE)). **Abstract/Summary:** A Country Study on Climate Change (Bangladesh Climate Change Study) was launched in October 1994 to address the following major issues: Preparation of a country-specific inventory of greenhouse gases (GHGs); Assessment of vulnerability of the country, with special reference to Bangladesh coastal zones, with respect to Climate Change; Assessment of mitigation options to develop appropriate strategies and policies for reducing GHG emission into the atmosphere. It then provides recommendations for an appropriate awareness and

dissemination program based on findings of the above components. A final report on each of the four components above have been prepared and been approved by the national Steering Committee. The present report is a synthesis and summary of the findings from three final reports. The report also deals with users for future research and investigation. Copyright © 1997 by GoB.

Asian Development Bank (ADB) (1994) *Climate Change in Asia: Bangladesh Country Report,* (Manila, The Philippines: Asian Development Bank, Regional Study on Global Environmental Issues Series)**. Abstract/Summary:** This country study reports the results of investigation into the impact of climate change in Bangladesh, the available options for adaptation and mitigation measures and response strategies that may be pursued at the national and the regional levels. The primary emphasis of the -study is on two areas, viz., water resources and agriculture but other areas of impact have also been investigated. Observations in Bangladesh indicate that there has been little or no increase in the average annual temperature in the country over the last four decades. On the other hand, the records on rainfall showed definite trends to increase. In terms of emissions Bangladesh ranks among the lowest emissions both on a total and on a per capita basis. This does not mean, however, that Bangladesh should not take mitigation measures to lower the emission levels. In case of mitigation measures related to methane emission, possibly not much can be done immediately without a long – term research effort in this regard. Copyright © 1994 by Asian Development Bank.

Asian Development Bank (ADB) (2008) *People's Republic of Bangladesh: Strengthening the Resilience of the Water Sector in Khulna to Climate Change* (Manila, The Philippines: Asian Development Bank (ADB), Technical Assistance Report, Project No. 42469 (December) ; available at: http://www.adb.org//Documents/TARs/BAN/42469-BAN-TAR.pdf. **Abstract/Summary:** With vast low-lying deltas, Bangladesh is regarded as particularly vulnerable to climate change. The country operations business plan of the Asian Development Bank (ADB) for Bangladesh 2009–2011 identifies two planned water sector investment projects in Khulna, where the consequences of climate change are expected to be particularly severe: the City Region Development Project and the Khulna Water Supply Project. The timely implementation of policy and advisory technical assistance for assessing the impacts of climate change and identifying adaptation options is deemed essential to maximize the development impacts of the planned projects. This view was fully endorsed by the Government of Bangladesh (the Government) during the Fact-Finding Mission for project preparatory technical assistance (PPTA) for the City Region Development Project in September 2008. A separate ADB Fact-Finding Mission visited Bangladesh from 12 to 16 October 2008. This report is based on the understanding reached with the Government during the mission regarding the impact, outcome, outputs, implementation arrangements, cost, financing arrangements, and outline terms of reference for the technical assistance (TA). The design and monitoring framework is in Appendix 1 of the report. The main outcome of the TA is a list of adaptation options, both structural and not, prepared for two planned investment projects—the City Region Development Project and the Khulna Water Supply Project—as well as for other Government projects and policy actions. The impact of the TA is the strengthened resilience of the water sector in Khulna to climate change. The total cost of the TA is estimated at $720,000 equivalent, $600,000 of which will be financed as a grant by ADB's Climate Change Fund. The Government will finance the remaining $120,000 equivalent to cover remunerating counterpart staff and providing office space, furniture, equipment, and

workshop venues. The cost estimates and financing plan are in Appendix 2 of the report. Copyright © 2008 by Asian Development Bank.

Asian Disaster Preparedness Center (ADPC); Institute of Water Modeling (IWM); Center for Environmental and Geographic Information Services (CEGIS); and School of Earth and Atmospheric Sciences, Georgia Institute of Technology (2004) *Climate/Flood Forecast Applications for Water-Related Disaster Mitigation in Bangladesh: Technology Transfer, Capacity Building and Demonstrations* (Bangkok, Thailand: Asian Disaster Preparedness Center (ADPC); Dhaka: Institute of Water Modeling (IWM); Dhaka: Center for Environmental and Geographic Information Services (CEGIS); and Atlanta, GA, USA: School of Earth and Atmospheric Sciences, Georgia Institute of Technology (March)). **Abstract/Summary:** This is a project proposal to improve the forecasting of climate-induced floods in order to better mitigate the negative impacts from them. The proposal includes among others an improved documentation of existing forecast products and on-going research, a better identification of constraints and opportunities in the generation of information, and a better understanding the relevance of forecast information for decision making. Copyright © 2004 by Asian Disaster Preparedness Center et al.

Ayers, Jessica M.; Bernhard G. Gunter, and John D. Shilling (eds.) (2008) *Proceedings of the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh* (held at the Rockefeller Foundation's Study and Conference Center in Bellagio, Italy, May 20-22), (Dhaka: Bangladesh Centre for Advanced Studies; Falls Church: Bangladesh Development Research Center; London: International Institute for Environment and Development; and Arlington: Millennium Institute); available at: http://www.bangladeshstudies.org/files/Proceedings.pdf. **Summary of Outcomes:** The single most important outcome of the workshop was a firm agreement among participants that there is an urgent need for applying a more comprehensive and coherent approach of climate change research in order to better understand the cross-sectoral impacts and feedback loops. Hence, there was broad agreement that the Millennium Institute's Threshold 21 model should be applied to Bangladesh. Other major outcomes of the workshop were the needs to: • encourage effective communication among stakeholders to design and agree on better policies, • improve knowledge about how to manage the impacts of and reduce vulnerabilities to climate change as part of the research activities, • undertake more region-specific planning/research across all sectors affected in that region (region refers here to a specific area within Bangladesh, e.g., coastal zone), • address resource implications, as the key actors (including researchers and government) cannot carry climate change adaptation polices forward without external assistance, which must be coordinated with the development goals and assistance, • emphasize the importance of taking a longer term view – over decades, and • take a fuller account of the full scope of the environmental impacts and time lags in policy implementation in order to assure the sustainability of Bangladesh's development. The workshop also resulted in: • bringing people together and stimulating future joint research among them, • motivating participants to get more engaged in climate change research, • encouraging participants to think outside the box, • exposing the work that is already going, and • clarifying the difference between the challenges of dealing with climatic extremes versus climate change trends. Copyright © 2008 by Bangladesh Centre for Advanced Studies et al.

Azad, Abul K.; S. W. Nashreen; and J. Sultana (2006) "State of Energy Consumption and CO_2 Emission in Bangladesh", *Ambio,* Vol. 35, No. 2, pp. 86-88; available at: http://ambio.allenpress.com/perlserv/?request=get-document&doi=10.1579%2F0044-7447(2006)35%5B86%3ASOECAC%5D2.0.CO%3B2&ct=1. **Abstract/Summary:** Carbon dioxide (CO_2) is one of the most important gases in the atmosphere, and is necessary for sustaining life on Earth. It is also considered to be a major greenhouse gas contributing to global warming and climate change. In this article, energy consumption in Bangladesh is analyzed and estimates are made of CO_2 emission from combustion of fossil fuel (coal, gas, petroleum products) for the period 1977 to 1995. International Panel for Climate Change guidelines for national greenhouse gas inventories were used in estimating CO_2 emission. An analysis of energy data shows that the consumption of fossil fuels in Bangladesh is growing by more than 5% per year. The proportion of natural gas in total energy consumption is increasing, while that of petroleum products and coal is decreasing. The estimated total CO_2 release from all primary fossil fuels used in Bangladesh amounted to 5072 Gigagram (Gg) in 1977, and 14 423 Gg in 1995. The total amounts of CO_2 released from petroleum products, natural gas, and coal in the period 1977–1995 were 83 026 Gg (50% of CO_2 emission), 72 541 Gg (44% of CO_2 emission), and 9545 Gg (6% CO_2 emission), respectively. A trend in CO_2 emission with projections to 2070 is generated. In 2070, total estimated CO_2 emission will be 293 260 Gg with a current growth rate of 6.34% y^{-1}. CO_2 emission from fossil fuels is increasing. Petroleum products contribute the majority of CO_2 emission load, and although the use of natural gas is increasing rapidly, its contribution to CO_2 emission is less than that of petroleum products. The use of coal as well as CO_2 emission from coal is expected to gradually decrease.

Azam, Jean-Paul (1996) "The impact of floods on the adoption rate of high yielding rice varieties in Bangladesh", *Agricultural Economics*, Vol. 13, pp. 179-189. **Abstract/Summary:** This paper analyses econometrically the impact of floods on the rate of adoption of high-yielding varieties (HYVs) of rice in Bangladesh. It uses a small model combining a modified logistic adoption function with a model of the process generating expectations errors by the farmers which encompasses most other expectation hypotheses. Using pooled cross-section and time-series data at the district level, the econometric results show a significant negative impact of expected flood damage on the HYV adoption rate of 'aman' rice. Moreover, it is shown that the adoption of HYV 'boro' rice is governed by essentially the same equation.

Bangladesh Centre for Advanced Studies (BCAS) (1996) *Bangladesh Least Cost Greenhouse Gas Abatement Strategy* (Dhaka: Bangladesh Centre for Advanced Studies (BCAS) with BUET, BIDS and BUP)**. Abstract/Summary:** This report contains the proceedings of the First National Workshop on ALGAS study, which was held on 8th May, 1996. The workshop was aimed at raising awareness among the different stakeholders who are engaged in GHG releasing activities. The workshop was divided into three sessions: i) the Inaugural Session, ii) the Technical Session, and iii) the Concluding Session. The Workshop was attended by about sixty selective participants representing many government and non government agencies involved in energy use and monitoring.

Bangladesh Centre for Advanced Studies (BCAS); Resource Analysis; and Approtech (1994) *Vulnerability of Bangladesh to Climate Change and Sea Level Rise. Concepts and Tools for*

Calculating Risk in Integrated Coastal Zone Management (Dhaka: Bangladesh Centre for Advanced Studies (BCAS), and Delft, The Netherlands: Resource Analysis (RA), and Approtech Consultants Limited); **Contents:** Volume I: Technical Report, Volume II: Institutional Report, Volume III: Summary Report. **Abstract/Summary:** This report has been prepared on behalf of the Government of Bangladesh, Department of Environment (DoE) of the Ministry of Environment and Forests (MoEF) by a multidisciplinary team of Bangladeshi and Dutch experts. The experts were selected by the Bangladesh Centre for Advanced Studies (BCAS) and Resource Analysis. The study was carried out as Bangladesh's input to the Intergovernmental Panel on Climate Change (IPCC) with support from the Government of The Netherlands: Directorate General of International Cooperation (DGIS) of the Ministry of Foreign Affairs and the Coastal Zone Management Centre of the Ministry of Transport, Public Works and Water Management. The Technical Report describes the concepts and the techniques used in the vulnerability assessment and included a detailed documentation of the different analyses carried out. The audience for this report consists of professionals involved in planning of natural resources, to whom the report provides a systematic framework for the analysis of long term developments. The Institutional Report gives an overview of the system of Government and Planning in Bangladesh and discusses in some detail institutional mechanisms for the water resource sector. This report is considered a first step in understanding the management arrangements in place and corresponding possibilities and constraints in implementing response strategies. The Summary Report is published for widespread dissemination within Bangladesh to policy makers, planners and scientists in government and other institutions to enable them to know the state of knowledge and activities being undertaken by the Government of Bangladesh regarding climate change and sea level rise. Copyright © 1994 by Bangladesh Centre for Advanced Studies et al.

Barlow, Mathew; Heidi Cullen; Brad Lyon; and Olga Wilhelmi (2006) "Drought Disaster in Asia", in: Margaret Arnold; Robert S. Chen; Uwe Deichmann; Maxx Dilley; Arthur L. Lerner-Lam; Randolph E. Pullen; and Zoe Trohanis (eds.) *Natural Disaster Hotspots Case Studies* (Washington, DC: The World Bank, Hazard Management Unit), pp. 1-19; available at: http://siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf?&resourceurlname=0821363328.pdf
Abstract/Summary: Drought disaster reports are compared with precipitation- based estimates of drought at the country level for the 27 countries listed in the Asia category in the EMDAT database for the 1975-2001 period. The last three years of the record have, by far, the largest number of reports. This pronounced maximum appears not to be an artificial feature of EM-DAT reporting but rather physically linked to the exceptionally severe drought impacting Asia during that time. An objective comparison was undertaken between the monthly disaster reports and two climate-based estimates of drought. Even at the country level, and with limited data, a relationship can be discerned between both climatic measures of drought and the incidence of drought disasters in the region. In fact, the climate drought estimate based on the 12-month WASP matches all reported drought disasters for Israel, Afghanistan, Syria, Pakistan, Armenia, and Malaysia, encompassing seven matches. Ten climatic droughts are also identified that do not have a corresponding disaster report (10 non-matches). There is some suggestion that the relationship is stronger in the semiarid countries. The relationship is present in other climatic zones, however; Laos, for instance, shows a relationship over multiple events. This link between climatic drought and disaster reports is consistent through the two large climate events that affected the region during the period of analysis. An understanding of the links between large-scale climate data and the incidence of disasters could enhance the utility of current climate

monitoring and forecasting efforts. This pilot effort provides a preliminary identification of such links; further investigation is recommended, as outlined in the next section. Copyright © 2006 by The World Bank.

Barnett, Jon and W. Neil Adger (2007) "Climate Change, Human Security and Violent Conflict", *Political Geography*, Vol. 26, No. 6 (August), pp. 639-655. **Abstract/Summary:** Climate change is increasingly been called a 'security' problem, and there has been speculation that climate change may increase the risk of violent conflict. This paper integrates three disparate but well-founded bodies of research – on the vulnerability of local places and social groups to climate change, on livelihoods and violent conflict, and the role of the state in development and peacemaking, to offer new insights into the relationships between climate change, human security, and violent conflict. It explains that climate change increasingly undermines human security in the present day, and will increasingly do so in the future, by reducing access to, and the quality of, natural resources that are important to sustain livelihoods. Climate change is also likely to undermine the capacity of states to provide the opportunities and services that help people to sustain their livelihoods. We argue that in certain circumstances these direct and indirect impacts of climate change on human security may in turn increase the risk of violent conflict. The paper then outlines the broad contours of a research programme to guide empirical investigations into the risks climate change poses to human security and peace. Copyright © 2008 by Elsevier B.V.

Begum, Selina and George Fleming (1997) "Climate Change and Sea Level Rise in Bangladesh, Part I: Numerical Simulation", *Marine Geodesy*, Vol. 20, No. 1 (Special Issue on Sea Level Problems of Bangladesh), pp. 33-54. **Abstract/Summary:** Numerical hydrodynamic models in one and two dimensions have been developed to simulate the effect of possible global climate and sea level changes on flooding in Bangladesh. The low, medium, and high scenarios of rise in sea level have been selected from the predictions of the general circulation models (GCMS). The models have been applied to test the sensitivity of flooding in Bangladesh to different scenarios of rise in sea level and increase in river discharge. The models have also been applied to simulate the combined effects of rise in sea level and increase in river discharge. Flooding in the coastal region and also in the upstream parts of the rivers has been found to be severely affected as a result of changes in the hydrodynamics of flow. The study is a combination of climate, hydrology, and hydraulics. This study will aid in preventive planning and sustainable development to cope with future scenarios of changes in flooding due to climate and sea level. Copyright © 1997 by Taylor and Francis Ltd.

Begum, Selina and George Fleming (1997) "Climate Change and Sea Level Rise in Bangladesh, Part II: Effects", *Marine Geodesy*, Vol. 20, No. 1 (Special Issue on Sea Level Problems of Bangladesh), pp. 55-68. **Abstract/Summary:** Global climate is changing as a consequence of global warming due to industrial, agricultural, and other human activities. The major effects of global warming are changes in the hydrological cycle and rise in sea level. Bangladesh is most vulnerable to the effects of climate change and sea level rise due to the low elevation of the land areas, the low gradient of the rivers, and exposure to the sea. It has been predicted by the application of a numerical model that there will be changes in the hydrodynamics of flow of the rivers in Bangladesh due to increase in river discharge and rise in sea level. As a result there will be significant effects on flooding, drainage, agriculture, tides, waves, and vital wetlands in Bangladesh. Probable critical effects on water resources planning and management are the focus

of this article. Comprehensive management and sustainable use of resources will provide possible solutions to adapt to short- and long-term changes. Copyright © 1997 by Taylor and Francis Ltd.

Brammer, Hugh (1989) "Monitoring the Evidence of the Greenhouse Effect and its Impact on Bangladesh", in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies)**. Abstract/Summary:** A rise in sea-level would raise low-flow and flood-season river levels in the southern half of Bangladesh. Such changes could be monitored by the country's existing network of tidal and river gauges. The effects which slowly-rising sea and river levels might have on adjoining land areas are difficult to predict precisely. The most serious effects probably would not occur in coastal areas where sedimentation from tidal flooding would continue to build up land levels. Interior floodplain regions which do not receive regular deposits of alluvium would suffer deeper and more prolonged seasonal flooding, with adverse consequences for agricultural production. Monitoring of such changes would be very difficult. The Bangladesh delta is dynamic, not static: considerable hydrological, geo-morphological, infrastructural and land use changes would be expected to occur, in the next 50 years, irrespective of any change in sea-level. Additionally, the considerable regional diversity and local complexity of the physical and agricultural environments imply that a rising sea-level might produce different effects in different areas. Consequently, several impact monitoring sites might be needed. The effects of possible climatic changes are not discussed. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Brammer, Hugh (1993) "Geographical complexities of detailed impacts assessment for the Ganges-Brahmaputra-Meghna delta of Bangladesh", in: *Climate and Sea Level Change: Observations, Projections and Implications*; edited by R. A. Warrick, E. M. Barrow, and T. M. L. Wigley (Cambridge, UK and New York: Cambridge University Press), pp. 246-262**. Abstract/Summary**: This chapter is part of a collection of papers presented at the UNEP/EC International Workshop on Climatic Change, Sea Level, Severe Tropical Storms and Associated Impacts, which was held in Norwich, U.K. in 1987. It stresses that a static approach to assess the impact of sea level rise is insufficient for predictive or planning purposes given the dynamic processes involved across Bangladesh, including changes in river flows, the impact of infrastructure build-up, and changes in land use. The chapter argues that the most likely adverse impact of sea level rise in Bangladesh is the increased incidence and depth of inland flooding due to higher river-bed channels and levees relative to surrounding land. The chapter also stresses the importance of drainage of inland areas as coastal lands accrete. Copyright © 1993 Cambridge University Press.

Brammer, Hugh; M. Asaduzzaman; and P. Sultana (1993) *Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 3); also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers), pp. 143-204 (Chapter 4). **Abstract/Summary:** This briefing presents possible impacts of global warming and sea-level rise on Bangladesh's water, agricultural, forestry, fisheries and livestock resources. These resources are the mainstay of the country's economy, and will remain so for the foreseeable future. It is important, therefore, that the potential impacts of global warming on these vital resources be assessed: firstly, so as to

inform decision-makers and the public about the likely scale and time-frame of the kinds of impacts foreseen; secondly, so as to focus attention on mitigation measures that need to be considered in policy and research planning; and thirdly, so as to indicate subject areas where additional data need to be collected and analyzed in order to reform predictions of possible impacts, and thereby improve the planning of any mitigatory measures that might be required. The report starts with a brief description of the physical and socio-economic setting of present land-use and production. Succeeding sections give further details about the country's water, crop agriculture, forestry, fisheries and livestock resources as a basis for assessing possible impacts of climate change and sea-level rise. The final section draws conclusions from this review and identifies follow-up actions that could be taken. Copyright © 1993 by Kluwer Academic Publishers.

Bray, Ian; Shaheen Chughtai; Sean Kenny; Swati Narayan; Ben Phillips; and Medha Soni (2008) *Rethinking disasters: Why death and destruction is not nature's fault but human failure* (New Delhi, India: South Asia Regional Centre, Oxfam (India) Trust). **Abstract/Summary:** Preparation can make an enormous difference. In Bangladesh, the creation of early warning systems, anticyclone shelters and other risk reduction measures has saved tens of thousands of lives. Although the population in Bangladesh has more than doubled in 40 years, the toll from the biggest cyclones has plummeted. When Cyclone Sidr struck in November 2007, an estimated 3.2 million Bangladeshis were evacuated from the coastal areas and over two million were already in special shelters when the cyclone hit. About 4,000 Bangladeshis died - compared with around 140,000 in a similar cyclone in 1991 and up to 500,000 in 1970. Our experience shows that preparedness costs a fraction of what the response can cost, saving money as well as lives. For example, Oxfam has helped Bangladeshi families buy radios, each costing a minimal $12, to monitor weather forecasts. However, this approach requires attention and commitment beyond times of emergency. Moreover, when disasters do strike, the inclusion of risk reduction principles into emergency response and recovery plans can ensure that affected people are less vulnerable than before. Adding greater urgency is the fact that climate change - for which rich countries have been overwhelmingly responsible - is making people even more vulnerable to shocks. Two thirds of South Asia's disasters are climate-related, and global warming will increase the frequency, severity and unpredictability of extreme weather events - as the 2007 South Asia floods illustrated dramatically. An increase in temperature beyond two degrees Celsius will cause sea levels to rise dangerously, threatening coastal areas with flooding and drinking water sources with saltwater contamination. Such temperature rises are predicted to cause Bangladesh to lose one tenth of its rice production and one third of its wheat production over the next 50 years. Copyright © 2008 by © Oxfam International.

Broadus, James M.; S. Milliman; D. Edwards; D. G. Aubrey; and F. Bable (1986) “Rising sea level and damming of rivers: possible effects in Egypt and Bangladesh”, in J. G. Titus (ed.), *Effects of Changes in Stratospheric Ozone and Global Climate*, Vol. 4 (Washington, DC: U.S. Environmental Protection Agency), pp. 165-189. **Abstract/Summary:** The projected worldwide rise of sea level during the next 100 years will be particularly hard-felt in deltaic areas where substantial areas are barely above sea level. Regional subsidence will increase the relative rate of sea level rise; and damming of large rivers could prevent sediment influx from compensating for regional subsidence, increasing coastal erosion. These effects will be felt most in developing countries, where the rivers are large, deltas extensive and inhabited, and proposed damming of large rivers may dramatically increase coastal erosion. To help understand the potential

consequences of sea level rise in the deltaic regions of the world, this study concentrated on two areas that seem especially vulnerable: the Nile River delta in Egypt, which has already been dammed, and the delta of the complex Ganges-Brahmaputra-Meghna River system in Bangladesh, in which river damming has begun and is expected to increase during the next 15 years. Copyright © 1986 by U.S. Environmental Protection Agency.

Brodus, James M. (2001) "Sea-level Rise and the Bangladesh and Nile Deltas", in: Jeanne X. Kasperson and Roger E. Kasperson (eds.) *Global Environmental Risk* (Tokyo and London: United Nations University Press and Earthscan Publications Ltd.), pp. 353-372**.** **Abstract/Summary:** The Ganges-Brahmaputra-Meghna Delta of Bangladesh and the Nile Delta of Egypt are among the areas of the world most vulnerable to the impacts of potential future sea-level rise. Closer examination of their vulnerabilities to future impact reveals an interrelated complex of extreme uncertainties about the problem, ranging from the relationship between greenhouse-gas emissions and actual future sea levels to the nature and effects of adaptive responses. **Note:** Though the book has been published in 2001, the chapters and their data are based on papers presented at a conference in 1989. Copyright © 2001 by United Nations University Press and Earthscan Publications Ltd.

Brouwer, Roy; Sonia Aftab; Luke Brander; and Enamul Haque (2006) "Economic valuation of flood risk exposure and flood control in a severely flood prone developing country", Amsterdam, The Netherlands: Institute for Environmental Studies, Vrije Universiteit, Poverty Reduction and Environmental Management (PREM), PREM Working Paper, No. 06/02 (March); available at: http://www.prem-online.org/archive/16/doc/PREM06-02.pdf. **Abstract/Summary:** This paper presents the results of a dichotomous choice contingent valuation (CV) study of flood control policy in Bangladesh. The application of CV studies in the domain of flood exposure and flood control, where people are asked to trade-off money income in terms of willingness to pay (WTP), the risk of flooding and corresponding impacts on their life and livelihood, is rare. The use of CV in developing countries furthermore faces the challenge of significant income constraints, limiting the applicability of the method. Average WTP in this study is 0.5 percent of annual household income. As expected, stated WTP varies significantly with different levels of exogenous flood risk exposure, proxied by the distance people live from the river and the level of inundation during the rainy season. WTP is furthermore significantly constrained by household income and the disutility from flood risks measured through higher or lower flood damage costs and risk aversion measured through people's attitude to flood protection. We find a number of problems with the CV application in this specific cross-cultural context, which are addressed in more detail in a follow-up survey. A test-retest carried out six months after the original survey shows that the stated WTP values are stable in eighty percent of the cases. Copyright © 2006 by Institute for Environmental Studies.

Brouwer, Roy; Sonia Aftab; Luke Brander; and Enamul Haque (2007) "Socio-economic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh", *Risk Analysis - An International Journal*, Vol. 27, No. 2, pp. 313-326. **Abstract/Summary:** In this paper we investigate the complex relationship between environmental risk, poverty and vulnerability in a case study carried out in one of the poorest and most flood prone countries in the world, focusing on household and community vulnerability and adaptive coping mechanisms. Based upon the steadily growing amount of literature in this field we develop and test our own analytical model. In a large-scale household survey carried out in

the south-east of Bangladesh, we ask almost seven hundred floodplain residents living without any flood protection along the river Meghna about their flood risk exposure, flood problems, flood damage and coping mechanisms. Novel in our study is the explicit testing of the effectiveness of adaptive coping strategies to reduce flood damage costs. We show that, as expected, households with lower income and less access to productive natural assets face higher exposure to risk of flooding. Disparity in income and asset distribution at community level furthermore tends to be higher at higher risk exposure levels, implying that individually vulnerable households are also collectively more vulnerable. Regarding the identification of coping mechanisms to deal with flood events, we look at both the ex ante household level preparedness for flood events and the ex post availability of community level support and disaster relief. We find somewhat paradoxically that the people that face the highest risk of flooding are the least well prepared, both in terms of household-level ex ante preparedness and community-level ex post flood relief. Copyright © 2007 by John Wiley & Sons, Inc.

Burton, Ian; Saleemul Huq; and Bo Lim (2004) *Adaptation Policy Framework* (New York: United Nations Development Programme). **Abstract/Summary:** The APF provides guidance on designing and implementing projects that reduce vulnerability to climate change, by both reducing potential negative impacts and enhancing any beneficial consequences of a changing climate. It seeks to integrate national policy making efforts with a "bottom-up" movement. The framework emphasizes five major principles: adaptation policy and measures are assessed in a developmental context; adaptation to short-term climate variability and extreme events are explicitly included as a step toward reducing vulnerability to long-term change; adaptation occurs at different levels in society, including the local level; the adaptation strategy and the process by which it is implemented are equally important; and building adaptive capacity to cope with current climate is one way of preparing society to better cope with future climate. The APF is a flexible approach in which the following five steps may be used in different combinations according to the amount of available information and the point of entry to the project: (1) defining project scope and design, (2) assessing vulnerability under current climate, (3) characterizing future climate related risks, (4) developing an adaptation strategy, and (5) continuing the adaptation process. The framework focuses on the involvement of stakeholders at all stages. Copyright © 2004 by United Nations Development Programme.

Butzengeiger, Sonja and Britta Horstmann (2004) *Sea-Level Rise in Bangladesh and the Netherlands—One Phenomenon, Many Consequences*, Bonn: Germanwatch; available at: http://www.germanwatch.org/download/klak/fb-ms-e.pdf; **Excerpts from the Section on Limited Solutions:** In view of the extreme population density it is impossible to retreat to higher situated areas. There are no free areas left in Bangladesh; its neighbor India is already very concerned about the past and present illegal immigration of Bangladeshi. Even today, houses are very often built on walls of earth in order to ensure a minimum protection against floods. But, like already existing earth dykes, these walls of earth are threatened by erosion and are not as durable as European dykes. The construction of big, modern dykes is problematic as well. If sea levels rise up to 1 meter, "normal" flood waves can be expected to increase from presently 7.4 meters to 9.1 meters. The present lack of financial and technical capacities add to the existing problems, though Bangladesh intensified its efforts in co-operation with international donors. Even if a complete dyke construction could be financed, it would destroy valuable agricultural areas. Since 1989, this issue has aroused local protests against a World Bank project pushed forward by France, Japan and the USA that foresees to construct 8,000 kilometers of river dykes

with costs amounting to US$ 10 billion. But with the help of international co-operation Bangladesh also achieved successes: in many directly affected coastal areas shelters on concrete pillars were built, reducing the number of victims from storm floods. Also, the development of early warning systems helps to minimize the number of victims. However, these measures cannot prevent loss of crops, houses and other infrastructure. All these facts show how disastrous the rising sea level can be for Bangladesh, despite the negligible contribution the country has made to climate change. Since its founding in 1972, Bangladesh's contribution to global emissions of the greenhouse gas carbon dioxide has been 0.06% only. Copyright © 2004 by Germanwatch.

Byravan, Sujatha and Sudhir Chella Rajan (2008) "The Social Impacts of Climate Change in South Asia"; available at website of Social Science Research Network (SSRN). **Abstract/Summary:** This paper focuses on an important set of social impacts resulting from climate change in South Asia, namely the potential displacement of vast numbers of people as a consequence mainly of sea level rise along the coasts and secondarily from drought in rural areas. It examines these impacts through the use of scenarios involving alternative assumptions about whether or not effective policies will be developed in time to address the physical changes that are likely to take place. The climate crisis that is likely to unfold in South Asia will create profound challenges. With a 5-metre sea level rise, there will be about 125 million climate migrants in this region alone with little or no legal standing under current international law. In fact the 75 million or so from Bangladesh will be especially vulnerable, as their entire nation-state becomes non-viable as an entity, with most of its land inundated and its economy defunct. Copyright © 2008 by the author(s).

Cannon, Terry (2002) "Gender and Climate Hazards in Bangladesh", *Gender and Development*, Vol. 10, No. 2 (July), pp. 45-50; also published in: Rachel Masika (ed.) *Gender, Development, and Climate Change* (Oxford: Oxfam Publishing), pp. 45-50. **Abstract/Summary:** Bangladesh has recently experienced a number of high-profile disasters, including devastating cyclones and annual floods. Poverty is both a cause of vulnerability, and a consequence of hazard impacts. Evidence that the impacts of disasters are worse for women is inconclusive or variable. However, since being female is strongly linked to being poor, unless poverty is reduced, the increase in disasters and extreme climate events linked with climate change is likely to affect women more than men. In addition, there are some specific gender attributes which increase women's vulnerability in some respects. These gendered vulnerabilities may, however, be reduced by social changes. Copyright © 2002 by Oxfam International and Taylor & Francis Group.

CARE (2002) *Community Vulnerability Assessment in Southeast Bangladesh (Final Draft)* (Dhaka: CARE Bangladesh (September)). Please see Chowhan et al. (2005) for further details.

CARE (2002) *Project Implementation Plan; Reducing Vulnerability to Climate Change (RVCC) Project* (Dhaka: Care Bangladesh (July)). Please see Chowhan et al. (2005) for further details.

CARE (2003) *Report of a Community Level Vulnerability Assessment Conducted in Southeast Bangladesh; Reducing Vulnerability to Climate Change (RVCC) Project* (Dhaka: Care Bangladesh (June)). Please see Chowhan et al. (2005) for further details.

CARE (2004) *Reducing Vulnerability to Climate Change (RVCC) Project* (Dhaka: Care Bangladesh). Please see Chowhan et al. (2005) for further details.

CARE and Coastal Development Partnership (CDP) (2003) *Climate Change Information Package; Reducing Vulnerability to Climate Change (RVCC) Project* (Khulna, Bangladesh: CARE Bangladesh; and Coastal Development Partnership (CDP), July). Please see Chowhan et al. (2005) for further details.

Cash, Benjamin A.; Xavier Rodó; and James L. Kinter III (2008) "Links between Tropical Pacific SST and Cholera Incidence in Bangladesh: Role of the Eastern and Central Tropical Pacific", *Journal of Climate*, Vol. 21, No. 18, pp. 4647-4663. **Abstract/Summary:** Recent studies arising from both statistical analysis and dynamical disease models indicate that there is a link between incidence of cholera, a paradigmatic water-borne bacterial illness (WBD) endemic to Bangladesh, and the El Niño – Southern Oscillation (ENSO). However, a physical mechanism explaining this relationship has not yet been established. We use a regionally coupled, or pacemaker, configuration of the Center for Ocean-Land-Atmosphere Studies atmospheric general circulation model to investigate links between sea surface temperature in the central and eastern tropical Pacific and the regional climate of Bangladesh. We find that enhanced precipitation tends to follow winter El Niño events in both the model and observations, providing a plausible physical mechanism by which ENSO could influence cholera in Bangladesh. The enhanced precipitation in the model arises from a modification of the summer monsoon circulation over India and Bangladesh. Westerly wind anomalies over land to the west of Bangladesh lead to increased convergence in the zonal wind field and hence increased moisture convergence and rainfall. This change in circulation results from the tropics-wide warming in the model following a winter El Niño event. These results suggest that improved forecasting of cholera incidence may be possible through the use of climate predictions. Copyright © 2008 by the American Meteorological Society.

Cash, Benjamin A.; Xavier Rodó; James L. Kinter III; Michael J. Fennessy; and Brian Doty (2008) "Differing Estimates of Observed Bangladesh Summer Rainfall", *Journal of Hydrometeorology*, Vol. 9, No. 5 (October), pp. 1106-1114 . **Abstract/Summary:** The differences in boreal summer (June–August) monthly-mean rainfall estimates over the Indian Ocean region in five research-quality products are examined for the period 1979–2003. Two products derived from the merged satellite and surface observations are considered: the Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP) and the Global Precipitation Climatology Project (GPCP). In addition, three products derived solely from rain gauge observations are considered: the Chen et al. product; the Indian Meteorological Department (IMD) product; and a new, objectively analyzed product based on the Climate Anomaly Monitoring System (CAMS) dataset. Significant discrepancies have been found between the different products across the entire Indian Ocean region, with the greatest disagreement over Burma and neighboring Bangladesh. These differences appear to be primarily due to the absence of reported rain gauge data for Burma and differences in the algorithms used to merge the satellite microwave emission and scattering data in coastal regions. Representations of rainfall across much of the eastern Indian Ocean region would likely be improved by the identification and inclusion of reporting stations from Burma and a refinement of the techniques used for merging microwave data. The differences among the five products are sufficient to affect both quantitative and qualitative conclusions drawn about rainfall, particularly over Bangladesh and

Burma. Consequently, the results of precipitation studies in this region will depend, in some cases, on the choice of the data product, including such basic questions as to whether a given summer was wet or dry. Of particular note is that the apparent relationship between rainfall and ENSO can depend on the choice of the data product. Copyright © 2008 by American Meteorological Society.

Chadwick, M. T.; J. G. Soussan; S. S. Alam; and D. Mallick (1997) *From Flood to Scarcity of Water: Re-Defining the Water Debate in Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies (BCAS)); available at: http://www.eldis.org/fulltext/bcaswater.pdf. **Abstract/Summary:** Various coping strategies have been developed to deal with the problems associated with lack of monsoon floodwaters. Farmers with higher land have adapted new cropping patterns and now tend to plant crops such as sugarcane, bananas and timber that require less water where they previously grew rice. Fishermen and part-time fishermen now have to go further afield to fish and tend to be concentrated on fewer water bodies, adding to competition for ever declining fish stocks and leading to disputes between village communities and professional and part-time fisherfolk. Several professional fisherfolk appear to have given up and switched primary livelihood activities, with many becoming fish traders and buying in fish from elsewhere. Others have abandoned fishing completely and own small shops and tea stalls or operate cycle rickshaws. The need to get more floodwater on the floodplain was also one of the suggestions of ways to reduce the level of drawdown of the watertable. Copyright © 1997 by Bangladesh Centre for Advanced Studies.

Chadwick, M. T.; J. G. Soussan; S. S. Alam; and D. Mallick (1997) *From Flood to Scarcity of Water: Re-Defining the Water Debate in Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies (BCAS)); available at: http://www.eldis.org/fulltext/bcaswater.pdf. **Abstract/Summary:** This is a 6-page note on an empirical study undertaken by a team of researchers from BCAS and the Environment Centre from the University of Leeds. They found that scarcity of adequate quality water is the main problem in the country even during flood. It was learnt from the stakeholder group consultations that scarcity of monsoon floodwaters appeared to be the primary concern of the majority of livelihood groups. There was a agreement on the resulting consequences. These include a reduction in soil fertility due to lack of silt being deposited on fields that replenish the soil nutrients. The research suggests that we may re-think the prevalent paradigm in Bangladesh from how to cope with too much water in monsoon (i.e., flood) to how to cope with lack of water in the future, especially with a climate change-induced increase in temperatures. Copyright © 1997 by Bangladesh Centre for Advanced Studies.

Choudhury, A. M. (1986) *Our Climate in Danger*, Trieste, Italy: International Centre for Theoretical Physics (ICTP), ICTP Internal Report IC/86/240; also published in the Proceedings of the Regional Seminar on the Applications of Remote Sensing Techniques To Coastal Zone Management and Environmental Monitoring organized by UNDP/ESCAP Regional Remote Sensing Programme (RAS/81/034) in Dhaka (18-26 November), pp. 213-221. Available at: http://streaming.ictp.trieste.it/preprints/P/86/240.pdf. **Abstract/Summary:** In this paper, the effect of the increase in the temperature of the earth's atmosphere as a consequence of the increase in CO_2 content and other trace gases has been reviewed. The results have been obtained by a number of model studies. The effect of the depletion of the ozone layer has also been considered. There is the horrific prediction that the global mean temperature of the earth will rise by about 3°C and the antarctic ice will melt by the middle of next century. As a result, the mean

sea level will rise by several meters and this will make many cities and countries (or part of countries) vanish from the globe. As Bangladesh is a low deltaic region, it will be especially vulnerable. Model computations show that in some regions rainfall will increase whereas in other regions especially in the tropics, rainfall will decrease and desertification will increase. If this happens, mankind will be faced with a major disaster in history. Effects on the society in general and remedial measures have been discussed. Copyright © 1986 by International Centre for Theoretical Physics.

Choudhury, A. M. (1994) Bangladesh Floods, Cyclones and ENSO, Trieste, Italy: International Centre for Theoretical Physics (ICTP), ICTP Internal Report IC/94/78; also published in the Proceedings of the International Conference on Monsoon Variability and Prediction, Vol. 1, pp 136-145, WMO,WCRP-84,WMO/TD-No. 619 (July); available at: http://streaming.ictp.trieste.it/preprints/P/94/078.pdf. **Abstract/Summary:** It has been found that in general there is a reduction of rainfall in all the regions of Bangladesh in all the seasons – pre-monsoon, monsoon and post monsoon during El Nino years. It has also been observed that in a strong El Nino year Bangladesh is not hit by a catastrophic flood or a catastrophic cyclone. In the past, occurrence of famines in this region of the world coincided with El Nino years. The years of weak El Nino or when the El Nino index is positive seem to be favorable for the occurrence of floods and cyclones in Bangladesh. A theory of the modulation of the monsoon in Bangladesh by the Walker circulation has been described in the paper. Copyright © 1994 by International Centre for Theoretical Physics.

Choudhury, A. M.; M. A. Haque; and D. A. Quadir (1997) "Consequences of Global Warming and Sea Level Rise in Bangladesh", *Marine Geodesy*, Vol. 20, No. 1 (Special Issue on Sea Level Problems of Bangladesh), pp. 13-31. **Abstract/Summary:** In the present article, problems associated with global warming and sea level rise in Bangladesh due to the greenhouse effect are discussed on the basis of predictions made by some climate models and analysis of long-term records of temperature and rainfall at a few stations in Bangladesh. A comparative analysis of the IPCC report and some model results indicate various climatic changes and sea level rise in the future environment of this region due to greenhouse warming. The change of climatic parameters, rainfall, and associated problems such as enhanced surface warming, floods, sea level rise, etc., has direct adverse effects on the socio-economy of Bangladesh. In view of the above, the monthly mean maximum and minimum temperatures for the months of May and December covering a period of 32 years (1961-1992) at eight uniformly distributed stations in Bangladesh have been processed and analyzed to investigate the long-term temporal behaviors. Seven-year moving averages of the monthly data have been calculated in order to investigate any trend of temperature during the study period. Annual rainfall data have also been used to see the temporal and spatial variability of rainfall in the country. The long-term trend of temperature in the region surrounding Bangladesh is also discussed based on investigations made by some Indian researchers. Some of the main results of this study are that the calculations show both increasing and decreasing trends over Bangladesh. The average increasing trend of temperature over Bangladesh, except in the southwest region (Khulna) in the pre-monsoon season of April and May, is around 0.11-0.20°C. The increasing trends have been observed for all the stations in the maximum and minimum temperatures of the month of December. In the winter season (December-January), the overall trend seems to be on the positive side, and it is around 0.33°C during the past 32-year period at the 95% confidence level. The results from greenhouse warming simulation of climate change models suggest a rise in annual mean surface temperature

of between 1.5 and 2.5°C over Bangladesh and its neighborhood by the end of the next century for the doubling of the CO_2 scenario. The seven-year moving averages of rainfall in Bangladesh showed a slight increase of annual rainfall of about 8 mm over the whole observation period with a slight decrease in the last few years. Yet, the overall flood situation in Bangladesh has worsened in the last few years because of intense precipitation in the upper catchment of all the river systems flowing through Bangladesh. Copyright © 1997 by Taylor and Francis Ltd.

Choudhury, A. M.; D. A. Quadir; S. Neelormi; and Ahsan Uddin Ahmed (2003) "Climate Change and its Impacts on Water Resources of Bangladesh", in: Amir Muhammed (ed.) *Climate Change and Water Resources in South Asia* (Islamabad, Pakistan, et. al: Asianics Agro Dev International; The Asia-Pacific Network for Global Change Research; Fred J. Hansen Institute for World Peace).Abstract/Summary: This Bangladesh country study (presented at a workshop in Kathmandu, Nepal, 7-9 January, 2003) has been carried out as a part of a South Asian Regional Study on Assessment of Climate Change-associated Vulnerabilities and Coping Mechanisms, which had been undertaken simultaneously in Bangladesh, India, Nepal, and Pakistan. The objective of the study is to assess the impacts of climate change variability associated extreme hydrological events on the shared water resources of the South Asian countries mentioned above. In the first year of the joint activity, an attempt has been made to analyze observed climate variability on Bangladesh, assess adverse impacts of such climate variability on bio-physical environment, economic and social lives of the country and its people, and to identify traditional coping strategy being applied in view of the observed climate variability. This report highlights only the findings of currently observed variability of climate parameters and their extremes, based primarily on secondary information, and how these are translated into biophysical, economic, and social vulnerability. According to Intergovernmental Panel on Climate Change (IPCC, 2001), discernable changes are about to take place in the climate system of the globe. South Asian region is likely to be one of the worst hit regions around the world due to its high susceptibility to extreme weather events as a consequence of high temporal, spatial, and inter-annual climate variability. It is prognosticated that the western Himalayan region will face increased vulnerability to drought, while the eastern Himalayan parts will experience increased floods in terms of both extent and frequency. While it is argued that 'normal' inundation rather helps rural society by facilitating agriculture, floods of catastrophic magnitude create problems, both in rural and urban areas. The poor are usually the worst victims of high intensity floods. Floods often trigger pauperization, while river bank erosion certainly renders many as homeless and destitute. Adaptation to such high intensity floods would require both engineering-driven hard measures and non-structural measures, the latter being mostly society-driven. A mix of both types of measures would enable the country to cope with floods under climate change scenarios. Copyright © 2003 by Asianics Agro Dev International et al.

Choudhury, A. M.; S. Neelormi; D. A. Quadir; S. Mallick; and A. U. Ahmed (2005) "Socio-Economic and Physical Perspectives of Water Related Vulnerability to Climate Change: Results of Field Study in Bangladesh", *Science and Culture*, Vol. 71, No. 7/8, pp. 225-238**.** **Abstract/Summary:** The present paper deals with the socio-economic perspectives of the water related vulnerability to climate change based upon the data collected from the Selected Hydrological Unit (SHU) through questionnaire survey supported by PRA/FGD and interview with key Informants. The SHU which is situated in the northern part of Bangladesh to the left Bank of the river Brahmaputra (locally named as Jamuna) is highly vulnerable to floods. The analysis of the past climate of Bangladesh shows that the average temperature increases at the

rate of 0.16 degree C per decade. The pre-monsoon and monsoon rainfall has increased by about 20% during the past 30 years. The hydrological observations show that the frequency of severe floods and the intensity have been found to increase during the last 3 decades. The scenarios of climate change show that the annual mean temperature over the region of the SHU is expected to rise by 1.5 and 2.8 degrees C by 2020 and 2050, respectively relative to 1990 and the annual precipitation by 9.1% and 22.7% for the above two time levels. The pre-monsoon precipitation would increase by 27% and 70%. The monsoon precipitation is expected to increase by 4.2% and 9.7% for the above two time levels. The SHU is highly vulnerable to severe floods. The lives of the people are seriously affected by the severe floods, dwelling houses are inundated and damaged and the resources such as agriculture, livestock and fisheries also suffer severe damages. People suffer from the lack of shelter, food, medicine and potable water. The increased rainfall is expected to further increase the flood intensity and enhance the vulnerability in the future. The riverbank erosion has been identified as another water related hazard which is more active during the floods. The people are coping to some extent in the agriculture sector. They wait until the peak flood is over for planting of the aman rice which is grown in the monsoon and post-monsoon season. In case, the crops were damaged due to severe floods, the farmers replant the aman rice in the fields as soon as the flood water recedes. It came out from the field information that the farmers do not depend on the aman rice anymore as they have shifted towards the irrigated cultivation in the dry season to recover the crop damages due to floods in the monsoon season. However, they have not abandoned the aman rice cultivation, because if there is no flood they can get a very good harvest. As regards the adaptation in other sectors such as housing and livestock, strong houses need to be built by raising the lands above flood level so that neither the dwelling houses nor the lawn of the houses are affected. In that case the livestock will not be affected anymore. This will solve the problems permanently and reduce the sufferings. However, a huge majority of the people lives below the poverty line and cannot afford these expensive coping options. Thus poverty alleviation is identified as a crucial means of increasing the adaptive capacity of the people.

Choudhury, Nusha Yamina; Alak Paul; and Bimal Kanti Paul (2004) "Impact of costal embankment on the flash flood in Bangladesh: a case study", *Applied Geography*, Vol. 24, No. 3, pp. 241-258. **Abstract/Summary:** Coastal areas of Bangladesh frequently experience tropical cyclones and associated tidal bore. In order to prevent cyclonic or storm-surge flooding and to increase crop production by preventing intrusion of saline ocean water, many coastal embankment projects were initiated in the 1960s by the Bangladesh government. After construction of these embankments, particularly their reconstruction in 1991 has increased the frequency of flash floods in coastal areas. The objective of this study is to examine to what extent the reconstruction of embankment is responsible for the increased severity of flash flooding.

Choudhury, Waziul Alam; Firoz Ahmed Quraishi; and Ziaul Haque (2006) "Mental Health and Psychosocial Aspects of Disaster Preparedness in Bangladesh", *International Review of Psychiatry*, Vol. 18, No. 6 (December)**. Abstract/Summary:** The aim of this paper is to highlight the activities and observations of some NGOs and some dedicated researchers in the field of psychosocial consequences of disaster in Bangladesh, particularly in the coastal areas and the tornado-affected areas of the district of Tangile and Jamalpur during the last two decades. Some of the advantages of the non-governmental organizations' (NGOs) work in relief

and development were their linkages with grass-roots people ensuring access to the community and community participation, the flexible approach of work, ability and willingness to learn from people and ability to connect people's lives with their realities. The most remarkable survey carried out by the Social Assistance and Rehabilitation for the Physically Vulnerable (SARPV-Bangladesh) after the 1996 tornado showed, on average, that women are more affected psychologically than men; 66% of the total sample in the disaster area were psychologically traumatized and required emergency services. The study supports the ideas that any disaster will have mental health consequences. Providing scientific psychological services is essential for real recovery from such a disaster. In developing countries like Bangladesh, limitations of mental health professionals and inadequate knowledge and practice about disaster mental health among the medical and paramedical staff, may lead to delays in the psychosocial management and rehabilitation of the survivors. To respond properly to a serious type of disaster like a cyclone or a tornado or recurrent devastating flood, the disaster mental health team should be aware of the socio-economic status, local culture, tradition, language and local livelihood patterns. Integration of the team with the network of various governmental and non-governmental organizations is essential to provide mental health services effectively.

Chowdhury, Ehsan Hafiz and Atiq Kainan Ahmed (2005) *Strengthening Disaster Risk Management in the Agricultural Sector in Bangladesh -- Study on Physical and Environmental Context, Institutional Analysis and Vulnerable Group Profiling in Selected Project Pilot Areas in the NW of Bangladesh* (Dhaka: Center for Environmental and Geographic Information Services (CEGIS)); available at: http://www.fao.org/sd/dim_pe4/docs/pe4_051201_en.pdf. **Executive Summary:** Under the FAO-DAE project titled "Support to the Strengthening of Disaster Preparedness in Agricultural Sector (SSDP) project" the present study has been carried out by the CEGIS multi-disciplinary team. - The major objectives of the CEGIS study was threefold: a) Development of a replicable methodology for vulnerability assessment and analysis; b) finding out the vulnerabilities in the three major areas (i.e. physical/environmental, livelihoods, and institutional) that can be used for plan of action for increasing preparedness; and c) leading towards contributing to the overall capacity building exercise of the DAE for agricultural disaster preparedness. The study has primarily focused on two different types of vulnerabilities: flood and drought. The study has been carried out with a preparedness approach and with specific respect to the agriculture sector in Bangladesh. Under the study, flood and drought hazard maps are produced. For drought hazard mapping innovative and nationally accepted DRAS model has been run. Flood hazard mapping has been yielded out of a model run with latest scientific data available for flood modeling. - The livelihoods and institutional analysis have been developed with a participatory vulnerability assessment framework which is based on the existing contextualized works carried out for livelihoods and vulnerability assessments in Bangladesh. Building on the three tiers of vulnerability analysis (environmental, livelihoods and institutional) the present study has developed an integrated analysis and pointed out some of the emerging issues that prevail in the flood and drought vulnerable pilot areas. The core issues emerged from the study is that all livelihoods of the people residing in these areas are vulnerable to multiple aspects of hazards. Some of these vulnerabilities are associated with climatic or environmental conditions, some are linked with anthropogenic causalities or livelihoods dimensions; and some are the results of people's access to adequate services from formal and informal institutional services. Furthermore, these are not only multiple dimensions of a single hazard but also multiple types of vulnerabilities within themselves. Amongst all these "spiral vulnerabilities" one

encouraging issue is, some people are also trying to stay less vulnerable – less affected through better managing of their vulnerabilities. These core knowledge acquired through the present study thereby has usefulness and has a direct utilization for the SSDP project and other initiatives of disaster preparedness. The capacity building process for preparedness both within the DAE outside would be benefited by the findings of study and the methodology developed for vulnerability assessment. Copyright © 2005 by Center for Environmental and Geographic Information Services.

Chowdhury, Md. Rashed and M. Neil Ward (2003) "Seasonal Rainfall and Stream-flow in the Ganges-Brahmaputra Basins of Bangladesh: Variability and Predictability", in: Paul Bizier and Paul DeBarry (eds.) *Proceedings of the World Water and Environmental Resources Congress 2003* (Reston, VA: American Society of Civil Engineers)**. Abstract/Summary:** The flows of the Ganges and Brahmaputra in Bangladesh are highly seasonal, and heavily influenced by the monsoon rainfall. As a result the rivers in the region swell to brims and often overflow during the monsoon months whereas during the dry months (Nov. – May) the flows in the rivers reduce dramatically. The region, therefore, faces two major hazards: floods during the monsoon and scarcity of water during the dry season. These hazards are most pronounced in the downstream regions, particularly in Bangladesh, which is the lowest riparian of the Ganges. The objects of this paper are i) to study the hydro-meteorological variability and change for the greater Ganges and Brahmaputra regions, including the headwater regions and their role in stream flow in Bangladesh, and ii) to quantify the variability of key stream flow features of the seasonal hydrographs for Ganges and Brahmaputra Rivers, and iii) to explore the climatic factors influencing these hydrologic changes. Copyright © 2003 by American Society of Civil Engineers.

Chowdhury, Naved Ahmed (2008) Climate Change, Vulnerability and Livelihood Possibilities and Prospect of the Charlands of Bangladesh (Dhaka: Unnayan Onneshan); available at: http://www.unnayan.org/env.unit/paper4.pdf. **Abstract/Summary:** This paper (which is the first in Unnayan Onneshan's Climate Study Series) examines the vulnerability situation of people in the Charlands of Bangladesh. These are sandbars that emerge as islands within the river channel or as attached land to the riverbanks as a result of the dynamics of erosion and accretion in the rivers. The Charlands are home to some of the poorest and most vulnerable people in Bangladesh and are particularly prone to the effects of frequent climatic shocks such as floods, droughts and cyclones. The paper concludes that interventions to increase agricultural productivity without addressing the vulnerability context of peoples' livelihood strategies will do little to affect poverty dynamics. Rather, the poverty impacts of development interventions are greater where there is convergence between the intervention strategy and household livelihood strategies. Copyright © 2008 by Unnayan Onneshan.

Chowdhury, Naved Ahmed (2008) Men, Women and the Environment Gender Issues in Climate Change (Dhaka: Unnayan Onneshan); available at: http://www.unnayan.org/env.unit/paper5.pdf. **Abstract/Summary:** This paper (which is the second in Unnayan Onneshan's Climate Study Series) throws light on inadequacy of the awareness of the inefficiencies and inadequacies of existing approaches and intervention methods in responding to emergency situations like climate change from a gender perspective. It therefore suggests that non-governmental, international and regional organizations should assist governments in developing gender-sensitive strategies to address climate change by: • making sound environmental management, risk management and

gender equality an integral part of sustainable development; • creating and implementing, with the involvement of community groups and women's groups, comprehensive rural and urban development strategies, that will include gender sensitive adaptation for climate change; • encouraging institutions to use formal guidelines to promote gender-sensitive environmental policies and programmers and apply gender mainstreaming tools where they exist; • making local residents full and equal partners in the development of safer communities and incorporate indigenous knowledge, skills and capacities, particularly of poor women into environmental management and climate change adaptation; and • collaborating in the creation of networks that promote community access to gender-sensitive information and communication technologies supporting information exchange on environmental management and climate change. In concludes that climate change initiatives offer clear opportunities to transform gender relations which limit the ability of both women and men to anticipate, survive, cope with, and recover from the effects of disasters. It is within this broad context that the need for a holistic and gender-sensitive approach to sustainable development and climate change adaptation and the implications of this framework need to be addressed. Copyright © 2008 by Unnayan Onneshan.

Chowdhury, Rabindranath Roy (2008) Climate Change and Bangladesh: Our Vulnerability and Response; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation provides an overview of Bangladesh's vulnerabilities to climate change as well as Bangladesh's responses, which include among others the NAPA, adaptation research modeling activities, and mitigation activities undertaken by Bangladesh under the Clean Development Mechanism (CDM). Copyright © 2008 by the author(s).

Chowhan, Gopal; Shyamal Kanti Barman; SAFE Development Group; with support from the RVCC Team (2005) *The Reducing Vulnerability to Climate Change (RVCC) Project: Reflecting on Lessons Learned* (Dhaka: CARE Bangladesh (March); available at: http://www.carebd.org/RVCC%20EoP%20Lessons%20Learned-Strategic-Final.pdf.
Abstract/Summary: CARE has undertaken a variety of studies analyzing the impacts of climate change at the local level, including specifically at the ability of households and communities to respond to adverse climate change impacts. Ensuring that the very real needs and interests of vulnerable communities throughout Bangladesh are properly addressed in adaptation planning is crucial if poor people are not to be lost in the whirl of integrated assessment modeling exercises and big money, high profile, national level adaptation strategies. CARE has identified a large group of extremely vulnerable households in the southwest that has moved from reasonably stable livelihoods to high levels of vulnerability and food insecurity. One problem area that is not currently being addressed by anyone is the disruption of farming systems that may occur as sea levels rise. While sea levels have not yet risen significantly as a result of global warming, the southwest part of Bangladesh is already exhibiting symptoms that may indicate what could appear from rising sea levels. These include water logging, poor drainage through river systems, siltation and saline intrusion. As a result of these changes over the last decade, farming systems have been seriously disrupted, and coping mechanisms do not exist yet to enable households that have been affected to be able to adjust to new farming systems. These households used to be able to produce two rice crops per year on land they could access through sharecropping or lease. Now, these households produce one rice crop in the winter season and have to search for other sources of food or income the rest of the year. Sharecroppers make up a significant portion of

this target group and are extremely food insecure. It is estimated that there are approximately 100,000 households that fall within the target group in the southwest of the country. The report concludes that the RVCC Project has achieved considerable success in piloting an approach to climate change adaptation at the grassroots level through awareness, action and advocacy. Significant results have been achieved in all areas: awareness of climate change issues has been raised at multiple levels throughout the southwest region; vulnerable households are testing agriculture and livelihood measures that will reduce their vulnerability to environmental change; Union Parishads (root level administrative units of local government) have greater capacity to address the vulnerability issues of their constituencies; and the issue of salinity and drinking water is gaining attention by decision-makers at local, regional and national levels. The learning-by-doing process adopted by the project has generated significant lessons that can inform the design of future programming on adaptation to climate change, or of livelihoods projects aiming to incorporate climate change considerations. Copyright © 2005 by CARE Bangladesh.

Christian Aid (2007) *Human Tide: The Real Migration Crisis* (London: Christian Aid, May); available at: http://www.christian-aid.org.uk/Images/human_tide3__tcm15-23335.pdf. **Abstract/Summary:** At least one billion people will be forced from their homes between now and 2050 as the effects of climate change deepen an already burgeoning global migration crisis, predicts a new Christian Aid report. With regards to climate change and Bangladesh, the report refers to the Stern Review (see Stern 2006), which states that due to climate change, large numbers of people will be compelled to leave their homes when resources drop below a critical threshold. Bangladesh is mentioned as an example as it faces the permanent loss of large areas of coastal land, affecting 35 million people (about one-quarter of its population). Copyright © 2007 by Christian Aid.

Cruz, R. V.; H. Harasawa; M. Lal; S. Wu; Y. Anokhin; B. Punsalmaa; Y. Honda; M. Jafari; C. Li; and N. Huu Ninh (2007) "Asia", in: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability -- Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* (Cambridge, UK: Cambridge University Press), pp. 469-506 (Chapter 10); available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter10.pdf**.** **Abstract/Summary:** This chapter of the 2007 IPCC Assessment Report focuses specifically on the Impacts in Asia; it contains various examples from Bangladesh. Copyright © 2007 by Cambridge University Press.

Dasgupta, Susmita; Benoit Laplante; Craig Meisner; David Wheeler; and Jianping Yan (2007) "The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis", *World Bank Policy Research Working Paper*, No. 4136 (February). **Abstract/Summary:** This paper assesses the consequences of continued sea level rise (SLR) for 84 developing countries using geographic information system (GIS) software to overlay spatially-disaggregated global data on critical impact elements (land, population, agriculture, urban extent, wetlands, and GDP) with the inundation zones projected for one to five meter SLR. Our results reveal that hundreds of millions of people in the developing world are likely to be displaced by SLR within this century; and accompanying economic and ecological damage will be severe for many. At the country level, results are extremely skewed, with severe impacts limited to a relatively small number of countries. However, the consequences of SLR for these countries are potentially catastrophic. For many others, including some of the largest countries (e.g., China), the absolute magnitudes

of potential impacts are very large. At the other extreme, many developing countries experience limited impacts. Among regions, East Asia and Middle East/North Africa exhibit the greatest relative impacts. Copyright © 2007 by The World Bank. **Note:** It needs to be stressed that the comparisons across countries and regions in this study is limited to inundation of the coastal zones. Including inland inundation, which is significant in the case of Bangladesh, would show far worse impacts for Bangladesh.

Datta, Dipankar and Kamal Kar (2006) "Getting the message across: Promoting ecological agriculture in Bangladesh", London, UK: International Institute for Environment and Development (IIED), *Gatekeeper Series*, No. 22 (May); available at: http://www.iied.org/pubs/pdf/full/14515IIED.pdf. **Abstract/Summary:** Amid mounting concern over increasing reliance on high-yielding varieties, chemical fertilizers and pesticides among Bangladesh's smallholder farmers, many NGOs have been training farmers in more sustainable farming methods. Despite this, the numbers of farmers adopting ecological agriculture have not been great. In this paper we explore why this is so, drawing on action research we conducted in 16 Bangladeshi villages. We found that although many trained farmers realize the importance of ecological agriculture, they are not always able to put the training into practice, especially on their major farming land which provides them with most of their livelihood security. However, farmers have adopted this approach more on their homestead land, which is less controlled by market forces and is free from other external factors. This perhaps reflects farmers' belief in the need for such an approach. A key roadblock to the wider adoption of ecological agriculture was the lack of organic fertilizers. Two suggestions to overcome this are to (1) establish commercial units to produce organic fertilizers and (2) promote crop diversification to improve the nutritional status of the soil, as well as improve food security and nutrition for their families. Other steps could include increasing the use of participatory and farmer-led approaches for introducing ecological agriculture; improving coordination among NGOs for more coherent training and joint marketing activities; widening target groups and increasing evidence-based advocacy for ecological agriculture at the policy level. Copyright © 2006 by International Institute for Environment and Development.

de Wilde, Koen (ed.) (2000) *Out of the Periphery: Development of Coastal Chars in Southeastern Bangladesh* (Dhaka: The University Press Ltd.). **Abstract/Summary:** A range of vulnerabilities and an unfulfilled potential for development are the main features of the coastal belt in the southeastern part of Bangladesh. On a day-to-day basis the people living on the coastal belt has to address vulnerabilities as diverse in nature as drainage congestion and the salinity of the soil constraining agricultural yields, cyclones and storms that pose risks to lives and property. Additionally, a heterogeneous social environment with undue influence of well positioned land grabbers can make life and living difficult. In the newly formed areas along the coast of the Bay of Bengal, the Government is hardly present, leading to low access to public services. Promoting development in such a situation is a considerable challenge. This book describes and reflects upon how the response to this challenge was given shape in char areas in the southern part of Noakhali District. It is primarily based on the experiences in the Char Development and Settlement Project, a development intervention financed by the Governments of Bangladesh and The Netherlands. The main purpose of the book is to provide lessons that can be applied in any future development programme in the chars. Copyright © 2000 by The University Press Limited.

Debsarma, S. K. (2003) "Intra-Annual and Inter-Annual Variations of Rainfall over Different Regions of Bangladesh", in: D. A. Quadir, K. Prasad, and M. A. Hussain (eds.) *Proceedings of SAARC Seminar on Climate Variability in the South Asian Region and its Impacts* (held on 10-12 December 2002) (Dhaka: SAARC Meteorological Research Center (SMRC))**.** **Abstract/Summary:** Series of 31-year (1970-2000) monthly rainfall data from 34 surface (synoptic) observatories of Bangladesh have been analyzed for the variations and trends over Bangladesh's four rainfall regions and over the whole country. There were a few missing data in the early seventies that were filled in by long period average values and by linear interpolation technique. Monthly and yearly averages of the four regions and country as a whole were calculated and then graphs were created together with linear as well as curvilinear (6th order) regression. Long-term episode cycles (periodicity) were also calculated. No clear-cut long-term periodicity was found for the months of September and December in all regions and all of Bangladesh. Regression lines for the period of 31 years indicate slowly increasing trend in most of the cases during January-March, almost stable during May-August and October and decreasing trend for annual rainfall during rest of the months. However, annual rainfall tended to increase in some regions and tended to decrease in other regions during the last decade (particularly after 1995). Linkages between annual rainfall and ENSO (El Nino-Southern Oscillation) and QBO (Quasi-Biennial Oscillation) were found. Copyright © 2003 by SAARC Meteorological Research Center (SMRC).

Dhar, O. N. and S. Nandargi (2004) "Co-existence of severe drought in India and extreme floods in Bangladesh during the 1987 monsoon season", *The International Journal of Meteorology*, Vol. 29, No. 289, pp. 161-167. **Abstract/Summary:** The year 1987 was a severe drought year for India due to failure of summer monsoon over most of the country except for the seven sub-divisions of northeast India (Arunachal Pradesh, Assam and Meghalaya, Nagaland and Manipur, Sub-Himalayan West Bengal and Sikkim, Gangetic West Bengal, Bihar Plateau and Bihar Plains) which received above normal rainfall. In the monsoon season of 1987, extreme floods in Bangladesh were caused by cross-border floods of three Indian rivers, namely the Brahmaputra, the Ganga and the Meghana and due to heavy monsoon rains over Bangladesh. This study has also confirmed that in some years, during summer monsoon season, there is an inverse relationship between rainfall over northeast India and rest of India. Copyright © 2004 by The International Journal of Meteorology.

Drakenberg, Olof and Daniel Slunge (2006) "Climate change and implications for Bangladesh - Input to discussion on Swedish cooperation strategy with Bangladesh (Göteborg, Sweden: Göteborg University, School of Economics and Commercial Law, Department of Economics, Environmental Economics Unit, Policy Brief (March); available at: http://www.hgu.gu.se/Files/nationalekonomi/EEU/Helpdesk/Climate%20change%20Bangladesh%20EEU%20comment%20060315.pdf. **Abstract/Summary:** The Policy brief was written at the request of Sida's Asia department and INEC as part of Sida-EEU's institutional collaboration on environmental economics and strategic environmental assessment. This policy brief gives a background to the implications of climate change for Bangladesh and points at possible implications for Swedish cooperation strategy with Bangladesh. Copyright © 2006 by the author(s).

Efroymson, Debra (2005) *Climate Change: Information and Suggestions* (Dhaka: Work for a Better Bangladesh (WBB) Trust); available at:

http://www.wbbtrust.org/research/Climate%20change.pdf. **Abstract/Summary:** This report contains a general description of the way we understand the basic process of climate change and how we are contributing to it. It also contains suggestions on what can be done to reverse the process and save our planet and ourselves. It suggests that Bangladesh engages in a two-pronged strategy: (a) to lobby the major polluters in the world (China and India will soon account for much of the carbon dioxide emissions, simply because their populations are so huge and their energy demands increasing so fast, but the US continues to be the main source, and certainly the most energy-wasteful country) to cut back drastically on their carbon emissions; and (b) to provide moral leadership and a practical example by following a development path that allows for better lifestyle without drastically increased energy consumption. That is, rather than emulating destructive and wasteful Western patterns, we should establish a conservation-minded, Eastern approach that focuses on quality of life, rather than on increased energy use. Copyright © 2005 by Work for a Better Bangladesh Trust.

Ericksen, N. J.; Qazi Kholiquzzaman Ahmad; and A. R. Chowdhury (1993) *Socio-Economic Implications of Climate Change for Bangladesh* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 4); available at: http://www.waikato.ac.nz/igci/downloads/BriefingDoc4.pdf; also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers, 1996), pp. 205-287 (Chapter 5). **Abstract/Summary:** Land and life are closely entwined in Bangladesh. Over 80 percent of the country's 115 million people live in the rural sector. The land area of 148,393km^2 is mainly the deltaic plains of the Ganges and Brahmaputra River systems. The prevailing climate is monsoonal, and the dominantly agricultural economy is attuned, to its wet and dry seasons. Lands are frequently flooded by heavy rains, over-full river channels, and sea surges associated with cyclones. Disasters are relatively common. Changes in climate in Bangladesh could, therefore, have serious implications for local economies and human welfare. This is the theme that is explored in this chapter. The main relationships between society and climate are identified so that the impacts of a changing climate, especially natural hazards, might have on society can be appraised. Understanding of the main relationships between society and climate will help assess the socio-economic vulnerability or resiliency of the country should it in future experience a period of rapid climate change. This theme is explored through four main questions: How does the current climate affect Bangladesh society and economy? What societal trends may influence the vulnerability of Bangladesh to changes in climate? What are the possible socio-economic impacts of climate change on Bangladesh in future? What alternatives are there for future adaptations to climate change? The chapter concludes with a summary of research needs and a framework for prioritizing options. Copyright © 1993 by Kluwer Academic Publishers.

Faisal, I. M. and S. Parveen (2004) "Food Security in the Face of Climate Change, Population Growth, and Resource Constraints: Implications for Bangladesh", *Environmental Management*, Vol. 34, No. 4, pp. 487-498. **Abstract/Summary:** Ensuring food security has been one of the major national priorities of Bangladesh since its independence in 1971. Now, this national priority is facing new challenges from the possible impacts of climate change in addition to the already existing threats from rapid population growth, declining availability of cultivable land, and inadequate access to water in the dry season. In this backdrop, this paper has examined the nature and magnitude of these threats for the benchmark years of 2030 and 2050. It has been shown that the overall impact of climate change on the production of food grains in Bangladesh

would probably be small in 2030. This is due to the strong positive impact of CO_2 fertilization that would compensate for the negative impacts of higher temperature and sea level rise. In 2050, the negative impacts of climate change might become noticeable: production of rice and wheat might drop by 8% and 32%, respectively. However, rice would be less affected by climate change compared to wheat, which is more sensitive to a change in temperature. Based on the population projections and analysis of future agronomic innovations, this study further shows that the availability of cultivable land alone would not be a constraint for achieving food self-sufficiency, provided that the productivity of rice and wheat grows at a rate of 10% or more per decade. However, the situation would be more critical in terms of water availability. If the dry season water availability does not decline from the 1990 level of about 100 Bm3, there would be just enough water in 2030 for meeting both the agricultural and nonagricultural needs. In 2050, the demand for irrigation water to maintain food self-sufficiency would be about 40% to 50% of the dry season water availability. Meeting such a high agricultural water demand might cause significant negative impacts on the domestic and commercial water supply, fisheries, ecosystems, navigation, and salinity management. Copyright © 2004 by Springer.

Faruque, Hossain Shahid Mozaddad and Md. Liakath Ali (2005) "Climate Change and Water Resources Management in Bangladesh", in: M. Monirul Qader Mirza and Qazi Kholiquzzaman Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers), pp. 230-252 (Chapter 9). **Abstract/Summary:** Possible change in climate will complicate water management problems in Bangladesh. In order to minimize the potential risks, studies have been undertaken regarding adaptation to climate change in Bangladesh and there appears to be consensus that the country is too vulnerable to be able to ignore the anticipated effects in current and future planning. Many of the proposed strategies, are needed even without climate change effects in order to accommodate the needs of the rising population. The basic strategies identified for accommodating the effects of climate change are; Physical measures to reduce drainage congestion (or at least avoid worsening the present situation); Pumped or other natural energy based (wind or tidal current) drainage may be required; Land filling using natural or artificial methods to prevent, or at least reduce, inundation and promote drainage; Increased tree and mangrove planting on accreted lands and in coastal belts; Measures for the improvement of livelihood condition of the coastal people; Encourage more efficient use of water resources. Strategic adaptation to climate change should produce a coordinated response, supported by all stakeholders, on three different levels: Planning and natural resources management, including the participation of different stakeholders in the decision-making process; Information needs, management and dissemination; International positioning and representation. Copyright © 2005 by A. A. Balkema Publishers.

France-Lanord, Christian; Valier Galy; Maarten Lupker; Bruno Lartiges; Albert Galy; Jerome Gaillardet; Ananta Gajurel; Mustafizur Rahman; and Sunil K. Singh (2008) Suspended sediment variability and erosion geochemical budget of the Brahmaputra-Ganga basin; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation highlights Bangladesh's delicate balance between sediment deposition and subsidence. Both are influenced by climate change. The presentation concludes that the geochemical approaches better document fluxes of sediments; yet, large uncertainties remain due to a lack of data. Copyright © 2008 by the author(s).

Freestone, D.; M. Farooque; and S. R. Jahan (1993) *Legal Implications of Global Climate Change for Bangladesh* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 5); also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers, 1996), pp. 289-334 (Chapter 6). **Abstract/Summary:** The potential responses to climate change and sea-level rise will be governed to a large extent by the legal context within which Bangladesh functions. The Bangladesh legal system has a wealth of experience in dealing with problems directly relevant to the climate change issue, such as inundation, flooding and population displacement. However, the scale of such problems is likely to be exacerbated by global warming. It is therefore imperative to search for ways of strengthening legal institutions in order to assist Bangladesh in addressing current problems as well as potential future problems. The purpose of this chapter is to examine both the national and international legal contexts that impinge upon decisions relating to climate and sea-level change. The chapter focuses on three critical questions. What are the characteristics of the national legal order, particularly with respect to land tenure and property rights, that may facilitate or constrain certain policy options or response strategies? What are the conventions or other rules of international law by which Bangladesh is bound that provide the framework for decision-making and action? Finally, what are the informational and research needs that would enhance the capability of Bangladesh to respond effectively to climate change and sea-level rise? This review suggests that there needs to be greater attention paid to ways of implementing international rules within the Bangladesh context in order to ensure coordination of internal policies with international norms.

Friendly, Alfred (ed.) (1998) *Bangladesh-2020: A Long Run Perspective Study* (Dhaka: The University Press Ltd. with Bangladesh Centre for Advanced Studies; available at: http://go.worldbank.org/NTPHG4XVE0. **Abstract/Summary:** This perspective study is the first attempt to map out a medium term future for Bangladesh, mindful of both current constraints and the vast potential for mobilizing the latest forces for positive change that could be unleashed. It is an attempt to examine long-term possibilities and opportunities in order to help policy makers take better decisions today.

Fung, Chak Fai; Francis Farquharson; and Jahir Chowdhury (2006) "Exploring the impacts of climate change on water resources - Regional impacts at a regional scale: Bangladesh" in: Siegfried Demuth, Alan Gustard, Eduardo Planos, Fred Scatena, and Eric Servat (eds.) *Climate Variability and Change—Hydrological Impacts (Proceedings of the Fifth FRIEND World Conference held at Havana, Cuba, November 2006)*, (Oxfordshire, UK: International Association of Hydrological Sciences (IAHS) Publication), pp. 389-393. **Abstract/Summary:** Bangladesh is located at the confluence of three major river basins: the Ganges, Brahmaputra and Meghna (GBM) basins. The GWAVA (Global Water AVailability Assessment) model, a global-scale gridded approach to hydrological modelling, has been applied to all GBM basins to investigate the impacts of climate change on water resources at a regional scale. The entire model set-up is composed of a coarse-scale GBM-wide model at 0.5 degrees resolution and a fine-scale model at 0.1 degrees representing Bangladesh. A suite of climate scenarios have been collated from regional climate data using the Hadley Centre's HadRM2 and that generated by the Indian Institute of Tropical Meteorology using the Hadley Centre's PRECIS. Scenarios for water demands have been developed for the present and future based on socio-economic data from various publicly available sources and local water management plans. The comparison of water

demands with supply using spatial-temporal distributed water availability indices enables areas of future scarcity to be identified. Copyright © (2006) by International Association of Hydrological Sciences.

Gaan, Narottam (2005) "Environmental scarcity, migration and future sea level rise in Bangladesh: security implications on India", *Asian Profile*, Vol. 33, No. 6 (December), pp. 617-630. **Abstract/Summary:** The link between environmental degradation or scarcity or resources and conflict has become apparent with global environmental crisis looming large in terms of global warming, acid rain, green house effects, sea level rise and punching hole in the ozone layer. In the case of Bangladesh, environmental scarcity of land and its acute shortages exacerbated by population growth have prompted millions of people migrate to India — an influx that has, in turn caused ethnic strife in its North Eastern states such as Assam. In consequence of sea level rise due to global warming, the environmental scarcity may be more severe and disasters like cyclones, storms and floods more frequent. This may add many more millions to the already continuing influx to India with serious implications on India's internal stability and security. Copyright © (2005) by Asian Research Service.

Giri, Chandra; Bruce Pengra; Zhiliang Zhu; Ashbindu Singh; and Larry L. Tieszen (2007) "Monitoring mangrove forest dynamics of the Sundarbans in Bangladesh and India using multi-temporal satellite data from 1973 to 2000", *Estuarine, Coastal and Shelf Science*, Vol. 73, Nos. 1-2 (June), pp. 91-100. **Abstract/Summary:** Mangrove forests in many parts of the world are declining at an alarming rate—possibly even more rapidly than inland tropical forests. The rate and causes of such changes are not known. The forests themselves are dynamic in nature and are undergoing constant changes due to both natural and anthropogenic forces. Our research objective was to monitor deforestation and degradation arising from both natural and anthropogenic forces. We analyzed multi-temporal satellite data from 1970s, 1990s, and 2000s using supervised classification approach. Our spatio-temporal analysis shows that despite having the highest population density in the world in its periphery, areal extent of the mangrove forest of the Sundarbans has not changed significantly (approximately 1.2%) in the last 25 years. The forest is however constantly changing due to erosion, aggradation, deforestation and mangrove rehabilitation programs. The net forest area increased by 1.4% from the 1970s to 1990 and decreased by 2.5% from 1990 to 2000. The change is insignificant in the context of classification errors and the dynamic nature of mangrove forests. This is an excellent example of the co-existence of humans with terrestrial and aquatic plant and animal life. The strong commitment of governments under various protection measures such as forest reserves, wildlife sanctuaries, national parks, and international designations, is believed to be responsible for keeping this forest relatively intact (at least in terms of area). While the measured net loss of mangrove forest is not that high, the change matrix shows that turnover due to erosion, aggradation, reforestation and deforestation was much greater than net change. The forest is under threat from natural and anthropogenic forces leading to forest degradation, primarily due to top-dying disease and over-exploitation of forest resources. Copyright © 2007 by Elsevier B.V.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Department of Environment (1993) *Assessment of the Vulnerability of Coastal Areas to Climate Change and Sea Level Rise. A Pilot Study of Bangladesh* (Dhaka: GoB, MoEF, Department of Environment; Bangladesh Center for Advanced Studies (BCAS); Resource Analysis (RA); and Approtech)**. Abstract/Summary:** The present study is a joint initiative of

the Government of the Peoples Republic of Bangladesh and The Netherlands Government as a follow up activity of the United Nations Conference on Environment and Development (UNCED) to fulfill the commitment of both the Governments to the Intergovernmental Panel on Climate Change (IPCC). The response strategy workgroup (WG-III) of IPCC has formed a Coastal Zone Management Subgroup (CZMS) in order to address the issues regarding degradation and destruction of low lying coastal areas. In its first report CZMS put forward recommendations [IPCC, 1990] for the development and implementation of an operational methodology with respect to the assessment of vulnerability to sea level rise in the context of Coastal Zone Management (CZM) planning. Present IPCC-CZMS activities are based on this IPCC 1990 First Assessment Report, which was adopted in the same year by the United Nations General Assembly and the Second World Climate Conference. The report concludes that integrated planning for the development of coastal zones, which properly accounts for long range impacts of climate change and sea level rise, would substantially reduce the vulnerability of these zones to such impacts. These conclusions and recommendations were confirmed both in the United Nations Framework Convention on Climate Change and in 'Agenda 21' of the UNCED especially in Chapter 17 on Oceans and Coasts. Copyright © 1993 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF) (1997) *Global Climate Change: Bangladesh Episode* (Dhaka: GoB, MoEF, Department of Environment, June)**. Abstract/Summary:** This document is the outcome of sectoral reports on emission inventory, vulnerability assessment and adaptation strategy, and mitigation strategy duly compiled and edited. In response to the national actions and to fulfill the country's obligation under the UN Framework Convention on Climate Change (UNFCCC) signed in 1992, Bangladesh undertook a study named " Bangladesh Climate Change Country Study" in 1994 with support from the U.S. Government. The study consists of the following components: Emission Inventory, Vulnerability Assessment and Adaptation Strategy, Mitigation Strategy, and Awareness and Dissemination. The study has resulted in a substantial body of information, data and insight into the greenhouse gas (GHG) emission and their possible mitigation as well as the vulnerability to climate change, especially sea level rise. Copyright © 1997 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF) (2002) *Initial National Communication under the United Nations Framework Convention on Climate Change* (Dhaka: GoB, MoEF, October); available at: http://www.doe-bd.org/4_Initial_National_Communication_under_the_UNFCC.pdf. **Abstract/Summary:** This report covers five areas: the national circumstances, a greenhouse gas inventory for Bangladesh, a description of Bangladesh's vulnerabilities and adaptations, Bangladesh's mitigation options, and Bangladesh's climate change response strategy. Copyright © 2002 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF) (2005) *National Adaptation Programme of Action (NAPA)*, (Dhaka: GoB, MoEF; and United Nations Development Programme (UNDP), November); available at: http://unfccc.int/resource/docs/napa/ban01.pdf. **Abstract/Summary:** The National Adaptation Programme of Action (NAPA) is prepared by the Ministry of Environment and Forest (MOEF), Government of the People's Republic of Bangladesh as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). Being convinced that adverse effects of climate stimuli including variability and extreme events in the overall development of Bangladesh would be

significant set the strategic goals and objectives of future coping mechanisms “to reduce adverse effects of climate change including variability and extreme events and promote sustainable development”. In the given context the National Adaptation Program of Action (NAPA) suggested measures for Bangladesh to address adverse effects of climate change including variability and extreme events based on existing coping mechanisms and practices, and suggested future strategies and coping mechanism. Copyright © 2005 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forests (MoEF) (2008) Bangladesh Climate Change Strategy and Action Plan 2008 (Dhaka: GoB, MoEF, September); available at: http://www.sdnbd.org/moef.pdf. **Abstract/Summary:** Bangladesh is one of the most climate vulnerable countries in the world and will become even more so as a result of climate change. Floods, tropical cyclones, storm surges and droughts are likely to become more frequent and severe in the coming years. These changes will threaten the significant achievements Bangladesh has made over the last 20 years in increasing incomes and reducing poverty, and will make it more difficult to achieve the MDGs. It is essential that Bangladesh prepares now to adapt to climate change and safeguard the future well-being of her people. Over the last 35 years, the Government of Bangladesh, with the support of development partners, has invested over $10 billion to make the country less vulnerable to natural disasters. These investments include flood management schemes, coastal polders, cyclone and flood shelters, and the raising of roads and highways above flood level. In addition, the Government of Bangladesh has developed state-of-the-art warning systems for floods, cyclones and storm surges, and is expanding community-based disaster preparedness. Climate resilient varieties of rice and other crops have also been developed. The challenge Bangladesh now faces is to scale up these investments to create a suitable environment for the economic and social development of the country and to secure the well-being of our people, especially the poorest and most vulnerable groups, including women and children. The Government of Bangladesh's vision is to eradicate poverty and achieve economic and social well-being for all the people. This will be achieved through a pro-poor Climate Change Strategy, which prioritises adaptation and disaster risk reduction, and also addresses low carbon development, mitigation, technology transfer and the provision of adequate finance. Sections I to V of the document provide the context, outline the implications and likely impacts of climate change in Bangladesh, provide an overview of different adaptation strategies and briefly outline mitigation issues. Sections VI to VII describe a ten-year programme to build the capacity and resilience of the country to meet the challenge of climate change over the next 20-25 years. The Climate Change Action Plan 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. The needs of the poor and vulnerable, including women and children, will be prioritised in all activities implemented under the Action Plan. The Climate Change Action Plan comprises immediate, short, medium and long-term programmes. The Climate Change Action Plan will be implemented under the overall guidance of the National Environment Committee, chaired by the Chief Adviser. It will be coordinated by concerned Ministry of Environment and Forests. Programmes funded under the Plan will be implemented by Ministries or their agencies, with the involvement, as appropriate, of civil society and the private sector. The Climate Change Strategy and Action Plan has been developed by the Government of Bangladesh in consultation with civil society, including NGOs, research organisations and the private sector. It builds on the National Programme of (NAPA), published in 2005. It will be reviewed and revised as experience and knowledge are gained in implementing adaptation and related research programmes. There are 37 programmes listed in Annex 1. The annotations for justification, the kind of activities to be undertaken, and the responsible ministries/agencies for each of the programme within the six pillars outlined above is also provided in the Annex 1. These programmes would be elaborated with all details in consultation with the stakeholders at the time of their planning and implementation. This list of programmes is by no means exhaustive. It only outlines the first set of activities that are to be undertaken in line with the needs of the communities and the overall development programme of Bangladesh. Copyright © 2008 by GoB, Ministry of Environment and Forests (MoEF).

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2007) *Climate Change and Bangladesh* (Dhaka: GoB, MoEF, Climate Change Cell, September); available at: http://www.climatechangecell-bd.org/publications/13ccbd.pdf. **Abstract/Summary:** This is a largely non-technical summary of the impacts of climate change in Bangladesh as of information available by September 2007. The 28-page long brochure shows that the impacts of climate change are most critical in Bangladesh as large part of the population is chronically exposed and vulnerable to a range of natural hazards. Already, the human suffering and cost to development is massive to this country and its people who are victims of human induced global warming. Between 1991 and 2000, 93 major disasters were recorded in Bangladesh, resulting in nearly 200,000 deaths and causing US$ 5.9 billion in damages with high losses in agriculture and infrastructure. Since then, the country is experiencing recurring floods frequently. The monsoon floods of this year are part of what the World Meteorological Organization sees as a global pattern of record extreme weather conditions. Climatic hazards, including extremes like floods, cyclones, tornado, storm surge, tidal bore, etc are not new to Bangladesh and the country has a scarred history claiming many lives and resulting in losses of assets, belongings. Some of the worst disasters in terms of mortality have taken place on this land. In Bangladesh during the past few decades, the effects of global warming have been evidenced in climate variability, change and extremes. More adverse impacts are projected for the coming decades, particularly for low lying coastline and floodplain ecosystems which characterize Bangladesh. Copyright © 2007 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2007) *From vulnerability to resilience - Bangladesh confronting climate challenges* (Dhaka: GoB, MoEF, Climate Change Cell, December); available at: http://www.climatechangecell-bd.org/publications/14cccbulletin05roadtobali.pdf.

Abstract/Summary: This 20-page bulletin summarizes the key issues related to climate change and Bangladesh for the High-level meeting in Bali in December 2007. It stresses that the talks at Bali on future commitments to combat global warming and response to climate change must ensure that (a) every human has an equal right to the atmosphere, (b) the top priority is setting targets for deep real emission reductions immediately, (c) climate victims have the right to just compensation and capacity to become climate resilient; and (d) the rights of the poorest and already climate victims as a first priority. Copyright © 2007 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2008) *Bangladesh - Reducing Development Risks in a Changing Climate – Vision – Challenge – Response – Future* (Dhaka: GoB, MoEF, Climate Change Cell, March); available at: http://www.climatechangecell-bd.org/publications/17reducingdevriskbd-uk-ccc.pdf. **Abstract/Summary:** This 24-page bulletin summarizes the key issues related to climate change and Bangladesh for the Bangladesh – UK Climate Change Conference in Dhaka on March 25, 2008. The key messages are as follows. Climate change threatens everyone. The poorest will be most affected, and already are suffering in Bangladesh. Climate change is a challenge to our gains from past development efforts, and poses serious risks to our future development plans and aspirations. To avoid the unmanageable, we must (a) take urgent and immediate action to reduce global emissions, (b) invest in climate friendly sustainable energy, and (c) develop sustainable consumption patterns, lifestyles and culture. To manage the unavoidable, we must (a) build national and community resilience, (b) invest in making development efforts climate proof, and (c) address risks to specific threats. To reduce development risks, (a) the people most vulnerable must be prioritized, (b) communities must be central to development planning and implementation, and (c) national development planning must mainstream risk management and adaptation to climate change. Copyright © 2008 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2008) *Changing the Way We Develop - Dealing with Disasters and Climate Change in Bangladesh* (Dhaka: GoB, MoEF, Climate Change Cell, February); available at: http://www.climatechangecell-bd.org/publications/15changingwaywedevelop.pdf. **Abstract/Summary:** This brief was prepared for The Oslo Policy Forum on Changing the Way We Develop: Dealing with Disasters and Climate Change (28-29 February), and the South-South Cooperation for Mainstreaming Disaster Risk Reduction: Consultation on Structuring an Efficient Mechanism in Oslo, Norway (February 27). The brief provides three reasons for why we need to change the way we develop. First, absolute levels of disaster risk are increasing due to various pressures, including climate change. Second, disasters affect poor countries and the poor people the most. And third, disasters pose a significant and growing threat to development which requires that national preparedness is critical to develop relevant capacity to mobilize and utilize necessary resource flows, domestic and international. Hence, building on these three reasons, the brief (1) describes the case of Bangladesh, one of the countries most vulnerable to natural disasters and adverse impacts of climate change. As a nation, our priority concern is to progress from our vulnerable state toward a state of climate resilience. Bangladesh showcases what will happen under climate change, and what many countries will need to do to protect themselves in the years ahead; (2) highlights how a nation of 150 million people who are mostly poor prepares to address the impacts of global warming nationally. The idea is to share our experience till date with other countries urgently requiring planning and mobilizing national efforts toward climate resilient development; and (3) aims to elevate the spirit, will and capacity

of vulnerable countries to support each other in preparing to address emerging climate challenges. Copyright © 2008 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2008) *From Vulnerability to Resilience - Bangladesh Preparing for Climate Resilient Development* (Dhaka: GoB, MoEF, Climate Change Cell, February); available at: http://www.climatechangecell-bd.org/publications/16vulnerabilitytoresilience.pdf. **Abstract/Summary:** This 4-page Communication Brief had been prepared for the visiting delegation of Members of the European Parliament to Bangladesh (February 6-8). The brief highlights how a nation of 150 million people who are mostly poor prepares to address the impacts of global warming nationally. The idea is to share our experience till date with other countries urgently requiring planning and mobilizing national efforts toward climate resilient development. National preparedness is critical to develop relevant capacity to mobilize and utilize necessary resource flows, domestic and international. This presentation aims to elevate the spirit, will and capacity of vulnerable countries to support each other in preparing to address emerging climate challenges. Copyright © 2008 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forest (MoEF), Climate Change Cell (2008) *Protecting Health from Climate Change* (Dhaka: GoB, MoEF; Climate Change Cell, February); available at: http://www.climatechangecell-bd.org/publications/18protectinghealthfromcc.pdf. **Abstract/Summary:** This bilingual 12-page paper had been prepared for World Health Day (7th April) and illustrates in pictures and short comments the main issues related to climate change and health in Bangladesh: (a) a rise in cholera and diarrhoea due to more contaminated water resulting from more floods, (b) increased psychological stresses due to losses of homes and livelihoods resulting from more disasters, (c) increased malnutrition due to less food intake resulting from more droughts, (d) a rise in respiratory diseases due to increased air pollution resulting from more greenhouse gases (e) an increase in dengue and malaria due to more mosquito resulting from global warming; (f) increased losses of life due to more injuries and disabilities resulting from more heat waves and more severe cyclones. Copyright © 2008 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Water Resources (2006) *Coastal Development Strategy* (Dhaka: GoB, Ministry of Water Resources, February), available at: http://www.iczmpbangladesh.org/rep/cds.pdf. **Abstract/Summary:** This 104-page document had been approved at the 2nd meeting of the Inter-Ministerial Steering Committee on the Integrated Coastal Zone Management Plan (ICZMP), held on February 13, 2006. The approval recognized the need for an area specific program in coastal Bangladesh as it was recognized in (a) a number of earlier initiatives and (b) policies and programs of different government agencies. The ICZMP project was implemented by the Water Resources Planning Organization (WRPO). One of the key outputs of the project is the Coastal Zone Policy (CZPo) which was approved by the government on 17 January 2005. The policy provides the directives and the framework for the development and implementation of integrated coastal zone management plan. It also gives direction for management of the coastal development process. The Coastal Development Strategy (CDS) focuses on the implementation of the coastal zone policy. The distinctive development opportunities of the coastal zone are considered as instrumental in reducing vulnerability and poverty of coastal communities. This strategy is an attempt to unlock the potentials of the coastal zone along with strategies to mitigate natural and man- made hazards

and to preserve, restore and enhance coastal ecosystems. The CDS has been prepared through multi-level and multi-sectoral dialogues. It describes priorities and targets based on coastal zone policy objectives and the available resources. The strategic priorities are to be implemented through three strategic routes: mainstreaming, investment and governance. In such selective approach, the strategy aims to be complementary to the ongoing but often segmented activities of different government agencies, NGOs and development partners. It focuses on participation and partnership. This strategy will lead to an integrated management of the coastal zone. Copyright © 2006 by GoB.

Government of the People's Republic of Bangladesh (GoB), Ministry of Water Resources, Bangladesh Water Development Board (2008) *Proceedings of International Seminar on Long Lead Flood Forecast Technology for Disaster Management*, held in Dhaka (3-4 September) (Dhaka: GoB, Ministry of Water Resources, Bangladesh Water Development Board (BWDB); available at: http://pdf.usaid.gov/pdf_docs/PNADN060.pdf. **Summary/Abstract:** The Bangladesh Water Development Board (BWDB) has so far achieved a 72-hour-lead time for the flood forecasting action. Over the years it was felt that a longer lead-time could significantly reduce flood induced losses. BWDB has now developed this technology in its Flood Forecasting and Warning Center (FFWC). The technology is the outcome of a research work conducted by Dr. Peter Webster at the Georgia Institute of Technology, in the United States. The Asian Disaster Preparedness Center (ADPC), in partnership with FFWC of BWDB and national partners, is testing and validating the technology in Bangladesh. The initial research work was conducted by ADPC with the support from USAID/OFDA during 2000-204. Based on good results, the Government of Bangladesh signed (through BWDB) a Memorandum of Understanding (MoU) in 2006 with the ADPC to further continue this work to enhance lead time for flood forecasting and warning system. During 2006-2009, the USAID supported SHOUHARDO program of CARE Bangladesh tested and transferred this technology then to the Bangladesh Government, which also aimed at building capacity for sustainable end-to-end generation and application of long lead forecasts. The model covers three types of forecast schemes: short-term (1-10 days), medium-term (20-25 days) and long term (1-6 months). It is observed that the 1-10 days forecasts performed extremely well, while the two other schemes are still on experiment. This long lead forecast technology aimed to harness the latest advances in weather forecasts and climate prediction by using data from the European Center for Medium-range Weather Forecasts (ECMWF), and to explore the possibilities for its application to various sectors, particularly agriculture. FFWC has already started the flood forecasting of the 2008 flood 10 days ahead. Five pilot areas namely (i) Rajpur union of Lalmonirhat district; (ii) Uria union of Gaibandha district; (iii) Kaijuri union of Sirajganj district; (iv) Bekra Atgram union of Tangail district; and (v) Gazirtek union of Faridpur district have been selected for testing the application of newly introduced long lead flood forecast information at the community level. The pilot testing of forecast information process entailed capacity building of stakeholders involved in interpretation, translation and communication of probabilistic forecast information to enable them to transform science based information into impact outlooks with response options in actionable languages at the community level. The pilot testing of long lead forecasts revealed that through enhanced disaster preparedness significant socio-economic benefits could be accrued to communities at risk in saving lives and minimizing risks to livelihood systems such as early harvesting to avoid major crop damage, planning of transplanting of rice crops to avoid investment losses , take protection measures for saving assets and livestock, pre-harvesting of culture fisheries, plan for flood response activities at the local government level to support

community responses and also take precautionary measures to protect infrastructures. Hence, long lead forecasts are one of the best tools to enhance our adaptation to climate change associated risks. Copyright © 2008 by Bangladesh Water Development Board.

Gunter, Bernhard G. (2008) *Bangladesh Climate Change Bibliography* (Falls Church, VA: Bangladesh Development Research Center (BDRC), May); available at: http://www.bangladeshstudies.org/files/Studies_related_to_climate_change_in_Bangladesh2.pdf.
Abstract/Summary: This bibliography was prepared as a background material for the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh, Bellagio, Italy (May 20-22). It provides references for about 250 items that are directly related to climate change in Bangladesh. It also contains some additional 30 items on disasters in Bangladesh (especially floods), which will increase in terms of their frequency and intensity in the future due to climate change. Copyright © 2008 by Bangladesh Development Research Center, Inc.

Gunter, Bernhard G. (2008) "The Bangladesh Climate Change Literature: Lessons & Gaps", Presentation made at the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh, Bellagio, Italy (May 20-22); available at: http://www.bangladeshstudies.org/files/Presentation_Gunter.pdf. **Abstract/Summary:** This presentation points out that effective and efficient adaptation policies requires (a) knowledge about the impacts of climate change, (b) knowledge about the vulnerabilities to climate change, (c) knowledge about the adaption options, and (d) an integration of adaptation policies with policies for sustainable economic development and disaster management Hence, the presentations presents the lessons and gaps structured into lessons and gaps about climate change impacts, lessons and gaps about climate change vulnerability, lessons and gaps about adaptation options, and lessons and gaps about mainstreaming climate change. The presentation closes with the top ten next steps. Copyright © 2008 by Bangladesh Development Research Center, Inc.

Gunter, Bernhard G.; Atiq Rahman; and A. F. M. Ataur Rahman (2008) "How Vulnerable are Bangladesh's Indigenous People to Climate Change?", Falls Church, VA, USA: Bangladesh Development Research Center (BDRC), *Bangladesh Development Research Working Paper Series*, No. 1 (April); available at: http://www.bangladeshstudies.org/files/WPS_no1-rev.pdf**.**
Abstract/Summary: This paper compares the vulnerabilities to climate change and climate variability of the indigenous people with the Bengali population of Bangladesh. It distinguishes between (a) individual vulnerabilities that are related to an individual's capability to adapt to climate change and; (b) spatial vulnerabilities, that is, vulnerabilities that are related to the location of a person (like the exposure to climate change-induced disasters). While an individual's capability to adapt to climate change is determined by many factors, some relatively simple approximation is to look at poverty, landlessness, and illiteracy. Spatial vulnerabilities are reviewed by looking at drought hazard maps, flood hazard maps, landslide hazard maps, and cyclone hazard maps. Hence, the paper compares levels of poverty, landlessness, illiteracy, and the more direct though also more subjective exposures to increased droughts, floods, landslides, and cyclones across the two population groups. The paper concludes with some broad suggestions on adaptation strategies of indigenous people as well as suggestions for policy interventions to reduce climate change-induced vulnerabilities for indigenous people in the Chittagong Hill Tracts (CHT). Copyright © 2008 by Bangladesh Development Research Center.

Habibullah, Mohammad; Ahsan Uddin Ahmed; and Zahurul Karim (1999) "Assessment of Foodgrain Production Loss Due to Climate Induced Soil Salinity: A Case Study", in: Saleemul Huq, Zahurul Karim, M. Asaduzzaman and F. Mahtab (eds.), *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 56-69**. Abstract/Summary:** The loss of food grain production due to soil salinity intrusion in the coastal districts was estimated under climate change scenarios. A computer model was developed that provided with a genesis of soil salinity build-up in the relatively drier months of the crop calendar. The time-series soil salinity database was compared with the field-level observations and the model was validated. It was found that the soil salinity generally increases rapidly in the winter months and reaches maximum values in April. The time-series database was then correlated with the time specific events in the crop calendar for two crops, Aman and Aus rice, to estimate the damage in production due to adverse effects of salinity. It was found that the impacts of soil salinity would be manifold under the climate change scenarios. It was also found that the estimated crop loss under the severe climate change scenario would be the maximum. Furthermore, more areas would become severely affected by soil salinity and thereby the affected lands would become unsuitable for a number of crops. As a result, the food security of the country would be threatened under climate change. The modeling was extended to examine crop loss considering adaptation in conjunction with the climate change scenarios. The results show that substantial improvement might be achieved by adapting to increased soil salinity, yet the projected loss would be significant. Copyright © 1999 by Kluwer Academic Publishers.

Hadi, Abdullahel (2001) "International Migration and the Change of Women's Position among the Left-Behind in Rural Bangladesh", *International Journal of Population Geography*, Vol. 7, No. 1, pp. 53-62**. Abstract/Summary:** While the impact of remittances upon the economic conditions of the sending communities has received much attention, the effects of international migration on women's position in society among the left-behind have not been adequately explored. This paper examines the changes in the left-behind women's position at the family level as a result of the migration of adult men overseas. Data came from a demographic surveillance system covering 70 villages in Bangladesh. All migrant families having at least one male member working abroad for more than six months were identified in the study villages in 1996. A comparable number of non-migrant families were selected at random from the same villages to yield a total sample of 1030 families. In-depth interviews were conducted with adult women of the sample families. Findings reveal that the overseas migration of adult males has a significant positive association with women's decision-making capacity and education of girls in the migrant families. The remittances as well as the influence of secular values have reduced the practice of dowry in marriages. Multivariate analysis suggests not only that remittances have increased the financial capacity of the migrant families, but also that secular influences from overseas might have modified the position of women when the role of other socio-economic factors is controlled. The study concludes that the overseas migration of adult men can create a context for change of the women's position in traditional communities. Copyright © 2001 John Wiley & Sons, Ltd.

Halls, A. S.; A. I. Payne; S. S. Alam; and S. K. Barman (2008) "Impacts of flood control schemes on inland fisheries in Bangladesh: guidelines for mitigation" *Hydrobiologia*, Vol. 609, No. 1 (September), pp. 45-58**. Abstract/Summary:** Flood control, drainage and irrigation (FCDI) schemes are widespread in Bangladesh. They are built to control water levels to improve agricultural production based on high yielding varieties (HYV) of rice that cannot tolerate rapid

inundation or that require irrigation, and to provide protection from extreme flood events. The benefits to the agricultural sector can be significant. At some sites in Bangladesh, farmers report up to 80% more agricultural production inside the schemes than outside. However, fish production and species richness is typically lowered by these structures. Fish yields inside a typical flood control compartment can be 50% lower than outside, with up to 25 species of fish absent or less abundant. Lower rates of recruitment of migratory whitefish species, whose lateral migrations are obstructed by the embankments, were found to be largely responsible for these differences. With a risk of more extreme flooding during the monsoon season but hotter and more arid dry season conditions predicted as a consequence of climate change, more flood control, drainage and irrigation (FCDI) schemes may need to be constructed to provide flood protection and to meet increasing irrigation needs. Based on fisheries monitoring and mark-recapture studies undertaken at 3 sluice gates, nine recommendations for operating sluice gates to mitigate the impacts of flood control, drainage and irrigation (FCDI) schemes on fish production and biodiversity are described. These recommendations aim to improve the access of migratory whitefish to modified floodplains and to improve or sustain the production of resident (non-migratory) blackfish whilst minimizing agricultural sector losses. Copyright © 2008 by Springer.

Halsnæs, Kirsten and Jan Verhagen (2007) "Development based climate change adaptation and mitigation—conceptual issues and lessons learned in studies in developing countries", *Mitigation and Adaptation Strategies for Global Change*, Vol. 12, No. 5 (June), pp. 665-684**.** **Abstract/Summary:** This paper discusses the conceptual basis for linking development policies and climate change adaptation and mitigation and suggests an analytical approach that can be applied to studies in developing countries. The approach is centered on a broad set of policy evaluation criteria that merge traditional economic and sectoral goals and broader social issues related to health and income distribution. The approach is inspired by institutional economics and development paradigms that emphasize human wellbeing, resource access, empowerment, and the arrived freedoms. It is outlined how indicators of wellbeing can be used to assess policies that integrate development and climate change policy objectives, and this approach is discussed in comparison with other work that rather have been inspired by sustainable development aspects of manmade, natural, and social capital. The experiences and results from case studies of development and climate that have done a first attempt to use human wellbeing indicators are reported and discussed. The studies include work from India, China, South Africa, Brazil, Bangladesh, and Senegal. A number of policy examples in the energy-, food-, and water sectors in these studies have shown up to demonstrate numerous linkages between development policies and climate change. Various analytical tools have been used in the studies including quantitative and qualitative scenario work as well as detailed micro-based analysis. The methodological conclusion that can be drawn from these studies is that it is possible to apply wellbeing indicators to the more detailed policy assessment, but a link to more general national and regional scenario work is not yet established. Copyright © 2007 by Springer.

Haq, Mainul; M. A. Taher Mia; M. F. Rabbi; and M. A. Ali (2008) Incidence and severity of rice diseases and insect pests in relation to climate change; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation uses observations in Bangladesh to document the incidence and severity of rice diseases and insect pests in relation to climate change, though it

also reviews the predictions made within the international literature. It concludes with approaches to mitigate the predicted problems. Copyright © 2008 by the author(s).

Haque, M. (1996) Climate Change. Issues for the Policy Markers of Bangladesh (Dhanmondi, Dhaka: Environment and Development Alliance (EDA))**. Abstract/Summary:** The study was based on existing literature available on potential impacts of expected climate change on costal and near shore environments. During this study period, three workshops were held at Bangladesh Academy for Rural Development (BARD), Comilla, Bangladesh Planning and Development Academy. Dhaka and BCS (Admn) Academy, Dhaka with the trainees of the regular training programmes. This document includes views of the participants during open discussion, panelists' remarks and set of recommendations. Copyright © 1996 by Environment and Development Alliance.

Harris, Jonathan M. and Neva R. Goodwin (2003) "Reconciling Growth and the Environment", Medford, MA, USA: Tufts University, Global Development and Environment Institute (GDAE), *Working Paper*, No. 03-03 (March); available at: http://www.ase.tufts.edu/gdae/publications/working_papers/03-03ReconcilingGrowthEnvironment.PDF; **Excerpts from pages referring to Bangladesh:** The entire nation of Bangladesh, with 133 million people (projected to increase to 200 million by 2050) is especially at risk of inundation, (….) The massive potential impact of global climate change raises a fundamental question about economic growth. The essential assumption underlying growth models is that human well-being will be increased by economic growth. Overall, despite great social inequalities and extensive environmental damage, this has been true during the twentieth century. But the projected climate change scenarios raise the possibility that conditions for the current generation of children, and for future generations, will be significantly worse in important respects. The loss of ocean- front property in the U.S. will be painful for those affected, but pales to insignificance in comparison to the devastating loss of homes of homes and lives in store for millions of people in Bangladesh and other low-lying countries. Malaria and other tropical diseases – long a major force against economic development – will infest a much larger portion of the planet. Existing crises in access to clean fresh water (see below), and related issues of health and military conflict, will accelerate. (…) In contrast to the economic development patterns of the twentieth century, when it was possible to view macroeconomic goals in terms of the promotion of stable growth, the challenge of climate change implies that macroeconomic policies must be judged not on whether they promote growth, but on what kind of qualitative change in economic systems they achieve. Copyright © 2003 by Tufts University.

Hashizume, Masahiro; Ben Armstrong; Shakoor Hajat; Yukiko Wagatsuma; Abu S. G. Faruque; Taiichi Hayashi; and David A. Sack (2007) "Association between climate variability and hospital visits for non-cholera diarrhoea in Bangladesh: effects and vulnerable groups", *International Journal of Epidemiology*, Vol. 36, No. 5, pp. 1030-1037; **Abstract/Summary:** This article estimates the effects of rainfall and temperature on the number of non-cholera diarrhoea cases and identifies population factors potentially affecting climate change vulnerability in Dhaka, Bangladesh. It uses time-series regression to analyze weekly rainfall, temperature and number of hospital visits for non-cholera diarrhoea. A Poisson regression model was used to model the relationships controlling for seasonally varying factors other than the weather variables. Modifications of weather effects were investigated by fitting the models separately to incidence series according to their characteristics (sex, age, socio-economic, hygiene and sanitation status). The analysis showed that the number of non-cholera diarrhoea

cases per week increased by 5.1% (with a 95% confidence interval between 3.3-6.8) for every 10 mm increase above the threshold of 52 mm of average rainfall over lags of 0–8 weeks. The number of cases also increased by 3.9% (with a 95% confidence interval between 0.6-7.2) for every 10 mm decrease below the same threshold of rainfall. Ambient temperature was also positively associated with the number of non-cholera diarrhoea cases. There was no evidence for the modification of both 'high and low rainfall' effects by individual characteristics, while the effect of temperature was higher amongst those individuals at a lower educational attainment and unsanitary toilet users. The article concludes that the number of non-cholera diarrhoea cases increased both above and below a threshold level with high and low rainfall in the preceding weeks. The number of cases also increased with higher temperature, particularly in those individuals at a lower socio-economic and sanitation status. Copyright © 2007 by International Epidemiological Association.

Hashizume, Masahiro; Ben Armstrong; Yukiko Wagatsuma; Abu S. G. Faruque; Taiichi Hayashi; and David A. Sack (2008) "Rotavirus infections and climate variability in Dhaka, Bangladesh: a time-series analysis", *Epidemiology and Infection*, Vol. 136, No. 9 (September), pp. 1281-1289. **Abstract/Summary:** This study investigates the relationships between hospital visits for rotavirus diarrhoea and temperature, humidity and river level in Dhaka, using time-series analysis adjusting for other confounding seasonal factors. There was strong evidence for an increase in rotavirus diarrhoea (by 40.2%) for each 1°C increase above a threshold of 29°C. Relative humidity had a linear inverse relationship with the number of cases of rotavirus diarrhoea. The river level above a threshold of 4.8 meter was associated with an increase in cases of rotavirus diarrhoea by 5.5% per 10-cm river-level rise. The findings provide evidence that factors associated with high temperature, low humidity and high river-level increase the incidence of rotavirus diarrhoea in Dhaka. Copyright © 2008 by Cambridge University Press.

Hassan, Muhammad Qumrul (2008) Global Climate Change and its Effects on Hydro-GeoEnvironment of Bangladesh Coastal Belt; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** The first half of this presentation provides a relatively broad overview of climate change including at the global level, while the second half focuses on various environmental factors and the climate change effects on the hydrological environment of the Bangladesh Coastal Belt, whereby it reviews the changes in salinity, land erosion and accretion, the impact of cyclones and floods. It also presents some of the impacts of climate change in other countries. Copyright © 2008 by the author(s).

Hofer, Thomas and Bruno Messerli (2003) "Uberschwemmungen in Bangladesh: naturbedingt oder vom Menschen verursacht? [Are the causes of floods in Bangladesh natural or man-made?]", *Geographische Rundschau*, Vol. 55, No. 11, pp. 28-33**. Abstract/Summary:** This article discusses the human factors that have contributed to make floods worse in Bangladesh. Please see Messerli and Hofer (2006) for more details. Copyright © 2003 by Westermann Verlag.

Hossain, M. (1989) "The Greenhouse Effect and the Coastal Area of Bangladesh: Its People and Economy", in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference*

held in Dhaka, Bangladesh, 5th March 1989 (Dhaka, Bangladesh Centre for Advanced Studies). **Abstract/Summary:** This paper deals mainly with consequences in relation to the coastal area of Bangladesh, one of the most vulnerable areas in the world if sea levels rise. It is clear though that all the areas are closely interrelated and any worthwhile analysis entails a multidisciplinary approach in a comprehensive framework. It also entails accurate time series data on a number of important scientific and socio-economic variables. Even if time and resources were at one's disposal, a thorough study would have been very difficult in the context of the present data situation and monitoring facilities. In view of the above, this paper concentrates more on 'what' is at stake rather than refining estimates of 'how much' of it, and includes the coastal area of Bangladesh: its resources, infrastructure, people and economy; the alternate scenarios under greenhouse effect; consequences and options are discussed within a policy framework and recommendations.

Hossain, S. M. Moazzem and Patrick Kolsteren (2003) "The 1998 Flood in Bangladesh: Is Different Targeting Needed During Emergencies and Recovery to Tackle Malnutrition?", *Disasters*, Vol. 27, No. 2, (June) pp. 172-184. **Abstract/Summary:** Bangladesh suffered the century's worst flood during July-October 1998 and appealed for assistance. To provide information for appropriate interventions to tackle nutritional problems, a rapid assessment survey was conducted to look at the nutritional situation, problems encountered by the community, their coping mechanisms and rehabilitation priorities in six rural areas. The survey was repeated after four months to measure the outcome of activities during the flood and the necessity for future assistance. There were 3,048 children measured in both surveys (1,597 and 1,451). The sample of most interest was a sub-group of 180 children present in two previous independent surveys. The analysis found that while moving from the crisis period to post-flood phase there was evidence of a 'crossover phenomenon' in the recovery pattern of nutritional status. Sixty-eight percent of the children who were malnourished (WHZ <-2SD) during the crisis period (18 percent) recovered enough to cross the cut-off point and became normal after four months. Another 8 percent of children (9 percent of all normal) who were normal during the crisis period, after four months had deteriorated to be malnourished. Thus, despite there being a shift in the overall distribution of nutritional status, there has been another shift that reduced the net effect. Subsequent episodes of diarrhoea, access to food and loan burden had also influenced the recovery pattern of the children's nutritional status as evident from the statistically significant associations. These findings raise questions about targeting acute malnutrition during emergencies, and using the same criteria during both the crisis and rehabilitation phases.

Huq, M. (1989) "Environmentally Sound Measures for Countering "Greenhouse Effect" in Bangladesh and their Cost-Effectiveness", in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989* (Dhaka, Bangladesh Centre for Advanced Studies). **Abstract/Summary:** In this paper a new approach for facing the global problem is presented, based on a concept of global rather than national economy, and disaster preparedness on a global scale with transnational cost-benefit trade-off with hopefully a formula for overall economic benefit. We could perhaps look at GE as a "blessing in disguise", acting as a catalyst for world acceptance of a New Economic Concept, necessitating adoption of environmentally sound technologies, heralding the dawning of a new era of universal techno-

economic advancement with emphasis on the role Bangladesh and the region. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Huq, Nazmul (2008) "Bangladesh and Climate Change: Need for a Comprehensive Adaptive Strategy", New Delhi, India: Centre for Trade and Development (CENTAD), Climate Brief 3 (May); available at: http://www.centad.org/download/Climate_Brief_3.pdf. **Abstract/Summary:** This four-page brief summarizes first the projected physiological impacts of climate change and discusses then Bangladesh's concern in light of the Bali Action Plan (BAP). It then reviews issues related to forests as carbon sink and market mechanisms to reduce emissions. The Brief concludes with suggestions on technology transfer, cooperation and trading. Copyright © 2008 by Centre for Trade and Development (CENTAD).

Huq, Saleemul (2001) "Climate Change and Bangladesh", *Science*, Vol. 294. No. 5547, p. 1617; available at: http://www.sciencemag.org/cgi/content/summary/294/5547/1617. **Abstract/Summary:** This one-page editorial summarizes the equity issues arising from climate change and concludes that the world community has an obligation to pay serious attention to their views on the establishment of developing-country emissions targets, which should be based on an equitable share of the global atmosphere (including, for example, a per-capita right to emissions). Copyright © 2001 by American Association for the Advancement of Science.

Huq, Saleemul (2002) "Lessons Learned from Adapting to Climate Change in Bangladesh", Report prepared for the World Bank. **Abstract/Summary:** The overall objective of the study was to mainstream climate change adaptation issues in the regular development strategies and operations of the World Bank in Bangladesh as well as to serve as an example for other countries. The study involved two distinct sets of activities, namely (i) analysis of existing information on climate change scenarios and their impacts in a manner that would make them intelligible to policy makers and planners, and (ii) identification of possible adaptation measures and engagement with key stakeholders in each of the vulnerable sectors to determine the feasibility of adopting the potential adaptation measures identified for those sectors. Five key sectors of the economy and physical resources of the country were selected (based upon the existing studies) as being amongst the most vulnerable to climate change, namely: coastal resources, fresh water resources, agriculture, human health, and ecosystems and biodiversity. Copyright © 2002 by The World Bank.

Huq, Saleemul (2004) "Adaptation to Climate Change in Developing Countries: Some Challenges", Paper presented at a seminar organized by the Research Network for Environment and Development (ReNED) on "Bridging Research and Development Assistance: Strategies for Adaptation to Climate Change in Developing Countries" in Copenhagen (26-27 August); summary available at: http://www.geogr.ku.dk/projects/rened/ProceedingsClimateSeminar.pdf. **Abstract**/Summary: The impacts of human induced climate change are becoming more and more likely to occur over the next two to three decades. While all countries will be impacted to some extent, the developing countries are likely to be impacted more than most for two reasons, namely: (i) they are generally located geographically within the tropical zones where impacts are likely to be severe and (ii) they generally have a low adaptive capacity (as compared to the developed countries). Thus, the challenge of adapting to climate change impacts in the developing countries are manifold, including: (i) generating the necessary knowledge about potential impacts of climate change within each country and region, (ii) identifying suitable

actions to enhance adaptive capacity, (iii) identifying suitable adaptation actions and (iv) generating the human and financial resources to implement adaptation measures. The paper explores some of these challenges and suggest ways forward to enhance the adaptive capacities of developing countries. Copyright © 2004 by the author(s).

Huq, Saleemul and Jessica Ayers (2008) "Climate Change Impacts and Responses in Bangladesh - Note", Brussels, Belgium: European Parliament, DG Internal Policies, Policy Department Economy and Science (January); available at: http://www.europarl.europa.eu/activities/committees/studies/download.do?file=19195. **Abstract/Summary:** This 20-page note (requested by the European Parliament) provides a useful summary of the context, sectoral impacts, and national and international policy responses to climate change in Bangladesh. The section on context identifies the following projected climate change impacts: increased intensity of cyclone winds and precipitation, increased moisture stress during dry periods, increased flooding, increased salinity, and greater temperature extremes. The section on sectoral impacts analyzes agriculture and fisheries, water resources and hydrology, coastal areas, forestry/biodiversity, human health, urban areas, and particularly vulnerable groups. The section on national policy response options discusses a selection of policies that reduce vulnerability to climate variability, and also specifically climate change. Finally, the last section on international policy response options discusses the role of the United Nations Framework Convention on Climate Change (UNFCCC) as well as selected donor initiatives, in supporting climate change impacts responses in Bangladesh. Copyright © 2008 by European Parliament.

Huq, Saleemul and K. Moinuddin (2004) "Climate change, vulnerability and adaptation in Bangladesh", in: V. I. Grover (ed.) *Climate Change Five Years after Kyoto* (Enflield, NH, USA: Science Publishers Inc.), pp. 251-271**. Abstract/Summary:** Climate change, vulnerability and adaptation in Bangladesh set the context including geographical position, geophysical characteristics, population, social development, literacy, natural resources (land, water regime, forests, biodiversity), climate, governance, economy, agriculture, industrial production, foreign trade, export, remittance, inflation rate, foreign development aid and debt, poverty, contribution to climate change, energy sector, emission of greenhouse gases and protection, vulnerability to cc, impact of crop sector & forests, soil salinity & erosion, effects on SLR and finally international negotiation & what needs to be done. Copyright © 2004 by Science Publishers Inc.

Huq, Saleemul and Mizan R. Khan (2003) "Mainstreaming National Adaptation Plans, *Tiempo,* No. 49 (September); available at: http://www.cru.uea.ac.uk/tiempo/floor0/recent/issue49/t49a3.htm. **Abstract/Summary:** This 3-page note outlines the key issues for preparing national adaptation strategy to climate change in Bangladesh. It summarizes the rationale for mainstreaming/integration, how integration can be ensured, and the resources available for integration. Copyright © 2003 by the University of East Anglia, the Stockholm Environment Institute, and the International Institute for Environment and Development.

Huq, Saleemul and Mizan R. Khan (2006) "Equity in National Adaptation Programs of Action (NAPAs): The Case of Bangladesh", in W. Neil Adger, Jouni Paavola, Saleemul Huq and M. J. Mace (eds.) *Fairness in Adaptation to Climate Change* (Cambridge, MA and London: The MIT Press), pp. 181-200 (Chapter 9). **Abstract/Summary:** The impact of climate change is likely to have the greatest impact in the 49 least developed countries (LDCs) because of the overwhelming dependence of their economies on climate sensitive resources, as well as because

of their low adaptive capacity. This profile challenges the planning for sustainable development and the realization the Millennium Development Goals (MDGs) within these regions of the world. This paper, therefore, raises several key issues in these contexts. How can the NAPA process factor in equity considerations? How can the COP-approved NAPA guidelines treat equity? How can the resulting planning strategies adequately address equity in implementation? The analysis is based on both secondary and primary sources. The content analysis reviews how procedural justice, participatory planning, and adaptation to climate change has been framed within Bangladesh. The article first reviews the differential vulnerabilities of groups of population to the impacts of climate change. It then explains diverse elements of equity considerations relevant in the NAPA process. The third section analyzes the NAPA guidelines documents, showing how procedures of equity are addressed in specific planning guidance. The final section presents thoughts on ensuring application of those equity provisions in the NAPA process. Copyright © 2006 by The MIT Press.

Huq, Saleemul and Mozaharul Alam (2003) "Flood Management and Vulnerability of Dhaka City", in: Alcira Kreimer; Margaret Arnold; and Anne Carlin (eds.) *Building Safer Cities: The Future of Disaster Risk* (Washington, DC: World Bank), pp. 121-135; available at: http://www.bvsde.paho.org/bvsacd/cd46/cap9-flood.pdf. **Conclusions and Recommendations:** Two severe floods hit Greater Dhaka City within a decade, causing enormous loss of life and livelihoods and damage to property. Immediately after the 1988 flood, a number of studies were carried out within the general framework of the Flood Action Plan (FAP) that specifically addressed the issue of flooding in Dhaka City. The first phase of the Greater Dhaka Integrated Flood Protection Project included embankments along the Turag and the Buriganga Rivers to protect Dhaka West. Improvements to the city's internal drainage system had also been completed before the second severe flood in 1998. Moreover, during the 1998 flood some protected areas went under water, indicating that current flood management practices must be improved. After implementation of the flood-control project in Dhaka West, unplanned and uncontrolled expansion of urban areas stretched rapidly toward the low-lying areas and floodplains adjacent to the flood-protection embankment and river. Residents of these lowlands suffer from inundation due to accumulation of rainwater after heavy rainfall. Land development through land-filling processes in the low-lying areas is causing a drastic reduction in water storage areas. Because of the rapid population increase and scarcity of land in Dhaka West, unplanned expansion is also taking place in Dhaka East at the same pace. It started on the eastern side of Biswa Road, DIT Road, Pragati Sarani, and Mymensingh Road, and is gradually stretching toward the Balu River. The areas where urbanization has already taken place are Mugdapara, Manda, Basabo, Sabujbag, Khilgaon, Goran, and Rampura. Some of these areas were the worst affected during the 1998 flood. Evaluation of Phase I work revealed that the existing earthen embankment is unstable and cracking in large sections, though some parts have recently been stabilized and other parts of the earthen embankment have been converted to roads. Construction of embankments through low-lying areas without providing adequate drainage facilities has caused internal flooding, adversely affecting the residents in those areas. The eastern part of the city consists of low-lying floodplains that are submerged during the monsoon season. They still remained unprotected. However, the growing population and land scarcity have forced people to settle in these low-lying areas. Implementation of Phase II of DIFPP will provide flood protection to this part of the city. While designing and implementing the plan, environmental impacts should be kept in mind and an adequate number of drainage facilities should be provided for the proposed embankment. The hydrological data should be analyzed

during the design phase of the flood protection infrastructure. Dredging work in the Buriganga, Turag, and Balu Rivers should be regularly carried out to maintain navigability and reduce drainage congestion. In addition to structural measures, nonstructural measures should also be considered to reduce flood damage. These measures include flood zoning, flood forecasting and warning, flood proofing, flood insurance, and evacuation measures. Flood zoning could be one of the most effective measures to ensure that expensive investments are not made in flood-vulnerable areas. It will also help to protect ecologically sensitive areas, natural drainage systems, and the surrounding wetlands that retain water. Since the western part of Dhaka is already developed, little can be done in this area except protecting the lakes and khals. The government has already issued a decree banning the filling in of any wetland for urban development. In exceptional cases, permission should be secured directly from the prime minister. The eastern part of the city is still largely a floodplain. Proper land development rules should be introduced without delay to minimize the loss from river flooding from the Balu River. It is anticipated that the city's future flood vulnerability will be aggravated due to climate change. Experts are forecasting that floods with the magnitudes of those in 1988 and 1998 may occur more frequently. Thus, it is imperative that a long-term flood-mitigation and climate change adaptation strategy be developed for the future management of floods in and around Greater Dhaka City. Copyright © 2003 by The World Bank.

Huq, Saleemul; Atiq Rahman; Mama Konate; Youba Sokona; and Hannah Reid (2003) *Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs)* (London: International Institute for Environment and Development, April); available at: http://www.iied.org/pubs/pdf/full/9219IIED.pdf. **Abstract/Summary:** Adaptation to climate change has become an important policy priority in international climate change negotiations, but has yet to become a major policy issue in developing countries, especially the LDCs, which have contributed least to greenhouse gases but are most vulnerable to climate change and have the least capacity to adapt. Experience from two LDCs, Bangladesh and Mali, shows that although much has been achieved in terms of describing and analyzing vulnerability to climate change and identifying potential adaptation options, there remains much more to be done to mainstream adaptation to climate change within the national policymaking processes in those countries. This paper presents basic statistics portray populations, GDP, growth rate of the LDC countries. The emissions of these countries and need for adaptation has also been highlighted in addition, a suggested set of key causes has been compiled. Copyright © 2003 by International Institute for Environment and Development.

Huq, Saleemul; Farhana Yamin; Atiq Rahman; Anish Chatterjee; Xiu Yang; Salimata Wade; Victor Orindi; and Johannes Chigwada (2005) "Linking climate adaptation and development: a synthesis of six case studies from Asia and Africa" (Brighton, UK: Institute for Development Studies (IDS) *IDS Bulletin*, Vol. 36, No. 4 (October), pp. 117-122; available at: http://www.eci.ox.ac.uk/~dliverma/articles/Yamin%20and%20Huq%20on%20climate%20and%20devt.pdf.
Abstract/Summary: Increased temperature, floods, droughts, extreme events and changes in precipitation pose additional risks for developing countries and vulnerable communities striving to alleviate poverty and to achieve sustainable development. Knowledge and experience of adapting to climatic conditions has been built up over a millennia by communities in many parts of the world, including developing countries, often on the basis of experimentation initiated by communities. This synthesis brings together the main insights and conclusions from case studies describing examples of successful community-led interventions in six countries: China, India,

Bangladesh, Senegal, Kenya and Zimbabwe. The climate impacts studied include extreme events, such as national floods, and quieter forms of climatic disaster such as long-term aridity/drought, temperature increase and wind-related land degradation. The synthesis examines the roles played by formal and informal institutions, policy champions, donors, knowledge and research in decreasing vulnerabilities and supporting community-led adaptation to climate change. The general research ideas of this article are (a) identifying and mapping the most vulnerable locations/communities within each country, (b) documenting local/indigenous knowledge and experience to cope with climatic hazards and transferring the knowledge where needed, (c) scaling up best practices by communities on adaptation to climate variability, (d) integrating climate change adaptation into development activities and policies (mainstreaming), and (e) establishing emergency communication infrastructure for the communities to manage disasters. The article also suggests the following Bangladesh country-specific research ideas: ● Effective regional cooperation in terms of information sharing and regional capacity building, particularly with neighboring countries. ● Government bodies and NGOs working in the areas of disaster should develop regular contingency plans to respond to floods. ● Structural measures such as rural infrastructure and flood shelters need to be designed in a participatory and socially responsive way, so that the poor and marginal groups can design as well as have access to these facilities. **Conclusions:** A number of conclusions (aimed at enhancing research capabilities and building adaptive capacity in developing countries in the future) can be drawn from the case studies. These include: ● Adaptation strategies for coping with future climate change impacts can use previous experience and knowledge of communities in regions already subject to climatic hazards. ● In most countries, there are already regions and communities that have faced adverse climatic hazards and have developed coping strategies that can be used or enhanced as the basis for future adaptation to climate change. ● A wide range of institutions can act as champions for adaptation actions ranging from governmental to non-governmental organizations to the private sector and research organizations. ● Interventions to enhance adaptation are more likely to be successful if based on indigenous actors, as they are more likely to have the trust and knowledge of local communities relevant to enhancing sustainable livelihoods. ● External donors can play a positive role in enhancing adaptation, provided it is used for strengthening local capacities in a way that avoids creation of long-term dependencies. ● Use of knowledge (and its generation through research and dissemination through outreach activities) is likely to be a critical factor in successful adaptations. To summarize, the case studies support the conclusions reached elsewhere on effective global citizen action: that research must be participatory; policy analysis sophisticated as well as legitimate and reality checked (both more likely if it has been jointly developed between holders of different kinds of knowledge); and because realities are ever changing, those involved in linking micro- to macro-realities and in policy advocacy should engage in organizational learning.

Huq, Saleemul; S. I. Ali; and A. A. Rahman (1995) “Bangladesh Is Used to Coping but Rising Seas Pose New Dangers”, *Climate Alert*, Vol. 8, No. 2 (March-April). **Abstract/Summary:** This one-page article points out that the people of Bangladesh have been living with natural hazards and catastrophe for thousands of years and the Bangladeshi have developed methods of coping with them. It then describe the new threat of climate change induced sea level rise and outline the main aspects of Bangladesh’s needs to develop a more comprehensive view of its coasts and how to manage them, taking into account global sea level rise, subsidence, population growth and development, and that it will need help from the world community to face this new challenge.

Huq, Saleemul; Z. Karim; M. Asaduzzaman; and F. Mahtab (eds.) (1999) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers). **Abstract/Summary:** This book is based on a substantial study carried by a team of experts in different fields from Bangladesh, following IPCC guidelines. The study has for the first time developed scenarios for the impact of climate change on agriculture and water sectors, focusing on coastal agriculture and beach erosion in the context of sea level rise. It has also taken a look at the aspect of adaptation to climate change for Bangladesh. **Contents:** Overview (by S. Huq and M. Asaduzzaman); Development of Climate Change Scenarios with General Circulation Models (by Ahsan Uddin Ahmed and Mozaharul Alam); Water Resources Vulnerability to Climate Change with Special Reference to Inundation (by Mozaharul Alam et al.); Climate Change Vulnerability of Crop Agriculture (by Zahurul Karim et al.); Assessment of Foodgrain Production Loss Due to Climate Induced Enhanced Soil Salinity (by Mohammed Habibullah, Ahsan Uddin Ahmed, and Zahurul Karim); Beach Erosion in the Eastern Coastline of Bangladesh (by S. M. R. Islam et al.); Vulnerability of Forest Ecosystems of Bangladesh to Climate Change (by Ahsan Uddin Ahmed et al.); Fish Resources Vulnerability and Adaptation to Climate Change in Bangladesh (by M. Y. Ali); Adaptation to Climate Change in Bangladesh: Future Outlook (by Ahsan Uddin Ahmed et al.).

Hussain, Sk. Guhlam (2008) Assessing Impacts of Climate Change on Cereal Production and Food Security in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation provides results from a simulation study that was conducted to assess the climate change related vulnerability of food grain production in Bangladesh, whereby the simulation study applied crop models for various kinds of rice and wheat among various locations in Bangladesh.

Hutton, David and C. Emdad Haque (2004) "Human Vulnerability, Dislocation and Resettlement: Adaptation Processes of River-Bank Erosion-Induced Displacees in Bangladesh", *Disasters*, Vol. 28, No. 1, (March) pp. 41-62. **Abstract/Summary:** The purpose of this research was to identify and analyse patterns of economic and social adaptation among river-bank erosion-induced displacees in Bangladesh. It was hypothesized that the role of social demographic and socio-economic variables in determining the coping ability and recovery of the river-bank erosion-induced displacees is quite significant. The findings of the research reveal that displacees experience substantial socio-economic impoverishment and marginalization as a consequence of involuntary migration. This in part is a socially constructed process, reflecting inequitable access to land and other resources. Vulnerability to disasters is further heightened by a number of identifiable social and demographic factors including gender, education and age, although extreme poverty and marginalization create complexity to isolate the relative influence of these variables. The need to integrate hazard analysis and mitigation with the broader economic and social context is discussed. It is argued that the capacity of people to respond to environmental threats is a function of not only the physical forces which affect them, but also of underlying economic and social relationships which increase human vulnerability to risk. Hazard analysis and mitigation can be more effective when it takes into account such social and demographic and socio-economic dimensions of disasters.

Iftekhar, M. S. (2006) "Conservation and management of the Bangladesh coastal ecosystem: Overview of an integrated approach", *Natural Resources Forum*, Vol. 30, No. 3, pp. 230-237. **Abstract/Summary:** Although the coastal ecosystem of Bangladesh contains a highly functional and structurally diverse ecology, this ecology is gradually being degraded. As a consequence, the quality of life of a large section of the coastal community is in economic decline. This poses a daunting challenge to the sectoral coastal management programmes, active since the 1960s, aiming at simultaneously ameliorating people's livelihood and supporting the ecosystem. These programmes have been reasonably successful in managing the ecosystem, but in many cases, the situation has become worse. The limitations of these programmes include the tendency to adopt an exclusionist approach, a narrowly departmentalized administration and weak management. Currently, the integrated coastal zone management (ICZM) approach is espoused as the main strategy. With the adoption of Bangladesh's Coastal Zone Policy of 2005, the foundation for integrated management was laid. The next realistic target will be to bring about changes in culture and mandate among coastal institutions in favor of integrated management. Copyright © 2006 by United Nations.

Institute for Water Modelling (IWM) (2005) *Impact Assessment of Climate Changes on the Coastal Zone of Bangladesh*. (Dhaka: Government of the People's Republic of Bangladesh (GoB), Ministry of Water Resources, Institute of Water Modelling, and Water Resources Planning Organization (WARPO)). **Abstract/Summary:** This final report presents an assessment of impacts of sea level rise on inundation, drainage congestion, salinity intrusion and change of surge height in the coastal zone of Bangladesh. Sea level rise scenarios are based on the recommendations of the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) and National Adaptation Program of Action (NAPA). The study has been based on the available data and numerical models available in IWM. Analysis of the impacts in terms of inundation depth, drainage congestion in coastal polders, salinity intrusion, changes in surge inundation depth and changes in erosion/deposition pattern. Report also includes methodology study area, data & model used and finally a conclusion. Copyright © 2005 by GoB.

International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) (2007) *Climate change and Bangladesh* (Dhaka: ICDDR,B; News and Events, October 22); available at: http://203.190.254.12/news/index.jsp?idDetails=130&typeOfNews=News%20and%20Events.
Abstract/Summary: This two-page articles summarizes first the impact of climate change on water resources, especially arising from sea level rise, and outlines then the major implications on infectious diseases, malaria, dengue, visceral leishmaniasis (VL), cholera and other diarrhoeal diseases. Copyright © 2007 by International Centre for Diarrhoeal Disease Research, Bangladesh.

Irfanullah, Haseeb Md; Md. Belayet Hussain; and Tajul Islam Chowdhury (2005) *Baira -- The Floating Garden for Sustainable Livelihood* (Dhaka: Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forestry (MoEF); UNDP; BCAS; and IUCN-Bangladesh). **Abstract/Summary:** Community Base Floodplain Resources Management in the Madhumati Floodplain, one of the interventions under SEMP promotes alternative livelihood options through Baira farming. The purpose of the present account is to illustrate the Baira extension initiatives taken under the SEMP. Local knowledge and participatory planning and interventions to promote baira farming as an alternative livelihood option. Community people

are interested in baira farming and adopted the technique under the initiatives. The extension of baira cultivation as an environment friendly livelihood options in the wetlands of Bangladesh to poverty to mitigate and to adapt to the consequences of climate change could be promoted. Copyright © 2005 by GoB et al.

Islam, M. B.; M. Y. Ali; M. Amin; and Sk. M. Zaman (2008) Climatic Variations: Farming Systems and Livelihoods in the High Barind Tract and Coastal Areas of Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation investigates the effect of climatic variations on farming systems and the peoples' livelihoods. It looks at technologies to mitigate drought situations as well as at the drought-resistance of various crops. It concludes with the main impact of climate change on agriculture, the adaptation measures that may be taken, and various issues related to institutional adaptation. Copyright © 2008 by the author(s).

Islam, M. F. and S. Parveen (2004) "Food Security in the Face of Climate Change, Population Growth, and Resource Constraints: Implications for Bangladesh", *Environmental Management*, Vol. 34, No. 4, pp. 487-498**. Abstract/Summary:** Ensuring food security has been one of the major national priorities of Bangladesh since its independence in 1971. Now, this national priority is facing new challenges from the possible impacts of climate change in addition to the already existing threats from rapid population growth, declining availability of cultivable land, and inadequate access to water in the dry season. In this backdrop, this paper has examined the nature and magnitude of these threats for the benchmark years of 2030 and 2050. It has been shown that the overall impact of climate change on the production of food grains in Bangladesh would probably be small in 2030. This is due to the strong positive impact of CO_2 fertilization that would compensate for the negative impacts of higher temperature and sea level rise. In 2050, the negative impacts of climate change might become noticeable: production of rice and wheat might drop by 8% and 32%, respectively. However, rice would be less affected by climate change compared to wheat, which is more sensitive to a change in temperature. This study based on population projection and analysis of future agronomic innovations further shows that the availability of cultivable land alone would not be a constraint for achieving food self-sufficiency, provided that the productivity of rice and wheat grows at a rate of 10% or more per decade. However, the situation would be more critical in terms of water availability. Meeting such a high agricultural water demand might cause significant negative impacts on the domestic and commercial water supply, fisheries, ecosystems, navigation, and salinity management. Copyright © 2004 by Springer.

Islam, M. Rafiqul (2006) "Managing Diverse Land Uses in Coastal Bangladesh: Institutional Approaches", in C. T. Hoanh, T. P. Tuong, J. W. Gowing and B. Hardy (eds.) *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture- Fishery-Aquaculture Conflicts, Comprehensive Assessment of Water Management in Agriculture Series*, No. 2, (Wallingford, U.K. and Cambridge MA: CABI Publishing), pp. 237-248; available at: http://www.iwmi.cgiar.org/Publications/CABI_Publications/CA_CABI_Series/Coastal_Zones/Hoanh_1845931076-Chapter18.pdf. **Abstract/Summary:** Land use in coastal Bangladesh is diverse, competitive and conflicting. Agriculture, shrimp farming, salt production, forestry, ship-breaking yards, ports, industry, settlements and wetlands are some of the uses. Land uses have

gone through major changes. Land use in the 1950s had been mainly for paddy cultivation, but salinity intrusion and tidal flooding prevented further intensification. Hence, in the 1960s–1980s, the World Bank and others helped with large-scale polderization in order to boost rice production. A decade later, drainage congestion inside and heavy siltation outside the polders made the southwestern area unsuitable both for agriculture, and, in extreme cases, even for human habitation. However, as the region has a history of traditional shrimp farming, polders provided an opportunity for intensive shrimp farming. Crop land and mangroves were transformed to shrimp farming. This created social conflict. Planned management of diverse land use, including zoning, has been recommended since. This chapter focuses on the complexities of land use in Bangladesh and the adopted institutional approaches. Copyright © 2006 by CABI Publishing.

Islam, M. Shahidul (2001) *Sea-Level Changes in Bangladesh: The Last Ten Thousand Years* (Dhaka, Asiatic Society of Bangladesh). **Abstract/Summary:** The book is an output of Ph.D. dissertation at the University of St. Andrews, U.K., under the sponsorship of the Association of commonwealth Universities. Relative sea level movements, both in geological time scale, as well as the current trends, refer to very complicated processes, operating globally, regionally and locally. Dr. Islam has widely reviewed these issues from theoretical to applied context. Based on empirical evidences, the fluctuating history of relative sea level movements, during the last ten thousand years for Bangladesh, have been reconstructed. The implications of such reconstructed marine transgression-regression sequences, on coastal geometry, shoreline migration, coastal vegetation successions and coastal dynamics, have been synthesized quantitatively. This book offers a clear explanation to the science of sea level changes and can be used widely by academics, policy makers, coastal and environmental scientists, geographers, university students and above all general readers. Copyright © 2001 by Asiatic Society of Bangladesh.

Islam, M. Shahidul and M. J. Tooley (1999) "Coastal and sea-level changes during the Holocene in Bangladesh", *Quaternary International*, Vol. 55, No. 1 (March), pp. 61-75. **Abstract/Summary:** The aim of the study is to reconstruct the Holocene sea-level history along a section of the coast of Bangladesh. Detailed litho-, bio- and chronostratigraphic techniques have been applied to unveil the nature of sedimentary sequences in association with the events of the Holocene marine transgressions and regressions. Samples were collected from Panigati near Khulna. The study provides evidence of five periods of marine transgression, each followed by a regression, during the Holocene. Each minerogenic sediment layer indicates a marine episode and the sediments were deposited under intertidal to estuarine conditions. Each peat layer is in situ and indicates a regression of the sea. It is difficult to separate the regional eustatic components contributing to these relative sea-level movements, although processes operating locally and regionally are clearly evident. A sea-level curve together with possible error ranges, has been proposed for this part of Bangladesh. Since the early to mid-Holocene, an average relative sea-level rise of 1.07 mm/yr has been estimated. Copyright © 1999 by Elsevier B.V.

Islam, M. Sirajul; A. A. Mahbub; and M. S. Islam (2008) Cool Rice for a Warmer Environment Concept, Progress and Prospect; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation reviews first the general impact of global warming on rice production and reviews then the main issues of rice production in Bangladesh, including high temperature stresses,

temperature trends and how it affected the rice production in Bangladesh, as well as approaches to cope with high temperature stress. Copyright © 2008 by the author(s).

Islam, Md. Monirul and Kimiteru Sado (2001) "Flood damage and management modelling using satellite remote sensing data with GIS: case study of Bangladesh", in: M. Owe, K. Brubaker, J. Ritchie, and A. Rango (eds.) *Remote sensing and hydrology 2000; Selected papers from a conference held at Santa Fe, New Mexico, USA, 2-7 April 2000)*, (Wallingford, Oxfordshire, UK: International Association of Hydrological Sciences (IAHS) Press, Centre for Ecology and Hydrology). **Abstract/Summary:** Physiographic divisions, geological divisions, land cover categories and drainage network data were used as geographical information systems components. Flood frequency and floodwater depth were estimated using NOAA AVHRR data for the development of a flood hazard map. The flood hazard map provides information for the development of counter measures and preparation of high risk areas, on a priority basis, against flood damage. It is concluded that the flood hazard map, which was developed by considering the interaction of floodwater depth and flood frequency, gives good results for other events. Copyright © 2001 by International Association of Hydrological Sciences.

Islam, Md. Monirul and Kimiteru Sado (2002) "Development Priority Map for Flood Countermeasures by Remote Sensing Data with Geographic Information System" *Journal of Hydrologic Engineering*, Vol. 7, No. 5 (September/October), pp. 346-355. **Abstract/Summary:** Bangladesh suffered damage on account of the most catastrophic floods of 1987, 1988, and 1998, resulting in untold suffering of the people. This paper demonstrates the technique to develop a flood hazard map and a land development priority map for countermeasures against flood damage. To create the final products, the flood hazard map and land development priority map, National Oceanic and Atmospheric Administration (NOAA) advanced very high resolution radiometer (AVHRR) data for the flood events of 1988, 1995, and 1998 were incorporated with geographic information system data. Flood-affected frequency and flood depth categories were estimated using NOAA AVHRR images. Special attention was paid to population density for the construction of the land development priority map, because highly dense populated areas represent the highly important urban and industrial areas of Bangladesh. The land development priority map offers a new opportunity for flood risk management, planning, design, and operation of flood control measures in Bangladesh, and should be useful in assigning priorities for the development of at-risk areas. Copyright © 2002 by American Society of Civil Engineers.

Islam, Md. Nazrul (2004) "Environmental Implications of the Ganges Water Diversion and Its International Legal Aspects", in: M. Monirul Qader Mirza (ed.) *The Ganges Water Diversion: Environmental Effects and Implications* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 197-221 (Chapter 10). **Abstract/Summary:** This chapter examines the international legal aspects of the environmental impacts in the Ganges basin in Bangladesh caused by upstream water diversion by India. It compares pre- and post-diversion environmental situations in the basin area in Bangladesh and documents the principal environmental concerns: international water sources, bio-diversity, climate change, absence of the environmental issues in the bilateral water agreements between Bangladesh and India particularly in the 1996 Ganges Water Treaty is also demonstrated, and measures to modify the 1996 Treaty in the light of international environmental conventions and laws are suggested. Copyright © 2004 by Kluwer Academic Publishers.

Islam, Md. Nazrul (2008) Understanding the Rainfall Climatology and Detection of Extreme Weather Events in SAARC Region: Part I - Bangladesh (Dhaka: SAARC Meteorological Research Centre (SMRC), SMRC Publication, No. 21. **Summary/Abstract:** It is well known that model detected extreme weather events are not free from uncertainties and that is why reliability tests (using the observational datasets before using the model outputs) are essential. In this publication, rainfall climatology is obtained from tropical rainfall measuring mission (TRMM) datasets. A climate model, named RegCM (Regional Climate Model), is used to generate extreme weather events. In this part I of this study, model simulated events are compared with observed datasets of the Bangladesh Meteorological Department (BMD). The observed datasets revealed that very wet days and extremely wet days increase at a rate of 3.93 and 1.31 mm per year respectively. The increase of wet days is high in the NE and SE regions of Bangladesh. The maximum of daily maximum temperature is decreasing by 0.04°C per year in Bangladesh, whereas the minimum of daily maximum temperature is almost static in nature. The maximum value of daily minimum temperature is increasing at a rate of 0.02°C per year. On the other hand, minimum of daily minimum temperature is increasing at a rate of 0.06°C per year. This is the signature of global warming that lower temperature is increasing in a faster rate even though the higher temperature is almost in static nature. Subsequent tests disclosed that model simulated outputs are at least able to detect the signal of extreme weather events. It is suggested that model outputs need to be calibrated with observed datasets. Once the calibration is completed, the model generated future scenarios may be used in forecasting extreme weather events with lower uncertainties. In the next part of this study, phase model outputs will be calibrated and the work will be extended for the entire SAARC domain.

Islam, Md. Nazrul (2008) Studies on Summer Monsoon Rainfall Using Regional Climate Model PRECIS (Dhaka: SAARC Meteorological Research Centre (SMRC) SMRC Publication, No. 22. **Summary/Abstract:** Summer monsoon rainfall is studied using regional climate model (RCM) called PRECIS (Providing REgional Climates for Impact Studies) for the SAARC domain. PRECIS is a PC-based RCM developed by the Hadley Centre of the United Kingdom Meteorological Office. The version 1.5.1 of PRECIS is available at SMRC to run for SRES A2 and B1 scenarios during 1961-2100. The model control run (1961-1990) is performed in 50 km horizontal grid resolution for the SAARC domain. In this work PRECIS rainfall is calibrated with ground-based rainfall measurement at 27 observational sites throughout Bangladesh. During the course of calibration, regression coefficients are obtained for 27 observational sites which are the key factors for the validation of model outputs. The model is again run for 2000-2006 to carry out the validation work. It is found that PRECIS over-performed by only 4.471% in estimating rainfall over Bangladesh. This excellent performance of PRECIS makes it useful for projecting rainfall in the whole SAARC region. It is important to note that without calibration PRECIS generated rainfall scenarios are unrealistic with observational rainfall pattern. Calibration makes the model outputs more realistic with the historical rainfall blueprint. Through this research, the rainfall forecast for the SAARC domain in 2009 is experimentally prepared. Model simulated rainfall in 2009 is calibrated for Bangladesh and the rainfall projection is found to be surplus 2.03% and 14.02% during monsoon (JJAS) and post-monsoon (ON) periods respectively. It is deficit to about 2.08% and 1.44% during pre-monsoon (MAM) and dry periods (DJF) respectively. The seasonal rainfall forecasting approach using downscaling of regional climate model output is quite new in SMRC and also in Bangladesh. The work is expected to extend for the entire SAARC domain through proper calibration and validation in a consecutive

research project. The ultimate goal is to be able to post seasonal rainfall forecast for entire SAARC region in the SMRC website. The rainfall forecast is very important for the SAARC member countries as they are densely populated and highly vulnerable to climate change. Copyright © 2008 by SAARC Meteorological Research Centre (SMRC).

Islam, Md. Nazrul (forthcoming) "Projection of Rainfall in SAARC Region: Part-1 Bangladesh" (forthcoming). **Abstract/Summary:** A regional climate model named Providing REgional Climates for Impacts Studies (PRECIS) adapted in generating rainfall scenarios for the SAARC (South Asian association for Regional Cooperation) region. At first, PRECIS generated rainfall scenario is calibrated with ground-based observed rainfall during baseline period (1961-1990) in Bangladesh. The regression coefficients obtained through calibration are utilized for validation of PRECIS generated rainfall during 2000-2006. PRECIS overestimated rainfall 12.37%, 1.58%, 10.81%, 4.79 and 13.18% in 2000, 2002, 2003, 2005 and 2006 respectively. It underestimated 0.64% and 10.84% in 2001 and 2004 respectively. On an average, PRECIS overestimated about 4.47%. Better performance of PRECIS through validation encourages employing it in rainfall forecasting for Bangladesh. In the second step, rainfall forecast for Bangladesh is experimentally obtained for 2009-2020. This work discloses that the PRECIS simulated rainfall is not directly useful in application purposes. However, after performing calibration, acceptable result is obtained in estimating rainfall in Bangladesh with R2 is 0.81 and correlation coefficient is 0.90. Change of rainfall is forecasted from -0.99% (in 2013) to 5.3% (2018) for Bangladesh during 2009 - 2020. Copyright © 2009 by the author.

Islam, Md. Nazrul (forthcoming) "Regional Climate Model for Rainfall Projection in Bangladesh", Paper to be presented at the 2nd International Conference on Water and Flood Management (ICWFM), Dhaka (15-17 March 2009). **Abstract/Summary:** Rainfall is projected using regional climate model (RCM) called PRECIS (Providing REgional Climates for Impact Studies) for Bangladesh. The model control run (1961-1990) is completed in 50 km horizontal grid resolution and model generated rainfall is calibrated with ground-based rainfall measurement at 27 observational sites throughout Bangladesh. The model is again run for 2000-2020 to carry out validation and forecast of rainfall. It is found that PRECIS over-performed by about 4.47% during 2000-2006 in estimating rainfall over Bangladesh with R^2 is 0.81 and correlation coefficient is 0.90. This admirable performance of PRECIS encourages using it for projection of rainfall as well as surface water in the country. The rainfall projection in 2009 is found surplus 2.03% and 14.02% in monsoon (JJAS) and post-monsoon (ON) periods respectively. It is deficit 2.08% and 1.44% in pre-monsoon (MAM) and dry periods (DJF) respectively. Surface water over Bangladesh is calculated 40.68×10^9 kg for baseline period. It varies from -0.98% (2013) to 5.53% (2018) during 2009 – 2020. Copyright © 2009 by the author.

Islam, Md. Nazrul and Hiroshi Uyeda (2007) "Use of TRMM in determining the climatic characteristics of rainfall over Bangladesh" *Remote Sensing of Environment*, Vol. 108, No. 3, pp. 264-276. **Abstract/Summary:** Five years of data from 1998 to 2002 of TRMM-3B42 version 5 (V5), 3B43 V5, 3B42 version 6 (V6), 3B43 V6, and the Bangladesh Meteorological Department rain-gauge network were analyzed to understand the climatic characteristics of rainfall over Bangladesh. TRMM-PR 2A25 data were used to obtain the precipitation field of the convection events. Daily rainfall measured by TRMM V5 3B42 was compared to that of rain-gauge values from pre-monsoon to post-monsoon months (March–November). The time sequence patterns of

the daily rainfall determined by the V5 3B42 and those from rain gauges were remarkably similar. The spatial and temporal averages of rainfall revealed good estimations of rainfall: during March to November, the V5 3B42- and rain gauge-estimated daily rainfall was 8.12 and 8.34 mm, respectively. In annual scale, TRMM V5 3B42-, V5 3B43-, V6 3B42-, V6 3B43- and rain-gauge estimated rainfall was 6.9, 6.4, 6.6, 6.8 and 7.1 mm/day, respectively. The average percentage of rainy days determined by V5 3B42 data with respect to the rain-gauge value was 96%. TRMM is useful for estimating the average values of rainfall in Bangladesh. The prominent difference between rainfall estimated by rain-gauge and V5 3B42 was found to be period- and location-dependent. The V5 3B42 overestimated the rainfall during the pre-monsoon period and in dry regions but underestimated it during the monsoon period and in wet regions. The reason for the differences according to season and locations is considered to be the vertical cross section of convection obtained by TRMM-PR 2A25 data. The rainfall overestimation in pre-monsoon and underestimation in monsoon period measured by V5 3B42 is reduced to reasonable amount by V6 3B42 and V6 3B43. In this manner, the merit of using TRMM data for climatological studies of rainfall over Bangladesh is shown.

Islam, Md. Nazrul and Hiroshi Uyeda (2008) "Vertical variations of rain intensity in different rainy periods in and around Bangladesh derived from TRMM observations", *International Journal of Climatology*, Vol. 28, No. 2, pp. 273-279. **Abstract/Summary:** In this paper, differences in rain intensity in and around Bangladesh during various rainy periods are described. The data were obtained from tropical rainfall measuring mission (TRMM) -2A25, -3B42 and -3B43. The version 5 (V5) 3B42 daily products overestimated rainfall in pre-monsoon and post-monsoon periods but underestimated it in the monsoon period compared with rain-gauge data. The version 6 (V6) daily products reduced the over- and under-estimation of rainfall. On the basis of the analyzed rainfall characteristics in different rainy periods, the 2A25 data was analyzed to reveal the vertical variations of rain intensity. Pre-monsoon rainfall was characterized by convective rain with strong intensity up to high altitudes and high echo tops that usually occurred over land and not over the Bay of Bengal. In contrast, during monsoon, intense rain occurred over the Bay of Bengal and land; however, the existence of strong and high echo tops was less significant than that during the pre-monsoon period. The radar echo tops and the height of strong rain intensity measured in the post-monsoon period were lower than those obtained in the monsoon period.

Islam, Md. Nazrul; M. Rafiuddin; Ahsan Uddin Ahmed; and Rupa Kumar Kolli (2008) "Calibration of PRECIS in employing future scenarios in Bangladesh", *International Journal of Climatology*, Vol. 28, No. 5, pp. 617-628. **Abstract/Summary:** Providing Regional Climates for Impacts Studies (PRECIS) is a regional climate model, which is used for the simulation of regional-scale climatology at high resolution (i.e. 50-km horizontal resolution). The calibration of rainfall and temperature simulated by PRECIS is performed in Bangladesh with the surface observational data from the Bangladesh Meteorological Department (BMD) for the period 1961–1990. The Climate Research Unit (CRU) data is also used for understanding the performance of the model. The results for the period 1961–1990 are used as a reference to find the variation of PRECIS-projected rainfall and temperature in 2071, in and around Bangladesh, as an example. Analyses are performed using the following two methods: (1) grid-to-grid and (2) point-to-point analyses. It is found that grid-to-grid analysis provides overestimation of PRECIS in Bangladesh because of downscaling of observed data when gridded from asymmetric low-density data network of BMD. On the other hand, model data extracted at observational sites provide better

performance of PRECIS. The model overestimates rainfall in dry and pre-monsoon periods, whereas it underestimates it in the monsoon period. Overall, PRECIS is found to be able to estimate about 92% of surface rainfall. Model performance in estimating rainfall increases substantially with the increase in the length of time series of datasets. Systematic cold bias is found in simulating the annual scale of the surface temperature. In the annual scale, the model underestimates temperature of about 0.61°C that varies within a range of +1.45°C to −3.89°C in different months. This analysis reveals that rainfall and temperature will be increased in Bangladesh in 2071. On the basis of the analyses, look-up tables for rainfall and temperature were prepared in a bid to calibrate PRECIS simulation results for Bangladesh. The look-up tables proposed in this analysis can be employed in the application of the projected rainfall and temperature in different sectors of the country. These look-up tables are useful only for the calibration of PRECIS simulation results for future climate projection for Bangladesh. Copyright © 2008 by Royal Meteorological Society.

Islam, Md. Shirazul and Md. Harun-ur-Rashid (2008) Climate Change and Sustainable Irrigation Management for High Value Crops in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation illustrates first the various irrigation techniques used in Bangladesh and presents then various effects of climate change on soil, water, and crop production in Bangladesh, including among others salinity, drought, and floods, and cyclones. It then presents the possible measures for sustainable water use in crop fields in Bangladesh in some details. Copyright © 2008 by the author(s).

Islam, Mursaleena and John B. Braden (2006) "Bio-economic development of floodplains: farming versus fishing in Bangladesh", *Environment and Development Economics*, Vol. 11, No. 1, pp. 95-126. **Abstract/Summary:** This paper explores economic development in the floodplain of large rivers, where both economic and ecological factors need to be considered for effective management. Floodplain management policies in Bangladesh emphasize structural changes to enhance agricultural production. However, these structural changes reduce fisheries production, an important natural resource sector and a source of subsistence for the rural poor. We develop a model where net returns to agriculture and fisheries are jointly maximized, taking into account the effect of flooding depth and timing on production, and value of catch in markets and for subsistence nutrition. Results for a region in Bangladesh show that optimal production in a natural floodplain yields higher net returns compared with a floodplain modified by flood control structures. This finding implies that neglecting the bio-economic relationship between fisheries and land use may significantly affect the long-run economic role of a river floodplain, particularly where subsistence consumption is important to social welfare. Copyright © 2006 by Cambridge University Press.

Islam, S. M. R.; Saleemul Huq; and A. Ali (1999) "Beach Erosion in the Eastern Coastline of Bangladesh -- Vulnerability and Adaptation to Climate Change for Bangladesh", in S. Huq, Z. Karim, M. Asaduzzaman; and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 72-93**.** **Abstract/Summary:** Land loss due to beach erosion caused by sea level rise in the eastern coastline of Bangladesh was calculated by using Brunn's formula. Estimation was done for three distinct areas: a) Bakkhali river valley b) Southern beach plain c) Nilla-Teknaf plain. In addition

Moheskhali channel area was also studied. The slope of this coastline was measured by conducting a survey at 21 different points along north-eastern coast considering coastline profile taken at 90 degree angle with respect to sea. These points were interpolated to define the coastline profile: Real world geographical location of each point was captured using Geographical Positioning System (GPS) and subsequently the shoreline profile was coupled with a GIS system. Bathymetric information was drawn from admiralty charts from which height (depth of water) and width of the continental shelf were determined. Brunn's formula gave the values for shoreline recession for 30 and 75 cm sea level rise for the year 2030 and 75, respectively. It was found that about 5,800 ha area along the shoreline would be lost in 2030, while 11.200 ha would be recessed in 2075. It was also found that about 13,750 and 252,000 tons of food grain production would be lost in 2030 and 2075, respectively, due to shoreline erosion.

Karim, M. F.; T. Tingsanchali; and K. Tanimoto (2002) "Flood Risk Assessment for the Ganges Floodplain in Bangladesh", *Proceedings of the International Coastal Engineering Conference*, Vol. 28, No. 3, pp. 3581-3593**. Abstract/Summary:** This article describes the analysis and simulation conducted by using a hydrodynamic model. After model calibration and verification, the model was used to simulate the flood flow of 100-year return period for a duration of four months. The maximum flooding depths at different locations in the rivers and floodplains were determined. The process in determining long flooding durations at every grid point in the hydrodynamic model is laborious and time-consuming. Therefore the flood durations were determined by using satellite images of the observed flood in 1988, which has a return period close to 100 years. Flood hazard assessment was done considering flooding depth and duration. By dividing the study area into smaller land units for hazard assessment, the hazard index and the hazard factor for each land unit for depth and duration of flooding were determined. From the hazard factors of the land units, a flood hazard map, which indicates the locations of different categories of hazard zones, was developed. It was found that 54% of the study area was in the medium hazard zone, 26% in the higher hazard zone and 20% in the lower hazard zone. Due to lack of sufficient flood damage data, flood damage vulnerability is simply considered proportional to population density. The flood risk factor of each land unit was determined as the product of the flood hazard factor and the vulnerability factor. Knowing the flood risk factors for the land units, a flood risk map was developed based on the risk factors. Such maps are very useful for the inhabitants and floodplain management authorities to minimize flood damage and loss of human lives.

Karim, Md. Rezaul (2006) "'Brackish-Water Shrimp Cultivation Threatens Permanent Damage to Coastal Agriculture in Bangladesh", in C.T. Hoanh, T. P. Tuong, J. W. Gowing and B. Hardy (eds.) *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture- Fishery-Aquaculture Conflicts, Comprehensive Assessment of Water Management in Agriculture Series, No. 2* (Wallingford UK and Cambridge MA: CABI Publishing), pp. 61-71; available at: http://www.iwmi.cgiar.org/Publications/CABI_Publications/CA_CABI_Series/Coastal_Zones/Hoanh_1845931076-Chapter5.pdf. **Abstract/Summary:** Over the past 20 years, brackish-water shrimp cultivation in the coastal zone of Bangladesh has contributed increasingly to the national economy, but there is a lack of quantitative data on the effects of shrimp farming at the household and community levels. This chapter investigates the impact of shrimp cultivation on the environment and farmers' livelihood in a typical sub-district of the coastal zone in Bangladesh. The variables involved with shrimp cultivation and their impact on the land are also

taken into consideration and an attempt is made to analyse the patterns of land-use change that occurred between 1975 and 1999. The extensive pattern of shrimp cultivation is achieved by expansion of area rather than by intensification. The expansion of shrimp farming has resulted in decreases in crop production and many environmental problems in the form of a shortage of livestock fodder, fuel scarcity and decreases in traditional labour forces. Under the present circumstances, shrimp cultivation is no doubt beneficial for a selected group of people, but it has negatively affected the livelihoods of landless and marginal farmers, making it difficult for them to survive in the area. Copyright © 2006 by CABI Publishing.

Karim, Mohammed Fazlul and Nobuo Mimura (2008) "Impacts of climate change and sea-level rise on cyclonic storm surge floods in Bangladesh", *Global Environmental Change*, Vol. 18, No. 3 (August), pp. 490-500. **Abstract/Summary:** This paper describes the impacts of sea surface temperature (SST) rise and sea-level rise (SLR) on cyclonic storm surge flooding in western Bangladesh. A calibrated numerical hydrodynamic model was used to simulate surge wave propagation through the rivers and overland flooding. The model was calibrated with base condition (present climate), and then eight flooding scenarios of plausible future conditions were assessed by considering increased surge heights. Flooded area, flooding depth and surge intrusion length were computed by superimposing the predicted maximum water level information on a digital elevation model (DEM). This analysis showed that for a storm surge under 2 °C SST rise and 0.3 m SLR, flood risk area would be 15.3% greater than the present risk area and depth of flooding would increase by as much as 22.7% within 20 km from the coastline. Within the risk area, the study identified 5690 km2 land (22% of exposed coast) as a high-risk zone (HRZ) where flooding of depth 1 m or more might occur, and people should move to nearby cyclone shelters during extreme cyclonic events. Predicted area of HRZ is 1.26 times the currently demarcated HRZ. It was estimated that 320 additional shelters are required to accommodate people in the newly identified HRZ. This information would be of value to policy and decision makers for future shelter planning and designing shelter heights. Copyright © 2008 by Elsevier B.V.

Karim, Zahurul (1995) "Agricultural Vulnerability and Poverty Alleviation in Bangladesh", in: T. E. Downing (ed.) *Climate Change and World Food Security* (Berlin, Heidelberg: Springer-Verlag (NATO ASI Series, 137)), pp. 307-346. **Abstract/Summary:** The vulnerability of the poor in Bangladesh and their exposure to natural hazards and climate change is reviewed. Sections focus on: the vulnerability of the poor; agro-ecological resources; environmental vulnerability; the impact of drought; analysis of climatic change scenarios; drought impacts due to climatic change; implications of climatic change; population growth and poverty alleviation; revitalizing the agricultural production system with available agronomic innovations; promoting cultivation of non-conventional food crops; enhancing rural agro-processing activities and; the implementation of medium-term measures through restructuring cropping patterns. It is concluded that the level of poverty and vulnerability of the poor must be addressed by the management of environmental vulnerabilities, generation and adoption of wide choices of technologies, and promoting agro-processing activities. Copyright © 1995 by Springer.

Karim, Zahurul; M. Ahmed; S. G. Hussain; and Kh. B. Rashid (1994) *Impact of climate change on the production of modern rice in Bangladesh* (Dhaka: Bangladesh Agricultural Research Council). **Abstract/Summary:** Bangladesh is located in a region that is vulnerable to environmental hazards, frequent floods, droughts, cyclones, and storm surges that damage life,

property, and agricultural production. This study uses climate models combined with crop simulation models to determine the possible effects of climate change on rice production in major agricultural regions of the country. Sensitivity simulations showed that rice yields decreased significantly with temperature increases in the two sites considered. The rice yields under the GCM climate scenarios alone decreased at both sites. When the physiological CO_2 effects were considered, the yield decreases under the climate change scenarios were offset. If the physiological CO_2 effects are not as positive as simulated in this study, rice production in Bangladesh could be damaged under climate change conditions. A decrease in rice production, combined with the rapidly increasing population would threaten the country's food security.

Karim, Zahurul; Sk. Ghulam Hussain, and M. Ahmed (1996) "Assessing impacts of climate variations on foodgrain production in Bangladesh", in: Lin Erda, W. Bolhofer. S. Huq, S. Lenhart, S. K. Mukherjee, J. B. Smith, and J. Wisniewski (eds.) *Climate Change Variability and Adaptation in Asia and the Pacific* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 53-62**. Abstract/Summary:** A simulation study was conducted to access the vulnerability of food grain production in Bangladesh to potential climate change. Simulation runs were made for high yield varieties of rice for Aus (March-August), Aman (July-November), and Boro (February-July), the traditional growing seasons, using the CERES-Rice model. Simulation runs were made for wheat, which is grown from November through March, using the CERES-Wheat model. Three General Circulation Model (GCM) scenarios namely baseline, CCCM and GFD3, and sensitivity analyses for 2°C and 4°C temperature rise at three levels of CO_2 (330, 580 and 660 ppmv) was used. In the simulation increased CO_2 level increased rice yields over Baseline yields and considerable spatial and temporal variations were noted. Temperature rise reduced the yields in almost all the location and all seasons and it was pronounced with 4°C increase. The detrimental effect of temperature rise was observed even with increased CO_2 level. Wheat yields increased with increased CO_2 level in all three locations. Adverse effect of temperature rise was more prominent on wheat with all levels of CO_2. Both for rice and wheat, it was noted that in CCCM and GFD3 scenarios yields were decreased over Baseline yields in all seasons and locations. Highest yield reductions (35%) and (31 %) were observed in Aus season in CCCM and GFD3 scenarios, respectively. Adverse effect of GFD3 scenario was more prominent on wheat than on rice. All rice yields are expressed as rough rice. Under CCCM and GFD3 scenarios reductions in aggregated production for the country were 27% and 27%for HYV Aus rice, 7% and 13%for HYV Aman rice, 3% and 7%for HYV Boro rice, and 20% and 61 % for wheat. Maximum reductions in aggregated production for all the crops were noted at 330 ppmv CO2 with 4°C temperature rise. Maximum increases in aggregated productions for the country of Aus, Aman, Boro rice, and wheat were observed at 660 ppmv level of CO_2 with no temperature rise followed by 580 ppmv CO_2 level. The impact of various water stress scenarios superimposed on different climate change scenarios revealed that under CCCM and GFD3 scenarios the yields of Boro rice declined with the increase in water stress. The percent yield reductions varied from 16% and 64%.

Karim, Zahurul; Sk. Ghulam Hussain; and Ahsan Uddin Ahmed (1999) "Climate Change Vulnerability of Crop Agriculture: A Case Study", in: Saleemul Huq, Zahurul Karim, M. Asaduzzaman and F. Mahtab (eds.) *Vulnerability and Adaptation to Climate Change for Bangladesh* (Dordrecht, The Netherlands: Kluwer Academic Publishers), pp. 39-54**. Abstract/Summary:** This report presents results of a simulation study conducted to assess the

vulnerability of food grain production due to climate change in Bangladesh. Two general circulation models were used for development of climate scenarios. The experiments considered impact on three high yielding rice varieties and one high yielding wheat variety. Sensitivity to changes in temperature, moisture regime and carbon-dioxide fertilization was analyzed against the baseline climate condition. The GFDL model predicted about 17 percent decline in overall rice production and as high as 61 percent decline in wheat production compared to the baseline situation. The highest impact would be on wheat followed by Aus variety. CCCM model predicted a significant, but much reduced shortfall in food grain production. It was found that increase in 4°C temperature would have severe impact on food grain production, especially for wheat production. On the other hand, carbon-dioxide fertilization would facilitate food grain production. A rise in temperature cause significant decrease in production, some 28 and 68 percent for rice and wheat, respectively. On the other hand, doubling of atmospheric concentration of CO_2 in combination with a similar rise in temperature would result into an overall 20 percent rise in rice production and 31 percent decline in wheat production. It was found that Boro rice would enjoy good harvest under a severe climate change scenario. However, the report also highlighted that the apparent increase in yield of Boro and other crops might be constrained by moisture stress. A 60 percent moisture stress on top of other climatic cause as high as 32 percent decline in Boro yield, instead of having an overall 20 percent net increase. It is feared that moisture stress would be more intense during the dry season, which might force the Bangladeshi farmers to reduce the area for Boro cultivation. Shortfall in food grain production would severely threaten food security of the poverty ridden country.

Karmakar, S. (2003) "Trends in the annual frequency of cyclonic disturbances and storms in the Bay of Bengal" in: D. A. Quadir, K. Prasad, and M. A. Hussain (eds.) *Proceedings of SAARC Seminar on Climate Variability in the South Asian Region and its Impacts (held on 10-12 December 2002)*, (Dhaka: SAARC Meteorological Research Center (SMRC)). **Abstract/Summary:** An attempt has been made to study the long term trends in the annual frequencies of cyclonic disturbances (i.e. sum of depressions, cyclonic storms and severe cyclonic storms), depressions, cyclonic storms and severe cyclonic storms forming in the Bay of Bengal utilizing 110 years data during the period 1891-2000. There has been significant increasing trend in annual the frequency of cyclonic disturbances (CD) during the period 1900 through 1948 and it has a sharp decreasing trend during 1949-2000. The rates of increase and decrease in frequency are 0.1426 per year and -0.1048 per year respectively. The overall trend in the frequency of cyclonic disturbances for the period 1891-2000 gives a slight decreasing tendency, the rate of decrease is -0.017 per year. Similar trends have been found in the case of depressions. The rates of increase and decrease in the frequency of depressions are 0.1322 per year and 0.1049 per year during the periods 1900-1948 and 1949-2000 respectively. A slight increasing trend has also been found in the annual frequency of depressions during period of 1891-2000 and the rate of increase is insignificant. The annual frequency of cyclonic storms has a slight increasing trend during the period 1900-1945, the rate of increase being 0.0213 per year, whereas there is a slight decreasing trend in the frequency of cyclonic storms during the period 1946-2000, the rate of decrease is -0.0188 per year. But for the overall period of 1891-2000, the frequency shows a decreasing trend, the rate of decrease being -0.0193 per year. The annual frequency of severe cyclonic storms for the periods 1900-1045 and 1949-2000 respectively shows increasing trends, which are not statistically significant. The rates of increase in the annual frequency of severe cyclonic storms are 0.0176 per year and 0.0247 per year during the periods

1900-45 and 1946-2000 respectively. For the overall period of 1891-2000, the annual frequency of severe cyclonic storms shows a slight increasing trend. The rate of increase in the annual frequency of severe cyclonic storms during the period 1891-2000 is 0.0023 per year. The study reveals that the annual frequency of depressions and cyclonic storms has the decreasing trends from mid 1950, whereas the annual frequency of severe cyclonic storms has the increasing trend. It means that most of the depressions and cyclonic storms have a tendency to be intensified into severe cyclonic storms after 1945. Attempt has also been made to study the polynomial trends and it has been found that the polynomial curves are fitted better than the linear ones. There are long term oscillations in the annual frequency of cyclonic disturbances and storms for a period of about 50-60 years.

Karmakar, S. and M. L. Shrestha (2000) *Recent Climate Changes in Bangladesh*, SAARC Meteorological Research Centre (SMRC), SMRC-No. 4 (September), Dhaka: SMRC Publication. **Abstract/Summary:** This paper is an attempt to study the recent climatic changes in Bangladesh by using the surface climatological data on monthly and annual mean maximum temperature, minimum temperature and monthly and annual rainfall for the period 1961-90. The study reveals that mean minimum and maximum temperature have increasing trends in some seasons and decreasing trends in some other seasons. Some of these changes are quite significant. The annual mean maximum temperature over Bangladesh has significant decreasing trend up to 1975 and very significant increasing trend after 1975. The overall trend of annual mean maximum temperature for the period 1961-90 is of increasing order, which is statistically significant. The annual mean minimum temperature over Bangladesh has an increasing trend up to 1978, which is statistically significant and after 1978 it has a slight decreasing trend which is not significant. The overall annual mean minimum temperature over Bangladesh for the period 1961-90 has a slight decreasing trend. The study also reveals that the annual mean temperature over Bangladesh has a slight increasing trend during the whole period 1961-90. In case of rainfall, it has been found that the seasonal rainfall over Bangladesh has increasing trends during all the seasons except the post-monsoon season when it shows a decreasing trend. The present changes in the climatic elements have been projected up to 2050 and 2100 years. Based on the present trend of 5-year running average of the climatic elements, the annual mean maximum temperature is likely to rise by 0.48°e and 0.88°e in 2050 and 2100 years respectively. The 5-year running average of annual mean minimum temperature is likely to decrease by 0.06°e and 0.11°e by 2050 and 2100 respectively. But the 5-year running average of overall annual mean temperature over Bangladesh has been found to rise. The projected rises of the 5-year running of annual mean temperature are 0.21°e and 0.39°e by 2050 and 2100 years respectively. The 5-year running average of rainfall over Bangladesh is likely to increase by 2050 and 2100 years during all the seasons except the post-monsoon season when it is likely to decrease. The 5-year running average of annual total rainfall over Bangladesh is likely to increase by 304.72 mm and 588.65 mm by 2050 and 2100 years respectively. The trend analysis has also been performed considering the actual values of maximum temperature, minimum temperature and rainfall. Based on this analysis the rise of 0.40° C and 0.73°C is expected in the annual mean maximum temperature by 2050 and 2100 years respectively whereas the annual mean minimum temperature is likely to rise by 0.04°C and 0.08°C by the year 2050 and 2100 respectively. But the overall annual mean temperature over Bangladesh is likely to increase by 0.22°e and 0.41°C by 2050 and 2100 years respectively. The annual total rainfall over Bangladesh is likely to increase by 295.94 mm and 542.55 mm by 2050 and 2100 years respectively.

Kausher, A.; R. C. Kay; M. Asaduzzaman; and S. Paul (1993) *Climate Change and Sea-Level Rise: the Case of the Coast* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 6); also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers, 1996), pp. 335-405 (Chapter 7)**. Abstract/Summary:** The future impact of sea-level rise and climate change on the coastal zone of Bangladesh will depend on the vulnerability and resilience of its physical, biological, social and economic systems. Previous studies have estimated future coastal impacts by calculating the areas of low-lying land and assuming that these areas will be permanently lost under rising seas. Such studies have failed to address the considerable natural resilience of the Bangladesh coastal zone. For example, the supply of river sediments to the coastal zone may well provide a buffer against sea level rise. Furthermore, there is considerable human resilience to environmental change; adapting to constantly shifting lands, floods and cyclones is part of the way of life of coastal people. Understanding of such factors is necessary in order to fully assess the future effects of climate and sea-level change on the coast. The purpose of this study is to examine the relevant aspects of the human, physical and biological systems of the coastal zone of Bangladesh as they pertain to the climate change issue. Each system is considered in terms of its vulnerability and resilience to present and future stresses. Elements of each coastal zone system that require urgent management attention are identified, as are important areas of uncertainty and future research directions. In so doing, the study aims to support Bangladesh's commitment under the Framework Convention on Climate Change to "develop and elaborate appropriate and integrated plans for coastal zone management" by summarizing the key scientific and management issues relating to the potential future impacts of climate change and sea-level rise.

Kelkar, Ulka and Suruchi Bhadwal (2007) *South Asian Regional Study on Climate Change Impacts and Adaptation: Implications for Human Development* (New York: UNDP, *Human Development Report Office, Occasional Paper*, No. 2007/27); available at: http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/kelkar_ulka%20and%20bhadwal_suruchi.pdf;
Conclusions: Various studies summarized in this paper show that climate change is a grave and immediate issue for South Asia. The impacts of climate change on food security, access to water, human health, ecosystems, urban areas, and frequency of disasters will have severe implications for the achievement of sustainable development. Present coping capacity is very limited particularly for small farmers, rural communities eking out precarious livelihoods dependent on natural resources, urban poor living in marginalized conditions, women and children. There are several good practices and policies, some of which are showcased above, but these need to be scaled up. While government programmes in these sectors address issues relevant for strengthening adaptive capacity to climate change, they do not as yet explicitly incorporate the increased risks due to climate change. Forums like the South Asian Association for Regional Cooperation (SAARC), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) and South Asia Cooperative Environment Programme (SACEP) promote regional cooperation to address some of these issues. Besides, there are major bilateral and multilateral initiatives taken forward by the World Bank, the Department for International Development, the International Development Research Centre and the Asian Development Bank. One of the three pillars of the World Bank Investment Framework seeks to focus on supporting adaptation to climate change. An adaptation work plan has been outlaid with components relating to screening public investments, adapting existing capital stocks, developing best

practice standards, promoting disaster preparedness, developing a research programme with agriculture and water resource as focus areas, finding ways to support incremental costs to promote adaptation in vulnerable regions and conducting country specific studies. The Nairobi Framework on Impacts, Vulnerability and Adaptation shall assist all countries, in particular developing countries, including the least developed countries and small island developing states to improve their understanding on impact, vulnerability and adaptation issues to be able to make informed decisions on practical adaptation actions and measures to respond to climate change. However, a sustained movement at a localized scale is required to facilitate meeting the basic needs of many who are deprived of access to food, safe drinking water and sanitation and shelter requirements. A holistic approach which addresses issues of natural resource management, sustainable livelihoods, and climate change adaptation requires development of a stronger knowledge base at various levels (local, national and global) for enhanced understanding of ecosystem functions and capacity, valuation and internalization of value of ecosystem services, and stakeholder engagement in ecosystems management.

Khan, A. H., Huq, S., Rahman, A. A., Shahidullah, M., Haque, A., Naqi, S. A., Rahman, M., Ahmed, S., Ali, S. I., Ali, M. Y., Ahmed, M., Islam, Y., Mollick., F. (1992) "Assessment of Vulnerability to Sea Level Rise: A Case Study of Bangladesh", in: *Global Climate Change and the Rising Challenge of the Sea -- Case Studies of Deltas* (Proceedings of the International Workshop held on Margarita Island, Venezuela, March 9-13, 1992). **Abstract/Summary:** This paper attempts to briefly highlight some of the likely impacts of a 0.3-meter and a 1.0 meter sea level rise on a number of physical, environmental, and socioeconomic parameters and focuses mainly on the possible response strategies and needs for developing suitable responses. The study covered physical changes and responses of the natural system to such climate changes; the impacts of such changes on the socioeconomic conditions and ecological system, with emphasis on the sustainability for development; and the capability of a society to respond to such impacts by taking mitigative or remedial measures. Sea level rise, change in river discharge and change in intensity of precipitation change in temperature/evaporation and cyclone frequency have been considered as possible effects of climate change in the present study.

Khan, A. S. (2005) "Study to Find Remedial Measures to Overcome Water Logging Problem in the Noakhali Area of Bangladesh" in: Glenn E. Moglen (ed.) *Managing Watersheds for Human and Natural Impacts: Engineering, Ecological, and Economic Challenges*, Proceedings of the Watershed 2005 Management Conference held July 19–22, 2005 in Williamsburg, VA, USA (Reston, VA: American Society of Civil Engineers). **Abstract/Summary:** The drainage congestion in the Noakhali area is a long-standing and complicated issue. It is seen that large-scale siltation in the drainage channels due to reduction in tidal prism arising out of and subsequent manmade interventions (Crossdam I and II) are the causes behind such development. Due to manmade interventions in the past the south of the area has undergone major morphological changes resulting in channel and bay siltation. Thus new land formations have developed with the constriction and closure of major drainage routes. Some 200,000 hectare remains water logged for more than half of the year. This has led to severe environmental hazards in the area. Study has been undertaken to use mathematical modelling technique to analyze the complex problem and obtain a comprehensive solution. A 1-Dimensional sub-model for the area has been set up from the existing South East Regional Model of Bangladesh. The

calibrated sub-model has been used to study various options of channel improvement and structural measures at the outfall channels. Later GIS flood depth maps have been produced to show the amount of improvement obtained in the various options. It has been observed that by controlling the outfalls of the rivers it has been possible to reduce siltation and flooding inside the area, but the major problem still remained outside the river outfalls where the discharge from the rivers and the tidal currents of the sea play a significant role in inducing the sedimentation process. Copyright © 2005 by American Society of Civil Engineers.

Khan, Haseena (2008) Using Jute to Meet the Challenges of Climate Change; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This is a detailed presentation on jute in Bangladesh. While climate change is not addressed in any details, the presentation suggests mostly indirectly that the production and use of jute could be useful for facing the challenges of climate change. Copyright © 2008 by the author(s).

Khan, M. S.; M. Eklimur Reza; and Md. M. Rahman (2004) "Rubber Dams in Bangladesh Harness Surface Water for Farmers to Irrigate at Lesser Cost", in: Gerald Sehlke, Donald F. Hayes, David K. Stevens (eds.) *World Water Congress 2004: Critical Transitions in Water and Environmental Resources Managemen*t, held June 27-July 1, 2004 in Salt Lake City, Utah (Reston, VA: American Society of Civil Engineers). **Abstract/Summary:** Farmers in Bangladesh have significantly extended agricultural activities into the dry winter-summer season over the past 2 decades to produce more through double and triple cropping and also to remain safe from damages due to floods. Agriculture in winter-summer season is fully irrigated. Ground water is now meeting the lion's share of this irrigation need. However, limit of abstraction of ground water within the capacity of technical and financial management by individual farmers, as it is now, will soon be reached at. It is, therefore, necessary that available surface water be harnessed, as far as possible, to support irrigation need in the dry season. Further to that, detection of arsenic contamination of ground water in some parts of the country in the recent past has made conservation of surface water all the more important. Also, surface water is cheaper and of better quality and so farmers have definite priority of choice of surface water over ground water for irrigation. There is no scope to develop reservoirs for storage of water in this flat country. With this background, Bangladesh has adopted Rubber Dams for conservation of water in the channels of its small and medium rivers to support winter-summer irrigation. Since introduction of the technology in 1995, Rubber Dams have been recognized as a successful method of water conservation under the conditions in Bangladesh. This paper presents the technology of Rubber Dams in some details together with Bangladesh's experience with Rubber Dams over the last 7 years. References have been made of the impact of Rubber Dam Projects on rural poverty reduction through the impact on agriculture of small and marginal farmers and through the scope of certain other economic activities for the local poor. Copyright © 2004 by American Society of Civil Engineers.

Khan, M. S.; R. Sen; S. Noor; H. M. Naser; and M. K. Alam (2008) Soil, Water and Climate Related Constraints for Crop Production in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation reviews first the causes and effects of global warming at

the global level and summarizes then the main climatic risks for Bangladesh. It then reviews the major constraints to an increase in crop productivity in Bangladesh, which are given as a decline in soil fertility, soil erosion and land loss, soil salinity, loss of water, and climatic stresses.

Khan, Mizan R. (2001) "Negotiating for a Better Climate", in: Rahman A. and M. A. Ali (eds.) *Bangladesh Environment 2001* (Dhaka: Unnayan Shamannay). **Abstract/Summary:** The issues of accepting responsibility and sharing of cost to arrest human-induced climate change remain at the center of negotiations. The UNFCCC through Article 3 (1) acknowledges the centrality of equity in climate change diplomacy. Annex-1 country Parties have accepted this cardinal principle. So, if there is any rationale in the argument that until recent times, the Annex-1 countries were unaware of the consequences of their fossil fuel-based development, there is the more convincing rationale that the non-Aannex-1 countries deserve equal environmental space in the global commons for their development. If early ignorance of the negative effects of development is justifiable and accepted, this warrants that the Annex-1 countries, based Article 3(1), should come forward with enough resources including technology to enable the Non-Annex-1 counterparts to avoid the earlier polluting path of industrialization. Only such an approach will contribute to resolving this greatest challenge before mankind.

Khan, Mizan R. (2003) "National Adaptation Program of Action and Conservation of Biodiversity in the LDCs", in: B. Dharmaji et al. (eds.) *Mainstreaming Biodiversity and Climate Change* (Colombo, Sri Lanka: International Union for Conservation of Nature and Natural Resources, Regional Biodiversity Programme). **Abstract/Summary:** Biodiversity conservation has been mentioned as one specific area in the Guiding Elements of NAPA, but it actually covers most of the other areas, such as loss of livelihoods of the poor, human health, food security, coastal zones and other environmental amenities. So, ensuring access to biological resources and flow of benefits to the poor on a sustainable basis will contribute towards enhancing their adaptive capacity both in the immediate and longer terms and will contribute to poverty reduction. It is, therefore, crucial that *procedural* justice is ensured in the NAPA preparation phase, and that *distributive* justice follows during the implementation phase. To ensure that this happens, NAPA team members must remain proactive in the NAPA preparation phase, so that national NAPAs include projects related to concerned issues.

Khan, Mizan R. (2004) "Climate Change Negotiations, LDCs and Bangladesh", in: United Nations Development Programme (UNDP) et al. (eds.) *People's Report 2002-2003: Bangladesh Environment* (Dhaka: UNDP et al.). **Abstract/Summary:** Human-induced climate change and their impacts on economies and societies have become new variables in development policies worldwide. One important development since the seventh meeting of the UNFCCC's Conference of the Parties (COP-7) at Marrakech is that adaptation tends to replace mitigation as the dominant paradigm in climate policy. Mitigation is not succeeding enough to mobilize pliable practitioners in the industrial world. The Group of 77 and China is a loose negotiating block, with differing interests among groups and regions. The commonality that binds the LDCs is the degree and level of vulnerability to climate change and their low adaptive capacity. Their concerns were not adequately reflected in the negotiations, led by the larger group of G-77 and China. So the LDCs emerged as a negotiating group in 2001, which focus on adaptation and

equity in funding. There are some provisions and Conference of the Parties (COP) decisions regarding equity in climate change issues. Another important aspect is that unlike the charity-based ODA approach, funding mechanisms in climate change are based on the principle of common but differentiated responsibilities. So this is a positive development under the UNFCCC and the LDCs need to work together to strengthen this new paradigm of international financing for the purpose. The LDCs need to greatly enhance their knowledge and skills in negotiation strategies and tactics. Bangladesh, with its relatively better expertise, can lead the LDC group through serving as the intellectual hub for climate negotiations. Copyright © 2004 by United Nations Development Program et al.

Khan, Mizan R. (2006) "Micro Insurance as an Instrument of Adaptation to Climate Change Impact", in: Atiur Rahman and Mahboob Hassan (eds.) *People's Report 2004-2005: Bangladesh Environment* (Dhaka: Unnayan Shamannay), pp. 305-312. **Abstract/Summary:** Historically, insurance served as a security instrument against risks in general. But insurance against losses from natural disasters in the developing countries is negligible. On the other hand, the disaster-hit governments in these countries could not afford to expand the safety nets to the most vulnerable. Since they have no access yet to insurance market, informal arrangements, such as kinship-based networks and micro-credit programs help the poor to avert starvation in case of accidents, death or small-scale disasters. But effectiveness of informal mechanisms is extremely limited in case of large-scale disasters. So a debate is undergoing whether micro-insurance can be an effective instrument of adaptation to climate change impacts. UNFCCC has been the curtain raiser in globalizing this debate. The discussions centre around few issues, such as whether catastrophic losses are insurable under the traditional system of insurance, how can insurance-related pools be made accessible to vulnerable poor communities and countries, whether the private insurers be interested to cover disaster losses at micro-levels, and how can the governments mobilize resources. The paper reviewed the experiences in disaster-related insurance schemes in the world at large, including in Bangladesh. There is skepticism yet about the efficacy of micro-insurance. At the same time, there is already a wealth of experience in the developing countries, particularly in providing life and loan insurance products. The paper suggests that the scale problem and related issues can be addressed through establishing public-private-NGO partnerships, with appropriate policy and financial support, nationally and globally. Copyright © 2006 by Unnayan Shamannay.

Khan, Mizan R. and M. A. Rahman (2007) "Partnership approach to disaster management in Bangladesh: a critical policy assessment", *Natural Hazards*, Vol. 41, No. 2, pp. 359-378. **Abstract/Summary:** The geographic location of Bangladesh at the confluence of the three mighty river systems of the world renders her one of the most vulnerable places to natural disasters. Human-induced climate change exacerbates the problem. This study shows that the Government of Bangladesh has already established a multi-layered institutional mechanism for disaster management, with formal recognition of the role of various stakeholders. Historically, NGOs and other informal support mechanisms in the country also have made significant contributions during and after disaster recovery. Despite the presence of some strengths, such as long experience in disaster response and recovery, the people's resilience, and donor support, the current management strategies suffer from a host of policy and institutional weaknesses. Most prominent is the absence of a functioning partnership among the stakeholders within these formal set-ups. What is lacking is the development and embodiment of a culture of collective decision-making in planning, in resource sharing, and in implementing disaster management

policies and programs in an integrated and transparent way. The article suggests a partnership framework to implement prevention, preparedness, response, and recovery phases of disaster management. Copyright © 2007 by Springer.

Khan, T. M. A., O. P. Singh and M. D. Sazedur Rahman (2000) "Recent sea level and sea surface temperature trends along the Bangladesh coast in relation to the frequency of intense cyclones", *Marine Geodesy*, Vol. 23, pp. 103-116. **Abstract/Summary:** Bangladesh, one of the most densely populated countries in the world, is a victim of frequent natural calamities like tropical cyclones, tornadoes, floods, storm surges and droughts. Now the sea level rise (SLR) has also been included in these natural calamities. The SLR is likely to have greater impact on that part of Bangladesh having low topography and a wide flood plain. Since 21% of the population lives in the low coastal belt, any increase in sea level will be a problem of ominous proportion for Bangladesh. Since the cyclogenesis enhances over the Bay of Bengal during May and November, the sea level and sea surface temperature (SST) trends of these two months have been analyzed and calculated. The results of the selected stations one in the eastern coast and another in the western coast of Bangladesh show that Bangladesh coastal sea level is rising in the same way as the global sea level, but the magnitude is quite different. The difference in the behavior of sea level rise along the Bangladesh coast and the global trend may be due to the tectonic activity such as subsidence of the land. The mean tide level at Hiron Point (in Sunderbans) has shown an increasing trend of about 2.5 mm/year in May and 8.5 mm/year in November. Similarly near Cox's Bazar (in the eastern coast of Bangladesh) it has registered a positive trend of about 4.3 mm/year in May and 10.9 mm/year in November. Thus the increment in the sea level along the Bangladesh coast during cyclone months is much more pronounced. In coastal waters near Hiron Point the SST has registered an increasing trend of about 1°C in May and 0.5°C in November during the 14-year period from 1985–1998. Near Cox's Bazar, SST has shown a rising trend of about 0.8°C in May and about 0.4°C in November during the same 14-year period. The magnitude of SST trend is slightly more along the west coast. Any change in the frequency and intensity of tropical cyclones will have far reaching implications in the South Asian region. The rise in SST in the cyclone months seems to be correlated with the frequency and intensity of tropical cyclones. During these months, an increasing trend in the frequency and intensity of severe cyclones has been observed. Copyright © 2000 by Taylor & Francis Group.

Koudstaal, Rob; Saskia E. Werners, and Ahsan Uddin Ahmed; in association with Atiq Rahman and Saleemul Huq (1999) *Considering Adaptation to Climate Change Towards a Sustainable Development of Bangladesh* (Washington, DC, World Bank, Study prepared for South Asia Region, October); Executive Summary available at: http://www.mungo.nl/CC_Bangla.htm; **Summary of conclusions and recommendations:** Climate change is not only an "environmental" concern but really a "development" concern for Bangladesh. This means that climate change as an issue must come out of the ghetto of "environmental problems" to take center stage as a major developmental problem. The study shows that Bangladesh is particularly vulnerable to climate change in its coastal zone, covering about 30 percent of the country. Here prospects of industrial development, based on its rich energy resources, will seriously be constrained by the increased occurrence of coastal storms, flooding and reduced fresh water availability. The study also analyzes impacts on water resources, agriculture, ecosystems and human health, concluding that in all these sectors, the country's drive to development might be seriously restrained if no anticipatory actions are taken. Ecosystems and biodiversity, as a key sector for sustainable development, merits particular attention and of all sectors vulnerable to

climate change this may be the most vulnerable. This not only refers to a few itemized ecosystems or endangered species. What is at stake is the "environment as a whole" and the activities of all Bangladeshi, which are still very dependent on the country's natural resources base. Even with sector-oriented anticipatory adaptation, the overall system may be losing its flexibility and resilience to adapt to changes. This will result not only in a loss of biodiversity, but in a loss of productivity as well, seriously challenging the country's prospect for sustainable development. The study identifies and discusses the possibilities and limitations for adaptation in the various sectors. It studies selected development programs on the need and possibilities to include climate change considerations in their approach and the possible contribution they could have to anticipatory adaptations. The results show that physical interventions on their own are generally in-effective and costly, whilst requiring maintenance arrangements and coordination of separate initiatives. More promising anticipatory adaptations are changes in behavioral patterns, human practices and international actions. However, these type of adaptations meet serious institutional constraints and consequently should be carefully prepared and, if possible, integrated in existing structures and procedures. The main mechanisms to gradually overcome these constraints are coordination of climate change activities, (integrated) planning and information management. It is highly recommended that next steps to reduce Bangladesh' vulnerability to impacts of climate change and sea level rise, concentrate on the adaptation mechanisms of planning, information management and international actions. Here, the National Water Management Plan (NWMP) that is currently being developed and the Integrated Coastal Zone Management Plan (ICZMP) under design offer key opportunities. The report also made a set of recommendations for specific actions.

Kramer, Arnoldo Matus (2007) "Adaptation to Climate Change in Poverty Reduction Strategies", New York, United Nations Development Programme (UNDP), *Human Development Report Office, Occasional Paper*, No. 2007/34; available at: http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/matus%20kramer_arnoldo.pdf. **Abstract/Summary:** Climate Change presents a major challenge for development and poverty eradication. There is a relation between poverty in low-income countries and economies heavy dependent on weather-sensitive resources, such as agriculture. Millions of poor people in developing countries are vulnerable to extreme weather events and climate change impacts on ecosystems, water and agriculture. This report looks at nineteen countries and their Poverty Reduction Strategy Papers (PRSP) and National Adaptation Programmes of Action (NAPA) by assessing criteria such as: a) the consideration of climate change scenarios and the vulnerabilities of the country; b) the analysis of poverty-climate links; and c) the climate change institutional framework of the country. It is important to acknowledge that the assessment does not provide a quantitative assessment. It assesses the integration of adaptation to climate change and climate risks management within a subjective qualitative framework. The results show that most countries have a low incorporation of adaptation to climate change into PRSP. But, that by incorporating NAPAs a better performance is shown. The best practices study cases present: Bangladesh successful approach to mainstream natural disaster management, which facilitated the evolution to incorporate climate change into PRSP. Mexico's Inter-ministerial Climate Change Commission is presented as a good example of cross sectoral institutional integration. The paper illustrates that natural hazards mainstreaming into PRSP and the development of NAPAs are a step forward into the establishment of an institutional process to incorporate climate change into national policies. The World Bank and the UNFCCC should coordinate efforts to support developing countries in their efforts to incorporate adaptation to climate change in PRSP.

Countries need to strength the coordination, networks and information flows between ministries, different levels of government and civil society to have a more efficient integration of climate change variables into poverty reduction and development strategies. Copyright © 2000 by United Nations Development Program.

Kumamoto, Mihoko and Bo Lim (2007) "Climate Change Impacts on the MDGs and Human Development in Asia Pacific", *Inside Asia Pacific*, Vol. 2, No. 2 (July); available at: http://www.undprcc.lk/rcc_web_bulletin/Issue2/PDF/Special_Feature_Climate_Change_Impacts_on_the_MDGs_and_Human_Development_in_Asia_Pacific.pdf. **Abstract/Summary:** This article is structured into seven sections. The first section briefly explains observed and projected changes in temperature, precipitation, sea level and extreme weather events. The second section reviews climate change implications on the Millennium Development Goals (MDGs); the third section covers Asia Pacific's vulnerability to climate change; the fourth section examines issues related to climate change and income poverty (the first MDG and food insecurity issues); the fifth section examines issues related to climate disaster risks and education (MDG 2) and gender equity (MDG 3). The sixth sections looks at human health and related MDGs, especially water related diseases from climate change, while the last section reviews UNDP's support for climate change adaptation and the integration of climate risks into UNDP Country Programming. Copyright © 2007 by UNDP Regional Centre in Colombo.

Kurukulasuriya, Pradeep (2008) "UNDP's Monitoring Framework for Climate Change Adaptation", Presentation made at the UFCCC Expert Meeting on Socio-economic information under the Nairobi work programme on impacts, vulnerability and adaptation to climate change (March); available at: http://unfccc.int/files/adaptation/sbsta_agenda_item_adaptation/application/pdf/20080310_undp_local.pdf. **Abstract/Summary:** This presentation concentrates on the challenges and principles for adaptation monitoring, issues related to monitoring at the local level (incl. socio-economic data), and the next steps.

Lim, Bo and Erika Spanger-Siegfried (eds.) (2005) *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures* (Cambridge: Cambridge University Press). **Abstract/Summary:** This technical document is divided into three main sections: the guidebook, nine technical papers, and a few case studies. These three sections are based on the major principles that highlight the interdisciplinary nature of adaptation processes and the importance of combining qualitative and quantitative knowledge. The report stresses the need to develop tools to address climate change and variability. The report also outlines a framework that provides a flexible tool for policy-makers, researchers, and local stakeholders in developing countries to create adaptation tools that are relevant to their specific needs. These tools will take into account not only current vulnerabilities and adaptive capacities, but future vulnerabilities to climate change and increasing variability. Copyright © 2005 by Cambridge University Press.

Lockwood, Harold; Muhammad Taher; and Fenella Frost (2005) *Review of DFID-Bangladesh Disaster Management Response Programme* (Dhaka: UNDP-Bangladesh, May); available at: http://www.undp.org.bd/projects/prodocs/CDMP/1st_DFID_Review_Report_2005.pdf. **Summary Recommendations:** The review team recommends that the Comprehensive Disaster Management Programme (CDMP) should be encouraged to move beyond the progress achieved so far within its parent ministry (Food and Disaster Management) and forge closer ties with other line ministries, UN agencies and NGOs which have on-going or planned programmes in disaster

management or related fields, where the incorporation of risk reduction elements could result in leverage of impact. There is significant scope for synergies with elements of the World Food Programme (WFP) partnership agreement (PA) also funded by DFID-B. CDMP should retain a primary focus on coordination and facilitation, rather than direct implementation; the project must go through a period of consolidation and resist the temptation of taking on too many new activities in order to avoid over-reaching itself in the short-term. In the medium term new donors should be strongly encouraged to work within the CDMP framework and not establish parallel structures. Both UNDP and DFID-B can take a lead in facilitating this process. Despite the fact that there are problems with the progress of the PA, these have been highlighted relatively early on in the process and there is still time to make progress. Therefore, the team recommends that DFID-B should consider continued support at least for the remaining period of the first phase. However, any consideration of future support, and particularly in deciding whether to fund the second three-year component of the programme, must be contingent upon a number of key commitments from WFP. In the short term these centre on the filling of the senior advisory posts and ensuring a smooth hand-over process, clarifying financial constraints and hiring of new national staff. Above all WFP must guarantee that the same personnel issues will not recur in the future if new replacements are found for the senior advisor positions.

Lu, Xianfu (2007) "Climate Change Impacts, Vulnerability and Adaptation in Asia and the Pacific", *Background note for the Training Workshop on Environmental Finance and GEF Portfolio Management 22-25 May 2007, Amari Watergate, Hotel, Bangkok, Thailand*; available at: http://ncsp.va-network.org/UserFiles/File/PDFs/Resource%20Center/Asia/BackgroundPaper.pdf. **Abstract/Summary:** This background note is covers the following issues: the observed climate change and its impacts; the projected climate change and sea level rise; the potential impacts of projected climate change and sea level rise and key vulnerabilities to these impacts; the Implications for sustainable development and guiding principles for designing adaptation portfolio. It also contains suggestions for further readings.

Madsen, Henrik and Flemming Jakobsen (2004) "Cyclone induced storm surge and flood forecasting in the northern Bay of Bengal", *Coastal Engineering*, Vol. 51, No. 4 (June), pp. 277-296. **Abstract/Summary:** A cyclone induced storm surge and flood forecasting system that has been developed for the northern Bay of Bengal is presented. The developed system includes a cyclone forecasting model that uses statistical models for forecasting of the cyclone track and maximum wind speed, and an analytical cyclone model for generation of cyclone wind and pressure fields. A data assimilation system has been developed that allows updating of the cyclone parameters based on air pressure and wind speed observations from surface meteorological stations. The forecasted air pressure and wind fields are used as input in a 2D hydrodynamic model for forecasting storm surge levels and associated flooding. An efficient uncertainty prediction procedure based on Harr's point estimation method has been implemented as part of the forecasting system for prediction of the uncertainties of the forecasted storm surge levels and inundation areas caused by the uncertainties in the cyclone track and wind speed forecasts. The developed system is applied on a severe cyclone that hit Bangladesh in April 1991. The simulated storm surge and associated flooding are highly sensitive to the cyclone data. The cyclone data assimilation system provides a more accurate cyclone track when the cyclone approaches the coastline, which results in a significant improvement of the storm surge and flood predictions. Application of the uncertainty prediction procedure shows that the large

uncertainties of the cyclone track and intensity forecasts result in large uncertainties of the forecasted storm surge levels and flood extend. The forecasting system shows very good forecasting capabilities up to 24 h before the actual landfall. Copyright © 2004 by Elsevier B.V.

Mallick, Dwijendra Lal; Atiq Rahman; Mozaharul Alam; Abu Saleh Md Juel; Azra N. Ahmad; and Sarder Shafiqul Alam (2005) "Case Study 3: Bangladesh -- Floods in Bangladesh: A Shift from Disaster Management Towards Disaster Preparedness", in: Farhana Yamin and Saleemul Huq (eds.) Vulnerability, Adaptation and Climate Disasters, *IDS Bulletin*, Vol. 36, No 4 (October)**. Abstract/Summary:** Bangladesh is a Least Developed Country (LDC) facing many impacts of climate change in the form of more frequent and severe floods, cyclones, droughts, sea level rise and salinity affecting large parts of the population through impacts on livelihoods, natural systems, agriculture, water supply and health. In the last two decades, Bangladesh has experienced four devastating floods, which may provide an early indication of the kinds of impacts associated with increased frequency and intensity of floods. This case study focuses on how the Disaster Management Bureau (DMB) takes into consideration the real needs and priorities of the community, while formulating and implementing programmes to enhance flood preparedness. This is being done through the Comprehensive Disaster Management Programme (CDMP). Traditional disaster management models focus on disaster relief and recovery. But these have done little to redress rising levels of risk. An all-risk management framework set out in the CDMP seeks to raise the capacities of at-risk communities, while lowering their vulnerability to specific hazards. The aim is to target resources towards risk reduction through mainstreaming disaster management within development and emergency relief programmes and away from pure relief. Making an active shift towards a holistic risk reduction approach that shifts attention towards prevention and preparedness makes good sense for governments, funders and communities. But it requires fundamental transformations in policy and institutions. This takes time and requires true involvement and dedication due to resource constraints, bureaucracy, vested interests and poor governance. Copyright © 2005 by Institute of Development Studies.

Martin J. and J. W. Day (2008) Restoring Natural System Functions to Sustain the World's River Deltas; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** Many of the world's deltas are experiencing rapid rates of deterioration that threaten the vital ecological and economic services they provide. Increases in sea-level rise, and more frequent cyclones due to global warming threaten to further accelerate this trend. Over the past century dams, dikes and levees have been built for the purposes of flood protection, navigation, water storage and energy generation. These actions have isolated river deltas from the river water and sediment that has sustained them. As a result many delta regions are forecast to experience serious declines in the future. For instance, by 2100 Bangladesh is projected to lose between 26 and 34% of habitable land, have 27 to 35% percent of the population displaced and suffer GDP losses between 22 and 31%. In order to address these threats in an era of energy scarcity natural system functions must be restored and rivers must be reconnected to deltaic floodplains. Restoring connections between rivers and marshes can counteract high rates of relative sea-level rise that lead to the submergence of deltaic marshes and losses of productivity. In the Mississippi Delta, river diversions are being built to restore the movement of riverine sediments to marshes located behind levees. Other approaches to sustain delta wetlands include the use of ring levees

to protect human settlements as opposed to linear levees. Managers must also realize the negative impacts of extracting water, gas and petroleum from beneath deltaic wetlands. To sustain river deltas and their human populations a balance must be struck between human endeavors such as, flood protection, agriculture and extraction of resources and natural system functions. Copyright © 2008 by the author(s).

Mastaller, Michael; Joseph A. Weinstock; and Roger Dee Montgomery (2000) *Bangladesh: Toward an Environment Strategy* (Manila, Philippines: Asian Development Bank). **Abstract/Summary:** This 95-page document reviews the ADB's 20-year history of providing environmental assistance to Bangladesh spans, with financing going to projects in the country directly or indirectly related to the environment. It takes stock of the new and continuing environmental issues facing the country, including some aspects of climate change. Copyright © 2000 by Asian Development Bank.

Matin, Nilufar and Muhammad Taher (2001) "The Changing Emphasis of Disasters in Bangladesh NGOs", *Disasters*, Vol. 25, No. 3, pp. 227-239. **Abstract/Summary:** Bangladesh is one of the most disaster-prone countries in the world, affected by cyclones and floods, as well as chronic hazards such as arsenic poisoning. NGOs have played a major role in bringing concerns related to risk management on to the national agenda and promoting a shift of focus from mere relief response to disaster mitigation and preparedness. The government has, after earlier skepticism, now accepted NGOs as major partners in these tasks. Innovative approaches, such as the use of microfinance, have been applied; many of which are related to preserving the gains of development efforts as part of rehabilitation. NGOs have pressured for better co-ordination with government. Improved structures are now approved, but it is still too early to judge their impact. Despite progress, neither NGOs nor governmental agencies have clearly defined roles in the effort to link disaster management priorities. This will ensure that longer-term development efforts build on local capacities and reduce vulnerabilities. Copyright © 2008 by Blackwell Publishing Ltd.

Matsuda, F.; S. Ishimura; Yukiko Wagatsuma; T. Higashi; Taiichi Hayashi; Abu S. G. Faruque; David A. Sack; and M. Nishibuchi (2008) "Prediction of epidemic cholera due to Vibrio cholerae O1 in children younger than 10 years using climate data in Bangladesh", *Epidemiology and Infection*, Vol. 136, No. 1, pp. 73-79. **Abstract/Summary:** To determine if a prediction of epidemic cholera using climate data can be made, we performed autoregression analysis using the data recorded in Dhaka City, Bangladesh over a 20-year period (1983–2002) comparing the number of children aged <10 years who were infected with Vibrio cholerae O1 to the maximum and minimum temperatures and rainfall. We formulated a simple autoregression model that predicts the monthly number of patients using earlier climate variables. The monthly number of patients predicted by this model agreed well with the actual monthly number of patients where the Pearson's correlation coefficient was 0·95. Arbitrarily defined, 39·4% of the predicted numbers during the study period were within 0·8–1·2 times the observed numbers. This prediction model uses the climate data recorded 2–4 months before. Therefore, our approach may be a good basis for establishing a practical early warning system for epidemic cholera. Copyright © 2008 by Cambridge University Press.

McGranahan, Gordon; Deborah Balk; and Bridget Anderson (2007) "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones", *Environment*

& Urbanization, Vol. 19, No. 1, pp. 17-37. **Abstract/Summary:** Settlements in coastal lowlands are especially vulnerable to risks resulting from climate change, yet these lowlands are densely settled and growing rapidly. In this paper, we undertake the first global review of the population and urban settlement patterns in the Low Elevation Coastal Zone (LECZ), defined here as the contiguous area along the coast that is less than 10 meters above sea level. Overall, this zone covers 2 percent of the world's land area but contains 10 percent of the world's population and 13 percent of the world's urban population. A disproportionate number of the countries with a large share of their population in this zone are small island countries, but most of the countries with large populations in the zone are large countries with heavily populated delta regions. On average, the Least Developed Countries have a higher share of their population living in the zone (14 percent) than do OECD countries (10 percent), with even greater disparities in the urban shares (21 percent compared to 11 percent). Almost two-thirds of urban settlements with populations greater than 5 million fall, at least partly, in the zone. In some countries (most notably China), urbanization is driving a movement in population towards the coast. Reducing the risk of disasters related to climate change in coastal settlements will require a combination of mitigation, migration and settlement modification.

Messerli, Bruno and Thomas Hofer (2006) *Floods in Bangladesh: History, Dynamics and Rethinking the Role of the Himalayas* (Tokyo: United Nations University Press). **Abstract/Summary:** This book reviews the question if deforestation and land use practices of Himalayan farmers are to blame for the recurring and devastating monsoon floods in the plains of the Ganga and Brahmaputra. It presents new evidence resulting from a research project on floods in Bangladesh in the context of highland-lowland linkages. Massive floods have occurred regularly before man's impact on the large river basins began. There is no statistical evidence that the frequency of flooding in Bangladesh has increased during the 20th century. There is indication however, that the inter-annual variation of floods and the areal extent of big events have increased since 1950. This trend can be related to similar trends in rainfall and discharge patterns. The hydro-meteorological processes in the Himalayas are not the main causes for floods in Bangladesh. The combination of simultaneous discharge peaks of the big rivers, high runoff from the Meghalaya Hills, heavy rainfall in Bangladesh, high groundwater tables and spring tides creates particularly favorable conditions for large-scale flooding. Lateral river embankments and the disappearance of natural water storage areas in the lowlands seem to have a significant impact on the flooding processes. Accordingly, the myth about deforestation creating big floods and the habit of blaming mountain dwellers for the flood catastrophes must be abandoned. However, this does not relieve the mountain inhabitants of their responsibility to use and manage the environment sustainably. Whereas politicians and engineers perceive monsoon floods as the main problem for Bangladesh, the flood affected people are more concerned - besides the devastating tropical cyclones - with lateral river erosion, landlessness and economic survival problems.

Miah, N. M. (2003) “Variations of temperature in Bangladesh”, in Quadir, D. A., Prasad, K., & Hussain, M. A. (eds.) *Proceedings of SAARC Seminar on Climate Variability in the South Asian Region and its Impacts (held on 10-12 December 2002)* (Dhaka: SAARC Meteorological Research Center (SMRC)). **Abstract/Summary:** Thirty years within (1971-2001) record of monthly average minimum temperature during the months of December and January in winter and monthly average maximum temperature during the months of April and May (Pre-monsoon) at Dinajpur, Rangpur, Rajshahi, Jessore, Ishurdi, Chuadanga and Srimangal stations are

examined by statistical method. These stations were selected because lowest minimum and highest maximum temperature are generally recorded at these stations. It has been found from the study that the temperature trend has increased by 0.012° C/yr in winter except for Rajshahi where the temperature trend is cooling. The temperature trend has increased by 0.013° C/yr in summer except for Chuadanga where the temperature trend is also found cooling in the summer. The average temperature has increased by 0.0125° C/yr within the period of 1971-2001 which is nearer to the global temperature increasing rate.

Milliman, J. D. and B. U. Haq (eds.) (1996) *Sea-Level Rise and Coastal Subsidence: Causes, Consequences, and Strategies* (New York et al.: Springer, Series: Coastal Systems and Continental Margins, Vol. 2). **Abstract/Summary:** Greenhouse-induced climate warming increasingly appears to be a reality, and the warming climate will be accompanied by an accelerated sea level rise - as much as 60-100 cm over the next century. What is commonly absent in the discussion of rising sea level, however, is the role played by the subsidence of low-lying coastal areas, which can have a far greater local effect than the eustatic rise of the sea. The combined sea-level rise and land subsidence will almost certainly make the greatest impact on coastal societies in the densely populated regions of southern Asia, but its effects will be felt globally. This volume explores the concepts of sea-level rise and coastal subsidence, both natural and anthropogenically accelerated, in the form of a series of case studies in such diverse locations as Bangkok, Bangladesh, Venice, and the Niger and Mississippi deltas, as well as a discussion of the economic, engineering and policy responses that must be considered if the effects of local sea-level rise are to be mitigated.

Milliman, J. D.; J. M. Broadus; and F. Gable (1989) "Environmental and economic implications of rising sea level and subsiding deltas: the Nile and Bengal examples", *Ambio,* Vol. 18, No. 6, pp. 340-345. **Abstract/Summary:** The sea level could increase 0.2 or 2.2 by 2100 hinging on the effects of carbon dioxide and chlorofluorocarbons on atmospheric temperature changes, parallel heat transfer to and thermal expansion of the ocean, more precipitation, and melting of polar ice. Local sea level increases also depend on subsidence. Normally deposition of sediment equalizes delta subsidence. Yet many activities change this balance including channeling, diverting, or damming rivers; destruction of mangrove forests; and removal of groundwater or hydrocarbons. Large increases in local sea level are a problem especially for low lying deltas with a large human population. 80% of Bangladesh comprises the Bengal Delta. Annual floods can cover as much as 35% of the entire country. India has diverted flow from the Ganges causing rising salinity in coastal streams in Bangladesh. Considerable drilling of shallow and deep wells has resulted in subsidence of twice the normal rate. Destruction of mangrove forests increases coastal erosion in Bangladesh. In Egypt, almost all the productive land and most of the population are located in the Nile Delta. The coast has an almost endless band of 1-5 m dunes which could protect Egypt against a sea level rise, but the Aswan Low and High dams have prevented the deposition of sediment in the Delta leading to coastal erosion. They have also ceased the freshwater influx to the delta causing increased salinization of soils. This in turn increases the demand for drilling shallow and deep wells and the increased removal of groundwater hastens subsidence. By 2100, local sea level rises of these 2 deltas may be as high as 3.3 4.5 m. This could result in the loss of 26% of habitable land in Egypt and 34% in Bangladesh. Rising sea levels would worsen environmental and economic effects. Future coastal

and fluvial planning for all areas with low lying deltas and large rivers should consider these scenarios. Copyright © 1989 by The Royal Swedish Academy of Sciences.

Ministry of Foreign Affairs of Denmark, Embassy of Denmark in Dhaka (2008) Climate Change Adaptation & Disaster Risk Reduction Screening, Management Plan and Subsequent Project Proposals of Danida Supported Agricultural Sector and Water Supply and Sanitation Sector Programme Support (Phases II) for Bangladesh (Dhaka: Embassy of Denmark, DRAFT Inception Report (November 6); available at: http://www.bangladesh-climate.org/reports.html. **Abstract/Summary:** This 34-page draft inception report which is structured into five sections. The first section comprises an introduction, specifically on the objectives of the assignment and the inception phase. The second section provides an outlook of climate change in Bangladesh, covering the context of vulnerability, the agricultural sector, water supply and sanitation, Bangladesh climate change strategies and institutions, institutional aspects on climate change, other development partners, and the linkage of present Danida assignment to ongoing climate change efforts in Bangladesh. The third section on methodology and approach for climate change screening and adaptation describes the overall assumptions and considerations, the timing and process, and the approaches and methodologies of the four phases (inception, climate change screening, adaptation and climate management plans, and pilot projects). The fourth section of the inception report covers the documentation of the process before the last section provides schedule and deliverables. In addition to the 34-page main report, the inception report also comes with numerous annexes. Copyright © 2008 by the Embassy of Denmark in Dhaka.

Mirza, M. Monirul Qader (1997) *Modeling the Effects of Climate Change on Flooding in Bangladesh* (Waikato, New Zealand: The University of Waikato, Ph.D. Thesis in International and Resource Studies). **Abstract/Summary:** Floods are annual phenomena in Bangladesh, a very flat deltaic country located at the confluence of the Ganges, Brahmaputra and Meghna rivers. On average, about one fourth of the country gets inundated every year. During extreme floods, as in 1988, about two-thirds of the country is covered by water. There is concern that in future, the magnitude, depth and extent of flooding in Bangladesh may get worse due to climate change. The objectives of this thesis were to analyze the sensitivity of discharges of the Ganges, Brahmaputra and Meghna rivers to climate change, and to estimate the consequent changes in the depth and extent of flooding in Bangladesh. Four major research steps were involved. The first step was to determine the relationship between precipitation and discharge at the boundary of Bangladesh. The second step was to develop climate change scenarios for the three river basins. The third step was to determine discharge changes at the boundary of Bangladesh for the climate change scenarios. The fourth task was to estimate the possible changes in flood extent and depth within Bangladesh. The modeling results also suggest that the vital role in altering various land categories (based on flood depth) will be played by the Brahmaputra and Meghna rivers. In contrast, the role of the Ganges River in flooding, specifically in the central Bangladesh region, is rather catalytic; because flood discharge of the Ganges River inhibits the drainage of the Brahmaputra River at their junction in the Baruria Transit. As a consequence, the Brahmaputra basin usually experiences a larger flooded area and a longer period of flooding than the Ganges basin in Bangladesh. The combined discharge of these two rivers impedes drainage of flood waters from the Meghna basin, resulting in a situation similar to the Brahmaputra basin - that is, widespread, prolonged flooding. In summary, the overall findings from the research show that with climate-change induced increases in peak discharges, Bangladesh may well experience a larger flooded area and a longer flooding period. The simulated results further indicate that

more land could be deeply flooded under future climate change. This suggests that substantial changes in the land categories suitable for high-yielding rice varieties could occur and that an enhanced high risk of flooding could reduce cropping intensity, with negative effects on agricultural production in Bangladesh. Copyright © 1997 by the author.

Mirza, M. Monirul Qader (2002) "Global warming and changes in the probability of occurrence of floods in Bangladesh and implications", *Global Environmental Change*, Vol. 12, No. 2, (July) pp. 127-138. **Abstract/Summary:** Bangladesh is very prone to flooding due to its location at the confluence of the Ganges, Brahmaputra and Meghna (GBM) rivers and because of the hydro-meteorological and topographical characteristics of the basins in which it is situated. On average, annual floods inundate 20.5 percent area of the country and this can reach as high as about 70 percent during an extreme flood event. Floods cause serious damage to the economy of Bangladesh, a country with a low per capita income. Global warming caused by the enhanced greenhouse effect is likely to have significant effects on the hydrology and water resources of the GBM basins and might ultimately lead to more serious floods in Bangladesh. The use of climate change scenarios from four general circulation models as input into hydrological models demonstrates substantial increases in mean peak discharges in the GBM rivers. These changes may lead to changes in the occurrence of flooding with certain magnitude. Extreme flooding events will create a number of implications for agriculture, flood control and infrastructure in Bangladesh. Copyright © 2002 by Elsevier B.V.

Mirza, M. Monirul Qader (2003) "Three Recent Extreme Floods in Bangladesh: A Hydro-Meteorological Analysis", *Natural Hazards*, Vol. 28, No. 1, (January) pp. 35-64. **Abstract/Summary:** Bangladesh is highly vulnerable to floods due to its geographical location at the deltas of the Ganges, Brahmaputra and Meghna (GBM) rivers. About 92.5 percent of the area of three basins lies outside the boundaries of the country. More than 80 percent of the annual precipitation of Bangladesh occurs in the monsoon period between June and September. The hydro-meteorological characteristics of the three river basins are unique and they often cause large to extremely large floods in Bangladesh. It is possible that these floods could inundate 70 percent of the country and the physical damage could be very serious for the economy of Bangladesh with its low gross domestic product (GDP). In 1987, 1988 and 1998, Bangladesh experienced three extreme floods, leaving trails of devastation and human misery. In this article it is demonstrated that these floods differed in terms of magnitude, extent, depth and duration. The external and internal hydro-meteorological dynamics were also different. Copyright © 2003 by Springer.

Mirza, M. Monirul Qader (2005) "Hydrologic Modeling Approaches for Climate Impact Assessment in South Asia" in: M. Monirul Qader Mirza and Q. K. Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers); pp. 23-53 (Chapter 2). **Abstract/Summary:** This chapter discusses the comparative advantages and limitations of various hydrologic models and their suitability for estimating changes in mean annual and mean peak discharge under selected climate change scenarios for the river basins in South Asia. It examines reduction of input variables for empirical modelling through the sensitivity analysis of runoff to changes in temperature and precipitation. This chapter also discusses application of hydrologic models in Bangladesh as a case study to assess climate change impacts. Copyright © 2005 by A. A. Balkema Publishers.

Mirza, M. Monirul Qader (2005) "The Implications of Climate Change on River Discharge in Bangladesh", in: M. Monirul Qader Mirza and Qazi Kholiquzzaman Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers); pp. 103-136 (Chapter 5); parts of this chapter were published as: Mirza, M. Monirul Qader; R. A. Warrick; and Neil J. Ericksen (2003) "The Implications of Climate Change on Floods of the Ganges, Brahmaputra and Meghna Rivers in Bangladesh", *Climatic Change*, Vol. 57, No. 3, (April) pp. 287-318. **Abstract/Summary:** This chapter examines possible changes in the magnitude, extent and depth of floods of the Ganges, Brahmaputra and Meghna (GBM) rivers in Bangladesh by using a sequence of empirical and hydrodynamic models. Various climate change scenarios were constructed to demonstrate a range of uncertainties as well as physiological variations. Future changes in the peak discharge of the Ganges River are expected to be higher than those for the Brahmaputra River. Peak discharge of the Meghna River may also increase considerably. As a result, significant changes in the spatial extent and depths of inundation in Bangladesh may occur. Faster changes in inundation are expected at low temperature increases than of higher temperature changes. Changes in land inundation categories may introduce substantial changes in rice agriculture and cropping patterns in Bangladesh. Reduction of increased flood hazard due to climate change requires strengthening of flood management policies and adaptation measures in Bangladesh.

Mirza, M. Monirul Qader (ed.) (2004) *The Ganges Water Diversion: Environmental Effects and Implications* (Dordrecht: Kluwer Academic Publishers). **Abstract/Summary:** This book presents multi-disciplinary analyses of the environmental effects and implications in Bangladesh and India of the Ganges water diversion. The analyses demonstrate that the downstream part of the Ganges River basin in Bangladesh, which has a sensitive ecosystem, has become very vulnerable to water diversion and as a result it has caused significant damage to many economic sectors and ecosystems. Areas upstream of the Farakka Barrage in India have become more vulnerable to floods and riverbank erosion. The Kolkata Port has marginally benefited from the water diversion. In the Hooghly River estuary, populations of flora and fauna have thrived. In the downstream areas of Bangladesh costly adaptation measures have been adopted and in many cases damages are irreparable. A regional cooperative framework is presented to foster water resources and environmental development in the Ganges river basin. **Contents:** Chapter 1: The Ganges Water Diversion: Environmental Effects and Implications - An Introduction, by: M. Monirul Qader Mirza, pp. 1-12; Chapter 2: Hydrological Changes in Bangladesh, by: M. Monirul Qader Mirza, pp. 13-37; Chapter 3: Role of Farakka Barrage on the Disastrous 1998 Flood in Malda (West Bengal), by: S. Mazumder, pp. 39-48; Chapter 4: Impact of Upstream Human Interventions on the Morphology of the Ganges-Gorai System, by: Maminul Sarker, pp. 49-80; Chapter 5: Effects on Water Salinity in Bangladesh, by: M. Monirul Qader Mirza and Maminul Sarker, pp. 81-102; Chapter 6: Farakka Barrage and its Impact on the Hydrology and Fishery of Hooghly Estuary, by: M. Sinha, pp. 103-124; Chapter 7: Implications on Ecosystems in Bangladesh, by: Ansarul Karim, pp. 125-161; Chapter 8: Watering the Bangladeshi Sundarbans, by: Alan Potkin, pp. 163-176; Chapter 9: Adverse Effects on Agriculture in the Ganges Basin in Bangladesh, by: M. Monirul Qader Mirza and Md. Hossain, pp. 177-196; Chapter 10: Environmental Impacts of the Ganges Water Diversion and its International Legal Aspects, by: Md. Islam, pp. 197-221; Chapter 11: Watching the Farakka Barrage: Role of Media, by: Moinuddin Naser, Harun-Ur-Rashid and Farzana Abdulhusein, pp. 223-246; Chapter 12: Vulnerability to the Ganges Water Diversion: Adaptation and Coping Mechanisms, by: M. Monirul Qader Mirza, pp. 247-285; Chapter 13: The Ganges Water-Sharing Treaty: Risk

Analysis of the Negotiated Discharge, by: M. Monirul Qader Mirza, pp. 287-303; Chapter 14: Regional Cooperation on Water and Environment in the Ganges Basin: Bangladesh Perspectives, by: Q. Ahmad and Ahsan Ahmed, pp. 305-325. Copyright © 2004 by Kluwer Academic Publishers.

Mirza, M. Monirul Qader and Ajaya Dixit (1997) "Climate change and water management in the GBM Basins", *Water Nepal*, Vol. 5, No. 1, pp. 71-100. **Abstract/Summary:** Changes in the climate will alter both the global hydrology and water resources. The vulnerability of water resources to climatic changes varies according to scale: global, regional or sub-regional. In the Ganga-Brahmaputra-Meghna basins, the extent of the inevitable impact has not yet been fully analyzed. This paper, which makes a preliminary effort toward that analysis, examines the sensitivity of runoff to changes in temperature and precipitation in the Ganga-Brahmaputra-Meghna rivers. Analysis indicates that changes in temperature are likely to change river flows, which in turn will affect low flow, drought, flood and sedimentation processes. These changes compound the challenges for water management as practiced in the countries of the basins. Pluralistic strategies which provide for flexible management of water resources in a world with an increasingly warmer climate and which adapt to the resultant changes will have to be formulated. Copyright © 1997 by Nepal Water Conservation Foundation.

Mirza, M. Monirul Qader and Ian Burton (2005) "Using the Adaptation Policy Framework to Assess Climate Risks and Response Measures in South Asia: The Case of Floods and Droughts in Bangladesh and India" in: M. Monirul Qader Mirza and Q. K. Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers); pp. 279-314 (chapter 11). **Abstract/Summary:** This chapter begins with a review of the impacts resulting from climate change in Bangladesh and India, especially increased floods during the monsoon season and increased droughts during the dry seasons. It then reviews the climate change adaptation policy framework and how it can be used to undertake risk assessment and replies to increased floods and droughts in Bangladesh and India. Copyright © 2005 by A. A. Balkema Publishers.

Mirza, M. Monirul Qader and Neil J. Ericksen (1996) "Impact of water control projects on fisheries resources in Bangladesh", *Environmental Management*, Vol. 20, No. 4, pp. 527-539. **Abstract/Summary:** Bangladesh is a very flat delta built up by the Ganges-Brahmaputra-Meghna/Barak river systems. Because of its geographical location, floods cause huge destruction of lives and properties almost every year. Water control programs have been undertaken to enhance development through mitigating the threat of disasters. This structural approach to flood hazard has severely affected floodplain fisheries that supply the major share of protein to rural Bangladesh, as exemplified by the Chandpur Irrigation Project. Although the regulated environment of the Chandpur project has become favorable for closed-water cultured fish farming, the natural open-water fishery loss has been substantial. Results from research show that fish yields were better under pre-project conditions. Under project conditions per capita fish consumption has dropped significantly, and the price of fish has risen beyond the means of the poor people, so that fish protein in the diet of poor people is gradually declining. Bangladesh is planning to expand water control facilities to the remaining flood-prone areas in the next 15 20 years. This will cause further loss of floodplain fisheries. If prices for closed-water fish remain beyond the buying power of the poor, alternative sources of cheap protein will be required. Copyright © 1996 by Springer.

Mirza, M. Monirul Qader and Q. K. Ahmad (eds.) (2005) *Climate Change and Water Resources in South Asia*, (Leiden, The Netherlands: A. A. Balkema Publishers). **Abstract/Summary:** This book addresses the most pressing water resource issues in South Asia, particularly in relation to climate change and variability. This is a region characterized by abundant water during the monsoon, when devastating floods occur, and by scarcity of water and droughts during the dry period. These extreme events often cause substantial damage to infrastructure, property, livestock and human populations. Agriculture and other key economic sectors suffer greatly during these events. The results of climate and hydrologic models indicate increased vulnerability unless adequate adaptation measures are designed and implemented. Such policies need to rely on a framework that includes active participation of the stakeholders. The book visualizes that the projected water problems in the region are likely to be more severe than those occurring at present. Among the specific problems reviewed in the book are: floods in Bangladesh; acute droughts in South Pakistan and West India; glacier retreats and snowmelt changes; glacier lake outburst floods in Nepal and Bhutan; landslides leading to sedimentation and jeopardizing water quality. Saltwater intrusion, caused by sea-level rise and growing groundwater withdrawal, are potentially serious problems, which may occur at relatively small rise levels. Rapid urbanization, population growth (and the resultant food demand) and economic growth (with consequences for lifestyle and diet) boost the water demand, but irrigation remains the largest water consumer, yet it is still not very efficient. Improvement of this efficiency is increasingly needed and the slogan "more crop per drop" is indeed valid in the region. The gap between water availability and demand is likely to become wider. **Contents:** 1. Climate Change and Water Resources in South Asia: An Introduction (by Monirul Mirza and Q. K. Ahmad); 2. Hydrologic Modeling Approaches for Climate Impact Assessment in South Asia (by Monirul Mirza); 3. Are Floods Getting Worse in the Ganges, Brahmaputra and Meghna Basins-(by Monirul Mirza, R. A. Warrick, Neil J. Ericksen and G. J. Kenny); 4. Climate Change and Water Resources Assessment in South Asia: Addressing Uncertainties (by Gary Yohe and Kenneth Strzepek); 5. The Impact of Climate Change on River Discharge in Bangladesh (by Monirul Mirza); 6. Climate Change and Glacier Lake Outburst Floods and the Associated Vulnerability in Nepal and Bhutan (by Motilal Ghimire); 7. Climate Change-Implications for India's Water Resources (by M. Lal); 8. Climate Change and Water Resources Management in Pakistan (by Asad Qureshi); 9. Climate Change and Water Resources Management in Bangladesh (by Hossain Faruque and M. Ali); 10. Adaptation Options for Managing Water Related Extreme Events under Climate Change Regime: Bangladesh Perspectives (by Ahsan Ahmed); and 11. Using the Adaptation Policy Framework to Assess Climate Risks and Response Measures in South Asia: The Case of Floods and Droughts in Bangladesh and India (by Monirul Mirza and Ian Burton).

Mirza, M. Monirul Qader; R. A. Warrick; and Neil J. Ericksen (2003) "The Implications of Climate Change on Floods of the Ganges, Brahmaputra and Meghna Rivers in Bangladesh", *Climatic Change*, Vol. 57, No. 3, (April) pp. 287-318. **Abstract/Summary:** Climate change in the future would have implications for river discharges in Bangladesh. In this article, possible changes in the magnitude, extent and depth of floods of the Ganges, Brahmaputra and Meghna (GBM) rivers in Bangladesh were assessed using a sequence of empirical models and the MIKE11-GIS hydrodynamic model. Climate change scenarios were constructed from the results of four General Circulation Models (GCMs) - CSIRO9, UKTR, GFDL and LLNL, which demonstrate a range of uncertainties. Changes in magnitude, depth and extent of flood discharge vary considerably between the GCMs. Future changes in the peak discharge of the Ganges River

are expected to be higher than those for the Brahmaputra River. Peak discharge of the Meghna River may also increase considerably. As a result, significant changes in the spatial extent and depths of inundation in Bangladesh may occur. Faster changes in inundation are expected at low temperature increases than of higher temperature changes. Changes in land inundation categories may introduce substantial changes in rice agriculture and cropping patterns in Bangladesh. Reduction of increased flood hazard due to climate change requires strengthening of flood management policies and adaptation measures in Bangladesh. Copyright © 2003 by Springer.

Mirza, M. Monirul Qader; R. A. Warrick; Neil J. Ericksen; and G. J. Kenny (2001) "Are floods getting worse in the Ganges, Brahmaputra and Meghna basins?", *Global Environmental Change*, Vol. 3, No. 2 (June), pp. 37-48; also published as Chapter 3 in Mirza and Ahmad (eds.) (2005). **Abstract/Summary:** The Ganges, Brahmaputra and Meghna/Barak rivers are lifelines for millions of people in South Asia in Nepal, India, Bhutan and Bangladesh. They supply water for food and fiber production and for industrial and domestic purposes. They are also sources of disastrous floods that cause substantial damage to agriculture and infrastructure in these countries. There are claims that flood discharges, areal extent, and damage-costs are getting worse in the Ganges, Brahmaputra and Meghna/Barak basins. The validity of these claims was examined by applying four different statistical tests to the peak discharge time series and flooded areas. The results indicate that no conclusive changes have occurred over the last few decades. Reports of increased flood damage may be due to a combination of other factors, such as improved damage assessment techniques, and the expansion and intensification of settlement in flood-prone areas, but this was not tested in this paper and should be top priority for future research. Copyright © 2001 by Elsevier B.V.

Moench, Marcus and Ajaya Dixit (eds.) (2004) *Adaptive capacity and livelihood resilience: adaptive strategies for responding to floods and droughts in South Asia--Identifying factors which enable South Asian communities to adapt to floods, droughts and climatic variability* (Boulder and Kathmandu: Institute for Social and Environmental Transition). **Abstract/Summary:** This 'Adaptive Strategies Project' is the result of collaboration between local organizations, regional NGOs, international organizations and academic institutions; it attempts to understand and define factors enabling communities to adapt to floods, droughts and climatic variability. Studies have indicated that vulnerability and adaptive capacity is influenced by eight major factors: the nature of livelihood systems within a region and the ability to diversify; the ability of people to migrate to obtain access to non-agricultural sources of income; the ability of information, services and resources to flow into and out of an affected region; the social infrastructure that households have access to, such as banks, NGOs and social networks existing patterns of vulnerability; the nature of physical infrastructure including the degree to which it is itself vulnerable, and the extent to which it promotes maintenance of livelihoods; the ability of households to obtain secure sources of water natural resource conditions, particularly the degree to which water surface systems have been disrupted. In addition to the influencing factors found through case studies, the authors highlight five further points of interest: the factors governing the flow of resources, services and people across local borders during flood or drought is a critical area for policy research at a national and global level; there is little information available, at present, to actors and decision-makers on changing dimensions of vulnerability; it is essential to improve our understanding of humanitarian implications of floods, droughts and climate variability; issues related to urbanization and urban quality of life are becoming more important through the relationship with migration; and the potential for expanding watershed

programmes, and shifting their focus to include factors relating to adaptation should be explored.

Mondal, M. K., T. P. Tuong, S. P. Ritu, M. H. K. Choudhury, A. M. Chasi, P. K. Majumder, M. M. Islam and S. K. Adhikary (2006) "Coastal Water Resource Use for Higher Productivity: Participatory Research for Increasing Cropping Intensity in Bangladesh", in C. T. Hoanh, T. P. Tuong, J. W. Gowing and B. Hardy (eds.) *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture- Fishery-Aquaculture Conflicts*, Comprehensive Assessment of Water Management in Agriculture Series, No. 2 (Wallingford, UK and Cambridge, MA, USA: CABI Publishing), pp. 72-85; available at: http://www.iwmi.cgiar.org/Publications/CABI_Publications/CA_CABI_Series/Coastal_Zones/Hoanh_1845931076-Chapter6.pdf.
Abstract/Summary: In Bangladesh, about 1.0 million ha of coastal saline soils have been mono-cropped with low-yielding, traditional rice varieties during the monsoon season from June to December. Most of these lands remain fallow in the dry season because of high soil salinity and the lack of good-quality irrigation water. This research was conducted with farmers' participation to test the hypothesis that a combination of on-farm storage of surface water, to prolong freshwater availability beyond the end of the rainy season, together with the proper selection of rice varieties, can increase cropping intensity and productivity of the area. Selected farmers and local leaders were involved in the whole process, from designing the new cropping systems to managing, testing and evaluation. In the wet season, the traditional rice varieties were replaced by short-duration, high-yielding varieties (HYV), which can be harvested earlier, about 1.5 months before traditional varieties. This opened up opportunities for early establishment (in mid- November) of short-duration HYV of rice during the dry season. River water was directly used for irrigation of the dry-season crop up to mid-February. Beyond this time, river water became too saline for irrigation purposes. Before it became too saline, river water was taken in through sluices in the first week of February and conserved in on-farm canal networks. The stored water was used to irrigate rice from mid-February to the end of March. The new cropping system increased annual rice yield by two- to threefold and farmers' profits by 1.5- to twofold compared with the farmers' traditional system, and with no apparent negative effect on the environment. The technology was taken up at a fast pace, indicating that farmers preferred it to shrimp farming. Principles of the technology can be applied to other monsoon, deltaic coastal areas.

Mondal, M. Shahjahan and Saleh A. Wasimi (2007) "Evaluation of Risk-Related Performance in Water Management for the Ganges Delta of Bangladesh", *Journal of Water Resource Planning and Management*, Vol. 133, No. 2 (March/April), pp. 179-187. **Abstract/Summary:** A risk-based evaluation is performed in the meeting of future water demands in the Ganges Delta of Bangladesh (GDB). This evaluation is based on reliability, resiliency, and vulnerability performance indicators, which have been newly defined to capture the time varying characteristics of the Ganges River system. The analysis includes the impacts of climate change on both demands and resources, and the generation of synthetic flows of the Ganges River. The values of the indicators reveal that the expected demand of the GDB up to the year 2050 can be supplied with the proposed Ganges Barrage under the "no change" and "most likely" climatic scenarios, provided that the groundwater remains usable. However, if an additional upstream diversion from the transboundary rivers takes place in India and/or a "possible adverse" change in climate occurs, the consequences may be devastating.

Moudud, H. J.; H. E. Rashid; and A. Atiq Rahman (eds.) (1988) Executive Summary and Recommendations of the National Workshop on Bangladesh Coastal Area Resource Development and Management (October 3-4, 1988), (Dhaka: Coastal Area Resource Development and Management Association (CARDMA)). **Abstract/Summary:** The members of the Jatiya Sangsad (Bangladesh Parliament) took a prominent part in the deliberations and it was their interest which contributed largely to the success of the workshop. The MP's, representing the coastal constituencies and having an intimate knowledge of the coastal area, were able to throw new light on many issues, highlight urgent problems and suggest guidelines for the future course of project implementation and action research. It clearly emerged from the exchange of ideas that the coastal area, and the adjacent sea, has a tremendous potential and the future of Bangladesh lies to a great extent on properly utilizing it. However, it was also clear that the ecology of this potentially highly productive area is fragile and needs careful management. Therefore, there was a consensus that a continuous programme of action research is needed, so that development can accelerate. A large number of topics concerning the problems and prospects of the coastal area came up for discussion by the scientists and politicians. CARDMA and the workshop participants consisting of people's representatives and experts developed a consensus to carry this interest forward into an action programme. The elements of this emerged from the consensus of the participants of the Workshop, which is reproduced in brief discussions of the topics and a series of recommendations. Three areas of work which have been identified for immediate action are Sundarbans, Chakaria Sundarban and aforestation of Sundarban in the Meghna estuary.

Najman, Y.; M. Bickle; M. BouDagher-Fadel; A. Carter; E. Garzanti; M. Paul; J. Wijbrans; E. Willett; G. Oliver; R. Parrish; S. H. Akhter; R. Allen; S. Ando; E. Chisty; L. Reisberg; and G. Vezzoli (2008) "The Paleogene record of Himalayan erosion: Bengal Basin, Bangladesh", *Earth and Planetary Science Letters*, Vol. 273, No. 1-2, pp. 1-14; available at: http://www.es.ucl.ac.uk/people/fadel/Papers/Najman_2008.pdf. **Abstract/Summary:** A detailed knowledge of Himalayan erosion is critical to evaluating crustal deformation processes, and the proposed link between Himalayan erosion and both global climate and ocean geochemistry. The most commonly quoted age of India-Asia collision is about 50 Ma, yet the record of Paleogene Himalayan erosion is scant, either absent or of low age resolution. We identify sediments shed from the rapidly exhuming southern flanks of the eastern-central Himalaya at 38 Ma, in the at least 1 km thick deltaic Barail formation of the Bengal Basin in Bangladesh. This formation was previously of disputed provenance and poorly dated. Our new biostratigraphic and isotopic detrital mineral ages date the Barail formation as spanning Late Eocene to Early Miocene. New provenance data from the Barail formation are consistent with Himalayan, and inconsistent with Indian cratonic or Burman sources. Detrital mineral lag time data show that exhumation of the orogen was rapid by 38 Ma. Our identification of sediments shed from the rapidly exhuming southern flanks of the eastern-central Himalaya at 38 Ma extends the known and accessible erosion record in this region by 16 Ma, from the previous oldest record at 21 Ma in the foreland basin of Nepal. The discovery of Himalayan detritus in the Bengal Basin from 38 Ma has four implications. First, it resolves the puzzling discrepancy between the lack of erosional evidence for Paleogene crustal thickening that is recorded in the hinterland. Second, it invalidates those previously proposed evidences of diachronous collision which were based on the tenet that Himalayan-derived sediments were deposited earlier in the west than the east. Third, it enables models of Himalayan exhumation to be revised to reflect vigorous erosion and rapid exhumation

by 38 Ma. Fourth, it provides evidence that rapid erosion in the Himalaya was coincident with the marked rise in some marine values since about 40 Ma. Copyright © 2008 by Elsevier B.V.

Nasreen, Mahbuba (2008) Impact of Climate Change on Food Security in Bangladesh: Gender and Disaster Perspectives; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation pointed out that disasters affect both women and men but that the burden of coping with disasters falls heavily on women's shoulders in Bangladesh. It also stressed that women suffer more than men from poverty, hunger, malnutrition, economic crises, environmental degradation, health related problems, insecurity and become victims of violence and political crises. It argued that the gendered division of labour becomes critical as gender roles often re-enforced and even intensified -- due to the additional work and changes in the environment brought on by a disaster. The presentation also stated that violations of women's rights becomes more prominent during disasters, that relief actions do not reach the people who need it most, and that women's own initiatives become crucial for their families' survival. Copyright © 2008 by the author(s).

Nelson, Deborah Imel (2003) "Health impact assessment of climate change in Bangladesh", *Environmental Impact Assessment Review*, Vol. 23, No. 3 (May), pp. 323-342. **Abstract/Summary:** Global climate change may have serious and irreversible impacts. Improved methods are needed to predict and quantify health impacts, so that appropriate risk management strategies can be focused on vulnerable areas. The disability-adjusted life year (DALY) is proposed as an effective tool in environmental health impact assessment. The DALY accounts for years of life lost to premature death and/or morbidity. Both the DALY and the determinants-of-health approach are applied to health impact assessment of global climate change in Bangladesh. Based on historical data, a major storm event may result in approximately 290 DALY per 1000 population, including both deaths and injuries, compared to a current all-cause rate of about 280 per 1000 in the region. A more precise result would require a large input of data; however, this level of analysis may be sufficient to rank risks, and to motivate and target risk management efforts. Copyright © 2003 by Elsevier B.V.

Nicholls, Robert J. (1995) "Synthesis of Vulnerability Analysis Studies", in P. Beukenkamp et al. (eds.), *Proceedings of the World Coast Conference 1993* (The Hague, The Netherlands: National Institute for Coastal and Marine Management, Coastal Zone Management Centre Publication), pp. 181-216; available at: http://www.survas.mdx.ac.uk/pdfs/nicholls.pdf. **Abstract/Summary:** Existing vulnerability analyses at a local, national and global level (The Global Vulnerability Analysis or GVA) are reviewed, synthesized and compared to establish common findings and validate the GVA. This comprises a `bottom-up' approach from the case studies and a `top-down' approach from the GVA. The GVA was developed using the Common Methodology and can be meaningfully compared with the country studies, assuming that its spatial limitations are considered. (Short summaries of the local and country case studies are given in Appendix 1). To date, 22 country case studies and 8 local area case studies have produced quantitative data related to vulnerability to a one-meter rise in sea level in 100 years and no development (present population and economic activity). Aggregation of these studies under these scenarios, and assuming no responses, shows that nearly 180 million people would be affected, assets presently worth over US $1,100 billion would be lost, and over 150,000 km^2

of land could be lost, including 62,000 km^2 of coastal wetlands. Small island states stand out as being particularly vulnerable from most perspectives. Coastal wetlands also appear to be highly vulnerable. Comparison between the GVA and the country studies demonstrates that the GVA produces reasonable estimates at the regional scale for population affected (by storm surge flooding), wetlands at loss and basic protection costs (maintaining existing standards of protection). There is insufficient data to check the updated (1993) protection costs which include regional hydraulics. However, this likely serves as a useful lower bound of realistic response costs for sea level rise. Several improvements to future vulnerability assessments would be useful. These include examining a wider range of response options between total retreat and total protection. In addition, an improved assessment of the vulnerability of coastal wetlands to sea-level rise should be encouraged. This includes modeling both the non-linear response of coastal wetlands to sea-level rise and the likely upland to wetland conversion which may occur as sea level rises. Lastly, the interaction of river flooding with sea level rise requires better evaluation in low-lying coastal areas.

Nicholls, Robert J. (2004) "Coastal Flooding and Wetland Loss in the 21st century: Changes under the SRES Climate and Socioeconomic Scenarios", *Global Environmental Change*, Vol. 14, pp. 69–86. **Abstract/Summary:** This paper considers the implications of a range of global-mean sea-level rise and socio-economic scenarios on changes in flooding by storm surges and potential losses of coastal wetlands. These scenarios are derived from the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) and four different storylines. The flood model predicts that about 10 million people/year experienced coastal flooding due to surges in 1990. The incidence of flooding will change without sea-level rise, but these changes are strongly controlled by assumptions on protection. Sea-level rise increases the flood impacts in all cases although significant impacts are not apparent until the 2080s. The trends of the results also suggest that flood impacts due to sea-level rise could become much more severe through the 22nd century. Coastal wetlands will be lost due to sea-level rise in all world futures, though these losses are relatively small compared to the potential for direct and indirect human destruction.

Nicholls, Robert J. (2006) "Storm Surges in Coastal Areas", in: Margaret Arnold; Robert S. Chen; Uwe Deichmann; Maxx Dilley; Arthur L. Lerner-Lam; Randolph E. Pullen; and Zoe Trohanis (eds.) *Natural Disaster Hotspots Case Studies*, Washington, DC: The World Bank, Hazard Management Unit, pp. 79-108 (Chapter 3); available at: http://siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf?&resourceurlname=0821363328.pdf. **Conclusions:** This document represents a first attempt to draw together the information related to storm surge "hotspots." The relevant information is widely scattered and often not in a form that can be readily synthesized and compared across regions. Therefore, it should be considered as a work in progress rather than as a definitive statement on storm surge hazard. It is also apparent that only the broad regions that are vulnerable to surges can be mapped with the present level of knowledge, which points to the need to continue this type of analysis so that comparative studies of hazards can be improved and developed. This provides an improved basis for sharing experiences and is fundamental to many international efforts that need objective methods to prioritize and target the limited resources for hazard mitigation. Nonetheless, a number of important conclusions can be drawn that are of relevance to the "hotspot" analysis: Surges are a major issue in only a few global regions, with the Bay of Bengal being the most

affected region, and Bangladesh being the main "hotspot" for surge impacts. • While surges are only one aspect of the impacts of a storm, they are the main killer, and surges have led to several million deaths over the last two centuries, mainly in Asia and particularly in Bangladesh. • High death rates due to surges appear to be linked to land claim and substantial coastal modification, which have encouraged growth in vulnerable coastal populations without appropriate consideration of the potential for surges (for example, southern North Sea and Bangladesh). • The death toll in surge events appears to have fallen substantially around the world as protection measures and forecasts/warnings are improved, including most recently in Bangladesh. • However, there is no room for complacency, and the surge hazard will continue to evolve throughout the 21st century due to changing socioeconomic conditions, coastal land use, and climatic risks. • Damages and disruptions due to surges are more difficult to define as they are one aspect of the storm and as these impacts are often aggregated with other damages, such as damages caused by tornados and other types of wind storms. Therefore, while it is useful to analyze surge by itself, it is also important to analyze the integrated impacts of coastal storms, as these are what coastal communities experience. In the future, a mixture of analyses is required—one that considers each storm hazard, as well as the integrated impacts. Copyright © 2006 by The World Bank.

Nicholls, Robert J.; N. Mimura; and J. C. Topping (1995) "Climate Change in South and South-East Asia: Some Implications for Coastal Areas", *Journal of Global Environmental Engineering*, Vol. 1, pp. 137-154. **Abstract/Summary:** The impacts of climate change on coastal areas in south and south-east Asia could be severe. Assuming no adaptation and existing population, a one-meter rise in sea level could displace nearly 15 million, 7 million and at least 2 million people from their homes in Bangladesh, India and Indonesia, respectively. Millions more people are threatened in Viet Nam. In view of the high probability of climate change, but the high uncertainty of its magnitude, adaptation to these threats requires a flexible and integrated approach. Continued investigation and implementation of no regret and low-cost anticipatory adaptation would be prudent. Copyright © 1995 by Edanz Editing.

Nishat, A., (1989) "Greenhouse Effect and Bangladesh: Hydrological Setting and Technical Options"; in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies)**. Abstract/Summary:** This paper covers various technical options for the hydrological and geo-morphological setting of Bangladesh. As a result of the "greenhouse effect" following issues have been addressed; Gradual increase in water level and probable subsidence of low lying lands in the southern part of the country, increase in problems of drainage due to rise in water levels. This could affect drainage during flood season as well as effect drainage from already empoldered areas. Increase in salinity and inland movement of saline front could affect agriculture and irrigation projects in the coastal areas. Changes in climatic pattern may increase occurrences of storms and cyclones both in frequency and intensity, and increase in temperature may influence normal growth of crops and vegetation. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Nishat, Ainun (2008) Climate Change and Water Security in Bangladesh: Concerns & Options; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This

presentation provided the likely impacts of climate change on water security. It showed various maps for flood inundations resulting from different levels of sea-level rise. It also presented the key options for adaptation in terms of flood and drought managements, storm surges, erosion and control measures, and capacity enhancements for disaster management. It concluded that we must prepare for adaptation to climate variability (the already occurring extreme events), keeping in mind the trend indicated in climate change forecasts; that it is the time now to act on adaptation; and that being located in the lowest part of the three major river basins, Bangladesh's preparation is constrained by cooperation and coordination with all upper riparian. Copyright © 2008 by the author(s).

Noshab, Farzana and Nadia Mushtaq (2001) *Water Disputes in South Asia* (Islamabad, Pakistan: Institute of Strategic Studies (ISS)); available at: http://www.issi.org.pk/journal/2001_files/no_3/article/4a.htm. **Abstract/Conclusion:** This study reviews the existing regional frameworks for water cooperation. Although the experience of SAARC - the only regional association for cooperation - has not been successful so far, since in itself it requires the building of mutual trust among the South Asian States. It suggests that political leaders in South Asian countries have to be convinced of the potential benefits accruing from such cooperation. The Indian hegemonic attitude towards other South Asian states needs to be redirected into a more cooperative one. Water conflicts over water resources is a universal phenomenon. An international agency for the management of water issues/conflicts, may become the next global focus. Copyright © 2001 by Institute of Strategic Studies.

O'Donnell, Max R.; Bacos, Dimitri; Bennish, and L. Michael (2002) "Nutritional Response to the 1998 Bangladesh Flood Disaster: Sphere Minimum Standards in Disaster Response", *Disasters*, Vol. 26, No. 3, pp. 229-241. **Abstract/Summary:** In this study we use a cross-sectional survey to evaluate the nutritional response to the 1998 Bangladesh Flood Disaster by 15 relief agencies using standards developed by the Sphere Project. The Sphere Project is a recent attempt by agencies around the world to establish universal minimum standards for the purpose of ensuring quality and accountability in disaster response. The main outcomes measured were resources allocated to disaster relief, types of relief activities and percentage of agencies meeting selected Sphere food aid and nutrition indicators. Although the process of nutritional response was measured, specific nutritional and health outcomes were not assessed. This review found that self-reported disaster and nutritional resources varied widely between implementing agencies, ranging from US$58,947 to $15,908,712. The percentage of resources these agencies allocated to food aid and nutritional response also varied, ranging from approximately 6 to 99 percent of total resources. Agencies met between 8 and 83 percent of the specific sphere indicators which were assessed. Areas in which performance was poor included preliminary nutritional analysis; beneficiary participation and feedback; disaster preparedness during non-emergency times; monitoring of local markets and impact assessment. Agencies were generally successful in areas of core humanitarian response, such as targeting the vulnerable (83 percent) and monitoring and evaluating the process of disaster response (75 percent). The results here identify both strengths and gaps in the quality of humanitarian response in developing nations such as Bangladesh. However, they also raise the question of implementing a rights-based approach to disaster response in nations without a commitment to meeting positive human rights in non-disaster times. Copyright © 2002 by Overseas Development Institute.

Orford, Margie with Stefan Raubenheimer and Barry Kantor (2004) *Climate change and the Kyoto protocol's clean development organism: Brazil, Bangladesh, Indonesia, South Africa* (London: Intermediate Technology Development Group (ITDG)). **Abstract/Summary:** This book contains four case studies. Each case study is a non-technical review of what inspires people to transform the dry language of this international climate change treaty into measurable improvements in people's lives. The projects described have reduced the emission of greenhouse gases through sustainable development in the four countries. The stories are accompanied by color photographs and children's artwork. Copyright © 2004 by Intermediate Technology Development Group (ITDG) Ltd.

Osman, Mohammad Showkat; M. Rafiqul Islam; and Abu M. Kamal Uddin (2006) *Bibliography on Bangladesh Coastal Issues* (Dhaka: Government of the People's Republic of Bangladesh (GoB), Ministry of Water Resources (MoWR), Water Resources Planning Organization (WARPO)); available at: http://www.iczmpbangladesh.org/rep/bib.pdf. **Abstract/Summary:** This bibliography lists 975 coastal zone related titles (mostly books and documents) as they are available in WARPO's Program Development Office (PDO) Library. The bibliography is organized by various sectors (agriculture, arsenic, climate change, coastal management, education, economics, environment, fisheries, forestry, gender, geo-hydro, information, infrastructure, institutions, land, law, natural hazards, people & livelihood, policy & planning, power & energy, sanitation, soil, tourism and water) and provides keywords for each publication listed. With regards to climate change, the bibliography contains 48 items specific on Bangladesh and 4 items on global climate change. Copyright © 2006 by GoB.

Pascual M.; L. F. Chaves; Benjamin A. Cash; Xavier Rodo; and M. Yunus (2008) "Predicting endemic cholera: the role of climate variability and disease dynamics", *Climate Research*, Vol. 36, No. 2 (April), pp. 131-140. **Abstract/Summary:** Retrospective studies of cholera time series in Bangladesh have established a role of the El Niño Southern Oscillation (ENSO), but also of the non-linear dynamics of the disease itself, through changes in the population levels of immunity in this endemic region. The prediction ability of a semi-mechanistic time series model that incorporates both these elements is examined. Results show that ENSO is a key covariate and confirm the importance of its interplay with immunity levels, now from the perspective of prediction. They support the feasibility of using the model as a forecasting tool: the lack of extreme events between 2001 and 2005 would have been anticipated with 75% confidence half a year ahead with a model fitted to data up to 2000. Long-term change in the transmission rate, the non-mechanistic part of the model, sets limits to the forecasting horizon because of a breakdown in its relationship with river discharge towards the end of the 1990s. We discuss this and other limitations of the approach as well as future directions related to the development of an early warning system for cholera in this region. Copyright © 2008 by Inter-Research.

Paudyal, Guna N. (2002) "Forecasting and warning of water-related disasters in a complex hydraulic setting-the case of Bangladesh", *Hydrological Sciences Journal*, Vol. 47, No. SPI, pp. S5-S18; available at: http://www.cig.ensmp.fr/~iahs/hsj/470/hysj_47_Sp_S005.pdf. **Abstract/Summary:** Bangladesh is situated in the active delta of the world's three major rivers— the Ganges, the Brahmaputra and the Meghna. The occurrence of water-induced disasters is a regular phenomenon in Bangladesh. Reducing the magnitude of damage by floods to life and property and minimizing environmental impacts has been the major concern of disaster management activities in Bangladesh. Due to the complex nature of the river systems

and their hydrological/hydraulic characteristics, the tasks of predicting the propagation of floods and planning and designing mitigation measures are quite difficult. However, recently, use of mathematical models has been found to be very promising in building the flood-preparedness system: studying the processes of flood disasters and evaluating alternative mitigation measures, both structural and non-structural. An overview of the mathematical models developed and applied to study and predict floods in Bangladesh is presented. Emphasis is given to real-time flood forecasting and warning. Copyright © 2002 by International Association of Hydrological Sciences.

Paul, Alak and Maksudur Rahman (2006) "Cyclone Mitigation Perspectives in the Islands of Bangladesh: A Case of Sandwip and Hatia Islands", *Coastal Management*, Vol. 34, No. 2 (April-June). **Abstract/Summary:** Most coastal areas of the world are now at risk from natural hazards such as cyclones, storm surges, beach erosions, tsunamis, sea level rises, and so on, resulting from geological and meteorological disturbances. In Bangladesh, during pre-monsoon and post-monsoon periods cyclone and tidal surges are considered the most catastrophic phenomena in coastal regions, including islands. Most coastal island residents of Bangladesh have been facing cyclones for centuries. The present study establishes a comparison between two neighboring islands, Sandwip and Hatia, of the Meghna estuary with respect to disaster reaction and management. Based on a questionnaire survey and observations, the study shows that the inhabitants of Hatia are more aware of and confident in disaster management than the inhabitants of Sandwip. Residents of both islands in the Meghna estuary have established trust in the warning signals following the heavy devastation of great cyclones of 1970, 1985, 1991, and 1997. The residents of Hatia have been facing cyclones and tidal surges more frequently than the residents of Sandwip due to the island's geographical location. In addition, shelter management and relief management are better developed in Hatia than Sandwip. Copyright © 2006 by Taylor & Francis Group.

Paul, Bimal Kanti (2005) "Evidence against disaster-induced migration: the 2004 tornado in north-central Bangladesh", *Disasters*, Vol. 29, No. 4, pp. 370-385**. Abstract/Summary:** Migration is generally considered to be one of the primary responses to a natural disaster. The existing literature widely acknowledges the fact that disaster victims migrate from affected areas. This paper, though, provides empirical evidence of the non-occurrence of out-migration in the aftermath of the 14 April 2004 tornado in Bangladesh. Data collected from 291 respondents from eight tornado-affected villages suggest that no one from these locations migrated to other areas. The constant flow of disaster aid and its proper distribution by the government and non-governmental organizations (NGOs) were the main reasons why victims did not leave. This study contributes to the disaster literature by providing three important findings: disasters do not always create out-migration; emergency aid can compensate in monetary terms for damage caused by disasters; and some of the arguments made in the literature against the provision of emergency relief for disaster victims are not always valid for all countries. Copyright © 2005 by Overseas Development Institute.

Paul, Bimal Kanti and Harun Rasid (1993) "Flood damage to rice crop in Bangladesh", *The Geographical Review*, Vol. 83, No. 2, pp. 151-159. **Abstract/Excerpt:** Every year, almost one-third of Bangladesh is flooded. However, because of topographical characteristics, the regions of the country experience varied degrees of flooding; some parts may be under deep floodwater, others unaffected. Flooding is beneficial only within certain limits of timing, duration, and

magnitude. A normal flood, known as borsha in Bangladesh, generally is associated with monsoon rains that occur between June and October. The residents adjust to it as a part of life. Indeed, although normal floods may cause some damage to crops and properties, they are widely considered a blessing for agriculture, because floodwaters provide soil moisture and plant nutrients from both nitrogen-fixing blue-green algae and decomposing plant remains. Copyright © 1993 by The American Geographical Society.

Pittock, A. Barrie (2005) *Climate Change: Turning up the Heat* (London, UK and Sterling, VA, USA: Earthscan; and Melbourne, Victoria, Australia: CSIRO Publishing). **Abstract/Summary:** This book covers a variety of climate change aspects from a global perspective; though it also contains a small section (pages 267-269) on the effects of climate change on India, Pakistan and Bangladesh. Copyright © 2005 by Earthscan and CSIRO Publishing.

Pouliotte Jennifer; Nazrul Islam; Barry Smit; and Shafiqul Islam (2006) "Livelihoods in rural Bangladesh", *Tiempo*, Issue 59 (April), pp. 18-22; available at: http://www.cru.uea.ac.uk/tiempo/portal/archive/pdf/tiempo59low.pdf. **Abstract/Summary:** For many of the poorest residents of Subarnabad, a village in rural Bangladesh, lack of money to meet basic needs is related to the environmental changes that have been occurring during the last 25 to 30 years. The authors describe the local vulnerabilities to environmental change such as saltwater intrusion and shrimp farm introduction in rural Bangladesh. By addressing local vulnerabilities and concerns, and building capacities in a broad sense, the authors argue that these initiatives can provide practical, effective and contextually-relevant ways to decrease vulnerability and facilitate adaptation to climate change within the context of ongoing development processes. Enhancing and diversifying livelihoods is a key component of this adaptive capacity. Copyright © 2006 by the University of East Anglia, the Stockholm Environment Institute, and the International Institute for Environment and Development.

Pramanik, M. A. H. (1989) "Detection of changes due to greenhouse effect: Application of Space and Remote Sensing Technology", in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies)**. Abstract/Summary:** The global environment is being degraded due to both natural and man-made activities. The natural phenomena include floods, cyclones, storm surges, drought, volcanic eruptions, earthquakes, etc. while the man-made activities worth mentioning are widespread deforestation, industrial and other pollution, destruction of natural resources and habitat, overpopulation, etc. The net effect of the activities are, among other things, increase in the atmospheric greenhouse gases such as carbon dioxide, nitrous oxide, methane, chlorofluorocarbons (CFC), and the global depletion of the ozone layer. An attempt has been made in this paper to review the state-of-the-art and knowledge of the phenomenon and its possible impacts on Bangladesh. A brief on the methodology for measurement both by conventional and remote sensing techniques has been given. A few recommendations are put forward to study and combat the greenhouse effect, particularly in the context of Bangladesh. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Preston, Benjamin L.; Ramasamy Suppiah; Ian Macadam; and Janice Bathols (2006) *Climate Change in the Asia/Pacific Region* - A Consultancy Report Prepared for the Climate Change and Development Roundtable (Aspendale, Australia: Commonwealth Scientific and Industrial Research Organisation (CSIRO), October); available at: http://www.csiro.au/files/files/p9xj.pdf**.**

Abstract/Summary: The Asia/Pacific region encompasses some of the planet's greatest cultural, economic, and ecological diversity. Approximately 60% of the world's population resides in the region, in communities ranging from major urban centers to remote rural communities. The collective economic activity of the region represents roughly 25% of the global domestic product. Rapid growth in large regional economies such as China and India has elevated human prosperity. However, unless ultimately decoupled from fossil fuel use, such growth also threatens to exacerbate the climate challenge. Furthermore, many of the countries within the Asia/Pacific region are developing nations, still struggling to tap into the global economic market and with little climate footprint. This means low performance in development indicators such as economic diversification, literacy, per capita income, and access to basic food and water security. Meanwhile, ongoing environmental degradation is eroding the valuable goods and services of the region's natural ecosystems. To combat these disadvantages, significant development assistance flows into the Asia/Pacific region on an annual basis. Australia contributed over $1 billion in aid to Asia/Pacific nations in 2004/05. These socioeconomic circumstances form the human and environmental context in which climate change and its consequences will be experienced. Climate risk in the Asia/Pacific region may be ameliorated through two complementary strategies: greenhouse gas mitigation and adaptation. Mitigation will reduce the magnitude of climate change to which the region is exposed over the long-term, but will do little to address climate risk over the near-term, particularly in the least developed nations where climate vulnerability is substantial yet responsibility for global greenhouse gas emissions is quite small. Under the United Nations Framework Convention for Climate Change, the developed world has already agreed to take the lead in pursuance of greenhouse gas mitigation. Yet, as these efforts progress, investments must also be made in increasing the capacity of Asia/Pacific nations to adapt to climate variability and climate change. This may be most effectively achieved by mainstreaming climate change adaptation into development assistance that addresses developing world needs with respect to governance, education, health, technology, security, and disaster management. Effective implementation of adaptation and capacity building projects is key to reducing future vulnerability of Asia/Pacific nations to climate change. This necessitates the development and maintenance of institutions and human capital that are knowledgeable regarding climate change and capable of effective decision-making, resource allocation, and risk management. At present, there are numerous examples of decision-making that will increase, rather than decrease, the future vulnerability of Asia/Pacific ecosystems and communities to climate change. Reigning in such behaviors and devising sustainable environmental management practices that harmonize economic development and wealth generation with natural resource management and vulnerability reduction is a core regional challenge.

Qureshi A. and D. Hobbie (1994) "Potential Impacts of Climate Change in Bangladesh" in: Asian Development Bank (ADB) (ed.) *Climate Change in Asia* (Manila, The Philippines: Asian Development Bank), pp. 10-42 (Chapter 2); available at: http://www.adaptationlearning.net/profiles/country/files/WorldBank_Climate%20change%20impacts%20in%20Bangladesh.pdf**. Abstract/Summary:** The potential effects of climate change on Bangladesh are considered for the period from the present to 2050. Most development projects have a planning horizon of 30 years or less, while a few have a planning horizon of 50 years or more. Results on potential impacts by 2030 and 2050 are qualitatively summarized below. At the conclusion of the chapter, an indication is given of the development sectors that may be most

sensitive to climate change. Analysis of changes in climate is based on model outputs for creating climate change scenarios. These tools incorporate latest scientific information on the sensitivity of global climate to greenhouse gas emissions and the effects of sulfate aerosols on global and regional climate. Many of the results are for a 1 m sea level rise or for climate change caused by CO_2 doubling, both of which may not happen until 2100 or beyond. Copyright © 1994 by Asian Development Bank.

Quadir, D. A.; M. A. Hussain; M. A. Hossain; N. Ferdousi; M. M. A. Sarker; and M. M. Rahman (2003) "Climate Change and its Impacts on Bangladesh Floods Over the Past Decades", in: D. A. Quadir, K. Prasad, and M. A. Hussain (eds.) *Proceedings of SAARC Seminar on Climate Variability in the South Asian Region and its Impacts (held on 10-12 December 2002)*, (Dhaka: SAARC Meteorological Research Center (SMRC)**. Abstract/Summary:** In the present paper, the recent climatic variability over Bangladesh and the adjacent areas of India and Nepal and its impact on Bangladesh floods have been studied. The data of precipitation and surface air temperature for the period 1961-1999 for Bangladesh, 1961-1990 for India and 1965-1996 (or as available) for Nepal have been used. The meteorological stations selected for the study covered the major portion of the basin area of the Ganges, Brahmaputra and Meghna (GBM) river system. The time series plots and regression analysis were applied to investigate the long term variability and trends of the pre-monsoon and monsoon period. The analysis shows that the precipitation over the study area has strong inter-annual variability. In the years of strong monsoon activity over the GBM basins inside and outside Bangladesh, severe floods occur in the basin areas. The analysis also shows that the monsoon precipitation has the increasing trends over most parts of Bangladesh and in the upper basin of GBM system adjacent to Bangladesh. The temperature over the Himalayan region has been increasing at a high rate during monsoon season, which is supposed to enhance the melting of snow and glaciers over the Himalayas during this time. The extreme precipitation events of monsoon on top of the increased level of precipitation over the vast basin areas of the GBM system has increased the intensity and duration of the severe floods of Bangladesh. The melting of snow and glaciers in Himalayas at a higher temperature than before further contributed to the runoff, which is likely to enhance the flow in the GBM systems and their tributaries. The time series plot of inundated areas due to monsoon floods in Bangladesh show that the area of inundation and intensity of the severe floods have been increasing since 1974. At the same time the return period of floods of such intensity has decreased in the recent decades. The water level and duration of the floods have also increased. The seasonal distribution of mean tidal levels (sea levels) shows that sea level is highest in Bangladesh coast during the monsoon season. It has also been shown that the sea level increases at a higher rate during the southwest monsoon and post-monsoon seasons. This effect retards the discharge of the floodwater to the Bay of Bengal. Thus, among many reasons of the increase of flood intensity and duration, the sea level rise and enhanced backwater effect due to the stronger monsoon flow on top of this increased sea level have been identified as important additional factors. The socioeconomic aspect of the damages caused by flood has also been discussed in the paper. Copyright © 2003 by SAARC Meteorological Research Center (SMRC).

Rahman, A. Atiq (2008) "Climate Change and its implication: Responsive strategic options for Bangladesh", Dhaka: UNDP Bangladesh, *Policy Dialogue*, No. 8 (March 13); available at: http://www.undp.org.bd/library/policypapers/Policy%20Dialogue%20Series%208.pdf**.**
Abstract/Summary: This note summarizes the main points of the presentation and the subsequent discussion. The key points listed are (1) climate change emerges as a great threat

towards development in all aspects; (2) climate security is a global issue today; (3) Bangladesh is one of the most vulnerable countries for climate change impact; (4) Bangladesh will be one of the worst effected countries for climate change due to (a) the sea level rise which will inundate land and (b) an increase in natural disasters; (5) climate change may affect achieving the MDGs, especially eradicating poverty and hunger; (6) mitigation and adaptation is needed simultaneously, that is, the adaptation to climate change is to be integrated with the relevant national policies and strategies; and (7) climate change is an issue of justice and must be addressed now. Copyright © 2008 by UNDP Bangladesh.

Rahman, A. Atiq and Mozaharul Alam (2003) "Mainstreaming Adaptation to Climate Change in Least Developed Countries" *Working Paper 2: Bangladesh Country Case Study* (London: International Institute for Environment and Development (IIED)); available at: http://www.iied.org/pubs/pdfs/10003IIED.pdf. **Main Lessons:** The main lessons from the study and exercise carried out in Bangladesh aimed at mainstreaming adaptation to climate change may be summarized as follows: (i) Information on climate change impacts needs to be translated from the scientific research domain into language and time scales relevant for policy makers. (ii) Research on potential impacts of climate change needs to be supported in-country to enable information to be improved and passed on to policy makers. (iii) All relevant stakeholders need to be involved-but their needs for information may vary and thus information must be suited to the stakeholder group being engaged with. (iv) Sectoral level policy makers, planners and managers are relatively more likely to mainstream adaptation to climate change into their on-going and planned work (provided the information on impacts is given to them in a suitable form). (v) High-level policy makers need to be especially targeted (with suitable material). (vi) National and international experts and researchers need to share their knowledge with people making decisions and plans on the ground more effectively. Copyright © 2003 by International Institute for Environment and Development.

Rahman, A. Atiq and Saleemul Huq (1989) "Greenhouse Effect and Bangladesh: A conceptual Framework", in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies)**. Abstract/Summary:** The study points out that Bangladesh is one of the most vulnerable countries to climate change impacts, yet contributes very little to global GHG emission. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Rahman, A. Atiq et al. (ed.) (1998) *Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS)-Bangladesh* (Manila, The Philippines: Asian Development Bank with contributions by BCAS)**. Abstract/Summary:** This report is an outcome of a country study conducted under the ALGAS project by the Bangladesh Centre for Advanced Studies (BCAS) in association with BIDS, BUET and BUP. The ALGAS study report includes greenhouse gas inventory for 1990, projections of GHGs emissions to 2020 and an analysis of GHGs abatement options for different economic sectors. The study includes the national GHGs abatement strategies consistent with national development priorities and the preparation of a portfolio of GHGs abatement projects and national policies and action plans embodying national development objectives. It suggests to develop a National Climate Change Strategy as required under UNFCCC using the ALGAS outputs as inputs; to prepare and implement an awareness raising programme on GHG abatement including publication, workshop, seminars, media exposure; to prepare and implement pilot projects for both GHG abatement and improved energy utilization; and to publicize results. The

study suggests also a time line for implementation. Copyright © 1998 by Asian Development Bank.

Rahman, A. Atiq; Mozaharul Alam; Sarder Shafiqul Alam; Md. Rabi Uzzaman; Mariam Rashid; and Golam Rabbani (2007) "Risks, Vulnerability and Adaptation in Bangladesh", New York, UNDP, *Human Development Report Office, Occasional Paper*, No. 2007/13; available at: http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/rahman_alam_alam_uzzaman_rashid_rabbani.pdf.
Abstract/Summary: This paper provides a comprehensive review of the risks, vulnerabilities, and adaptation options and limitations to climate change in Bangladesh. The last section contains suggestions for mechanisms of implementation and 25 recommendations, covering the following aspects: (1) Recognition, Acceptance and Awareness Building on Climate Change amongst all actors; (2) Demonstrate Linkages between Impacts and Risks to Development (3) Shift Planning Paradigms to include Climate Change issues; (4) Develop Communication Tools; (5) Climate Proofing Development Efforts and Mainstreaming Climate Actions into Development; (6) Learning from Climate Variability and Preparing for Climate Change; (7) Develop Tools and Methodologies for Local Level Adaptation; (8) to develop Adaptation Projects using Common Approaches and Methodologies; (9) Develop National Climate Change Strategies; (10) Prioritizing Mitigation Plus Adaptation Projects; (11) Explore Possibilities of Micro Insurance for Climate Change; (12) Reaching the Needy and Marginalized; (13) Utilization of Existing Networks and Institutional Vehicles; (14) Use of Eco-Specific Participatory Management Tools; (15) Develop Research Capabilities; (16) Develop and Extend Adaptation and Mitigation Technologies for Local Needs; (17) Assessment and technology transfer of local level Disaster Management Practices; (18) To develop better forecasting of seasonal variability; (19) Facilitate Voluntary Movement and skill development of climate affected populations; (20) Government Agencies and Climate Negotiators to be trained better and faster; (21) Accessing Adaptation and Mitigation Funds; (22) Enhance Government – NGO collaboration of Climate Activities; (23) Learning from World Wide Community Level Experiences of climate Variability; (24) Developing Common Regional Positions and Global Leadership Roles, and (25) South Asian Regional Programme on Private Sector Development. Copyright © 2007 by United Nations Development Program.

Rahman, Atiq; Nick Robins; and Annie Roncerel (eds.) (1993) *Exploding the Population Myth – Consumption versus Population: Which is the Climate Bomb?* (Brussels, Dhaka, Roma, and Santiago: Climate Network Europe (CNE), Bangladesh Centre for Advanced Studies (BCAS)/ Climate Action Network South Asia (CANSA), Lega per l'Ambiente, and Centre for Technology (TEKHNE)). **Abstract/Summary:** This report examines the climate change issues related to population growth versus consumption and draws six conclusions related to (a) the principles of equity, (b) the importance of consumption patterns relative to demographic issues, (c) the use of population issues to obscure crucial qualitative elements, (d) the need for a systematic approach, (e) the need to design effective strategies, and (f) the requirement for a new global commitment towards more equitable living styles. Copyright © 1993 by Climate Network Europe et al.

Rajan, Sudhir Chella (2008) *Climate Migrants in South Asia: Estimates and Solutions - A Report by Greenpeace* (Bangalore, India: Greeenpeace India, March); available at: http://www.greenpeace.org/raw/content/india/blue-alert-report.pdf. **Abstract/Summary:** This study shows that if global temperatures rise by about 4-5ºC in the course of the century, the South Asian region could face a wave of immigrants displaced by the impacts of climate change

including sea level rise and drought associated with shrinking water supplies and monsoon variability. Copyright © 2008 by Greenpeace.

Ramamasy, Selvaraju and Stephan Bass (2007) *Climate Variability and Change: Adaptation to Drought in Bangladesh – A Resource Book and Training Guide*, Pathumthani, Thailand: Asian Disaster Preparedness Center (ADPC); and Rome, Italy: Food and Agriculture Organization (FAO), Natural Resources Management and Environment Department); available at: http://www.fao.org/NR/clim/abst/clim_070901_en.htm. **Abstract/Summary:** In Bangladesh, where agriculture is the largest sector of the economy, agricultural production is under pressure from increasing demands for food. A large percentage of the population is already vulnerable to a range of natural hazards with increasing climate variability and climate change expected to aggravate the situation further by causing more frequent and intense droughts and increasing temperatures. General Circulation Model data project an average temperature increase in Bangladesh of 1.0ºC by 2030 and 1.4ºC by 2050. Within this context, FAO and the Asian Disaster Preparedness Center (ADPC) are guiding an assessment of livelihood adaptation to climate variability and change in the drought-prone areas of Northwest Bangladesh. The project, implemented under the Comprehensive Disaster Management Programme and in close collaboration with the Department of Agricultural Extension (DAE), is specifically designed to characterize livelihood systems, profile vulnerable groups, assess past and current climate impacts, and increase understanding of local perceptions of climate impacts, coping capacities and existing adaptation strategies. The initiative has guided development of a good practice menu of adaptation options that is being evaluated and field tested in partnership with local communities. As part of this initiative, a series of capacity-building and training activities on "climate change impacts and adaptation to drought" has been undertaken for national and local-level technical working group members, disaster managers and community representatives. The working group members are drawn from key research and extension organizations in Bangladesh including the DAE, Directorate of Relief and Rehabilitation, Department of Livestock, Department of Fisheries, Bangladesh Rice Research Institute and Bangladesh Agricultural Research Institute. This resource book has been prepared as a reference and training guide for building the capacity of agricultural extension workers and development professionals to deal with climate change impacts and adaptation, specifically targeting drought-prone areas of Bangladesh. It also presents suggestions for a three-day training course that would be readily adaptable for any areas of Bangladesh affected by climate-related risks. The information presented on climate change adaptation would enable participants to prepare, demonstrate and implement location-specific adaptation practices and, thus, to improve the adaptive capacity of rural livelihoods to climate change in agriculture and allied sectors. Copyright © 2007 by Food and Agriculture Organization.

Rana, M. Y. and M. F. Lambert (2000) "Generating A Flood Level Probability Map for Bangladesh", *Rural and Environmental Engineering*, No. 38, pp. 30-39**. Abstract/Summary:** Flooding in Bangladesh has considerable economic and sociological impacts. For this reason a map showing consistent and easily accessible flood level information would benefit the development of flood management programs which involve flood warning, flood zoning, flood proofing, and flood protection. Flood levels in Bangladesh are affected by many factors, which give rise to considerable joint probability problems when estimating extreme events. An approach which overcomes these difficulties is to generate contours of flood levels for particular

exceedance probabilities using the time series of historical annual maximum water level data. This has been performed across Bangladesh and has resulted in the preparation of a flood level probability map. Water level data have been analyzed from 266 stations, and a total of 131 out of the 266 stations examined were found to be stationary and independent. The average length of the data samples was 29 years. Stations that had less than 15 years of data were not included in the analysis. Six different probability distributions were fitted against the annual maximum water level data at selected stations for comparison purposes. The results indicated that the Generalized Extreme Value distribution was the best among the six distributions. As a result the Generalized Extreme Value distribution has been adopted to develop the flood level probability map. At most of the gauging sites the Generalized Extreme Value distribution indicated the presence of an upper bound in the extreme flood levels. Copyright © 2000 by Japanese Society of Irrigation, Drainage and Reclamation Engineering.

Rashid, A. K. M. M. (2003) *People's Knowledge, Attitudes and Behavior Regarding Climate Change: Result from a Baseline Study in Southwest Bangladesh; Reducing Vulnerability to Climate Change (RVCC) Project* (Khulna, Bangladesh: CARE Bangladesh, June). Please see Chowhan et al. (2005) for further details.

Rashid, H. E. (1989) "Greenhouse Effect: Its Implications for the Agriculture Sector in the Coastal Area of Bangladesh" in: H. J. Moudud, H. E. Rashid, A. A. Rahman, and M. Hossain (eds.) *The Greenhouse Effect and Coastal Area of Bangladesh* (Dhaka: Bangladesh Centre for Advanced Studies). **Abstract/Summary:** This paper on the impacts of the Greenhouse Effect on the agriculture sector (crops, livestock, fisheries and forestry) in the coastal area of Bangladesh is based on three scenarios outlined by the WMO/UNEP expert consultations in Villach and Bellagio in 1987. It considers that the Upper Scenario of sea-level and temperature rise (and increase in rainfall) could be disastrous for Bangladesh. On the other hand the Middle Scenario, which is more probable, is much more manageable, provided the necessary monitoring system and certain land-building activities are given immediate priority. As for the Low Scenario, Bangladesh could in fact benefit, if the sea-level actually falls as predicted according to this report. The Agriculture Sector (which includes crops, livestock, forestry and fisheries) will be affected by the Greenhouse Effect (GE) in two ways: by the rise in sea-level and by a change in the climate. Initial reports on the GE were rather alarming with predictions of a rise in sea-levels of up to 5 meters. Subsequent calculations seem to have considerably modified the first predictions. The UNEP and WMO sponsored expert consultations in 1987, which was published as "Developing Policies for responding to climatic change" (WMO/UNEP 1988) concluded that there could be three different scenarios for the GE, termed as the Upper, Middle and Low Scenarios. Copyright © 1989 by Bangladesh Centre for Advanced Studies.

Rasid, Harun and A. Mallik (1995) "Flood adaptations in Bangladesh: Is the compartmentalization scheme compatible with indigenous adjustments of rice cropping to flood regimes?", *Applied Geography*, Vol. 15, No. 1, pp. 3-17. **Abstract/Summary:** Compatibility of the proposed compartmentalization scheme with indigenous adjustments of rice cropping to flood regimes in Bangladesh is assessed in the context of the floodplain farmers' preferences for regulated flood levels. A systematic sample survey among the residents of 23 villages in five major floodplains of Bangladesh—the upper and lower Brahmaputra, the Ganges, the Meghna and the Dhaleswari—provided data on indigenous practices of rice cropping and respondents' preferences for regulated flood levels. The results of the questionnaire survey indicated that,

irrespective of significant spatial variations in preferences for specific ranges of flood levels, an overwhelming majority of respondents preferred regulated levels that coincided with the overall range of the normal flood regimes, to which different varieties of monsoon season rice crops have been adjusted. Despite such coincidence of respondents' preference with the objective of compartmentalization to regulate flood levels, the scheme is considered incompatible with indigenous practices of rice cropping because of its operational constraints and problems with the construction and maintenance of flood control compartments and their potential environmental impacts. Copyright © 1995 by Elsevier B.V.

Rasid, Harun and Wolfgang Haider (2003) "Floodplain Residents' Preferences for Water Level Management Options in Flood Control Projects in Bangladesh", *Natural Hazards*, Vol. 28, No. 1, (January) pp. 101-129**. Abstract/Summary:** A maximum difference conjoint (MDC) model was part of a questionnaire to assess floodplain residents' preferences for the outcomes of water level management inside an enclosed embankment system on the left bank of the Dhaleswari River, called the Compartmentalization Pilot Project (CPP)-Tangail. The outcomes were described as (a) varied flood depths in the rice field, (b) incidence of flooding on the courtyard and inside homes, (c) changes in floodplain and culture fisheries, and (d) varied conditions of drainage congestion. Following a standard survey, the respondents from inside and outside a completed section of the compartment (Cluster 1b) were shown profiles of these flood management outcomes and were asked to indicate for each profile the one most preferred and the one least preferred item. The results of the study indicated that the respondents had a clear preference for preventing flooding of their homes and courtyards and for an ideal water depth of 2 ft in the aman rice fields. At the same time, they also showed a strong concern about malfunctioning of sluices and to a lesser extent about the changes in the fish habitat. The successful application of the MDC as an approach to model tradeoffs among rural residents of Bangladesh shows that a relatively complex quantitative survey method, incorporating choice cards as pictograms, can be applied successfully even in a developing country. Copyright © 2003 by Springer.

Rasul, Golam (2006) "State Policies and Land Use in the Chittagong Hill Tracts of Bangladesh", London: International Institute for Environment and Development (IIED), *Gatekeeper Series*, No. 119 (May); available at: http://www.iied.org/pubs/pdf/full/14511IIED.pdf**. Abstract/Summary:** Degradation of land and forests by short rotation slash and burn agriculture, known locally as jhum, has become a serious concern in the Chittagong Hill Tracts (CHT) of Bangladesh. Polices and programmes to promote alternative land use practices have largely failed. Conventionally, indigenous people are blamed for the problem, which is attributed to their conservatism and unwillingness to adopt alternative land use systems. However, this explanation overlooks the constraints inherent in adopting alternative land use practices. This paper offers an alternative explanation by examining the impact of state policies on land use in the CHT over the past two centuries. Copyright © 2006 by International Institute for Environment and Development.

Reid, Hannah and Andrew Simms with Victoria Johnson (2007) *Up in Smoke? Asia and the Pacific* (London: new economics foundation (nef) and International Institute for Environment and Development (IIED), November); available at: http://www.iied.org/pubs/pdfs/10020IIED.pdf. **Abstract/Summary:** This 95-page report contains a section on Bangladesh (pp. 15-23), illustrating among other illustrations the striking

threat from climate change to food production in Asia. Over 70 per cent of Bangladeshis rely on farming in one way or another, and it employs seven out of ten people in the labour force. But temperature and rainfall changes have already affected crop production in many parts of the country, and the area of arable land has decreased. A study by the International Rice Research Institute (IRRI) showed that increases of 1°C at night-time during the growing season, well within the predicted range of global warming, would reduce global rice yields by 10 per cent while another global study showed that the production of rice and wheat could fall by eight per cent and 32 per cent respectively by the year 2050. In a region whose population is still rising, if the ability to grow food is weakened by climate change, the health and livelihoods of millions of people will be at risk. Copyright © 2007 by new economics foundation and International Institute for Environment and Development.

Royal Haskoning (2003) *Controlling or Living with Floods in Bangladesh: Toward an Interdisciplinary and Integrated Approach to Agricultural Drainage* (Washington, DC: The World Bank); available at: http://go.worldbank.org/HOAW1Y98M0. **Abstract/Summary:** The river and flood plain systems, and the manmade improvements—embankments, roads, and the agricultural and fisheries systems—serve highly diverse stakeholders in fierce competition for scarce land and water resources. In contrast to many of the semi-arid areas, drainage is not solely intended to evacuate excess (irrigation) water but to manage water levels and quality so as to meet the requirements of all stakeholders. This case study is an attempt to develop a typology that would do justice to these specific circumstances, to the land use forms that have been developed, and to subsequent drainage functions that need to be performed. The institutional environment in Bangladesh is reviewed, and arrangements more conducive to sustainable forms of drainage development are discussed. Copyright © 2003 by The World Bank.

Saari, Markus and Saeedur Rahman (2003) "Development of the coastal embankment system in Bangladesh", in: C. Goudas, G. Katsiaris, V. May, and T. Karambas (eds.) *Soft Shore Protection* (New York et al.: Springer, Series: Coastal Systems and Continental Margins, Vol. 7), pp. 115-126**. Abstract/Summary:** The shift from hard shore to soft shore protection has been an impetus to further our understanding of coastal processes and to develop effective, environmentally friendly, and low-cost defense strategies against the erosive sea action. This collection of application-oriented contributions on Soft Shore Protection represents a milestone for environmental coastal engineering science and technology. It covers, among other subjects, nourishing techniques and light structures that slow down or even eliminate erosion, as well as possibilities that coastal management authorities and specialists need to know. This article examines these issues for the case of Bangladesh. Copyright © 2003 by Springer.

Salequzzaman Md; Laura Stocker; Dora Marinova; and Peter Newman (2003) "Adaptation and Sustainability Issues of Global Warming Consequences in Coastal Bangladesh", Paper presented at the International Sustainability Conference on 17-19 September 2003 in Perth, Western Australia; available at: http://www.sustainability.dpc.wa.gov.au/conferences/refereed%20papers/Salequzzaman,M%20-%20paper.pdf. **Abstract/Summary:** Global warming consequences and impacts of sea level rise characterize the recent evolution of the coastal environment. All of these resulted from 'greenhouse gases' caused mainly by the burning of fossil fuels. It is important therefore to reduce the reliance on fossil fuels and increase the use of renewable energy. Bangladesh is not a significant 'greenhouse gas' contributor, but is the victim of potential threats of sea level rise from global warming because of its natural physical setting in a coastal environment. It is

projected that by 2050 the mean sea level may rise as much as 1.8 meters. This may result in the loss of up to 16% of the land that supports 13% of the country's GDP. This impact will change the present coastal water current and movement, precipitation and run-off, and also the tidal range of coastal Bangladesh. Some recent studies suggest that the tidal range in some parts of coastal Bangladesh has a good potential for producing tidal energy (an important source of renewable energy) by utilizing the existent costly infrastructure of coastal embankment and sluice gates. Once this tidal energy is adapted in coastal Bangladesh, the future global warming will increase its further potentiality. Coastal Bangladesh is extremely resourceful and very important for the economic, environmental and cultural activities of the local as well as national and international community. Until now, most of the potential resources of this area have not been used properly, mainly due to lack of electricity and integrated coastal management practices. Thus, the paper discusses the global warming threats to coastal Bangladesh and how utilizing the potentiality of tidal energy could mitigate these threats. The paper also presents a framework how tidal energy could be integrated with various potential coastal resources for the sustainable development of coastal Bangladesh.

Salinger, James; M. V. K. Sivakumar; and Raymond P. Motha (2005) "Reducing Vulnerability of Agriculture and Forestry to Climate Variability and Change: Workshop Summary and Recommendations", in: Salinger, James; M. V. K. Sivakumar; and Raymond P. Motha (eds.) *Increasing Climate Variability and Change* (Amsterdam, The Netherlands: Springer), pp. 341-362**. Abstract/Summary:** The International Workshop on Reducing Vulnerability of Agriculture and Forestry to Climate Variability and Climate Change held in Ljubljana, Slovenia, from 7 to 9 October 2002 addressed a range of important issues relating to climate variability, climate change, agriculture, and forestry including the state of agriculture and forestry and agrometeological information, and potential adaptation strategies for agriculture and forestry to changing climate conditions and other pressures. During the past century, changes in temperature patterns have, for example, had a direct impact on the number of frost days and the length of growing seasons with significant implications for agriculture and forestry. Land cover changes, changes in global ocean circulation and sea surface temperature patterns, and changes in the composition of the global atmosphere are leading to changes in rainfall. These changes may be more pronounced in the tropics. For example, crop varieties grown in the Sahel may not be able to withstand the projected warming trends and will certainly be at risk due to projected lower amounts of rainfall as well. Seasonal to interannual climate forecasts will definitely improve in the future with a better understanding of dynamic relationships. However, the main issue at present is how to make better use of the existing information and dispersion of knowledge to the farm level. Direct participation by the farming communities in pilot projects on agrometeorological services will be essential to determine the actual value of forecasts and to better identify the specific user needs. Old (visits, extension radio) and new (internet) communication techniques, when adapted to local applications, may assist in the dissemination of useful information to the farmers and decision makers. Some farming systems with an inherent resilience may adapt more readily to climate pressures, making long-term adjustments to varying and changing conditions. Other systems will need interventions for adaptation that should be more strongly supported by agrometeorological services for agricultural producers. This applies, among others, to systems where pests and diseases play an important role. Scientists have to guide policy makers in fostering an environment in which adaptation strategies can be effected. There is a clear need for integrating preparedness for climate variability and climate change. In many developing countries, the present conditions of agriculture and forestry

are already marginal, due to degradation of natural resources, the use of inappropriate technologies and other stresses. For these reasons, the ability to adapt will be more difficult in the tropics and subtropics and in countries in transition. Food security will remain a problem in many developing countries. Nevertheless, there are many examples of traditional knowledge, indigenous technologies and local innovations that can be used effectively as a foundation for improved farming systems. Before developing adaptation strategies, it is essential to learn from the actual difficulties faced by farmers to cope with risk management at the farm level. Agrometeorologists must play an important role in assisting farmers with the development of feasible strategies to adapt to climate variability and climate change. Agrometeorologists should also advise national policy makers on the urgent need to cope with the vulnerabilities of agriculture and forestry to climate variability and climate change. The workshop recommendations were largely limited to adaptation. Adaptation to the adverse effects of climate variability and climate change is of high priority for nearly all countries, but developing countries are particularly vulnerable. Effective measures to cope with vulnerability and adaptation need to be developed at all levels. Capacity building must be integrated into adaptation measures for sustainable agricultural development strategies. Consequently, nations must develop strategies that effectively focus on specific regional issues to promote sustainable development.

Satterthwaite, David; Saleemul Huq; Mark Pelling; Hannah Reid; and Patricia Romero Lankao (2007) "Adapting to Climate Change in Urban Areas - The possibilities and constraints in low- and middle-income nations" (London, UK: International Institute for Environment and Development (IIED), *Human Settlements Discussion Paper Series*, Theme: Climate Change and Cities-1); available at: http://www.iied.org/pubs/pdfs/10549IIED.pdf. **Abstract/Summary:** This paper discusses the possibilities and constraints for adaptation to climate change in urban areas in low- and middle-income nations. These contain a third of the world's population and a large proportion of the people and economic activities most at risk from sea-level rise and from the heat waves, storms and floods whose frequency and/or intensity climate change is likely to increase. Section I outlines both the potentials for adaptation and the constraints. Section II discusses the scale of urban change. Section III considers direct and indirect impacts of climate change on urban areas and which nations, cities and population groups are particularly at risk. This highlights how prosperous, well-governed cities could generally adapt, but most of the world's urban population lives in cities or smaller urban centers ill-equipped for adaptation. A key part of adaptation concerns infrastructure and buildings - but much of the urban population in Africa, Asia and Latin America lack the infrastructure to adapt. Most international agencies have long refused to support urban programmes, especially those that address these problems. Section IV discusses innovations by urban governments and community organizations and in financial systems that address such problems, including the relevance of recent innovations in disaster-risk reduction for adaptation. It notes how few city and national governments are taking any action on adaptation. Section V discusses how local innovation in adaptation can be encouraged and supported at national scale, and the funding needed to support this. Section VI considers the mechanisms for financing this and the larger ethical challenges that achieving adaptation raises - especially the fact that most climate-change-related urban (and rural) risks are in low-income nations with the least adaptive capacity, including many that have contributed very little to greenhouse-gas emissions.

Sayeed, Shireen K. (2007) "Bangladesh - Linking Climate Change to Disaster Management [Country-in-Focus]", *Inside Asia Pacific*, Vol. 2, No. 2 (July); available at: http://www.undprcc.lk/rcc_web_bulletin/Issue2/country_Bangladesh.shtml; **Section on "The Way Forward: Integrating Future Climate Risks Into Disaster Management":** Bangladesh is probably one of the few countries with a fairly comprehensive disaster management programme which links policy interventions at the national level to sub-national level plans and local level actions. The disaster response and mitigation system in Bangladesh is well coordinated and is considered a priority by the government and its line agencies as well as the armed forces, who play a crucial role in disaster situations. The CDMP has put in place institutions for both Climate Risk Management (CRM) and Disaster Risk Reduction (DRR) in the country. It has created a Climate Change Cell within the Department of Environment to conduct research and feed into the disaster risk reduction process. Although Bangladesh has progressed in terms of having some mechanisms in place while other countries are yet to have them, more action is needed to make the system functionally effective. It would require an Integrated National Framework for CRM & DRR, broader understanding of climate change risks and impacts at all levels, as well as capacity building for assessing risks and analyzing them with sectoral and cross-sectoral perspectives and implications. It would also be necessary to assess the implications of climate change on the lives and livelihoods of the people, and to develop and implement participatory community action plans in order to adapt to climate change. In particular sea level rise, as a result of global climate change, is a looming danger for Bangladesh in the future and the country needs to prepare for mitigating its effects and adapting to it.

Sayeed, Shireen Kamal (2008) "Climate Change in the Context of Global and Local Policies and Governance", Presentation made at the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh, Bellagio, Italy (May 20-22); available at: http://www.bangladeshstudies.org/files/Presentation_Sayeed.pdf. **Abstract/Summary:** The presentation begins with illustrating the emergence of the climate change concept in Bangladesh, and noted that climate change has traditionally been seen as an environmental issue but now it is increasingly recognized as a development issue. It then discusses the relevance of both mitigation and adaptation in Bangladesh. In terms of mitigation, the United Nations Development Program (UNDP) is particularly interested in meeting energy needs through a mitigation strategy. It is also pointed out that climate change requires special considerations for the least developed countries (LDCs), like for example debt relief. The presentation provided a discussion of the link between global and local policies for climate change through cross-cutting issues, such as food insecurity, energy needs, health, biodiversity loss, and population growth. The costs of adaptation across various sectors including education, industry, infrastructure, communication, and transportation are discussed, calling for a more integrated approach to vulnerability analysis. The issue of climate change governance at both the local and global level was addressed, and it was stressed that climate change must now be seen as a development issue and not just an environmental issue. The UN now recognizes climate change as a human rights issue. At the country level in Bangladesh, policy and institutional building is needed in order to effectively mainstream adaptation into the national, sub-national, and local level activities. At this moment, activity is too concentrated in the Department of Environment (DoE). Defining the way forward across all 40 sectors is a major need. The presentation then looked at some funding issues. Funding must be condition free and the potential for comprehensive disaster management must be improved. Private financing and

public/private partnership building should be encouraged. The creation of a special climate change Trust Fund exclusively for Bangladesh is currently under consideration by Bangladesh's donors. The presentation proposed several ways forward: • The Government does not want a national climate change policy, so there is a need to develop individual sectoral plans for climate change adaptation. Sectoral coordination, and cross-sector monitoring and evaluation are needed, possible coordinated by the Ministry of Environment and Forest (MoEF). The MoEF also plans to provide climate change inputs into the Poverty Reduction Strategy Paper (PRSP). • Financial institutions should develop mechanisms to support adaptation, including the provision of easy credit for technologies. • Non-governmental organizations (NGOs) need to build capacity at the community level, for which they need support from donors. • Donors must help the government and civil society in formulating new projects, for example, by providing easy credit for technologies. • Donors also need to pool funds, yet to know how this will operate/be accessed, how they will access, and on what conditions.

Schaerer, Claudia and Ahsan Uddin Ahmed (2004) "Adaptation to Climate Change in Vulnerable Communities: Lessons from Practice in Southwestern Bangladesh", in: Ahsan Uddin Ahmed and N. Haque (eds.) *Adaptation to Climate Change Knowledge Sharing for Capacity Building* [Workshop Proceedings held in COP-9 at Milan (December, 10, 2003)] (Dhaka: Climate Action Network South Asia (CANSA))**. Abstract/Summary:** The first part of the workshop contained presentations from lessons in practice. The first presentation described project activities aimed at reducing vulnerability to climate change in the South-west Bangladesh. The second presentation described an innovative concept about to be piloted as a project in Bangladesh aiming at reducing disaster risks of the poorest through their sustainable livelihood development. The presentations are included in this report. The second part focused on a panel discussion where well-known researchers and activists engaged in climate change vulnerability and adaptation issues and concerns. The panelists were unanimous on 'one' point. The process at the intergovernmental negotiations covered by SBSTA/SBI or the COPs was very far removed from learning from the lessons in practice and on-the-ground. They also called on CANSA to continue facilitating knowledge sharing and management on climate change impacts and adaptation at community level. Finally, the workshop called on all participants to propose follow-up actions on sharing knowledge and practices among different users.

Schneider, S. H.; S. Semenov; A. Patwardhan; I. Burton; C.H.D. Magadza; M. Oppenheimer; A.B. Pittock; Atiq Rahman; J. B. Smith; A. Suarez; and F. Yamin (2007) "Assessing key vulnerabilities and the risk from climate change", in: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability -- Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press), pp. 779-810 (Chapter 19); available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter19.pdf. **Abstract/Summary:** This chapter of the IPCC's 2007 assessment focuses on the vulnerabilities and risks from climate change, while Bangladesh is not mentioned explicitly, the issues addressed are highly relevant for Bangladesh as Bangladesh is already at high risk from observed climate variability and climate change, and will be more adversely affected in the near future by projected changes in climate and increases in the magnitude and/or frequency of already damaging extreme events).

Schubert, Renate; Hans Joachim Schellnhuber; Nina Buchmann; Astrid Epiney; Rainer Grießhammer; Margareta Kulessa; Dirk Messner; Stefan Rahmstorf; and Jürgen Schmid (2008) *Climate Change as a Security Risk* (London, UK and Sterling, VA, USA: Earthscan Publications); 20-page Summary available at: http://www.wbgu.de/wbgu_jg2007_kurz_engl.pdf**.** **Abstract/Summary:** The core message of WBGU's risk analysis is that without resolute counteraction, climate change will overstretch many societies' adaptive capacities within the coming decades. This could result in destabilization and violence, jeopardizing national and international security to a new degree. However, climate change could also unite the international community, provided that it recognizes climate change as a threat to humankind and soon sets the course for the avoidance of dangerous anthropogenic climate change by adopting a dynamic and globally coordinated climate policy. If it fails to do so, climate change will draw ever-deeper lines of division and conflict in international relations, triggering numerous conflicts between and within countries over the distribution of resources, especially water and land, over the management of migration, or over compensation payments between the countries mainly responsible for climate change and those countries most affected by its destructive effects.

Selvaraju, R.; A. R. Subbiah; S. Bass; and I. Juergens (2007) "Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh: developing institutions and options: case study", Rome: Food and Agriculture Organization (FAO), *Institutions for Rural Development*, No. 5 (February); available at: ftp://ftp.fao.org/docrep/fao/009/a0820e/a0820e.pdf. **Abstract/Summary:** The impacts of climate variability and change are global concerns, but in Bangladesh, where large numbers of the population are chronically exposed and vulnerable to a range of natural hazards, they are particularly critical. Agricultural production is already under pressure from increasing demands for food and the parallel problem of depletion of land and water resources caused by overuse and contamination. The impacts of climate variability and change cause additional risks for agriculture. Within this context, FAO and the Asian Disaster Preparedness Center (ADPC) are guiding a project to assess livelihood adaptation to climate variability and change in the drought-prone areas of Northwest Bangladesh. The project specifically looks at: characterization of livelihood systems, profiling of vulnerable groups, assessment of past and current climate impacts, and understanding of local perceptions of climate impacts, local coping capacities and existing adaptation strategies. This report summarizes the project methodology developed and successfully tested during 2005/06, it discusses interim findings and recommendations resulting from the ongoing pilot learning process.

Shahid, Shamsuddin and Houshang Behrawan (2008) "Drought risk assessment in the western part of Bangladesh", *Natural Hazards*, Vol. 46, No. 3 (September), pp. 391-413. **Abstract/Summary:** This article presents a method for spatial assessment of drought risk in Bangladesh. A conceptual framework, which emphasizes the combined role of hazard and vulnerability in defining risk, is used for the study. Standardized precipitation index method in a GIS environment is used to map the spatial extents of drought hazards in different time steps. The key social and physical factors that define drought vulnerability in the context of Bangladesh are identified and corresponding thematic maps in district level are prepared. A composite drought vulnerability map is developed through the integration of those thematic maps. The risk is computed as the product of hazard and vulnerability. The results show that droughts pose the

highest risk to the northern and northwestern districts of Bangladesh. Copyright © 2008 by Springer.

Shamsuddoha, Md. (2005) *Climate Change, Disaster and the Bangladesh Coastline* (Dhaka: Research Development & Coastal Livelihoods COAST Trust). **Abstract/Summary:** River currents strengthened by rising sea levels have devoured half of Bangladesh's biggest island in 40 years, leaving half a million people homeless. From a size of 6,400 square kilometers (3,968 square miles) in 1965, Bhola island near the mouth of the Bay of Bengal is now only half its original size. River erosion is a perennial problem in Bangladesh which is criss-crossed by a network of 230 rivers. But rising sea levels were responsible for the erosion of coastal islands such as Bhola that were not previously vulnerable to the problem. The erosion of Bhola island only started in the 1960s. Before that the size was stable and only a small amount of erosion took place on one side. From the mid-1960s the erosion began and the rate has accelerated over the years. The government estimates that six million people out of the country's 140 million population, are displaced each year due to river erosion. Copyright © 2005 by Research Development & Coastal Livelihoods COAST Trust.

Shamsuddoha, Md. and Rezaul Karim Chowdhury (2007) *Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh* (Dhaka: COAST Trust; and Equity and Justice Working Group (EJWG)); available at: http://equitybd.org/newsletter/english/Issue-5/Disaster_BD.pdf. **Abstract/Contents:** This 34-page booklet covers the following 12 topics: (1) Geo-Social Context of Bangladesh's Coast; (2) Climate Change and Global Environmental Scenario; (3) Sea Level Rise and Bangladesh; (4) Bangladesh's Coast: The Worst Victim to Natural Disasters; (5) Other Natural Disasters and Bangladesh; (6) Disaster Preparedness in Bangladesh; (7) Disaster and Global Scenario; (8) Governance: A Critical Concern that Increases Insecurity; (9) Climate Change, Disaster and Development Challenges; (10) Disaster Preparedness: Needs a Long Term Planning; (11) Capacity Building: The Only Way; and (12). Factors for Capacity Building. Copyright © 2007 by COAST Trust; and Equity and Justice Working Group.

Shamsuddoha, Md. and Rezaul Karim Chowdhury (2008) Political Economy of Bali Climate Conference: A Roadmap of Climate Commercialization (Dhaka: Equity and Justice Working Group (EJWG), January); available at: http://equitybd.org/newsletter/english/Issue-9/PE_ClimateChange.pdf. **Abstract/Summary:** This policy discussion paper has been written based on the key elements of UNFCCC Climate Change Conference held in Bali, Indonesia, December 2007. This policy discussion paper critically reviewed the Bali climate negotiation; intended to provide an insight to the readers, especially developing country's policy makers, negotiators, on the recent dimension of mitigating climate change impacts. This discussion paper tries to cancel out the concept of 'climate commercialization' on which Bali Climate talks eventually rounds, and justifies the urgency of the reduction of green house gases emissions that should be reflected in the post Kyoto global policy regime on climate change. It is expected that this policy discussion paper will be a useful document for the developing country policy makers, environmental NGOs, CSOs in formulation policies and positions on sustainable development in the context of the climate change negotiation. Copyright © 2008 by Equity and Justice Working Group (EJWG).

Sharma, R. C.; E. Duveiller; and G. Ortiz-Ferrara (2007) "Progress and challenge towards reducing wheat spot blotch threat in the eastern Gangetic Plains of South Asia: Is climate change already taking its toll?", *Field Crops Research*, Vol. 103, No. 2, pp. 109-118. **Abstract/Summary:** Spot blotch, caused by Cochliobolus sativus, is a serious constraint to wheat production (Triticum aestivum L.) in the warmer plains of South Asia. Fourteen genotypes were tested in Bangladesh, India and Nepal during 6 years (2000–2005) to determine disease severity and resistance stability over these years. We analyzed the area under the disease progress curve per day (AUDPC/day) to assess spot blotch severity, and examined grain yield, 1000-kernel weight (TKW), days to heading, and plant height. Disease severity differed in the 6 years and several genotypes showed low disease severity in all years. A few genotypes had high grain yield and low disease severity in all years. Genotype Altar-84/Ae. Sq. (224)//Yaco, with the lowest disease severity and highest 1000-kernel weight (TKW) and grain yield was also the most stable for spot blotch resistance, TKW and grain yield. Results demonstrated that wheat genotypes with improved spot blotch resistance, high grain yield, acceptable TKW, and plant height are available as a result of the regional and international collaboration in South Asia. Despite this progress, the challenge lies ahead because of an apparent tendency of increasing spot blotch overall severity in the region and decreasing TKW over 6 years (2000–2005). Higher, average night time temperature during the month of March is an indicator showing that wheat crop performance is challenged in two ways—increasing spot blotch severity and decreasing TKW causing lower yield. The results underline the possible effect of changing climatic factors on disease pressure and the continuous need to identify new resistance sources to develop more spot blotch resistant wheat for the warmer Eastern Gangetic Plains of South Asia. Copyright © 2007 by Elsevier B.V.

Shilling , John, D. (2008) "Bangladesh, Climate Change, and T21", Presentation made at the International Planning Workshop on Conceptualizing Effective and Efficient Adaptation Policies to Climate Change in Bangladesh, Bellagio, Italy (May 20-22); available at: http://www.bangladeshstudies.org/files/Presentation_Shilling.pdf. **Abstract/Summary:** This presentation shows how the Threshold model 21 (T21) can be used as an effective tool for developing an integrative approach for managing climate change in Bangladesh. The first part of the presentation provides the T21's analytic and operational strengths, illustrated some of T21's application, and the dynamic approach of T21. It then provides specific examples about how the T21 works and how it could be applied to analyze the impact of, as well as policy responses to, climate change in Bangladesh. Some of the main applications were then detailed as follows: • expand basic structure of T21 to include climate change factors at appropriate levels of detail over a reasonable time horizon; • produce scenarios showing the effects of different characteristics of climate change to illustrate their broader impacts; • generate sensitivity analysis of parameters and assumptions that are uncertain and of different timing of impacts; • show causal relations and track changes to better understand causes and effects of various impacts and outcomes; • test alternative ways to mitigate and adapt, and estimate the costs and benefits of the alternatives; and • establish effective monitoring and evaluation processes based on model, which can help find solutions where goals are missed. The second part of the presentation provided a detailed look at how the T21 works by presenting specific country applications of the T21, the T21 menu, the baseline simulation and its match with historical data, specific simulations of policy interventions, and how results can be viewed and the reasons for the results can be analyzed. This demonstrated the ease of using T21 and its transparency. These attributes

help T21 facilitate dialogues among stakeholders and promote cooperation and deciding on and applying climate change policies. Copyright © 2008 by Millennium Institute.

Shin, Man Yong; Danesh Miah; and Kyeong Hak Lee (2008) "Mitigation options for the Bangladesh forestry sector: Implications of the CDM" *Climate Policy*, Vol. 8, No. 3, pp. 243-260. **Abstract/Summary:** The Clean Development Mechanism (CDM) under the Kyoto Protocol has expedited various global warming mitigation opportunities that allow Bangladesh to receive investments from those Annex I countries wishing to offset their emissions of greenhouse gases. Bangladesh has a special interest in strategies for combating global warming because its large areas that need to be planted represent a potentially large carbon sink, and at the same time its high rate of deforestation represents a huge carbon source. To properly assign carbon credits within the forestry sector of Bangladesh, a number of important issues and uncertainties need to be examined and resolved. Afforestation and reforestation (A/R) offers opportunities for carbon credits, which is subject to the end-use of the forest products. A/R may be the best option, as well as conserving the existing carbon sink offered by Bangladesh for mitigating global warming. This article discusses the legal issues raised in combating global warming; the potential of the Bangladesh forestry sector to combat global warming; implications of the forestry options for different land uses; and issues to be settled regarding carbon credits. Future policy and governance issues are considered which will enable the Bangladesh forestry sector to mitigate global warming and to obtain carbon credits. Copyright © 2008 by Earthscan.

Shrestha, Madan Lall (1998) The Impact of Tropical Cyclones on the Coastal Regions of SAARC Countries and Their Influence in the Region (Kathmandu, Nepal: SAARC Meteorological Research Centre (SMRC))**. Abstract/Summary:** This study documents and assesses the major impacts of tropical cyclones, i.e., flooding of hinterland, threats to coastal population, damage to property and destruction of infrastructure. Copyright © 1998 by SAARC Meteorological Research Centre (SMRC).

Siddiqui, Kamal Uddin and A. N. H. Akther Hossain (eds.) (2006) *Options for Flood Risk and Damage Reduction in Bangladesh* (Dhaka: The University Press Limited). **Contents:** This book contains the papers presented at the National Workshop on "Options for Flood Risks and Damage Reduction in Bangladesh", held at Bangladesh-China Friendship Centre in Dhaka, in 2004. It addresses climate change indirectly as climate change will increase floods, and hence, the damage resulting from them. Copyright © 2006 by The University Press Limited.

Singh, O. P. (2001) "Cause-effect relationships between sea surface temperature, precipitation and sea level along the Bangladesh coast", *Theoretical and Applied Climatology*, Vol. 68, No. 3/4, pp. 233-242**. Abstract/Summary:** The Bangladesh coast, which lies on the confluence of three mighty rivers, the Ganges, the Brahmaputra and the Meghna, with the Himalayas to the north and the Bay of Bengal to the south, is an ideal zone for sea level rise due to enhanced rainfall during the monsoon season from June to September. An attempt has been made here to look into the cause-effect relationships between observed trends in sea surface temperature (SST) over the Bay of Bengal and the trends in monsoon rains and sea level in Bangladesh. The study utilizes the 14-year satellite-derived SSTs over the Bay of Bengal for 1985-1998, the tide gauge stations data along the Bangladesh coast for 1977-1998 and the 31-year monsoon rainfall data for Bangladesh, 1961-1991. Copyright © 2001 by Springer.

Singh, O. P. (2002) "Spatial Variation of Sea Level Trend Along the Bangladesh Coast", *Marine Geodesy*, Vol. 25, Number 3 (July), pp. 205-212**. Abstract/Summary:** The Bangladesh coast is threatened by rising sea level due to various factors. The results based on the analysis of past 22 years of tidal data of the Bangladesh coast reveal that the annual mean tidal level in the eastern Bangladesh coast is rising at an alarmingly high rate of 7.8 mm/year, which is almost twice the observed rate in the western region. This type of sea level trend seems to be the result of changing local conditions like increased precipitation and land subsidence during the recent decades. It seems that the higher rate of land subsidence in the eastern Bangladesh coast is the main causative factor for the steeper sea level trends there. The differential sea level trends show that the subsidence component in the sea level rise may be as high as 4 mm/year in the eastern Bangladesh coast. However, this needs to be verified with actual geological observations.

Singh, O. P. (2002) "Predictability of sea level in the Meghna estuary of Bangladesh", *Global and Planetary Change*, Vol. 32, No. 2, 15 (April) pp. 245-251**. Abstract/Summary:** The Bangladesh coast, which is already vulnerable to sea-level-associated disasters like flooding and inundation due to monsoons and the tropical cyclones, is being threatened by the phenomenon of sea-level rise, worsening the situation further in the densely populated deltaic region which is hardly 1 m above mean sea level. The interannual component of sea-level variability is very large on the Bangladesh coast. The present paper deals with the problem of predicting mean tide level 1 month in advance in the estuarine zone of the Bangladesh coast during the adverse weather period from September to December. Regression equations have been presented using the Southern Oscillation Index (SOI) as predictor and mean tide level in the Meghna estuary as predicted. Mean tidal levels during the adverse period were found to be predictable on the basis of SOI 1 month in advance. Consequently, the results may find applications in the disaster preparedness programmes for Bangladesh.

Singh, O. P.; T. M. A. Khan; and M. S. Rahman (2000) *The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case*, SAARC Meteorological Research Centre (SMRC), SMRC-No. 3 (Dhaka: SMRC Publication)**. Abstract/Summary:** Bangladesh, one of the most densely populated countries in the world, is a victim of frequent natural calamities like tropical cyclones, tornadoes, floods, storm surges and droughts. Now the sea level rise (SLR) has also been included in these natural calamities. The SLR is likely to have greater impact on Bangladesh due to its low topography and a wide flood plain. Since 21 percent of the population lives in the low coastal belt, any increase in sea level will be a problem of ominous proportion for Bangladesh. The results of trend analysis applied on the tidal data of selected stations located in the three coastal regions of Bangladesh show that Bangladesh coastal sea level is rising in the same way as the global sea level, but the magnitude is quite different. The three stations are Hiron Point, Char Changa and Cox's Bazar in the western, central and eastern regions respectively. The difference in the behavior of sea level rise along the Bangladesh coast and the global trend is mainly due to the tectonic activity such as subsidence of the land in the coastal region of Bangladesh. The mean tidal level at Hiron Point (in Sundarban) has shown an increasing trend of about 4.0 mm/year. Similarly at Char Changa near Meghna Estuary and near Cox's Bazar (in the eastern coast of Bangladesh) it has registered a positive trend of about 6.0 mm/year and 7.8 mm /year respectively. Thus the increment in the sea level along the Bangladesh is much more pronounced as compared to the global rate. As some geological studies along Bangladesh coast reveal that major threat to Bangladesh coast is

subsidence, steeper increase of sea level along Bangladesh coast may be associated with subsidence in addition to the thermal expansion due to warming of seawaters. Since for Bangladesh, SW-monsoon and the cyclonic periods during Pre-monsoon and Post-monsoon seasons are very important, the trend analyses with actual data and the pentad running averages are performed for these seasons respectively. Copyright © 1998 by SAARC Meteorological Research Centre (SMRC).

Singh, O. P.; T. M. A. Khan; T. S. Murty; and M. S. Rahman (2001) "Sea Level Changes Along Bangladesh Coast in Relation to the Southern Oscillation Phenomenon", *Marine Geodesy*, Vol. 24, No. 1, pp. 65-72**. Abstract/Summary:** Interannual variations of sea level along the Bangladesh coast are quite pronounced and often dominate the long-term sea level trends that are taking place. The El Niño/Southern Oscillation (ENSO) induced variation is an important component of interannual mode of variations. The present article deals with the relationship between the sea level variations along the Bangladesh coast and the Southern Oscillation phenomenon. The mean tide level data of monsoon season (June to September) pertaining to Hiron Point (in Sundarbans) and Char Changa (on the mouth of Meghna River) have been analyzed and correlated to the Southern Oscillation Index (SOI). The annual variation of mean tide level in the coastal areas of Bangladesh reveals that the tide level reaches its peak during the monsoon season. The maximum tide level during the calendar year is recorded in August. Thus, it is not surprising that the inundation of the coastal belt of Bangladesh due to the floods is most common during the summer monsoon season, especially from July to September. Therefore, the sea level variations during the monsoon are of paramount importance to Bangladesh. The results of the present study show that both at Hiron Point and Char Changa there is a substantial difference between the mean tide level during the El Niño and La Niña monsoons. The mean tide level at Hiron Point is higher by about 5 cm during August of La Niña years as compared to that during the El Niño years. The difference at Char Changa, which is located at the mouth of Meghna River, is much higher. This is probably due to the increased fresh water discharge into the Meghna River during La Niña years. Thus at the time of crossing of a monsoon depression, the chances of widespread inundation are higher during a La Nina year as compared to that during an El Niño year. The Correlation Coefficients (CCs) between Mean Tide Levels (MTLs) at Hiron Point and Char Changa and the SOI during September (at the end of monsoon) are +0.33 and +0.39 respectively. These CCs are statistically significant at 90% and 95% levels, respectively. These results may find applications in the preparedness programs for combating sea level associated disasters in Bangladesh. Copyright © 2001 by Taylor & Francis Group.

Smith, Dan and Janani Vivekananda (2007) *A Climate of Conflict: The Links between Climate Change, Peace and War* (London, UK: International Alert, November); available at: http://www.waterwiki.net/images/6/6b/International_Alert.pdf**. Abstract/Summary:** This report takes the IPCC's 2007 assessment as its starting point and looks at the social and human consequences that are likely to ensue – particularly the risks of conflict and instability. We've identified 46 countries at risk of violent conflict and a further 56 facing a high risk of instability as a result of climate change. The impact of climate change will make the poorest communities across the world poorer. Many of them are already affected by conflict and instability and thus face a dual risk. International Alert's new research finds that the consequences of climate change will fuel violent conflict, which itself hinders the ability of governments and local communities to adapt to the pressures of climate change. Copyright © 2007 by International Alert.

Smith, Joel B. and Jeffrey K. Lazo1 (2001) "A Summary of Climate Change Impact Assessments from the U.S. Country Studies Program", *Climatic Change*, Vol. 50, Numbers 1-2 (July), pp. 1-29**. Abstract/Summary:** Forty-nine countries participating in the U.S. Country Studies Program (USCSP) assessed climate change impacts in one or more of eight sectors: coastal resources, agriculture, grasslands/livestock, water resources, forests, fisheries, wildlife, and health. The studies were generally limited to analysis of first order biophysical effects, e.g., coastal inundation, crop yield, and runoff changes. There were some limited studies of adaptation. We review and synthesize the results of the impact assessments conducted under the USCSP. The studies found that sea level rise could cause substantial inundation and erosion of valuable lands, but, protecting developed areas would be economically sound. The studies showed mixed results for changes in crop yields, with a tendency toward decreased yields in African and Asian countries, particularly southern Asian countries, and mixed results in European and Latin American countries. Adaptation could significantly affect yields, but it is not clear whether the adaptations are affordable or feasible. The studies tend to show a high sensitivity of runoff to climate change, which could result in increases in droughts or floods. The impacts on grasslands and livestock are mixed, but there appears to be a large capacity for adaptation. Human health problems could increase, particularly for populations in low-latitude countries with inadequate access to health care. The USCSP assessments found that the composition of forests is likely to change, while biomass could be reduced. Some wildlife species were estimated to have reduced populations. The major contribution of the USCSP was in building capacity in developing countries to assess potential climate impacts. However, many of the studies did not analyze the implications of biophysical impacts of climate change on socioeconomic conditions, cross-sectoral integration of impacts, autonomous adaptation, or proactive adaptation. Follow-on work should attempt to develop capacity in developing and transition countries to conduct more integrated studies of climate change impacts.

Smith, Joel B.; A. Atiq Rahman; Monisul Q. Mirza; with contributions by Gavin J. Kenny; Graham C. Sims; and Richard A. Warrick (1998) *Considering adaptation to climate change in the sustainable development of Bangladesh* (Washington, DC: South Asia Region, World Bank, and Boulder, CO, USA: Stratus Consulting Inc.). **Abstract/Summary:** This is a 103 page-long report that provides one of the first comprehensive reviews of the linkage between climate change and sustainable development, which is however outdated today.

South Asian Association for Regional Cooperation (SAARC) (Undated) *Country Report on the Study on Greenhouse Effect and its Impact on the SAARC Region*. (Dhaka: Government of the People's Republic of Bangladesh (GoB), Draft). **Abstract/Summary:** The major emphasis of the study was to summarize findings on climate change in Bangladesh. These are, rising trend in minimum temperatures but no definite trend in maximum temperature; no definite trend in mean seasonal temperature, fluctuation of annual rainfall, and mean monthly frequency and magnitude of heavy rain falls.

Sperling, Frank (ed.) (2003) *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation*, (Abidjan, Cote d'Ivoire; Manila, The Philippines, et al.: African Development Bank (AfDB), Asian Development Bank (AsDB), the United Kingdom's Department for International Development (DFID), The Netherlands, European Community,

Germany, Organization for Economic Co-Operation and Development (OECD), United Nations Development Program (UNDP) United Nations Environment Program (UNEP) and the World Bank; available at: http://povertymap.net/publications/doc/PovertyAndClimateChange_WorldBank.pdf. **Abstract/Summary:** This 56-page report focuses on (1) Poverty Reduction – the Challenge of the 21st Century; (2) Climate Change is Happening and Will Increasingly Affect the Poor; (3) Adaptation is Necessary; (4) Strengthening Adaptation Efforts; and (5) Next Steps. Copyright © 2003 by African Development Bank et al.

Steele, Paul and Sergio Feld (2007) "Climate Change and the MDGs: Challenges and Opportunities in Asia-Pacific", *Inside Asia Pacific*, Vol. 2, No. 2 (July); available at: http://www.undprcc.lk/rcc_web_bulletin/Issue2/cover.shtml. **Abstract/Summary:** Asia-Pacific is at the forefront of climate change, both in terms of the impacts on the region and the Millennium Development Goals (MDGs), and how the world responds. Asia-Pacific is already the region that suffers most from extreme weather events and these will increase with climate change. Recent examples include floods this year that displaced almost half a million people in Jakarta, Indonesia, cyclones in Karachi and across Pakistan that displaced a million people and the heat waves and floods in India that affected several million people. The threat of sea level rise on many small island countries in the Pacific is well known, but in the archipelagos of Indonesia and the Philippines, many islands could also disappear and people be forced to migrate. Crop yields are predicted to fall in many places as rainfall patterns change, rivers dry up and heat waves increase, undermining the region's progress towards achieving MDG 1 on reducing poverty and malnutrition. The retreat of the Himalayan glaciers, which serve as water towers for the great rivers of Asia — the Ganges, Indus, Mekong and Yantgze will affect millions of people, impacting on MDG 1, as well as the health and gender equality MDGs. So while there is much congratulation about Asia-Pacific being on track to meet the MDGs, this may not last as climate change takes hold. Copyright © 2007 by United Nations Development Program.

Stern, Nicholas (2007) *The Economics of Climate Change: The Stern Review* (Cambridge, UK: Cambridge University Press); pre-publication version available at: http://62.164.176.164/6520.htm. Summary/Abstract: This 700-page report is the most detailed study undertaken to assess the effect of climate change and global warming on the world economy. Bangladesh is mentioned various times as an example for the threats countries face due to climate change. For example, the review points out that 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 one meter rise in sea levels, which is a possibility by the end of the 21st century. Copyright © 2007 by Cambridge University Press.

Streatfield, Peter Kim and Zunaid Ahsan Karar (2008) "Population Challenges for Bangladesh in the Coming Decades", *Journal of Health, Population and Nutrition*, Vol. 26, No. 3 (September), pp. 261-272; available at: http://www.icddrb.org/images/jhpn263-Population_Challenges_for_Bangladesh_.pdf. **Abstract/Summary:** Bangladesh currently has a population approaching 150 million and will add another 100 million before stabilizing, unless fertility can soon drop below replacement level. This level of fertility decline will require a change in marriage patterns, which have been minimal so far, even with increasing female schooling. It would also benefit from a long-awaited shift to long-term contraception. In addition to the consequence of huge population size, the density of population is already five times that of

any other 'mega' country (>100 million), a very challenging situation for an agricultural society. Most of the future growth will be urban, increasingly in slums. Numbers of young people will not increase, but numbers of older people will increase 10-fold this century, creating a large burden on the health system, especially for chronic illnesses. High density of population means that agricultural land is virtually saturated, with very limited capacity to expand food production. Climate change may have dramatic impacts on agriculture, through flooding and drought resulting from weather changes and geopolitical influences on transborder rivers. Rising sea-levels and consequent salinity will affect crops and require shifts to alternative land use. Serious long-term planning is needed for meeting the growing needs of the population, both for distribution and consumption.

Sudmeier-Rieux, Karen; Hillary Masundire; Ali Rizvi and Simon Rietbergen (eds.) (2006) *Ecosystems, Livelihoods and Disasters: An Integrated Approach to Disaster Risk Management*, Ecosystem Management Series No.4 (Cambridge, UK: IUCN – The World Conservation Union); available at: http://www.gdrc.org/uem/disasters/disenvi/CEM-004.pdf**. Abstract/Summary:** The purpose of this publication is to provide recommendations for making disaster risk reduction strategies more effective. A comprehensive approach to disaster management involves a number of actors and actions outside the expertise and realm of environmental organizations. In the direct aftermath of a disaster, saving lives and providing for safety and basic needs is clearly the domain of emergency professionals and humanitarian agencies. As the focus turns to human livelihood recovery, clean-up, and preparing for future hazards, however, considerable negative long-term consequences can arise from neglecting environmental concerns. Although many existing environmental guidelines, laws and policies are relevant to post-disaster emergency response and reconstruction efforts, they are rarely applied in times of crisis. In many cases they are not integrated with the procedures of humanitarian agencies and others involved in emergency response, who are generally the first on the ground. They also cannot be easily utilized by non-specialists. The way forward is clear: organizations and professionals involved in humanitarian assistance and in environmental management need to work together more closely to develop workable solutions and bring about real integration on the ground. This publication summarizes some of the key lessons we have learned from the work we have jointly undertaken following recent disasters in Asia and Latin America. We hope it will inspire relief and development agencies and conservation organizations to form similar partnerships elsewhere, and to share the lessons learned from their efforts.

Sultana, W.; M. A. Aziz; and F. Ahmed (2008) Climate change: Impact on Crop Production and its Copping Strategies; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** The objectives of this study presented were to study the climate change impact on field crop production in Bangladesh and to determine future coping strategies. The study used a variety of methodologies including a review of the literature, laboratory research, and field research. The study includes among others the analysis of salt tolerance, leaf to leaf compartmentation, osmoregulation, and membrane stability. The presentation suggests a variety of coping strategies and conclusions.

Takagi, T.; T. Oguchi; J. Matsumoto; M. J. Grossman; M. H. Sarker and M. A. Matin (2007) "Channel braiding and stability of the Brahmaputra River, Bangladesh, since 1967: GIS and remote sensing analyses", *Geomorphology*, Vol. 85, No. 3-4, pp. 294-305. **Abstract/Summary:** Spatial and temporal changes in channel distribution in the large, sandy, braided system of the Brahmaputra River, Bangladesh, were analyzed using satellite images and GIS. Supervised classification of the images within the braided belt, i.e., channels and bars between the bank-lines, provided raster land cover data for 14 different years between 1967 and 2002. The width of the braided-belt, the number and width of channels, the distribution of land cover attributes and land stability change were examined from the data. The results indicate that the recent history of the dynamics of the Brahmaputra can be divided into four phases: 1) the late 1960s to early 1970s, 2) the mid-1970s to early 1980s, 3) the mid-1980s to early 1990s, and 4) the mid-1990s to early 2000s. Spatial distributions of the land cover and channels in Phase 4 were the least complex suggesting a state of dynamic equilibrium. Land cover and channel distributions during Phase 2 were partly less complex indicating quasi-dynamic equilibrium. Phases 1 and 3 can be regarded as transitional phases with more complex conditions. Frequent large floods may have triggered significant changes in the river system during Phases 1 and 3. Copyright © 2007 by Elsevier B.V.

Tanner, Thomas M.; A. Hassan; K. M. N. Islam; D. Conway; R. Mechler; A. U. Ahmed and M. Alam (2007) *ORCHID: Piloting Climate Risk Screening in DFID Bangladesh* (Brighton, UK: University of Sussex, Institute of Development Studies, Research Report); available at: http://www.iiasa.ac.at/Research/RAV/Presentations/orchid_summary_research_report_2007.pdf. **Abstract/Summary:** ORCHID (Opportunities and Risks of Climate Change and Disasters) responds to 2006 White Paper commitments by piloting a screening approach to consider climate risk management in DFID Bangladesh. The approach combines the related concerns of disaster risk reduction and adaptation to future climate change. Climate change science inputs building on trend analysis suggest increases to the existing hazard burden in Bangladesh. Greater monsoon rainfall is likely to increase flooding and decreased dry season rainfall is likely to exacerbate drought and inland water salinity. Both problems are compounded by sea level rise in coastal regions. The risk assessment found a prevailing level of risk to almost all projects from regular catastrophic disaster events. The most climate-sensitive DFID-B interventions were selected for more detailed assessment. DFID-B already supports disaster risk reduction and climate change adaptation initiatives through targeted interventions such as the Comprehensive Disaster Management Programme. Other mainstream interventions also contribute to reducing climate-related vulnerability. Current and future climate risks are being already managed by existing activities of the Chars Livelihoods Programme, including the raising of homesteads on earth mounds above the 20-year flood line. A cost benefit analysis of this option was undertaken factoring in projected climate change impacts. It suggests positive benefit to cost ratios (net efficiency) for commonly used discount rates even under a high cost assumption. A variety of the screening recommendations have been integrated within DFID-B interventions. Reducing vulnerability to climate variability and change have been taken forward as key funding criteria for the Economic Empowerment of the Poorest (EEP) challenge fund. The second phase of the Rural Infrastructure Improvement Project (RIIP2) has included disaster risk assessment procedures as part of the strengthening of best practice in social and environment impact assessment procedures necessary for the envisaged infrastructure works. A cost benefit analysis of flood-proofing of roads and highways suggests that road-raising and drainage measures could be economically efficient by reducing disaster impacts in the medium term. This is salient to

ongoing DFID-B financial and technical support to the Bangladesh Roads and Highways Department. Other recommended options for managing risks included greater attention to infrastructure design in health, education and private sector development programmes, to non-structural measures such as livelihoods diversification, education, training, and improved research and monitoring. Copyright © 2007 by Institute of Development Studies.

Tänzler, Dennis; Alexander Carius; and Sebastian Oberthür (2002) "Climate Change and Conflict Prevention", (Berlin: Adelphi Research; Report on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety); available at: http://www.adelphi-research.de/projektberichte/ClimateSide.pdf. **Abstract/Summary:** This 8-page report makes reference to a Bangladesh case study that showed that Bangladesh has already been a primary victim of extreme weather events (cyclones, floods and droughts) that forced people to migrate. Since environmental stress will intensify due to climate change impacts, the conflict potential may also rise and might eventually lead to international tensions and regional instability. Copyright © 2002 by Adelphi Research.

Thomalla, Frank; Terry Cannon; Saleemul Huq; Richard J. T. Klein; and Claudia Schaerer (2005) "Mainstreaming Adaptation to Climate Change in Coastal Bangladesh by Building Civil Society Alliances", in: Louise Wallendorf, Lesley Ewing, Spencer Rogers, and Chris Jones (eds.), *Proceedings of the Solutions to Coastal Disasters 2005 Conference in Charleston, South Carolina, USA (May 8–11, 2005)* (Charleston, South Carolina: American Society of Civil Engineers (ASCE)), pp. 668-684; available at: http://www.pik-potsdam.de/research/research-domains/transdisciplinary-concepts-and-methods/favaia/pubs/thomalla_etal_2005.pdf.
Abstract/Summary: Bangladesh is one of the world's poorest countries and is prone to a multitude of climate-related impacts such as floods, droughts, tropical cyclones and storm surges. The vulnerability of people living in the coastal zone has been demonstrated in numerous studies. The subsiding coastal zone in Bangladesh is particularly vulnerable as it is affected by more than twice the mean predicted global rate of sea-level rise. The consequences are saltwater intrusion into surface and groundwater systems, drainage congestion and water logging, and changes in morphodynamic processes resulting in increased riverbank erosion. In addition, sea-level rise has the potential to make cyclones and coastal inundation even more damaging than they are today. Civil society organizations have made major contributions to poverty alleviation and disaster reduction in Bangladesh. However, despite the wealth of information available and the initiatives taken by both the GoB and civil society organizations, effective adaptation, aimed at protecting vulnerable households and livelihoods in exposed coastal communities, is constrained by the limited exchange of information between and within the GoB and civil society organizations. There is clearly a disconnect between, on the one hand, the widely declared need to start planning for adaptation at local, regional and national levels and, on the other hand, the knowledge base available at these levels to support such planning. The report analysis that underlying this disconnect are a) a lack of information at the local level about the potential risks of climate change and about national and international approaches and policies to reduce these risks; and b) a lack of information at the national and international level about local vulnerabilities, adaptation needs and development opportunities. Focusing on Bangladesh's coastal zone, a project is being developed that aims to support and advance adaptation to climate change and its mainstreaming into development activities by: • Enabling non-governmental organizations from the grassroots to the national level to work together in producing and sharing knowledge, insights and know-how; • Producing and disseminating comprehensive and updated

information on local and household level vulnerabilities to climate change; • Developing a long-term vision towards establishing an effective and efficient dialogue between civil society organizations and the Government of Bangladesh on adaptation and development. Copyright © 2005 by American Society of Civil Engineers.

Tingsanchali, T. and M. F. Karim (2005) "Flood Hazard and Risk Analysis in the Southwest Region of Bangladesh", *Hydrological Processes*, Vol. 19, No. 10, pp. 2055-2070**.** **Abstract/Summary:** Flood hazard and risk assessment was conducted to identify the priority areas in the southwest region of Bangladesh for flood mitigation. Simulation of flood flow through the Gorai and Arial Khan river system and its floodplains was done by using a hydrodynamic model. After model calibration and verification, the model was used to simulate the flood flow of 100-year return period for a duration of four months. The maximum flooding depths at different locations in the rivers and floodplains were determined. The process in determining long flooding durations at every grid point in the hydrodynamic model is laborious and time-consuming. Therefore the flood durations were determined by using satellite images of the observed flood in 1988, which has a return period close to 100 years. Flood hazard assessment was done considering flooding depth and duration. By dividing the study area into smaller land units for hazard assessment, the hazard index and the hazard factor for each land unit for depth and duration of flooding were determined. From the hazard factors of the land units, a flood hazard map, which indicates the locations of different categories of hazard zones, was developed. It was found that 54% of the study area was in the medium hazard zone, 26% in the higher hazard zone and 20% in the lower hazard zone. Due to lack of sufficient flood damage data, flood damage vulnerability is simply considered proportional to population density. The flood risk factor of each land unit was determined as the product of the flood hazard factor and the vulnerability factor. Knowing the flood risk factors for the land units, a flood risk map was developed based on the risk factors. These maps are very useful for the inhabitants and floodplain management authorities to minimize flood damage and loss of human lives. Copyright © 2005 by John Wiley & Sons, Ltd.

Twigg, John (2002) Corporate social responsibility and disaster reduction: A Global Overview, (London: Development Planning Unit (DPU), University College London (UCL)); available at: http://www.benfieldhrc.org/disaster_studies/csr/csr_overview.pdf. **Contents:** This 84-page report has six main sections (1) an introduction, which sets out the study's purpose and methodology, and defines the key terms and concepts employed; (2) a survey of relevant background issues, principally the opportunities and challenges to corporate social responsibility (CSR) activity in the international development and disaster reduction arenas; (3) a presentation and discussion of the evidence of CSR involvement in natural disaster reduction from around the world; (4) the main conclusions and recommendations arising from the research; (5) a list of documents cited in the main report; and (6) an appendix containing six more detailed case studies of CSR and disaster reduction, supporting the presentation and discussion in the third section. While Bangladesh is not one of the case studies, many of the issues related to disaster management and climate change are highly relevant for Bangladesh. Copyright © 2002 by University College London.

Uddin, Abu Mostafa Kamal (2006) *Climate Change Impact Modeling - Institutional Road Map* (Dhaka: Government of the People's Republic of Bangladesh (GoB), Ministry of Environment and Forests (MoEF), Department of Environment, August). **Selected paragraphs from the**

Executive Summary: Bangladesh is already experiencing climate related hazards like floods, droughts, cyclones and others which are being aggravating following climate change (and variability). A significant part of the coastal region is threatened by salinity intrusion and submersion due to sea level rise. The general predictions are: more floods, untimely floods, more droughts, drainage congestion, salinity intrusion, more cyclones with higher intensities. To understand climate impacts and risks, some key questions need to be answered: Will these hazards become more frequent and intense? Will their magnitude increase? Which locations are most vulnerable? When will hazards occur? And what shall be possible impacts? For example: A farmer would like to know likely precipitation patterns while planning his crop calendar, preparing his land, sowing, harvesting, etc. Obviously the development practitioners, professionals and policy makers need to gather this knowledge to provide extension and other services to the primary stakeholders. Worldwide, modeling provides useful scenarios of impacts of climate change in seeking answers to the questions. Collective works pursued during the workshop has been analyzed and is being presented in this document. Specific needs of different sectors from the impact modelling exercise to pursue 'sustainable climate resilient development' have been compiled. Activity based modelling presentations in the workshop indicated what different modelling exercises could offer to meet these needs. It became clear that climate modelling, water modelling and application modelling are necessary to support a 'climate resilient development' process. Another milestone finding of the workshop was that the quality of the data from BMD and BWDB used for calibration of climate modelling as a baseline data needs to be improved. Following the workshop further consultations were held with the institutions and professionals engaged in the modelling activities. Discussions with the professionals and institutions focused on two major areas: (a) Output formats including spatial (e.g. used mesh size in the model) and temporal (e.g. defined spells over the seasons) resolutions; compatibility of climate models with water models and application models in practice in the country; and (b) Developing profiles of the relevant modelling institutions including capacity, experience, exposure, networking and willingness to achieve and contribute in this regard. It became evident that there is a need to establish institutional homes separately for climate modelling, water modelling and application modelling. Each of the modelling exercise requires input and contribution from a number of organizations for each model and partnerships have to be strengthened and/or developed. And again institutional arrangements have to be established among institutional homes so that output from climate modelling could be utilized as input for water and application modelling. The profile of the model practicing institutions reveals that BUP could be considered for housing climate change models with BUET as technical associate, BMD and BWDB as model developing associate, SMRC as regional associate and IPCC as international associate. IWM could be home for water modelling with WARPO and SPARSSO as technical associate, BWDB, and BUP as model developing associate, SMRC as regional associate and DHI as international associate. CEGIS could be home for application modelling with BARC as technical associate and IWM and BUP as model developing associate. It should be mentioned that these arrangements can be adjusted over time. Rather these are initial arrangements with an open approach, as the capacity of the modelling practice shall increase in the country and new professionals and institutes shall emerge and shall join the team in any areas relevant to. All the institutions involved in climate change impact modelling shall adopt latest technology and customized for the country. In the context of overall risk management the climate risk management is a substantial area to deal with. Accordingly modelling shall provide us present climate hazards and trends (past hazards) for specific water systems and

corresponding livelihood systems shall allow us to assess climate risks at this point in time and shall be used in risk reduction initiatives of the country. There shall also be climatic hazards scenarios following global warming at local level which shall be used to initiate risk reduction initiatives in the coming future. These hazards scenarios shall also be used to deal with climate risk management in the development process of the country. The vision is to establish an integrated climate change impact modelling approach to incorporate climate risk management in the development process of the country for ensuring safety of human lives and properties. However, the mission is outlining pathways for climate change (and variability) modelling matching development needs and existing modelling practices, strengthening capacity where needed and establish institutional arrangements that shall ensure appropriate impact scenarios to the development stakeholders in Bangladesh. Copyright © 2006 by GoB.

Uddin, Abu Mostafa Kamal; Ahsan Uddin Ahmed; Nasimul Haque; Aminul Islam; Mohammad Reazuddin; Ian Stanford Rector; Mirza Shawkat Ali; Ziaul Haque; and Ralf Ernst (2006) *Climate Resilient Development: Country Framework to Mainstream Climate Risk Management and Adaptation* (Dhaka: GoB, Department of Environment, Climate Change Cell, Working Paper, November); **Executive Summary:** Our climate is changing. Global warming induced changes in precipitation and temperature is already happening in different geographical regions. Untimely rain, flood, dry periods, storms, cyclones, are occurring more frequently in greater intensities. Changes in the climate are likely to take place more rapidly over the next few decades, as different model generated predictions describe. Responses to climate change is a necessity for all countries prone to climatic hazards and are likely to face more severe and intense climatic hazards occurring more frequently. The climate change impacts are exerting pressure on the development process, putting the interventions to risk on one hand and threatening the production system on the other. As climate change impacts development, it has to be dealt while pursuing development through national development planning. The goal and objective of the country framework has been set to achieve this. The overarching goal of this country framework is to operationalize climate risk management and adaptation mainstreaming in development. This would ensure national development to proceed in a manner that quality of life of all citizens of each country improves and their livelihoods assured. The objective of the country framework is establishing a mechanism that facilitates national development planning and implementation to integrate adaptation to climate change and climate risk management systematically and over time. To achieve this, a participatory approach is necessary. Principles governing the country framework should strive for climate resilient development by integrating climate concerns in planning activities and maintaining synergies both within and between national, regional and international institutional architecture and policy instruments. The basic approach the Country Framework follows is to coordinate in a partnership mode, integrate of climate risk management, ensure participation of all stakeholders and devise location-specific climate resilient development plans. Defining risk environment includes current and future climate risks, accommodating peoples' perceptions and using climate modeling facility to enable one to pinpoint risks over time and space. To do so, characterizing the natural conditions, socioeconomic conditions, and institutional environment must be adequately characterized. Responding to the climate risks involves formulation of micro level risk reduction action plan (RRAP), identification of climate related sectoral development plans, social communication, knowledge management, capacity building, demonstration of good practice, implementation of the action plans (piloting), monitoring, evaluation and feedback mechanism and scaling and implementation. Institutional facilitation for adaptation includes creating enabling policy environment, mainstreaming and

coordination, partnership building, institutional arrangements and Governance (continuity, transparency, handling political interferences, financing, and enabling implementation. The country framework on one hand supports pursuing disaster risk reduction through identifying current and future climatic induced hazards, while on the other supports climate resilient development. The Country Framework provides a much necessary platform for implementing NAPAs in LDCs and serves as an example of climate resilient development persuasion. Copyright © 2006 by GoB.

Uddin, Md. Nasir (2005) "Awareness and Training Need for Integrating Climate Change Issues in Policies and Programme", Presentation made at the 15th Asia-Pacific Seminar on Climate Change in Yokohama, Kanagawa, Japan (11-15 September); available at: http://www.ap-net.org/docs/15th_seminar/bangladesh_rws1_050913.pdf. **Abstract/Summary:** This presentation provides first an overview of Bangladesh's most severe disasters that can be linked to climate change. It then points out that (i) climate change and its direct and indirect effects are amongst the key environmental and development issues that the Government of Bangladesh is seriously addressing, (ii) the government is very much aware and concerned about environmental degradation and global warming and their detrimental effects, and (iii) sea level rising is a real threat of climate change for Bangladesh. It then provides information on (i) the main activities and studies undertaken by Bangladesh with regards to climate change, (ii) Bangladesh's Climate Change Cell, and (iii) the policies, purposes and formulation strategy of Bangladesh's National Adaptation Programme. The presentation closes with three slides on structural and non-structural disaster mitigation actions undertaken in Bangladesh. Copyright © 2005 by the author(s).

Uddin, Sk. Noim and Ros Taplin (2008) "Toward Sustainable Energy Development in Bangladesh", *Journal of Environment and Development*, Vol. 17, No. 3, pp. 292-315**.** **Abstract/Summary:** This article examines Bangladesh's current energy strategies and institutional settings and investigates future strategies for the advancement of renewable energy. It argues that further significant efforts could be made toward energy sustainability in Bangladesh and the development for a national sustainable energy strategy. Among other future strategies, the implementation of the Kyoto Protocol's Clean Development Mechanism (CDM) could assist in facilitation of energy sustainability for Bangladesh. Copyright © 2008 by SAGE Publications.

United Nations Development Programme (UNDP) (2007) *Human Development Report 2007/2008 - Fighting climate change: Human solidarity in a divided world* (Basingstoke, UK and New York, NY, USA: Palgrave Macmillan); available at: http://hdr.undp.org/en/reports/global/hdr2007-2008/. **Abstract/Summary:** This report shows that climate change is not just a future scenario. Increased exposure to droughts, floods and storms is already destroying opportunity and reinforcing inequality. Meanwhile, there is now overwhelming scientific evidence that the world is moving towards the point at which irreversible ecological catastrophe becomes unavoidable. Business-as-usual climate change points in a clear direction: unprecedented reversal in human development in our lifetime, and acute risks for our children and their grandchildren. This report contains many references to Bangladesh, mostly as examples. Copyright © 2007 by United Nations Development Program.

United Nations Development Programme (UNDP) Bangladesh (2007) *Strategic Programme Framework 2006-2010 - Energy and Climate Change* (Dhaka: United Nations Development

Programme (UNDP) Bangladesh); available at: http://www.undp.org.bd/library/policypapers/Energy%20and%20Climate%20Change%20Strategic%20Framework%20(Revision%20C).pdf**.** **Abstract/Summary:** Energy plays a vital role in our society, underpinning all areas of economic activity. It is fundamental to virtually all aspects of human endeavors. The economic growth of Bangladesh is highly depended on access to affordable and reliable energy services in order to increase their productivity and enhance competitiveness. Without access to modern and sustainable energy services, poor people are deprived of opportunities for economic development and improved living standards. This is because modern energy services provide lighting, cooking, heating, refrigeration, transportation, motive power, and electronic communication that are indispensable to increasing productivity, creating enterprises, employment, and incomes. There is now growing understanding that none of the MDGs can be met without major improvement in the quality and quantity of energy services. In fact, access to energy services affects practically all aspects of sustainable development, including access to water, agricultural productivity, population levels, health care, education, job creation, gender equality and climate change impacts. Copyright © 2007 by United Nations Development Program.

United Nations Environment Programme (UNEP) (2000) *State of Environment, Bangladesh 2001* (Pathumthani, Thailand: UNEP, Regional Resource Center for Asia and the Pacific (RRC.AP)); available at: http://www.rrcap.unep.org/reports/soe/bangladeshsoe.cfm**. Abstract/Summary:** The Bangladesh State of Environment (SoE) Report has been prepared as a response to the recommendations provided in Agenda 21 at the Earth Summit. The objective of the SoE report is to identify the key environmental issues that act as barriers to attain sustainable development, and provide guidelines for environmental planning, policy setting, and provided options that can be undertaken to offset any negative environmental trends. Five environmental issues have been identified on a priority basis as points of national concern. These have been critically evaluated by using the methodology of the Organization for Economic Cooperation and Development (OECD), known as a Pressure-State-Impact-Response (P-S-IR) framework analysis. The pressures and driving forces responsible for modifying the original state of the resource base and its current status have been critically evaluated. The present conditions of the key issues, along with their subsequent impacts are shown in the report. It also highlights different policies and measures that have been pursued to reduce the pressures on environment, and/or to mitigate the impacts. In order to alleviate further deterioration of present environmental conditions, several appropriate and necessary responses, both in the area of policy and programs, have been proposed. These will enhance and modify environmental conditions in a positive manner, as well as improve the quality of life in Bangladesh. Copyright © 2001 by United Nations Environment Program.

Unnayan Onneshan (2008) Climate change as if development mattered -- A Perspective on Developing Bangladesh Strategy -- Policy Brief (Dhaka: Unnayan Onneshan); available at: http://www.unnayan.org/reports/Climate.Change.Policy.Brief.pdf. **Abstract/Summary:** This 4-page policy brief summarizes the main issues relevant for Bangladesh in developing a strategy to address climate change, based on the more detailed policy paper with the same title. Copyright © 2008 by Unnayan Onneshan.

Unnayan Onneshan (2008) Climate change as if development mattered -- A Perspective on Developing Bangladesh Strategy -- Policy Paper (Dhaka: Unnayan Onneshan); available at:

http://www.unnayan.org/reports/Climate.Change.Policy.Paper.pdf. **Abstract/Summary:** Millions of people living below the poverty line in underdeveloped countries like Bangladesh are likely to be the worst victims of climate change due to their limited capacity to deal with shocks and crises. Their rights can only be protected if we can frame the climate change debate in terms of: distribution of impacts; distribution of responsibility; and distribution of costs and benefits. Fundamental is to focus on right to development, equality, distributive injustice and corrective justice for historical emissions. This also requires greater grounding, with rigor to frame principles leading to burden sharing formulas, including ecological debt, equal rights per capita entitlements, as opposed to "grandfathering" rule. The claiming of rights is a matter of justice, not of advancing the ideas of begging bowls to rich countries, but to hold them accountable. In fact climate injustice affects the poor, marginalized, particularly women, in terms of erosion of their right to live with dignity. The increasing urbanization, resulting out of the rural, urban divide, the increasing inequality among the rich and poor in both rich and poor countries, and the lack of accountability of big corporations as well government contribute to environmental injustice as well as adverse consequences of climate change. The key issue is this: while those responsible for pollutions are often rich people and rich countries, those who are at the receiving end are poor people and poor countries. Furthermore, the climate change undermines the hard-earned development gains of the last several decades and also threatens the sustainability of Bangladesh's achievement in terms of development. The climate change puts Bangladesh to find out a strategy a comprehensive strategy to mitigate its causes, to enable her to adapt to its effects, to mobilize financial resources, and to augment clean technology for sustainable development. Given the poverty dimension, economic growth, technological development and nation's capacity to adapt, climate change is therefore a development issue. A national response in this regard, must have to travel beyond the usual of disaster management, risk reduction, adaptation to climate variability and natural hazards. This has to be integrated into the national development strategy, with emphasis on right to development and justice, with people at the centre, and driven by, and centered on, livelihood. The fundamentals of the strategy should be: right to development, right to economic, social and political self-determination, right to highest quality health and well-being, right to clean and healthful ecology, right over natural resource system, and rights of indigenous peoples (institutions, property, labour, cultures & environment). This policy paper aims to present a framework for development of national climate change strategy, with people and their livelihood at its core.

Wahhab, Md. Abdul (1998) "Climate Change Mitigation in Asia and Financing Mechanisms (contributions from Bangladesh)", in: P. R. Shulka and Pramod Deo (eds.) *Climate Change Mitigation in Asia and Financing Mechanisms, Proceedings of a Regional Conference, Goa, India, 4-6 May 1998* (Roskilde, Denmark: UNEP Collaborating Center on Energy and Environment, Riso National Laboratory, December), pp. I.19-I.26; available at: http://www.uneprisoe.org/EconomicsGHG/Conferences/goapart1.pdf. **Abstract/Summary:** This paper contains important discussion of the climate change related concerns of a developing nation that faces severe impacts. It also lists the previous studies related to climate change analysis conducted in Bangladesh. Very useful information about the sources and quantum of carbon dioxide and methane emissions are provided. The highlight of the paper however is the discussion on mitigation strategy which shows that major options for Bangladesh are increased use of natural gas, energy efficiency, energy pricing reforms and enhanced funding by adopting active policy related to jointly implemented activities across countries. The article calls for a

powerful worldwide collaboration to combat climate change and other global environmental problems. Copyright © 1998 by Riso National Laboratory.

Walter, Jonathan and Andrew Simms (2002) *The End of Development? Global Warming, Disasters and the Great Reversal of Human Progress* (London: The New Economics Foundation, and Dhaka: Bangladesh Centre for Advanced Studies (BCAS)); available at: http://www.neweconomics.org/gen/z_sys_publicationdetail.aspx?pid=119**. Abstract/Summary:** This booklet analyzes the linkages between global warming and disasters. Ignoring climate change related disasters may frustrate the Millennium Goals. Nine of the ten warmest years on record have occurred since 1990. The number of weather-related disasters has doubled in the past decade, affecting the lives of two billion people. Unprecedented floods have occurred in Europe and the Himalayas, catastrophic droughts in Southern Africa and smog is South East Asia shocked the world. Pacific islanders are drawing up long term plans to evacuate. Global warming is gathering pace. Scientific projections show that there will be more floods, more drought and more diseases. Sudden-impact hazards like tropical cyclones will also get more intense and frequent. Copyright © 2002 by The New Economics Foundation and Bangladesh Centre for Advanced Studies.

Warrick, Richard A. and Qazi Kholiquzzaman Ahmad (eds.) (1996) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers). **Contents:** Chapter 1: The Implications of Climate Change for Bangladesh: A Synthesis (by Q. K. Ahmad; R. A. Warrick; Neil J. Ericksen; and M. Q. Mirza) [pp. 1-34]; Chapter 2: The Greenhouse Effect and Climate Change (by R. A. Warrick; A. K. Azizul Hoq Bhuiya; and M. Q. Mirza) [pp. 35-96]; Chapter 3: Sea-Level Changes in the Bay of Bengal (by R. A. Warrick; A. K. Azizul Hoq Bhuiya; W. M. Mitchell; T. S. Murty and K. B. S. Rasheed) [pp. 97-142]; Chapter 4: Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh (by H. Brammer, M. Asaduzzaman; and P. Sultana) [pp. 143-203]; Chapter 5: Socio-Economic Implications of Climate Change for Bangladesh (by Neil J. Ericksen; Q. K. Ahmad; and A. R. Chowdhury) [pp. 205-287]; Chapter 6: Legal Implications of Global Climate Change for Bangladesh (by D. Freestone, M. Farooque; and S. R. Jahan) [pp. 289-334]; Chapter 7: Climate Change and Sea-Level Rise: The Case of the Coast (by A. Kausher; R. C. Kay; M. Asaduzzaman; and S. Paul) [pp. 335-405]; **Extract from Preface of editors (pp. x-xi):** The analyses and specific findings in this book, tentative though they may be in certain areas, should provide a better understanding of the existing and emerging issues and, hence, be useful as inputs into the policy-making process. This assessment also suggests three main directions for further policy-relevant research in Bangladesh. First, for some aspects of the problem (for example, climate and agriculture) sufficient data and models are available for conducting sensitivity analyses of the potential effects of climate and sea-level changes on Bangladesh. However, these data and models have not yet been combined in a way that would allow systematic analyses of the impacts of climate change and variability to be easily carried out. In these circumstances, the generation of new knowledge is perhaps less urgent than the integration of existing knowledge. Second, for other aspects of the problem, basic data are not available and critical relationships between climate and environment are poorly understood (for example, subsidence, sedimentation and relative sea-level rise rates in the coastal zone; climate and vector-borne diseases). In such cases, the lack of basic knowledge preludes detailed analyses of the effects of climate change and variability. This lack of knowledge hinders comprehensive climate impact assessment for Bangladesh and the development and implementation of strategies for reducing adverse effects.

Third, it became apparent that there is little understanding of the full range of strategies by which the people and organizations in Bangladesh could, or would, adapt to climate and sea-level change (including fluctuations and extremes). It is this capacity for human response that largely determines the extent of vulnerability and resilience to environmental change. The lack of knowledge concerning human response represents a major gap in knowledge in attempting to assess the implications of global warming and sea-level rise in Bangladesh. Copyright © 1996 by Kluwer Academic Publishers.

Warrick, Richard A.; A. K. Azizul Hoq Bhuiya; and M. Monirul Qader Mirza (1993) *The Greenhouse Effect and Climate Change* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 1); also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers, 1996), pp. 35-96 (Chapter 2). **Abstract/Summary:** The threat of global climate change promises to be the single most pressing environmental issue as the world enters the 21st century. Increasingly, it becomes incumbent upon decision-makers from a wide array of backgrounds to gain a sound understanding of the fundamentals of the climate change issue and how it relates to their areas of responsibility. The purpose of this paper is to review the main elements of the climate change problem and the implications for Bangladesh in order to highlight the key scientific and policy issues involved. This is accomplished by addressing seven main questions: How has climate changed and why? How is the composition of the atmosphere changing? What are the effects on the Earth's radiation budget? Have variations in greenhouse gases caused climate to change? How might the global climate change in the future? How might the climate of Bangladesh change? What are the implications for policy? The document concludes with reflections on the next steps for action and research. Copyright © 1996 by Kluwer Academic Publishers.

Warrick, Richard A.; A. K. Azizul Hoq Bhuiya; W. M. Mitchell; T. S. Murty; and K. B. S. Rasheed (1993) *Sea-Level Changes in the Bay of Bengal* (Dhaka: Bangladesh Unnayan Parishad, Briefing Document No. 2); also published in: Richard A. Warrick and Qazi Kholiquzzaman Ahmad (eds.) *The Implications of Climate and Sea-Level Change for Bangladesh* (Dordrecht and Boston: Kluwer Academic Publishers, 1996), pp. 97-142 (Chapter 3). **Abstract/Summary:** The report argues that the possibility of future sea-level rise should be a source of grave concern to the many inhabitants of low-lying coastal areas, including those of Bangladesh. A major portion of the world's population lives in coastal areas and is potentially vulnerable to changes in sea level. At local and regional levels, present variations in sea level are reminders that the sea can be highly destructive. Short-term extreme events, like the storm surge that swept over the south-western coast of Bangladesh in April 1991 or Hurricane Andrew that pounded the shores of Florida in the United States of America in August 1992, can bring death, social dislocation and economic damage of crippling magnitude. Copyright © 1996 by Kluwer Academic Publishers.

Warrick, Richard A.; G. J. Kenny; G. C. Sims, Neil J. Ericksen; Qazi Kholiquzzaman Ahmad; and M. Monirul Qader Mirza (1996) "Integrated Model Systems for National Assessments of the Effects of Climate Change: Application in New Zealand and Bangladesh", *Water, Air, & Soil Pollution*, Vol. 92, No. 1-2 (November), pp. 215-227**. Abstract/Summary:** To examine the sensitivity of environmental systems to climatic variability and change, integrated model systems for climate impact assessment are being developed for New Zealand (CLIMPACTS) and Bangladesh (BDCLIM). Features common to both model systems include a global climate

model, regional modules for generating climate scenarios, and models for biophysical impact analyses. For CLIMPACTS, modified ecosystem models for horticultural crops, arable crops, and pasture production are being incorporated. For BDCLIM, the emphasis is on analysis of possible changes in agro-climatic zones and hydrology, including the risks of floods and droughts. The initial emphasis of both systems is on nationwide spatial analyses, using simplified models as much as possible. The development of integrated model systems supports the needs of the respective countries in assessing scientific uncertainties, evaluating vulnerabilities, and identifying adaptation options as a basis for international reporting requirements under the U.N. Framework Convention on Climate Change and for policy and planning at national and regional levels. The major advantage of such integrated model systems is that they can readily be updated as the science of climate change advances, thus providing an evolving tool for future reassessments of climate impacts. Copyright © 1996 by Springer.

Watson, Robert T.; Marufu C. Zinyowera; and Richard H. Moss (eds.) (1997) *The Regional Impacts of Climate Change: An Assessment of Vulnerability*, Summary for Policymakers, A special Report of IPCC Working Group II, published for the Intergovernmental Panel on Climate Change (IPCC) (Geneva: IPCC); available at: http://www.ipcc.ch/pub/sr97.htm**. Note:** While many of these assessments are still valid, they are updated in the IPCC's Fourth Assessment Report of 2007; for issues specifically related to Bangladesh, see the references within this bibliography to (a) Adger, Agrawala, Mirza, Conde, O'Brien, Pulhin, Pulwarty, Smit and Takahashi (2007); (b) Cruz, Harasawa, Lal, Wu, Anokhin, Punsalmaa, Honda, Jafari, Li and Huu Ninh (2007); (c) Schneider, Semenov, Patwardhan, Burton, Magadza, Oppenheimer, Pittock, Rahman, Smith, Suarez and Yamin (2007); and (d) Yohe, Lasco, Ahmad, Arnell, Cohen, Hope, Janetos and Perez (2007). Copyright © 1997 by Intergovernmental Panel on Climate Change.

World Bank (2000) Bangladesh: Climate Change and Sustainable Development. Report No. 21104 BD (Dhaka: World Bank, South Asia Rural Development Team, October); available at: http://go.worldbank.org/CW8WDU9WQ0. **Abstract/Summary:** The study focuses on Bangladesh since it is universally acknowledged to be extremely vulnerable to climate change. The low-lying topography, funnel shaped coast exposing the land to cyclones and tidal surges, seasonal flooding, widespread poverty, large population base, poor institutional development etc. have particularly made Bangladesh vulnerable to climate variability. The population of Bangladesh which is likely to be affected by climate change could be between 20 and 30 million. The study identifies various climactic factors (temperature, precipitation, evaporation, etc.), provides possible climate change scenarios, and discusses adaptation possibilities. Details of the scenarios are provided in chapter two of this report, and chapter three elaborates on adaptation issues and strategies. Copyright © 2000 by The World Bank.

World Bank (2006) *Urban Flood Mitigation and Sanitation Improvement* (Washington, DC: World Bank, Information Notes, June 12). **Abstract/Summary:** The World Bank is working closely with other donors to assist the Government of Bangladesh to provide a better urban environment through improved water supply, sanitation and drainage services. The proposed Dhaka Chittagong Urban Flood Mitigation and Sanitation Improvement Project support the Government's goal of Sanitation for All by 2010. The project is expected to include the provision of water and sanitation services to low income communities. It will also improve Dhaka's storm water drainage systems and pumping stations in order to alleviate serious flooding and water logging in the capital. The Danish International Development Agency

(DANIDA), Swedish International Development Cooperation Agency (SIDA), Japan Bank for International Cooperation (JBIC) and Japan International Cooperation Agency (JICA), are preparing projects with Dhaka Water and Sewerage Authority (DWASA) and Chittagong Water and Sewerage Authority (CWASA). Copyright © 2006 by The World Bank.

Yohe, G. W.; R. D. Lasco; Q. K. Ahmad; N. W. Arnell; S. J. Cohen; C. Hope; A. C. Janetos; and R. T. Perez (2007) "Perspectives on climate change and sustainability", in: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability -- Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press), pp. 811-841 (Chapter 20); available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter20.pdf. **Abstract/Summary:** Efforts to cope with the impacts of climate change and attempts to promote sustainable development share common goals and determinants including access to resources (including information and technology), equity in the distribution of resources, stocks of human and social capital, access to risk-sharing mechanisms and abilities of decision-support mechanisms to cope with uncertainty Reducing vulnerability to the hazards associated with current and future climate variability and extremes through specific policies and programmes, individual initiatives, participatory planning processes and other community approaches can reduce vulnerability to climate change. Efforts to reduce vulnerability will be not be sufficient to eliminate all damages associated with climate change. Nonetheless, some development activities exacerbate climate-related vulnerabilities. This chapter makes twice specific references to Bangladesh. Copyright © 2007 by Cambridge University Press.

Yohe, Gary and Kenneth Strzepek (2005) "Climate Change and Water Resource Assessment in South Asia: Addressing Uncertainties" in: M. Monirul Qader Mirza and Qazi Kholiquzzaman Ahmad (eds.) *Climate Change and Water Resources in South Asia* (Leiden, The Netherlands: A. A. Balkema Publishers); pp. 77-101 (Chapter 4). **Abstract/Summary:** This chapter is designed to reflect the sensitivity to short-term climate variability (expressed in terms of the changes in frequency of flooding events in Bangladesh along the Ganges, Brahmaputra and Meghna rivers) to long-term secular change (expressed in terms of long-term trends in maximum monthly flows) along a wide range of not-implausible climate futures. It therefore explores a case for which the boundaries of a coping range are easily defined by flooding thresholds. When the authors ultimately turn to a discussion of how to evaluate adaptation options that might expand the coping range (exposure to flooding) or reduce the cost of flooding (sensitivity to flooding in terms of multiple metrics), they do so in a way that can accommodate enormous uncertainty. Copyright © 2005 by A. A. Balkema Publishers.

Yusuf, Harun K. M.; Subash Dasgupta; and M. A. Halim Khan (2008) Climate Change: An Emerging Threat to Agriculture and Food security in Bangladesh; Presentation made at the International Symposium on Climate Change and Food Security in South Asia (Dhaka, August 25-29); available at: http://www.wmo.ch/pages/prog/wcp/agm/meetings/rsama08/rsama08_present.html. **Abstract/Summary:** This presentation provides first a broad overview of the global sources of climate change, presents then the main physiological impacts of climate change in Bangladesh, and draws towards the end relatively broad conclusions from them on the emerging threat to agriculture and food security in Bangladesh. Copyright © 2008 by the author(s).

Part – III: General Climate Change Resources

Part III is structured into four sections:

1. Main International Organizations working on Climate Change
2. Research Centers/Institutes that focus on Climate Change
3. Websites of Networks and/or with Specific Tools, Projects, etc.
4. Climate Change related Newsletters specifically on Bangladesh

The listing sequence within each section is in alphabetical order.

III.1. Main International Organizations working on Climate Change

Adaptation Learning Mechanism (ALM)
http://www.adaptationlearning.net/

Asian Development Bank (ADB): Climate Change - ADB Programs
http://www.adb.org/Documents/Brochures/Climate-Change/default.asp

Food and Agriculture Organization (FAO) of the United Nations
http://www.fao.org/climatechange/home/en/

Global Environment Facility (GEF)
http://www.gefweb.org/

Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch/

International Maritime Organization (IM) of the United Nations
http://www.imo.org/

International Monetary Fund (IMF): Climate Change
http://www.imf.org/external/np/exr/facts/enviro.htm

International Strategy for Disaster Reduction (ISDR) of the United Nations
http://www.unisdr.org/isdrindex.htm

Special Unit for South-South Cooperation (SU/SSC)
http://tcdc1.undp.org/

United Nations Development Programme (UNDP): Climate Change
http://www.undp.org/climatechange/

United Nations Framework Convention on Climate Change (UNFCCC)
http://unfccc.int/

United Nations Environment Programme (UNEP)
http://www.unep.org/

World Bank: Climate Change
http://go.worldbank.org/W13H8ZXSD1

World Health Organization (WHO): Climate Change and Human Health
http://www.who.int/globalchange/climate/en/

World Meteorological Organization (WMO)
http://www.wmo.int/pages/themes/climate/index_en.html

III.2. Research Centers/Institutes that focus on Climate Change

Adaptation and Impacts Research Division (AIRD), Center for Environment, University of Toronto
http://www.environment.utoronto.ca/Research/FacultyResearch/AIRD.aspx

Bangladesh Centre for Advanced Studies (BCAS)
http://www.bcas.net/

bangladesh-climate.org—Climate Change - Screening and Management Planning for Agriculture and Water
http://bangladesh-climate.org/

Cambridge Centre for Climate Change Mitigation Research (4CMR)
http://www.landecon.cam.ac.uk/research/eeprg/4cmr/index.htm

Canada Climate Change Development Fund (CCDF)
http://www.acdi-cida.gc.ca/CIDAWEB/acdicida.nsf/En/JUD-4189500-J8U

Center for Capacity Building (CCB) at the National Center for Atmospheric Research (NCAR)
[Soon to be: Consortium for Capacity Building at the University of Colorado: http://www.colorado.edu/]
http://www.ccb.ucar.edu/

Center for International Climate and Environmental Research, Oslo (CICERO)
http://www.cicero.uio.no/home/

Climate Change and Disasters Group, Institute of Development Studies (IDS)
http://www.ids.ac.uk/go/research-teams/vulnerability-team/research-themes/climate-change

Climate Change Cell (of the Government of Bangladesh)
http://www.climatechangecell-bd.org/

Euro-Mediterranean Center on Climate Change (CMCC)
http://www.cmcc.it/web/public/home

European Commission—Climate Action
http://ec.europa.eu/climateaction/index_en.htm

Federal Ministry for Economic Cooperation and Development (BMZ)—Energy and Climate Protection
http://www.bmz.de/en/issues/energie/index.html

Friends of the Earth (UK)—Climate
http://www.foe.co.uk/campaigns/climate/index.html

Friends of the Earth (USA)—Global Warming
http://action.foe.org/content.jsp?content_KEY=2726&t=2007_Global-Warming.dwt

Greenpeace International—Stop Climate Change
http://www.greenpeace.org/international/campaigns/climate-change

Hadley Centre for Climate Prediction and Research
http://www.metoffice.gov.uk/research/hadleycentre/

International Institute for Environment and Development (IIED)
http://www.iied.org/

International Institute for Sustainable Development (IISD): Climate Change and Energy
http://www.iisd.org/climate/

IUCN — The International Union for Conservation of Nature: Climate Change
http://www.iucn.org/what/issues/climate/index.cfm

Netherlands Climate Assistance Programme, The (NCAP): Bangladesh
http://www.nlcap.net/countries/bangladesh/

Oslo Policy Forum on Changing the Way We Develop: Dealing with Disasters and Climate Change
http://www.oslopolicyforum.no/

Pew Center on Global Climate Change, The
http://www.pewclimate.org/

Potsdam Institute for Climate Impact Research
http://www.pik-potsdam.de/

Red Cross/ Red Crescent Centre on Climate Change and Disaster Preparedness
http://www.climatecentre.org/

TERI — The Energy and Resources Institute
http://www.teriin.org/

Tyndall Centre for Climate Change Research
http://www.tyndall.ac.uk/

UK Department for International Development (DFID)
http://www.dfid.gov.uk/

USAID Global Climate Change Program
http://www.usaid.gov/our_work/environment/climate/

World Business Council for Sustainable Development—Energy &Climate
http://www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=NjY&doOpen=1&ClickMenu=LeftMenu

WWF – Climate Change
www.panda.org/climate/

III.3. Websites of Networks and/or with Specific Tools, Projects, etc.

Adaptation Learning Mechanism (ALM): Bangladesh Country Profile
http://www.adaptationlearning.net/profiles/country/country.php?id=BG

AdaptNet
http://www.globalcollab.org/gci/adaptnet/

Asia-Pacific Network for Global Change Research (APN)
http://www.apn.gr.jp/en/indexe.html

Capacity Strengthening of Least Developed Countries for Adaptation to Climate Change (CLACC)
http://www.clacc.net/

CDP-CARE: Reducing Vulnerability to Climate Change (RVCC) Partnership Project
http://www.cdpbd.org/rvcc_home.html

Climate Action Network - South Asia (CANSA)
http://www.can-sa.net/

Climate Change Knowledge Network (CCKN)
http://www.cckn.net/va.asp

Davos Climate Alliance
http://www.davosclimatealliance.org/

DFID—Key Sheets on Climate Change and Poverty
http://www.dfid.gov.uk/pubs/files/climatechange/keysheetsindex.asp

eldis—Climate Change
http://www.eldis.org/go/topics/resource-guides/environment/climate-change

eldis—Climate Change Adaptation
http://www.eldis.org/go/topics/dossiers/climate-change-adaptation

Gateway to the UN System's Work on Climate Change
http://www.un.org/climatechange/

Gender and Climate Change
http://www.gencc.interconnection.org/

Gender and Climate Change Network – Women for Climate Justice (GenderCC Network)
http://www.gendercc.net/

Global Climate Change Research Explorer
http://www.exploratorium.edu/climate/

Global Climate Observing System (GCOS)
http://www.wmo.ch/pages/prog/gcos/index.php?name=about

Investor Network on Climate Risk
http://www.incr.com/

Medical Alliance to Stop Global Warming
http://www.psr.org/site/PageServer?pagename=MedicalAlliance_to_StopGlobalWarming

Network on Climate Change—Bangladesh (NCC,B)
http://www.nccbd.org/

OneClimate.net
http://www.oneclimate.net/

OneWorld South Asia—Seventh Annual Regional Meeting on the theme "Climate Justice for Realisation of the MDGs: Southern Perspectives and Voices" in New Delhi (February 8-9, 2008)
http://www.owsa-arm.org/

Rockefeller Foundation—Initiative on Climate Change Resilience
http://www.rockfound.org/initiatives/climate/climate_change.shtml

Stop Global Warming
http://www.stopglobalwarming.org/

Tiempo Climate Cyberlibrary
http://www.tiempocyberclimate.org/

III.4. Climate Change related Newsletters specifically on Bangladesh

Bangladesh Renewable Energy Newsletter (BREN)
http://www.bcas.net/Publication/Pub_Index.html

BEN — Bangladesh Environmental Newsletter
http://www.bcas.net/Publication/Pub_Index.html

Climate Change Cell Information Bulletin
http://www.climatechangecell-bd.org/library.html

Clime Asia [Newsletter of the Climate Action Network - South Asia (CANSA)]
http://www.can-sa.net/clime-asia/index.htm

Forthcoming newsletter:
Climate Change Newsletter of the Danish Embassy in Dhaka
http://www.bangladesh-climate.org/