Climate Change and Bangladesh

Annotated Bibliography

Climate Change Cell
Department Of Environment

Comprehensive Disaster Management Programme
Government of the People's Republic of Bangladesh

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Shamim Ara Begum
Abu M. Kamal Uddin
Ralf Ernst
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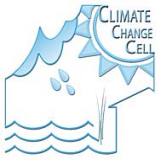
July 2006



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About 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.

The Climate Change Cell's work program focuses on four main areas:

Building the capacity of Government to coordinate and integrate climate change issues in mainstream development activities across government. It also acts as a secretariat to coordinate other national climate change activities such as National Communication preparation, the NAPA process, and the Clean Development Mechanism.

Strengthening existing knowledge and availability of information on impact prediction and adaptation to climate change. This includes compiling and synthesizing existing studies, and filling some of the gaps, as well as improving information exchange between science and policy-makers

Awareness raising, advocacy and coordination with partners across government, NGOs, civil society, private sector and donor organizations. Using a variety of mechanisms and information products, the Cell is working to promote the integration of climate change adaptation and risk reduction in development activities, especially within climate sensitive sectors and the disaster risk reduction process.

Improving capacity to adapt livelihoods to climate change in the agriculture sector. Working with FAO, we are field-testing livelihood adaptation strategies with farmers to better respond to disasters and climate change risks. This includes translation of climate change modeling into agricultural response options and livelihood adaptation practices. The initial focus is on drought conditions, with a view to facilitating replication elsewhere.

The global climate is changing and it is likely to change further over coming decades due to increasing concentrations of 'greenhouse gases' in the earth's atmosphere caused largely by human activities.

This will result in greater variations in weather patterns, a greater frequency of extreme weather events such as floods, droughts and tropical storms, and gradual rises in average temperatures and sea-levels.

Bangladesh is extremely vulnerable to climate change impacts because of its geographical location, high population density, high levels of poverty, and the reliance of many livelihoods on climate-sensitive sectors, particularly rural agriculture and fisheries. These impacts will be falling more heavily on the women and girls of Bangladesh.

Climate change therefore threatens both previous achievements and future efforts to reduce poverty in Bangladesh to date, particularly by reducing water and food security and damage to essential infrastructure during more frequent disaster events.

Department of Environment

DFID Department for International Development

UNDP

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Preface

Global climate is changing, impacting all spheres of the earth including physical, natural, social and economic domains, lives and livelihoods of people. It is vital to understand the country's setting together with the exposure (hazards, vulnerabilities, risks) to deal with climate risk management. Bangladesh has been identified as one of the countries most vulnerable to the impacts of climate change due to her geographic location and socio-economic situation. Climate change impacts in Bangladesh are likely to result in

- an increase in the number and the regional extend of floods and longer periods of flooding as a consequence of increased precipitation during monsoon periods and rising sea levels,
- an increase in periods of drought in parts of the country as a consequence of reduced rainfall in winter months,
- an increase in the number and intensity of cyclones and tropical storms.

To enable climate risk management, knowledge based decision making systems have to be available incorporating community knowledge as well as scientific knowledge. Knowledge management should facilitate accessibility of existing knowledge; identify knowledge needs and gaps and ways to fill these gaps. Knowledge management systems also should identify and promote good practices.

The Technical Advisory Group of the Climate Change Cell has suggested a comprehensive review of climate change related literature in Bangladesh as a first step for identifying research needs in the area of climate change and adaptation and for developing a climate change research strategy for the country. Assisted by the Technical Advisory Group, the Climate Change Cell compiled all literature available on the topic. The bibliography provides a brief summary of each document that has been included.

It is hoped that this annotated bibliography of existing knowledge on climate change and Bangladesh could serve as a starting point, enabling researchers and professionals to draw on existing knowledge as well as identify knowledge gaps to pursue research. The annotated bibliography accommodates climate related scientific papers and publications, research results, working papers, books and others. However, it is not exhaustive and is intended to be a living document and appended over time.

The bibliography has been structured in to three parts. Part I provides list of publications by author, Part II provides annotations and part III indexes publications by title and issues / aspects of climate change. All registration has been sorted in alphabetic order.

Climate Change Cell, July 2006

Acknowledgement

I express my gratitude to all the experts and professionals who provided valuable information on the state and status of various initiatives taken to generate knowledge on climate related issues.

In this respect I extend my thanks to Ian Rector, Chief Technical Adviser, Comprehensive Disaster Management Programme (CDMP), Mohammad Reazuddin, Director, Department of Environment (DoE) and Component Manager, Climate Change Cell, and Ralf Ernst, Technical Adviser, Climate Change Cell for their motivation and support that has served as the basis to develop this annotated bibliography.

Acknowledgement is due also to professionals, particularly Mirza Shawkat Ali and Ziaul Haque of the DoE, who devoted their attention in understanding the need and expectation for this bibliography.

Acknowledgement is due to Dr. Ahsan Uddin Ahmed of Bangladesh Unnayan Parishad and Dr. Zahurul Karim of Arannayak Foundation, who reviewed the draft and guided registering appropriate and updated publications in the context for the annotated bibliography.

Finally, I thank Dr. Shamim Ara Begum for compiling the bibliography.

Abu M. Kamal Uddin

Contents

Ahmed, A. U., 2005. Application of Solar Energy for Mitigation of Greenhouse Gases in Bangladesh. In Eusuf, M. (ed). Solar Photovoltaic Systems in Bangladesh- Experiences and Opportunities. Pp-171-181. The University Press Limited. Bangladesh Center for Advanced Studies.

Ahmed, A. U., 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.

Ahmed, A. U., 2005. Adaptation Options for Managing Water –Related Extreme Events Under Climate Change Regime: Bangladesh Perspectives. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp. 255-278. A. A. Balkema Publishers, Leiden, The Netherlands.

Ahmed, A. U., 2004. A Review of the Current Policy Regime in Bangladesh in Relation to Climate Change Adaptation. CARE-RVCC Project, Khulna, Bangladesh.

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

Ali, A., 2003. Impacts of Climate Change on Tropical Cyclones and Storm Surges 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. Pp- 130. SAARC Meteorological Research Center (SMRC), Dhaka.

Ahmed, A. U., 2003. Climate Variability and Flood: Observed Coping Mechanisms In Bangladesh. Abstract Volume. The 13th Stockholm Water Symposium, August 11-14, 2003. Pp- 187.

Ahmed, A. U., and Haque, N., 2002. Managing Climate Change. In Ahmad, Q.K. & Ahmed, A.U. (eds). Bangladesh: Citizens Perspectives on Sustainable Development. Pp-149. Bangladesh Unnayan Parishad, Dhaka.

Ahmed, A. U., and Rahman, A., 2000. Review of Activities Towards the National Communication of Bangladesh to the UNFCCC. In Ahmed, A.U., Chantanakome, W., Jung, Y., Karyadi, A., Mulandar, S., Onchan, T., Parikh, J., Rahman, A., Ramakrishna, K., Sharma, R., Singh, G., Velasco, Y. T., Zhang, Z. (eds). Asia Looking Ahead. Initial Stages of National Communications Reporting. The Wood Hole Research Center, USA. Also published by BCAS in 1999 as an advanced version.

Alam, M., Rahman, A. A, Haque, N., Kabir, S. A., 2000. Bangladesh. In Biagini, B., (ed). Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations. A Climate of Trust Report. Washington, DC. National Environmental Trust.

Ahmed, A. U., 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 2000. Pp. 71-93.

Ahmed, A. U., Alam, M., 1999. Development of Climate Change Scenarios with General Circulation Models. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 13- 20. Kluwer Academic Publishers, The Netherlands.

Ahmed, A. U., Alam, M., Rahman, A.A., 1999. Adaptation to Climate Change in Bangladesh: Future Outlook. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 125-143. Kluwer Academic Publishers, The Netherlands.

Ahmed, A. U., Siddiqi, N. A., Choudhuri, R. A., 1999. Vulnerability of Forest Ecosystems of Bangladesh to Climate Change. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F. (eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 93-113. Kluwer Academic Publishers, The Netherlands.

Alam, M., Nishat, A., Siddiqui, S. M., 1999. Water Resources Vulnerability to Climate Change with Special Reference to Inundation. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 21-38. Kluwer Academic Publishers, The Netherlands.

Ali, M. Y., 1999. Fish Resources Vulnerability And Adaptation to Climate Change in Bangladesh. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 113 -124. Kluwer Academic Publishers, The Netherlands.

ADB, 1998. Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS). Bangladesh. Asian Development Bank, Global Environmental Facility, United Nations Development Programme.

Asaduzzaman, M., Reazuddin, M., and Ahmed, A. U. (eds), 1997. Global Climate Change. Bangladesh Episode. Department of Environment (DoE), Ministry of Environment and Forest. Government of the People's Republic of Bangladesh.

Ahmed, A. U., Reazuddin, M., Islam, K., 1996. Bangladesh Emissions of Greenhouse Gases –Preliminary Findings. In Braatz, B. V., Jallow, B. P., Molnar, S., Murdiyarso, D., Perdomo, M., and Fitzgerald J. F. (eds). Greenhouse Gas Emission Inventories: Interim Results from the US Country Studies Program. Pp. 161- 170. Kluwer Academic Publishers. The Netherlands. Environmental Science and Technology Library.

Ahmed, A. U., Huq, S., Karim, Z., Asaduzzaman, M., Rahman, A. A., Alam, M., Ali, Y., Chowdhury, R. A., 1996. Vulnerability and Adaptation Assessments for Bangladesh. In Smith, J. B., Huq, S., Lenhart, S., Mata, L. J., Nemesova, I, and Toure, S., (eds).

Vulnerability and Adaptation to Climate Change: Interim Results from the US Country Studies Program. Kluwer Academic Publishers. The Netherlands. Environmental Science and Technology Library.

Ahmad, Q.K., Warrick, N., Ericksen, J. and Mirza, M.Q., 1996. The Implications of Climate Change for Bangladesh: A Synthesis. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 1-34. Kluwer Academic Publishers. The Netherlands.

ADB, 1994. Climate Change in Asia: Bangladesh Country Report. Asian Development Bank, Manila, Philippines.

Ali, S. I. and Huq, S., 1990. International Sea level Rise: National Assessment of Effects and Possible Responses for Bangladesh. Bangladesh Centre for Advanced Studies (BCAS).Unpublished.

BCAS, 1996. Bangladesh Least Cost Greenhouse Gas Abatement Strategy. Proceedings of the First National Workshop ALGAS Study. Bangladesh Centre for Advanced Studies (BCAS), Dhaka. BUET, BIDS and BUP.

Brammer, H., Asaduzzaman, M., Sultana, P., 1996. Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh. In Warrik, R.A. and Ahmad, Q.K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 143-204. Kluwer Academic Publishers. The Netherlands.

BCAS-RA-Approtech, 1994. Vulnerability of Bangladesh to Climate Change and Sea Level Rise. Concepts and Tools for Calculating Risk in Integrated Coastal Zone Management. Volume I: Technical Report, Volume II : Institutional Report, Volume III : Summary Report : Bangladesh Centre for Advanced Studies (BCAS), Resource Analysis (RA), Delft, The Netherlands, and Approtech Consultants Limited, Dhaka, Bangladesh.

Brammer, H., Undated. Monitoring the Evidence of the Greenhouse effect and its Impact on Bangladesh. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Broadus, J., Milliman, J., Edwards, S., Aubrey D., and Gable, F., Undated. Rising Sea Level and Damming of Rivers: Possible Effects in Egypt and Bangladesh. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA.

Choudhury, A.M., Quadir, D.A., Neelormi, S., and Ahmed, A.U., 2003. Climate Change and its Impacts on Water Resources of Bangladesh. In Dr. Amir Muhammed (ed). Climate Change and Water Resources in South Asia. Proceedings of year end workshop Kathmandu, Nepal, 7-9 January, 2003. Asianics Agro Dev International, Islamabad, Pakistan. The Asia-Pacific Network for Global Change Research. Fred J. Hansen Institute for World Peace.

Debsarma, S. K., 2003. Intra-Annual and Inter-Annual Variations of Rainfall over Different Regions of 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. Pp- 137. SAARC Meteorological Research Center (SMRC), Dhaka.

Department of Environment, 1993. Assessment of the Vulnerability of Coastal Areas to Climate Change and Sea Level Rise. A Pilot Study of Bangladesh. Final Report. Volume I Department of Environment. Ministry of Environment, Government of Bangladesh. Bangladesh Center for Advanced Studies (BCAS), Resource Analysis, Approtech.

Ericksen, N.J., Ahmad Q.K. and Chowdhury, A.R., 1996. Socio-Economic Implications of Climate Change for Bangladesh. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 205-288. Kluwer Academic Publishers. The Netherlands.

Faruque, H. S. M., and Ali, M. L., 2005. Climate Change and Water Resources Management in Bangladesh. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp- 231. A. A. Balkema Publishers, Leiden, The Netherlands.

Freestone, D., Farooque, M. and Jahan, S.R., 1996. Legal Implications of Global Climate Change for Bangladesh. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp.289-334. Kluwer Academic Publishers. The Netherlands.

Huq, S., Khan, M., 2006. Equity in National Adaptation Programs of Action (NAPAs): The Case of Bangladesh. In Adger, W.N., Paavola, J., Huq, S., and Mace, M.J.(editors). Fairness in Adaptation to Climate Change. The MIT Press, UK. Pp- 181-200

Huq, S. and K. Moinuddin, 2004. Climate change, vulnerability and adaptation in Bangladesh. In V. I. Grover,(edi.) Climate Change Five Years after Kyoto. Science Publishers Inc., Enfield (NH) USA. Pp. 251 – 271.

Huq, S., Rahman, A., Konate, M., Sokona, Y., and Reid, H., 2003. Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCS). International Institute for Environment and Development (IIED). Bangladesh Centre for Advanced Studies (BCAS). ENDA, Shell Foundation, Sustainable Energy Program.

Huq, S., 2002. Lessons Learned from Adapting to Climate Change in Bangladesh. World Bank, Washington D.C.

Habibulla, M., Ahmed, A. U., Karim, Z., 1999. Assessment of Food grain production loss due to climate induced enhanced soil salinity. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 56-71. Kluwer Academic Publishers, The Netherlands.

Haque, M., 1996. Climate Change. Issues for the Policy Markers of Bangladesh. Environment and Development Alliance (EDA), Dhanmondi, Dhaka

Hossain, M., Undated. The Greenhouse effect and the Coastal Area of Bangladesh: Its People and Economy. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Huq, M., Undated. Environmentally Sound Measures for Countering" Greenhouse Effect" in Bangladesh and their Cost-Effectiveness. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

IWM, 2005. Impact Assessment of Climate Changes on the Coastal Zone of Bangladesh. Final Report. Institute of Water Modelling. Water Resources Planning Organization (WARPO), Ministry of Water Resources. Government of Peoples Republic of Bangladesh.

Islam, M.F. and Parveen, S, 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.

Islam, S.M.R., Huq, S., Ali, A., 1999. Beach Erosion in the Eastern Coastline of Bangladesh. Vulnerability and Adaptation to Climate Change for Bangladesh. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 72-93. Kluwer Academic Publishers, The Netherlands.

Karmakar, S., 2003. Trends in the annual frequency of cyclonic disturbances and storms in the Bay of Bengal. 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. PP-110. SAARC Meteorological Research Center (SMRC), Dhaka.

Karmakar, S. and Shrestha, M. L., 2000. Recent Climatic Changes in Bangladesh. SMRC No. 4. SAARC Meteorological Research Centre, Dhaka.

Karim, Z., Hussain, S.G., Ahmed, A. U., 1999. Climate Change Vulnerability of Crop Agriculture. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp.39-54. Kluwer Academic Publishers, The Netherlands.

Karim, Z., Hussain, S.G., Ahmed, M., 1996. Assessing Impacts of Climate Variations on Foodgrain Production in Bangladesh. Water, Air, and Soil Pollution 92: 53-62

Kausher, A., Kay, R.C., Asaduzzaman, M and Paul, S. 1996. Climate Change and Sea-Level Rise: The Case of the Coast. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 335-406. Kluwer Academic Publishers. The Netherlands.

Karim, Z., Ahmed, M., Hussain, S.G., Rashid, Kh.B., 1994. Impact of climate change on the production of modern rice in Bangladesh. Bangladesh Agricultural Research Council, Dhaka.

Karim, Z., 1987. Applications of Land Resources and Climate Change Data Base in development planning. Climate Change International conference, organized by University of Hawaii, Verginia Tech., USA

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., Undated. Assessment of Vulnerability to Sea Level Rise: A Case Study of Bangladesh. 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. Pp- 143.

MoEF, 2005. National Adaptation Programme of Action (NAPA). Ministry of Environment and Forest, Government of the People's Republic of Bangladesh. Final Report. November 2005. Dhaka.

Mirza, M.M.Q., 2005. The Implications of Climate Change on River Discharge in Bangladesh. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp- 103. A. A. Balkema Publishers, Leiden, The Netherlands.

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. Pp-94. SAARC Meteorological Research Center (SMRC), Dhaka.

Mirza, M. M.Q., 1997. Modeling the Effects of Climate Change on Flooding in Bangladesh. A thesis for the Doctor of Philosophy in the International and Resource Studies at The University of Waikato.

Mirza, M. M.Q., Undated. Global warming and changes in the probability of occurrence of floods in Bangladesh and implications. Global Environmental Change.

Moudud, H. J., Rashid, H. E., Rahman, A. A., (eds), Undated. Executive Summary and Recommendations of the National Workshop on: Bangladesh Coastal Area Resource Development and Management. Report 1. October 3-4, 1988, Dhaka. Coastal Area Resource Development and Management Association (CARDMA).

Nishat, A., Undated. Greenhouse effect and Bangladesh: Hydrological Setting And Technical Options. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Pramanik, M.A.H., Undated. Detection of changes due to greenhouse effect : Application of Space and Remote Sensing Technology. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Quadir, D. A., Hussain, M. A., Hossain, M. A., Ferdousi, N., Sarker, M. M. A., and Rahman, M. M., 2003. Climate Change and its Impacts on Bangladesh Floods Over the Past Decades. 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. Pp- 165. SAARC Meteorological Research Center (SMRC), Dhaka.

RVCC, 2002. Project Implementation Plan. Reducing Vulnerability to Climate Change (RVCC) Project. CARE Canada.

Rahman A. A. & Huq, S., Undated. Greenhouse Effect And Bangladesh: A conceptual Framework. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Rashid, H. E., Undated. Greenhouse Effect: Its Implications for the Agriculture Sector in the Coastal Area of Bangladesh. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

Schaerer, C. and Ahmed, A.U., 2004. Adaptation to Climate Change in Vulnerable Communities: Lessons from Practice in Southwestern Bangladesh. In Ahmed, A.U., and Haque, N. (eds). Adaptation to Climate Change Knowledge Sharing for Capacity Building. Pp- 09. Workshop Proceedings held in COP-9 at Milan. 10 December, 2003. Climate Action Network South Asia CANSA, Dhaka.

Singh, O.P., Khan, T. M. A., and Rahman, M. S., 2000. The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case. SMRC-No. 3. SAARC Meteorological Research Centre (SMRC), Dhaka.

SAARC, Undated. Country Report on the Study on Greenhouse Effect and its impact on the SAARC Region. Draft. Government of the People's Republic of Bangladesh.

Thomalla, F., Cannon, T, Huq, S., Klein R. J. T., and Schaerer, C., 2005. 'Mainstreaming adaptation to climate change in coastal Bangladesh by building civil

society alliances. Proceedings of the Solutions to Coastal Disasters Conference 2005, American Society of Civil Engineers (ASCE), Charleston, South Carolina, USA, 8-11 May 2005, 668-684.

World Bank, 2000. Bangladesh: Climate Change and Sustainable Development. Report No. 21104 BD. World Bank Office, Dhaka. South Asia Rural Development Team. October, 2000.

Wahhab, M. A., 1998. Climate Change Mitigation in Asia and Financing Mechanisms (contributions from Bangladesh). In Shulka, P.R and Deo, P. (eds). Climate Change Mitigation in Asia and Financing Mechanisms. Proceedings of a Regional Conference, Goa, India, 4-6 May 1998. Pp-I.I. UNEP Collaborating Center on Energy and Environment, Riso National Laboratory, Denmark.

Warrick, R.A., Bhuiya, A.K.A. H., and Mirza, M.Q. 1996. The Greenhouse Effect and Climate Change. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp.35-96. Kluwer Academic Publishers. The Netherlands.

Warrick, R.A., Bhuiya, A.K.A. H., Mitchell, W.M., Murty, T.S. and Rasheed, K.B.S., 1996. Sea-Level Changes in the Bay of Bengal. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 97-142. Kluwer Academic Publishers. The Netherlands.

Part – II : Annotated Bibliography

Ahmed, A.U., 2005. Application of Solar Energy for Mitigation of Greenhouse Gases in Bangladesh. In Eusuf, M. (ed). Solar Photovoltaic Systems in Bangladesh- Experiences and Opportunities. Pp-171-181. The University Press Limited. Bangladesh Center for Advanced Studies.

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 discuss 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 GHG mitigation by use of solar photo-voltaic systems is low in Bangladesh at the moment.

Ahmed, A. U., 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.

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.

Ahmed, A. U., 2005. Adaptation Options for Managing Water –Related Extreme Events Under Climate Change Regime: Bangladesh Perspectives. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp. 255-278. A. A. Balkema Publishers, Leiden, The Netherlands.

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, especially those addressing long-term climate change - induced adverse impacts, 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 have been key 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.

Ahmed, A. U., 2004. A Review of the Current Policy Regime in Bangladesh in Relation to Climate Change Adaptation. CARE-RVCC Project, Khulna, Bangladesh.

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 regime should be established, giving adequate emphasis on interministerial coordination; inter-policy coherence as well as conflict resolution; creation of an institutional arrangement for the implementation of the CCP and mainstreaming adaptation to climate variability and change. The institutionalization of 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 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 SOD may be extended to include management of disasters such as riverbank and coastal erosion, drought, salinity intrusion, etc.

- The 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 in the NFiP, needs to be re-examined in view of policy directives offered by the NLUP, NAP and CZP.

- Issues concerning climate variability and change need to spearheaded and coordinated both nationally and internationally by one designated institution rather than more than one institution.

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

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.

Ali, A., 2003. Impacts of Climate Change on Tropical Cyclones and Storm Surges 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. Pp- 130. SAARC Meteorological Research Center (SMRC), Dhaka.

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 level.

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 2°C and 4°C. Different scenarios of storm surges under two different levels of SLR (0.3m and 1.0m) and temperature increase (2°C and 4°C) are developed by using a hydrodynamic model of storm surges for the Bay of Bengal.

Ahmed, A.U., 2003. Climate Variability and Flood: Climate Variability and Flood: Observed Coping Mechanisms In Bangladesh. Abstract Volume. The 13th Stockholm Water Symposium, August 11-14, 2003. Pp- 187.

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.

Ahmed, A.U., and Haque, N., 2002. Managing Climate Change. In Ahmad, Q.K. & Ahmed, A.U. (eds). Bangladesh: Citizens Perspectives on Sustainable Development. Pp- 149. Bangladesh Unnayan Parishad, Dhaka.

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 natural institutional and social setting a set of concrete recommendations has been made in the article for mainstreaming adaptation.

Ahmed, A.U., and Rahman, A., 2000. Review of Activities Towards the National Communication of Bangladesh to the UNFCCC. In Ahmed, A.U., Chantanakome, W., Jung, Y., Karyadi, A., Mulandar, S., Onchan, T., Parikh, J., Rahman, A., Ramakrishna, K., Sharma, R., Singh, G., Velasco, Y. T., Zhang, Z. (eds). Asia Looking Ahead. Initial Stages of National Communications Reporting. The Wood Hole Research Center, USA. Also published by BCAS in 1999 as an advanced version.

This document provides an initial assessment of the process for developing Bangladesh's first National Communication under UNFCCC.

Alam, M., Rahman, A. A, Haque, N., Kabir, S. A., 2000. Bangladesh. In Biagini, B., (ed). Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations. A Climate of Trust Report. Washington, DC. National Environmental Trust.

Bangladesh is one of the most vulnerable countries to the impacts of climate change. There is an increasing awareness of the issues involving mitigation and adaptation, as well as the roles of government, NGOs, and the private sector.

The government of Bangladesh has initiated several policy actions that support activities under the climate convention, including reduction of GHG emissions and considerations on adaptation. Many of the key policies and actions are focused towards the sustainable development goals. The water sector, for example, is initiating a process to integrate climate change scenarios. Energy sector policy has emphasized the role of renewable energy, particularly solar PV.

In the transport sector, the thrust of GHG reduction takes the form of pollution control and reducing the threat of health hazards. A good example is the initiation of compressed natural gas (CNG) in place of gasoline/petrol; initial results are attractive. In Bangladesh, tree plantation has become a major annual event and festival involving government, NGOs and local communities.

The city of Chittagong, Bangladesh's second largest and its chief port, is undertaking an urban waste management project to recover methane as useful energy from landfill. The results will have a significant impact on urban planning, waste management, and GHG reduction.

Ahmed, A. U., 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 2000. Pp. 71-93.

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.

Ahmed, A. U., Alam, M., 1999. Development of Climate Change Scenarios with General Circulation Models. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 13- 20. Kluwer Academic Publishers, The Netherlands.

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 1.3^0C and 2.6^0C for the years 2030 and 2070, respectively. It was found that there would be a seasonal variation in changed temperature: 1.4^0C change in the winter and 0.7^0C in the monsoon months in 2030. For 2070 the variation would be 2.1^0C and 1.7^0C 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 per cent and 27 per cent 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.

Ahmed, A. U., Alam, M., Rahman, A.A., 1999. Adaptation to Climate Change in Bangladesh: Future Outlook. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 125-143. Kluwer Academic Publishers, The Netherlands.

This article examines the possibilities, opportunities and challenges of adaptation to climate change for the people of Bangladesh. The human induced climate change is no longer a theoretical concept. There is a global consensus among scientists, professionals, academics, policy makers and strategists that the globe has already committed to certain degree of change in climate system. Climate change will affect all human and ecological systems and socio-economic development activities. Pressure has been mounting on the global leadership to take necessary steps in response to changes in climate system. Response options to climate change are those which would modify the effects of agents of change and effectively reduce consequential vulnerability. In general, there are two broad types of response options, namely mitigation and adaptation.

Mitigation, in one hand, can only slow down the rate of climate change and can not prevent its occurrence. Since mitigation activities do not ensure reduction of relative vulnerability of a person on an individual level, many people, especially those in the least developed countries, would be sceptic about committing to consider mitigation option (s) for the global benefit. Adaptation options, on the other hand, can reduce vulnerability to some extent on an individual level. More importantly, the positive effect of committing to adaptation practices by an individual or a community would have immediate visible impacts. Therefore, adaptation to climate variability and change is more likely to occur.

The country 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 (Ahmed *et al.*, 1996), it can not 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.

Ahmed, A. U., Siddiqi, N. A., Choudhuri, R. A., 1999. Vulnerability of Forest Ecosystems of Bangladesh to Climate Change. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F. (eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 93-113. Kluwer Academic Publishers, The Netherlands.

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 fórest 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.

Alam, M., Nishat, A., Siddiqui, S. M., 1999. Water Resources Vulnerability to Climate Change with Special Reference to Inundation. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 21-38. Kluwer Academic Publishers, The Netherlands.

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. MIKEll, 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.

Ali, M. Y., 1999. Fish Resources Vulnerability And Adaptation to Climate Change in Bangladesh. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 113 -124. Kluwer Academic Publishers, The Netherlands.

Fish and Fisheries have been playing a very significant role in nutrition, culture and economy of Bangladesh from time immemorial. Currently, about 80 per cent of the animal protein intake in the daily diet of the people comes from fish. The fisheries sector, it is estimated, contributes 3.5 per cent 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.

ADB, 1998. Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS). Bangladesh. Asian Development Bank, Global Environmental Facility, United Nations Development Programme.

This work done under the ALGAS study will provide direct input into the GHG abatement part of the Climate Change Strategy to be developed. This study suggested to develop a National Climate Change Strategy as required under UNFCCC using the ALGAS outputs as inputs; Prepare and Implement an awareness raising programme on GHG abatement including publication, workshop, seminars, media exposure, Prepare and implement pilot projects for both GHG abatement and improved energy utilization, and publicize results. The study has also suggested time line for implementation.

Asaduzzaman, M., Reazuddin, M., and Ahmed, A. U. (eds), 1997. Global Climate Change. Bangladesh Episode. Department of Environment (DoE), Ministry of Environment and Forest. Government of the People's Republic of Bangladesh.

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.

- 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.

Ahmed, A. U., Reazuddin, M., Islam, K., 1996. Bangladesh Emissions of Greenhouse Gases –Preliminary Findings. In Braatz, B. V., Jallow, B. P., Molnar, S., Murdiyarso, D., Perdomo, M., and Fitzgerald J. F. (eds). Greenhouse Gas Emission Inventories: Interim Results from the US Country Studies Program. Pp. 161- 170. Kluwer Academic Publishers. The Netherlands. Environmental Science and Technology Library.

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 CO_2, and land-use change emitted about 43,963 Gg CO_2. Reforestation has served as a carbon sink by sequestering some 45,173 Gg CO_2. Hence, net emissions of carbon dioxide in 1990 were 13,470 Gg CO_2. 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 CH_4, while emissions from the livestock sector contributed about 453 Gg CH_4. From energy production, approximately 6.31 Gg CH_4 was emitted as a result of venting, flaring, transmission and distribution. Emissions from wastes contributed 76 Gg CH_4 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 CH_4.

Ahmed, A. U., Huq, S., Karim, Z., Asaduzzaman, M., Rahman, A. A., Alam, M., Ali, Y., Chowdhury, R. A., 1996. Vulnerability and Adaptation Assessments for Bangladesh. In Smith, J. B., Huq, S., Lenhart, S., Mata, L. J., Nemesova, I, and Toure, S., (eds). Vulnerability and Adaptation to Climate Change: Interim Results from the US Country Studies Program. Kluwer Academic Publishers. The Netherlands. Environmental Science and Technology Library.

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.

Ahmad, Q.K., Warrick, N., Ericksen, J. and Mirza, M.Q., 1996. The Implications of Climate Change for Bangladesh: A Synthesis. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 1-34. Kluwer Academic Publishers. The Netherlands.

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. (Earlier version published locally by BUP – CERS- CRU, available at BUP, Dhaka)

ADB, 1994. Climate Change in Asia: Bangladesh Country Report. Asian Development Bank, Manila, Philippines.

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.

Ali, S. I. and Huq, S., 1990. International Sea level Rise: National Assessment of Effects and Possible Responses for Bangladesh. Bangladesh Centre for Advanced Studies (BCAS).Unpublished.

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.

BCAS, 1996. Bangladesh Least Cost Greenhouse Gas Abatement Strategy. Proceedings of the First National Workshop ALGAS Study. Bangladesh Centre for Advanced Studies (BCAS), Dhaka. BUET, BIDS and BUP.

The First National Workshop on ALGAS study 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.

Brammer, H., Asaduzzaman, M., Sultana, P., 1996. Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh. In Warrik, R.A. and Ahmad, Q.K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 143-204. Kluwer Academic Publishers. The Netherlands.

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 analysed 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. (Earlier version published locally by BUP – CERS- CRU, available at BUP, Dhaka)

BCAS-RA-Approtech, 1994. Vulnerability of Bangladesh to Climate Change and Sea Level Rise. Concepts and Tools for Calculating Risk in Integrated Coastal Zone

Management. Volume I: Technical Report, Volume II : Institutional Report, Volume III : Summary Report : Bangladesh Centre for Advanced Studies (BCAS), Resource Analysis (RA), Delft, The Netherlands, and Approtech Consultants Limited, Dhaka, Bangladesh.

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 organized by the Bangladesh Centre for Advanced Studies and Resource Analysis from The Netherlands. The study was carried out as Bangladesh' 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 present report is part of a set of three documents, containing:

- A *Technical Report* in two volumes, which 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.

- An *Institutional Report,* which gives an overview of the system of Government and Planning in Bangladesh and discusses in some detail institutional mechanisms for the water resource's sector. This report is considered a first step in understanding the management arrangements in place and corresponding possibilities and constraints in implementing response strategies.

- A *Summary Report,* which is being 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.

Brammer, H., Undated. Monitoring the Evidence of the Greenhouse effect and its Impact on Bangladesh. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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, geomorphological, 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.

Broadus, J., Milliman, J., Edwards, S., Aubrey D., and Gable, F., Undated. Rising Sea Level and Damming of Rivers: Possible Effects in Egypt and Bangladesh. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA.

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.

Choudhury, A.M., Quadir, D.A., Neelormi, S., and Ahmed, A.U., 2003. Climate Change and its Impacts on Water Resources of Bangladesh. In Dr. Amir Muhammed (ed). Climate Change and Water Resources in South Asia. Proceedings of year end workshop Kathmandu, Nepal, 7-9 January, 2003. Asianics Agro Dev International, Islamabad, Pakistan. The Asia-Pacific Network for Global Change Research. Fred J. Hansen Institute for World Peace.

A Country Study on Bangladesh has been carried out as a part of a South Asian Regional Study on Assessment of Climate Change-associated Vulnerabilities and Coping Mechanisms, simultaneously undertaken in India, Nepal, and Pakistan, in addition to Bangladesh. 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.

Debsarma, S. K., 2003. Intra-Annual and Inter-Annual Variations of Rainfall over Different Regions of 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. Pp- 137. SAARC Meteorological Research Center (SMRC), Dhaka.

Bangladesh is divided into four regions (Northwest, Northeast, Southwest and Southeast regions) on the basis of coherent rainfall pattern. 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 the four regions of Bangladesh 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) regressions by using MS-Excel. 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 were found.

Department of Environment, 1993. Assessment of the Vulnerability of Coastal Areas to Climate Change and Sea Level Rise. A Pilot Study of Bangladesh. Final Report. Volume

I Department of Environment. Ministry of Environment, Government of Bangladesh. Bangladesh Center for Advanced Studies (BCAS), Resource Analysis, Approtech.

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 (SLR) 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 CC & SLR, 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

Ericksen, N.J., Ahmad Q.K. and Chowdhury, A.R., 1996. Socio-Economic Implications of Climate Change for Bangladesh. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 205-288. Kluwer Academic Publishers. The Netherlands.

Land and life are closely entwined in Bangladesh. Over 80 per cent of the country's 115 million people live in the rural sector. The land area of 148,393km2 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.
(Earlier version published locally by BUP – CERS- CRU, available at BUP, Dhaka)

Faruque, H. S. M., and Ali, M. L., 2005. Climate Change and Water Resources Management in Bangladesh. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp- 231. A. A. Balkema Publishers, Leiden, The Netherlands.

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.

Freestone, D., Farooque, M. and Jahan, S.R., 1996. Legal Implications of Global Climate Change for Bangladesh. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp.289-334. Kluwer Academic Publishers. The Netherlands.

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.
(Earlier version published locally by BUP – CERS- CRU, available at BUP, Dhaka)

Huq, S., Khan, M., 2006. Equity in National Adaptation Programs of Action (NAPAs): The Case of Bangladesh. In Adger, W.N., Paavola, J., Huq, S., and Mace, M.J.(editors). Fairness in Adaptation to Climate Change. The MIT Press, UK. Pp- 181-200.

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 further challenges 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.

Huq, S. and K. Moinuddin, 2004. Climate change, vulnerability and adaptation in Bangladesh. In V. I. Grover (edi.) Climate Change Five Years after Kyoto. Science Publishers Inc., Enfield (NH) USA. Pp. 251 – 271.

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.

Huq, S., Rahman, A., Konate, M., Sokona, Y., and Reid, H., 2003. Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCS). International Institute for Environment and Development (IIED). Bangladesh Centre for Advanced Studies (BCAS). ENDA, Shell Foundation, Sustainable Energy Program.

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 high lighted in addition, a suggested set of key causes has been compiled.

Huq, S., 2002. Lessons Learned from Adapting to Climate Change in Bangladesh. World Bank, Washington D.C.

Bangladesh, with a population nearing 130 million, is one of the poorest countries in the world while also being one of the most vulnerable to the impacts of climate change.

The overall objective of the study was to mainstream climate change adaptation issues in the regular development strategies and operations in Bangladesh and serve as an example for other countries of the world.

The study process 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.

Habibulla, M., Ahmed, A. U., Karim, Z., 1999. Assessment of Food grain production loss due to climate induced enhanced soil salinity. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 56-71. Kluwer Academic Publishers, The Netherlands.

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.

Haque, M., 1996. Climate Change. Issues for the Policy Markers of Bangladesh. Environment and Development Alliance (EDA), Dhanmondi, Dhaka.

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.

Hossain, M., Undated. The Greenhouse effect and the Coastal Area of Bangladesh: Its People and Economy. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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 GE; consequences and options are discussed within a policy framework and recommendations.

Huq, M., Undated. Environmentally Sound Measures for Countering" Greenhouse Effect" in Bangladesh and their Cost-Effectiveness. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of

Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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.

IWM, 2005. Impact Assessment of Climate Changes on the Coastal Zone of Bangladesh. Final Report. Institute of Water Modelling. Water Resources Planning Organization (WARPO), Ministry of Water Resources. Government of Peoples Republic of Bangladesh.

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 Intergovermental 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.

Islam, M.F. and Parveen, S, 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.

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 CO2 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.

Islam, S.M.R., Huq, S., Ali, A., 1999. Beach Erosion in the Eastern Coastline of Bangladesh. Vulnerability and Adaptation to Climate Change for Bangladesh. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp. 72-93. Kluwer Academic Publishers, The Netherlands.

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.

Karmakar, S., 2003. Trends in the annual frequency of cyclonic disturbances and storms in the Bay of Bengal. 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. PP-110. SAARC Meteorological Research Center (SMRC), Dhaka.

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 Shrestha, M. L., 2000. Recent Climatic Changes in Bangladesh. SMRC No. 4. SAARC Meteorological Research Centre, Dhaka.

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.

Karim, Z., Hussain, S.G., Ahmed, A. U., 1999. Climate Change Vulnerability of Crop Agriculture. In Huq, S., Karim, Z., Asaduzzaman, M., Mahtab, F.(eds). Vulnerability and Adaptation to Climate Change for Bangladesh. Pp.39-54. Kluwer Academic Publishers, The Netherlands.

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-di-oxide fertilization was analyzed against the baseline climate condition.

The GFDL model predicted about 17 per cent decline in overall rice production and as high as 61 per cent 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-di-oxide fertilization would facilitate food grain production. A rise in temperature cause significant decrease in production, some 28 and 68 per cent 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 per cent rise in rice production and 31 per cent 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 per cent moisture stress on top of other climatic cause as high as 32 per cent decline in Boro yield, instead of having an overall 20 per cent 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.

Karim, Z., Hussain, S.G., Ahmed, M., 1996. Assessing Impacts of Climate Variations on Foodgrain Production in Bangladesh. Water, Air, and Soil Pollution 92: 53-62.

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 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 CO_2 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%.

Kausher, A., Kay, R.C., Asaduzzaman, M and Paul, S. 1996. Climate Change and Sea-Level Rise: The Case of the Coast. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 335-406. Kluwer Academic Publishers. The Netherlands.

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 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 "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.
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 " (Article 4 Section i.e) by summarising the key scientific and management issues relating to the potential future impacts of climate change and sea-level rise.
(Earlier version published locally by BUP – CERS- CRU, available at BUP, Dhaka)

Karim, Z., Ahmed, M., Hussain, S.G., Rashid, Kh.B., 1994. Impact of climate change on the production of modern rice in Bangladesh. Bangladesh Agricultural Research Council, Dhaka.

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, Z., 1987. Applications of Land Resources and Climate Change Data Base in development planning. Climate Change International conference, organized by University of Hawaii, Verginia Tech., USA

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., Undated. Assessment of Vulnerability to Sea Level Rise: A Case Study of Bangladesh. 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. Pp- 143.

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.

MoEF, 2005. National Adaptation Programme of Action (NAPA). Ministry of Environment and Forest, Government of the People's Republic of Bangladesh. Final Report. November 2005. Dhaka.

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 "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.

Mirza, M.M.Q., 2005. The Implications of Climate Change on River Discharge in Bangladesh. In Mirza, M. M. Q., and Ahmad, Q.K. (eds). Climate Change and Water Resources in South Asia. Pp- 103. A. A. Balkema Publishers, Leiden, The Netherlands.

Bangladesh lies in the delta of three large rivers - the Ganges, Brahmaputra and Meghna (GBM), which is often termed as a "land of rivers and water." With a complex network of 230 rivers, including 57 cross boundary rivers, about 92.5% of the 175 million hectares (mha) of combined basin area of the GBM Rivers (Fig. 5.1) is beyond the boundary of Bangladesh and is located in China, Nepal, India and Bhutan. Bangladesh acts as a drainage outlet for the cross-border runoff. More than 90% of the annual runoff is generated outside of Bangladesh. However, there is a high seasonal difference in the availability of water. For example, for the Ganges River, the ratio of dry and monsoon runoff is 1:6. This illustrates that Bangladesh has an abundance of water in the monsoon while the country still faces surface water scarcity in the dry season. Irrigated agriculture is highly dependent on dry season surface water availability. On average, annually floods engulf roughly 20% of the area of the country, or about 3.03 mha (Mirza, 2003). In extreme cases, floods may inundate about 70% of Bangladesh, as it occurred during the floods of 1988 and 1998 (Ahmed and Mirza, 2000). Hydrological droughts are very common in the rivers of Bangladesh.

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. Pp-94. SAARC Meteorological Research Center (SMRC), Dhaka.

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 (Premonsoon) 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.

Mirza, M. M.Q., 1997. Modeling the Effects of Climate Change on Flooding in Bangladesh. A thesis for the Doctor of Philosophy in the International and Resource Studies at The University of Waikato.

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.

Mirza, M. M.Q., Undated. Global warming and changes in the probability of occurrence of floods in Bangladesh and implications. Global Environmental Change.

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 *:10.5* per cent area of the country and this can reach as high as about 70 per cent during an extreme flood event. Floods cause serious damage to the economy or 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 or 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 or flooding with certain magnitude. Extreme flooding events will create a number of implications for agriculture flood control and infrastructure in Bangladesh.

Moudud, H. J., Rashid, H. E., Rahman, A. A., (eds), Undated. Executive Summary and Recommendations of the National Workshop on: Bangladesh Coastal Area Resource Development and Management. Report 1. October 3-4, 1988, Dhaka. Coastal Area Resource Development and Management Association (CARDMA).

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 peoples 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.

Nishat, A., Undated. Greenhouse effect and Bangladesh: Hydrological Setting And Technical Options. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

This paper covers various technical options for the hydrological and geomorphological 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 effect drainage during flood season as well as effect drainage from already empoldered areas.

Increase in salinity and inland movement of saline front could effect 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.

Pramanik, M.A.H., Undated. Detection of changes due to greenhouse effect : Application of Space and Remote Sensing Technology. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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.

Quadir, D. A., Hussain, M. A., Hossain, M. A., Ferdousi, N., Sarker, M. M. A., and Rahman, M. M., 2003. Climate Change and its Impacts on Bangladesh Floods Over the Past Decades. 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. Pp- 165. SAARC Meteorological Research Center (SMRC), Dhaka.

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) show 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.

RVCC, 2002. Project Implementation Plan. Reducing Vulnerability to Climate Change (RVCC) Project. CARE Canada.

Crucially in the case of vulnerable communities in Bangladesh, few studies have considered impacts in any great detail at the local level. Furthermore, the report argues, there have been no assessments done on a local basis looking at the ability of households and communities to respond to adverse climate change impacts. The time is ideal for a climate change adaptation project in Bangladesh that considers existing adaptive capacities at the household and community levels. 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.

Rahman A. A. & Huq, S., Undated. Greenhouse Effect And Bangladesh: A conceptual Framework. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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.

Rashid, H. E., Undated. Greenhouse Effect: Its Implications for the Agriculture Sector in the Coastal Area of Bangladesh. In Moudud, H. J., Rashid, H. E., Rahman, A. A., Hossain, M., (eds). The Greenhouse Effect and Coastal Area of Bangladesh. Proceedings of an International Conference held in Dhaka, Bangladesh, 5th March 1989.

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 3 different scenarios for the GE, termed as the Upper, Middle and Low Scenarios.

Schaerer, C. and Ahmed, A.U., 2004. Adaptation to Climate Change in Vulnerable Communities: Lessons from Practice in Southwestern Bangladesh. In Ahmed, A.U., and Haque, N. (eds). Adaptation to Climate Change Knowledge Sharing for Capacity

Building. Pp- 09. Workshop Proceedings held in COP-9 at Milan. 10 December, 2003. Climate Action Network South Asia CANSA, Dhaka.

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.

Singh, O.P., Khan, T. M. A., and Rahman, M. S., 2000. The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case. SMRC-No. 3. SAARC Meteorological Research Centre (SMRC), Dhaka.

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.

SAARC, Undated. Country Report on the Study on Greenhouse Effect and its impact on the SAARC Region. Draft. Government of the People's Republic of Bangladesh.

The major emphasis of the study was to summarise 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 rainfalls.

Thomalla, F., Cannon, T, Huq, S., Klein R. J. T., and Schaerer, C., 2005. 'Mainstreaming adaptation to climate change in coastal Bangladesh by building civil society alliances. Proceedings of the Solutions to Coastal Disasters Conference 2005, American Society of Civil Engineers (ASCE), Charleston, South Carolina, USA, 8-11 May 2005, 668-684.

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 organisations, 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 organisations. 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 organisations 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 organisations and the Government of Bangladesh

on adaptation and development.

World Bank, 2000. Bangladesh: Climate Change and Sustainable Development. Report No. 21104 BD. World Bank Office, Dhaka. South Asia Rural Development Team. October, 2000.

The study under discussion 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.

Wahhab, M. A., 1998. Climate Change Mitigation in Asia and Financing Mechanisms (contributions from Bangladesh). In Shulka, P.R and Deo, P. (eds). Climate Change Mitigation in Asia and Financing Mechanisms. Proceedings of a Regional Conference, Goa, India, 4-6 May 1998. Pp-I.I. UNEP Collaborating Center on Energy and Environment, Riso National Laboratory, Denmark.

The article calls for a powerful worldwide collaboration to combat climate change and other global environmental problems.

Warrick, R.A., Bhuiya, A.K.A. H., and Mirza, M.Q. 1996. The Greenhouse Effect and Climate Change. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp.35-96. Kluwer Academic Publishers. The Netherlands.

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.

Warrick, R.A., Bhuiya, A.K.A. H., Mitchell, W.M., Murty, T.S. and Rasheed, K.B.S., 1996. Sea-Level Changes in the Bay of Bengal. In Warrick, R. A. and Ahmad, Q. K. (eds). The Implications of Climate and Sea-Level Change for Bangladesh. Pp. 97-142. Kluwer Academic Publishers. The Netherlands.

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.

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Country Report on the Study on Greenhouse Effect and its impact on the SAARC Region.	Impact
Detection of changes due to greenhouse effect: Application of Space and Remote Sensing Technology.	Impact

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Development of Climate Change Scenarios with General Circulation Models.	Impact
Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh.	Impact
Environmentally Sound Measures for Countering" Greenhouse Effect" in Bangladesh and their Cost-Effectiveness.	Impact
Equity in National Adaptation Programs of Action (NAPAs): The Case of Bangladesh.	Adaptation
Executive Summary and Recommendations of the National Workshop on: Bangladesh Coastal Area Resource Development and Management. Report 1	Response
Fish Resources Vulnerability And Adaptation to Climate Change in Bangladesh.	Vulnerability Adaptation
Food Security in the Face of Climate Change, Population Growth, and Resource Constraints: Implications for Bangladesh.	Impact
Global Climate Change. Bangladesh Episode.	Emissions, Impacts & Vulnerability
Global warming and changes in the probability of occurrence of floods in Bangladesh and implications.	Impact
Greenhouse Effect And Bangladesh: A conceptual Framework.	Impact
Greenhouse effect and Bangladesh: Hydrological Setting And Technical Options.	Impact
Greenhouse Effect: Its Implications for the Agriculture Sector in the Coastal Area of Bangladesh.	Impact
Impact Assessment of Climate Changes on the Coastal Zone of Bangladesh. Final Report.	Impact
Impact of climate change on the production of modern rice in Bangladesh.	Impact

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Impacts of Climate Change on Tropical Cyclones and Storm Surges in Bangladesh.	Impact
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Mainstreaming adaptation to climate change in coastal Bangladesh by building civil society alliances.	Adaptation
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Modeling the Effects of Climate Change on Flooding in Bangladesh. A thesis.	Impact
Monitoring the Evidence of the Greenhouse effect and its Impact on Bangladesh.	Impact
National Adaptation Programme of Action (NAPA)	Adaptation
Project Implementation Plan. Reducing Vulnerability to Climate Change (RVCC) Project.	Vulnerability
Recent Climatic Changes in Bangladesh. SMRC No. 4	Climate change over all
Review of Activities Towards the National Communication of Bangladesh to the UNFCCC.	Response, Impact & Vulnerability
Rising Sea Level and Damming of Rivers: Possible Effects in Egypt and Bangladesh.	Impact
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The Greenhouse Effect and Climate Change.	Response, Impact
The Greenhouse effect and the Coastal Area of Bangladesh: Its People and Economy.	Impact
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The Implications of Climate Change on River Discharge in Bangladesh.	Impact
The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case. SMRC-No. 3.	Vulnerability
Toward integrating adaptation to climate change in current policy regime: perspectives on Bangladesh's water resources and associated sectors.	Adaptation
Trends in the annual frequency of cyclonic disturbances and storms in the Bay of Bengal.	Impact
Variations of temperature in Bangladesh.	Response
Vulnerability and Adaptation Assessments for Bangladesh.	Vulnerability Adaptation
Vulnerability of Bangladesh to Climate Change and Sea Level Rise. Concepts and Tools for Calculating Risk in Integrated Coastal Zone Management. Volume I: Technical Report, Volume II : Institutional Report, Volume III : Summary Report :	Vulnerability
Vulnerability of Forest Ecosystems of Bangladesh to Climate Change.	Vulnerability
Water Resources Vulnerability to Climate Change with Special Reference to Inundation	Vulnerability