

Climate Change Study Cell

Concept Paper
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Institute of Water and Flood Management (IWFM)
**Bangladesh University of Engineering
and Technology (BUET)**

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1. Introduction

There is now scientific evidence that climate changes have affected the physical, biological and human systems. The Intergovernmental Panel on Climate Change (IPCC) in their Fourth Assessment recognized observed changes in many natural systems of every continent and most oceans due to regional climate changes, particularly temperature increases (Parry et al., 2007). The observed changes have occurred in different sectors and systems including hydrology, water resources, coastal zones, ecosystems, agriculture, forestry, health systems and socio-economic activities. Peak discharge is occurring earlier in rivers affected by snow melt. Lakes and rivers around the world are warming, with effects on thermal structure and water quality. Sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves and increasing damage from coastal flooding in many areas. Both terrestrial and marine biological systems are being strongly influenced by recent warming. Both agriculture and forestry have shown vulnerability to recent trends in heat waves, droughts and floods. Health system is affected due to recent warming, climate variability and changes. The impacts of climate changes on different systems and sectors are emerging.

Several factors such as geography, high-density population, poor economy, illiteracy etc. have made Bangladesh one of the countries most vulnerable to climate change. Climate risks now need to be integrated into national development projects and strategies. In this regard, a **Climate Change Study Cell** at BUET can play very important role by creating knowledge base and producing trained man power to face the impending climate change risk. The activities of the **Climate Change Study Cell** can increase the awareness of policymakers, planners of potential impacts of climate change in different sectors. Knowledge on climate change impacts could help taking adaptation measures into national policy and planning processes.

1.1. Global Climate Risk

Climate change is a global problem. Long-term changes in climate have been observed at continental, regional and ocean basin scales. These include changes in temperatures, changes in precipitation, ocean salinity, wind patterns and extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.

Most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The IPCC in their Fourth Assessment concluded that continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (IPCC, 2007). Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.

It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent. It is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.

The IPCC predicted the possible impacts on different systems and sectors including hydrology, water resources, coastal zones, ecosystems, agriculture, forestry, health systems and socio-economic activities due to changes in climate and sea-level. The impacts of climate change will vary regionally. The net annual costs that are very likely to be imposed by impacts of climate change will increase over time as temperature increases.

Drought-affected areas will probably increase, and extreme precipitation events, which are likely to increase in frequency and intensity, will increase flood risk. Increased frequency and severity of floods and droughts will have implications for sustainable development. Sea-level rise will extend areas of salinisation of groundwater and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas.

The resilience of many ecosystems (their ability to adapt naturally) is likely to be exceeded by 2100 by an unprecedented combination of change in climate, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land-use change, pollution, over-exploitation of resources). The terrestrial biosphere is likely to become a net carbon source by 2100, thus amplifying climate change, given continued greenhouse gas emissions and other unmitigated global changes, such as land-use changes. Roughly 20 to 30% of species are likely to be at increasingly high risk of extinction as global mean temperatures exceed 2 to 3°C above pre-industrial levels.

All coastal ecosystems are vulnerable to climate change and sea-level rise, especially corals, salt marshes and mangroves. Coastal flooding in low-lying areas is very likely to become a greater risk than at present due to sea-level rise and more intense coastal storms.

Projected changes in the frequency and severity of extreme climate events, together with increases in risks of fire, pests, and disease outbreak, will have significant consequences on food and forestry production, and food insecurity, in addition to impacts of projected mean climate.

The projected relative risks in health system due to climate changes in 2030 show an increase in malnutrition in some Asian countries. The decrease in the availability of crop yields in seasonally dry and tropical regions will increase hunger, malnutrition and consequent disorders, including child growth and development in some areas.

1.2. Climate Risk in Bangladesh

Bangladesh is mainly the delta of the Ganges and Brahmaputra rivers and most of the land is elevated below 10 meters above sea level. The low lying topography, riverine and coastal flooding, tropical cyclones, storm surges,

tornadoes, widespread poverty, higher population density, poor institutional development etc. have made Bangladesh more vulnerable to climate change and variability. The IPCC in their Fourth Assessment identified changes in observed temperature and precipitation in Bangladesh. The temperature shows an increasing trend of about 1°C in May and 0.5°C in November during the period from 1985 to 1998 and the decadal rain anomalies is above the long term averages since 1960s (Cruz et al., 2007). The National Adaptation Programme of Action (NAPA) has established the likely climate change scenarios for Bangladesh based on the Third IPCC Assessment Report (Khan et al., 2006). They projected an increase in mean December-January-February (DJF) temperature of 2.7°C and June-July-August (JJA) temperature of 1.9°C while a decrease in DJF precipitation of 10% and increase in JJA precipitation of 12% by 2100. The estimated sea level rise is 88 cm by 2100.

Climate change is likely to have several important impacts on Bangladesh. The most significant may be through sea-level rise. The main threats of climate change to Bangladesh are increased flooding, drainage congestion, decrease of fresh water availability, disturbance of morphological processes, salinity intrusion, frequent cyclone and storm surge flooding. Most vulnerable sectors due to climate changes include coastal resources, water resources, agriculture, human health and ecosystem/biodiversity. The sea level rise would increase the salinity intrusion and coastal flooding. Saline water intrusion would affect the ability of ecosystem to adapt and the different species of plants and animals would be adversely affected. World Bank (2000) predicted that with 60 cm rise in sea level, the Sundarbans would be lost. Due to the possibility of increase in soil salinity under climate change scenarios, it is very likely that food grain production would be extremely vulnerable. There would be decrease in area suitable for rice production.

The reference crop evapo-transpiration would increase by about 3% and 5% during the dry season by the years 2030 and 2050 in the Ganges Delta Area (GDA) (Mondal and Wasimi, 2004). The increase in the dry season water demand due to climate change would affect the proposed water management planning and design in the GDA. The major river flows of Bangladesh would be largely affected due to climate change. The mean annual flows of the Ganges and the Brahmaputra would be increased by 2050s (Farquharson et al., 2007). The decreasing trend in low flows would decrease the water availability in already water stressed areas of the country.

2. Role of Educational Institutes in Climate Risk Management

2.1. Awareness

The importance of research related to climate changes continues to increase, as major climate-related initiatives begin at both international and national level. The recent publication of the Fourth Assessment Report of IPCC has amplified this importance more. The educational institutions can provide capabilities and opportunities for climate system modeling and research. They can contribute to better understanding of climate changes, its impact on humans and ecosystems and thus can help in increasing awareness of the planners, policy makers to take

adaptive measures to cope with the climate change impacts. The increase in awareness program can be carried out through training and education.

2.2. Examples of Some Universities

2.2.1. University of Tokyo, Japan

Center for Climate System Research (CCSR) of the University of Tokyo is involved in many research activities related to climate modeling. They have obtained significant results from simulation of global warming by implementing the model heritage of CCSR. They are also generating important results from paleo-climate simulation. Thus they are bringing greater advances in the climate modeling research. Their current research activities include improved global warming and climate change modeling, modeling of meso-scale weather and urban climate, refined modeling of cloud and chemical processes, paleo-climate, extraterrestrial planetary climate modeling, and analysis of data from new satellite sensors and ground-based measurements.

2.2.2. Penn State University, USA

National Center for Atmospheric Research (NCAR) provides the university research and teaching community with tools such as aircraft and radar to observe the atmosphere and with the technology and assistance to interpret and use these observations, including supercomputer access, computer models, and user support. NCAR and university scientists work together on research topics in atmospheric chemistry, climate, cloud physics and storms, weather hazards to aviation, and interactions between the sun and earth. Pennsylvania State University (PSU) and NCAR has developed the widely used meso-scale model (known as MM5) to simulate or predict meso-scale and regional-scale atmospheric circulation. The MM5 model is continuously being improved by contributions from users at several universities and government laboratories. About 600 users from 200 institutions are using the MM5 model. At the University of Washington, the MM5 has become the centerpiece of an environmental modeling system. MM5 operational forecasts are now being used to predict stream flow for eight watersheds in western Washington. Some agencies are also using MM5 output for air quality modeling.

Earth System Science Center (ESSC) of Pennsylvania State University is doing research to describe, model, and understand the Earth's climate system. **ESSC** uses a combination of modeling, empirical analysis, and exploration of fundamental processes to investigate the behavior of the climate system. **ESSC** is also involved in the development of new educational tools including interactive climate modeling tools to service both Penn State and the broader community.

2.3. BUET as a venue

2.3.1. Activities

BUET is a leading institution in Bangladesh for education and research in engineering and technology. Department of Physics, Department of Civil

Engineering, Department of Water Resources Engineering, Department of Urban and Regional Planning and Institute of Water and Flood Management have the potential to carry out researches related to climate change.

2.3.2. Departments

A research team is already working in the area of atmospheric physics in the Department of Physics, BUET. The research is mainly in the field of climate modeling, satellite meteorology, radar meteorology, monsoon meteorology and tropical cyclone. This group is currently involved in MAHASRI and GEOSS projects with the collaboration of a Japanese research group. These projects are for real time flood monitoring and forecasting in this region, especially in the Meghna Basin of Bangladesh. They are currently involved in a collaboration research with HyARC, Nagoya University for the statistical studies on the characteristics of precipitation in and around Bangladesh. They are also using MM5 modeling system from 2002 for studying the organization, mechanism and basic characteristics of convections developed in this region. Regional Climate Model (RCM) named RegCM3 is running in the Department from 2004 under APN project through BUP, Bangladesh. Another RCM called PRECIS is running in the Department from 2005 in collaboration with DoE (Department of Environment), Ministry of Environment and Forest. RCMs are being used to obtain the climatic scenario in this region.

Department of Civil Engineering is carrying out researches related to water and air quality modeling, water supply and sanitation, urban safety, groundwater quality etc.

Water Resources sector are more vulnerable to climate change. Department of Water Resources Engineering carries out research on river morphology, irrigation, surface water and ground water modeling, extreme water events like floods, droughts, etc.

The Department of Urban and Regional Planning (URP) at BUET is primarily concerned with the human settlement development planning at the urban, rural, regional and local levels. The activities of the Department focus on physical, social, economic and political aspects of human settlements. Knowledge of impacts of climate change on different sectors would help the researchers of URP to improve their planning and thus can contribute to national level.

2.3.3. Institutes

Research activities of IWFM focus on water management with major emphasis on water resources management in floodplain environment. The institute is already carrying out some projects related to climate change studies. For example, the research project namely Impact of Climate and Sea Level Change in Part of Indian Sub-Continent (CLASIC), consultancy project such as Development of a Base Document in the Backdrop of Climate Change Impacts: Characterizing Bangladesh Country Settings. There are also some upcoming consultancy projects related to climate change. There are trained faculties on climate modeling. Thus the Institute has the potential to carry out climate change related studies and improve climate modeling research in Bangladesh.

3. Proposed Study Cell

3.1. Vision

The vision of the Climate Change Study Cell is to establish itself as the premier knowledge center on climate change risk and adaptation for Bangladesh.

3.2. Mission

- To improve knowledge about climate change and associated risk to Bangladesh;
- To increase awareness of the planners, policy makers about the effects of climate change;
- To become institutional home for climate modeling and predicting future scenarios;
- To strengthen capacity of professionals in climate change modeling; and
- To share knowledge and expertise with other organizations.

3.3. Activities

Following list of activities has been proposed for this cell.

- Research
- Short courses
- Workshop
- Seminar
- Advisory Services
- Conference
- Publications
- Climate change Database
- Dissemination of information through web

3.4. Programme

The Cell will develop a programme on the basis of the proposed activities. The approach will be as follows:

- The programme fits in the context of Bangladesh
- The programme draws on the strength of BUET
- The programme runs sustainably in BUET with or without external support.

The Cell is proposed to be housed in an existing Institute, namely IWFM. The Cell will share IWFM resources thereby not requiring additional support from BUET. The programme will also not be limited by dependence on external support. External funding will be sought for supporting activities, which have already been identified in the programme of the Cell.

4. Home of the Cell

4.1. Institute of Water and Flood Management (IWFM)

Institute of Water and Flood Management (IWFM) pursues research and capacity development in the field of water and flood management that is vital for economic development and social prosperity of the country. The Institute also provides advisory and consultancy services to government and non-government organizations. In recent past, it has carried out number of studies related climate change. Many of the studies have been conducted through collaboration with professionals within and outside BUET.

4.1.1. *Research Projects*

Research activities at the Institute focus on water management with major emphasis on water resources management in floodplain environment, river and coastal hydraulics, wetland hydrology, hazard management, urban water management, irrigation and water management, environmental impact of water development, water resources policy.

A brief list of atmosphere and climate related research projects conducted at the institute are given below.

1. **Impact of Climate and Sea level change in part of the Indian Sub-Continent (CLASIC)**. This project was initiated at the end of August 2003 in collaboration CEGIS (Bangladesh), Hadley center (UK) and CEH (UK). The project is funded by DFID, UK under its knowledge and Research program. The purpose of this project is to investigate the implications of climate change on water resources availability from Ganges, Brahmaputra and Meghna basins in the Indian subcontinent with particular reference to Bangladesh.
2. **Improving Flood Forecasting of Bangladesh using Artificial Neural Network (ANN) and Remotely Sensed Rainfall Data**. This ongoing project was initiated on March 2007 in collaboration with Civil Engineering and Physics department of BUET. This project proposes to use rainfall-runoff ANN to forecast flood water level at various river gauge stations in Bangladesh using the TRMM satellite rainfall data of upstream Ganges, Brahmaputra and Meghna (GBM) basins of those rivers.
3. **Water Impact Study of Atmospheric Brown Clouds**. (ABC project) Several Asian universities are participating in this project, which is funded by UNEP.

4. **Rainfall Estimation over Bangladesh using Remote Sensing Data.** This one-year project was completed on 2006 in collaboration with Physics department of BUET. This objective of this project is to investigate cloud characteristics of precipitation systems developed over Bangladesh and to develop a linear relationship between TRMM-PR satellite data and actual rainfall over Bangladesh.

4.1.2. *Advisory services*

One of the missions of the Institute is to provide expert advisory services to government and non-government organizations. The faculty members of the Institute have been involved in the following consultancy and advisory services related to climate change.

1. **Development of a Base Document in the Backdrop of Climate Change Impacts: Characterizing Bangladesh Country Settings.** Client: CDMP, 2007.
2. **Impacts of Sea Level Rise on Land Suitability and Adaptation Options.** Client: UNDP, 2004-2006.
3. **Vulnerability analysis of coastal livelihood groups in the coastal zone of Bangladesh;** Client: FAO, 2003-04.
4. **Impact of Climate Change on Stream flow Vulnerability on Urban Runoff,** Client: IUCN, 2004.

4.1.3. *Trained Manpower*

There are sixteen full time faculty members currently working in the institute. Fifteen of the faculty members have Ph.D degree. Many of these faculty members have professional training related to climate change science. A short list of relevant training courses attended by some of the faculty members are given below:

1. Training course on "GAWAVA hydrologic model using RCM climate change data", Center for Ecology and Hydrology (CEH), UK, 2004
2. South Asia Regional Training Workshop on *Watershed Modeling* under Asia-Pacific Network's (APN) Scientific Capacity Building/Enhancement for Sustainable Development in Developing Countries (CAPaBLE) programme, organized by Global Change Impact Studies Centre and Pakistan Meteorological Department during 7-18 March, 2005, in Islamabad, Pakistan.
3. "Advanced Use of Remote Sensing in Water Resource and Irrigation Management", International Institute for Geo Information Science and Earth Observation (ITC), the Netherlands, April 03-June22, 2007.

5. Proposed Activities in near Future

5.1. Short course

A 3-days short course on “**Climate change risk and adaptation in water sector**” will be offered at the end of 2007. This course will be organized by Directorate of Continuing Education (DCE), BUET in collaboration with institute of water and flood management (IWFM), BUET and Climate Change Cell of DOE. Major topics will be covered in this course are given below:

1. Introduction to climate change research
2. Vulnerability and risk in water sector
3. Implication of climate change
4. Adaptation to climate
5. Climate change impact modeling

5.2. Workshop on CLASIC

A workshop on CLASIC project will be held in November 2007. During the workshop, deliberation on climate change concerns for Bangladesh and climate change modeling will take place.

5.3. International Conference on Climate Change

Under the SaciWATERS project of IWFM, a 3-day workshop on climate change is proposed to be held during October 2008. A 1-day international conference can be arranged during the same time.

5.4. Website

A new web site will be launched on climate change study cell at BUET. This site will reside at <http://buet.ac.bd/iwfm/climate/index.htm>. The contents of the web site will as follows.

- Data and results of climate change impact models
- Softwares and tools
- Documents and publications
- Links of useful web sites
- News on climate change

This site will create a knowledge base for climate change related activities conducted at this cell and create bridge among other related activities in Bangladesh.

6. Road map

Climate Change Study Cell will start its journey in 2007. By the year, 2009 it may be converted into a fully independent Center in BUET. In the mean time it will cross several milestones, which are as follows:

Activities

Start offering short courses and training

Equip and organize the cell as climate change modeling house

Start offering certificate course on climate change science

Become an independent center in BUET

Milestone

end 2007

mid 2008

end 2008

mid 2009

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