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Understanding climate change and Livelihoods in coastal Bangladesh

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UNDERSTANDING CLIMATE CH
LIVELIHOODS IN COASTAL BAN

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In recent years, there has been a growing concern about the effect of climate-induced sea-level rise on the environment, population and livelihoods around the worlds' coastline. However, these issues are highly spatially variable, as sea level is only one of several drivers of coastal change (Nicholls et al 2007). It was recognised in the 1980s (Milliman et al 1989) that deltaic environments are amongst the most vulnerable coastal areas to such rise because of their low altitude and often large, poor and growing population.

Threats act on multiple scales including global (e.g. sea level rise), regional (e.g. catchment management reducing water and sediment input) and delta plain (e.g. water extraction, sediment starvation, natural and more importantly human-induced subsidence) scales. The result of these changes might result in an increase in flooding, salinization of water resources and soil, land loss due to erosion, subsidence and inundation, and degrading the quality of ecosystem services such as crop productivity, fish stocks and protection against storm surges. Thus, delta environments are complex social-environmental systems where the change is only partially driven by sea level rise and climate change, and human-induced development activities are also critical drivers.

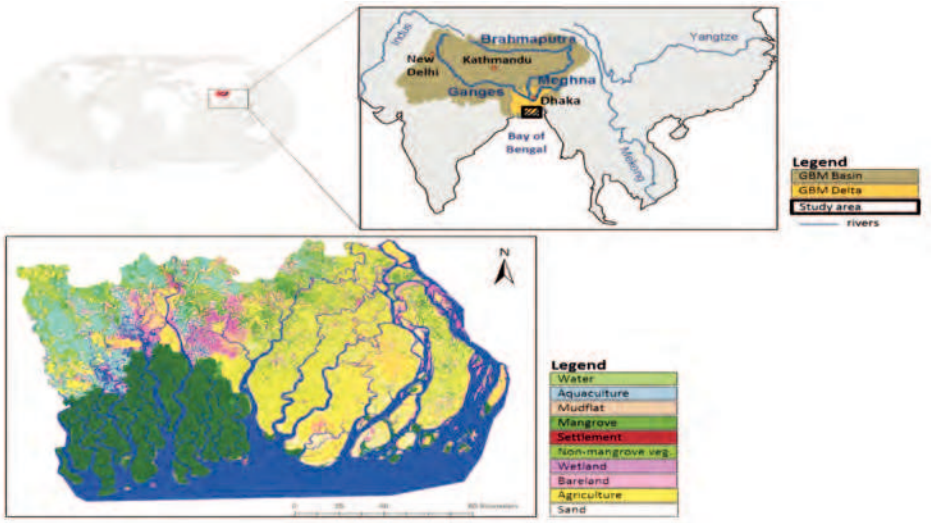

Figure 1: Location and land cover of the study area within the overall Ganges-Brahmaputra-Meghna Delta and wider region.

Drivers of coastal change in South-West Bangladesh

The Ganges-Brahmaputra-Meghna (GBM) Delta is one of the world's most dynamic and significant deltas (Figure 1). The total population is in excess of 100 million people in both Bangladesh and India (West Bengal). The source of the Ganges and Brahmaputra rivers is in the Himalayas and freshwater travels through five countries (China, Nepal, India, Bhutan, Bangladesh) before reaching the GBM delta and the Bay of Bengal. The delta is changing rapidly with a growing urban population including major cities such as Dhaka, Chittagong and Khulna. At the same time, the delta has important ecosystem services which have allowed this large population to be fed and to steadily grow the economy (e.g. intensive rice paddy), as well as being home to the world's largest mangrove forest, the Sunderbans. The study area in Figure 1 is extremely low and flat: the elevation ranges from 1 m on tidal flats, to 1-3 m on the main river and estuarine floodplains. Hence, it is the most vulnerable area in Bangladesh and there is significant poverty of the 14 million inhabitants (>50%, WRI 2005). There are multiple threats from human and climate-induced upstream, deltaic and marine changes, recently receiving international attention due to its high vulnerability to climate change (World Bank 2010) and a succession of major storms and cyclones such as Cyclone Sidr in 2007, Cyclone Aila in 2009 or Tropical Storm Mahasen in 2013. During storm tides and in times of low river flow, salinization is also of major concern.

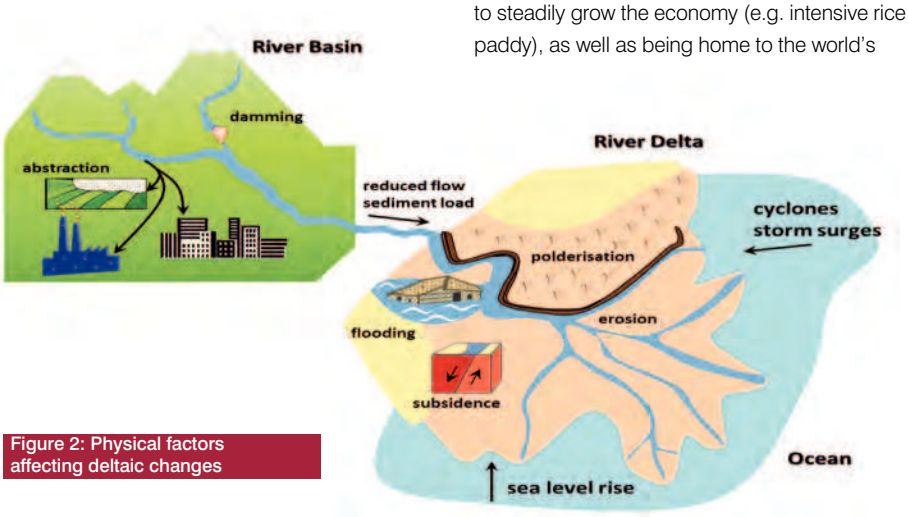

Figure 2: Physical factors affecting deltaic changes

Biophysical Considerations of the Delta

When considering the physical processes (Figure 2), sea level rise, erosion, river floods, cyclones, storm surges, saline intrusion, upstream damming and subsidence affects the morphology of the delta plain (Woodroffe et al. 2006). Relative (or local) sea level rise is estimated to be up to 8 mm/year (Singh 2002) implying significant subsidence (i.e. the gradual sinking of an area), which is alarming although

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this is disputed and needs better definition. Subsidence in Bangladesh is caused by tectonic movements, sediment compaction and anthropogenic changes (e.g. cropping/farming methods, deforestation, urbanisation, etc.). However, the other factors of coastal change might be equally important. Erosion is a consequence of river flows (i.e. bank erosion), waves, and overland flows during heavy rainfall and flooding. River floods mainly occur during the wet season, when a large volume of water is received from the upstream catchments. This results in 10-68% inundation of Bangladesh annually (FFWC, Salehin et al. 2007). Cyclones and storm surges also occur frequently, causing increased erosion, crop/livestock losses and inundation of land with saline water. This further increases the already serious salinity issue, which has a detrimental effect on the agriculture production. If land becomes saline, there is little option what the land can be used for in the future: producing limited saline tolerant crops or turning the field into a shrimp farm. The damming of upstream river reaches and water diversion to irrigation and other uses in India significantly reduce the amount of incoming freshwater and sediment during the dry season, which allows greater saltwater intrusion. This situation is further worsening by polderisation in coastal Bangladesh, where the land is surrounded by embankments to keep the saline tidal sea water and river flood water out of the agriculture fields. The long-term downside of polderisation is that river floods do not deposit nutrient rich sediments on the fields and siltation takes place in the rivers as a result of the decrease in tidal volume during flood tides. Hence, elevation is lost through rise in river bed elevation and subsidence (making drainage more difficult and increasing potential flood depths and waterlogging) and the soil quality gradually decreases unless expensive fertilisers are purchased.

Socio-Economic Context of the Delta

There is growing socio-environmental stress on the delta. Populations are undergoing complex shifts in behaviour with net migration out of the delta region to the main cities. This process is

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complex and a number of factors are involved. Shrimp farming is becoming an attractive option where salinity has risen, but is becoming recognised as a temporary solution with inequitable distribution of benefits away from the poor and progressively landless. Extreme events can cause immediate catastrophic financial situations for families, and there is only a limited safety net for the poorest. However, the growths of flood warnings and cyclone shelters have greatly reduced the death toll during extreme floods and cyclones. Bio-physical processes play an important role in people's lives. Crop productivity, forest goods, fish stocks and arsenic pollution of groundwater resources are directly affecting the livelihoods of the population.

Governance Dimensions

Each component of the ecosystem (i.e. water, fisheries, vegetation, forests and wildlife, etc.) is governed by a different legal regime which will be identified. Laws and institutions rarely include cross-cutting issues and are often confined within sectorial boundaries. This is somewhat compounded by a fragmented legal regime and inconsistencies within laws and regulations. Weaknesses in government planning structures in combination with the heavy reliance on donor funding potentially result in donor initiated projects that are not optimum in achieving national goals and policies.

The ESPA Deltas Project

Environmental change and people's livelihood is complex in deltaic environments. There is a lack of understanding of the relative importance of the above factors. The ESPA-funded "Assessing Health, Livelihoods, Ecosystem Services and Poverty Alleviation In Populous Deltas" project (2012-16, http://www.espadelta.net/) aims to address this gap in a policy relevant way. The project was founded on the recognition of the interaction of the biophysical, governmental and socio-environmental factors unfolding on the delta and has established an integrative research process based upon these three main themes. The project is providing policy makers with the knowledge and tools to evaluate the effects of policy decisions on people's livelihoods in the tidal influenced delta plain. It is being conducted by a multidisciplinary and multi-national team (24 institutes from UK, Bangladesh, India and China) of policy analysts, social and natural scientists and engineers using a participatory, holistic approach to formally evaluating ecosystem services and poverty in the context of the wide range of changes that are occurring. The approach is being developed in the coastal Bangladesh study area (Figure 1) but is designed to be generic and transferable to other deltaic settings. The methodology is built upon a combined system-based conceptualisation of the human-environmental interactions and stakeholder engagement. The four major building blocks of the project are: (1) policy analysis, (2) understanding of social interactions, (3) understanding of the status and changes of the biophysical environment, and (4) integrative modelling of the system using scenarios.

The ESPA Deltas methodology is built on substantial stakeholder engagement and iterative learning throughout the project. There is participatory involvement of stakeholders (from government to civil societies) in all stages of the research starting from the identification of research questions to developing scenarios and exploring these within model frameworks. This ensures trust, interest and willingness to participate. This integrative tool will be used as an iterative learning instrument to explore a range of climate, social and governance scenarios in close collaboration with decision makers. The project will identify perceived critical threats and inform policy makers of the potential benefits of policy changes to promote sustainability, to reduce poverty and to embrace integrated management.

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