

CLIMATE CHANGE AND INFRASTRUCTURE IN BANGLADESH

INFORMATION BRIEF



Photo: IUCN / Abdul Quayyum

KEY POINTS

- The consequences of damage due to climate change to road and rail infrastructures have negative impacts on all economic activities, transportation, income and livelihood of the affected population. The vulnerability of Bangladesh's infrastructure, the national economy, and the welfare of the people will increase if existing infrastructure is not well maintained and if proper adaptation measures are not undertaken.
- These impacts are both short term and long term. This paper highlights these impacts and suggests appropriate adaptation mechanisms to address these issues.
- This paper also looks at existing policy, and suggests areas requiring increased research and action.

INTRODUCTION

Climate Change is no longer something to happen in the future; it is happening now. Bangladesh is one of the countries expected to be worst affected by Climate Change. The combination of frequent natural disasters, high population density and low resilience to economic shocks, make Bangladesh very vulnerable to climatic risks. The Government of Bangladesh is very much concerned about this. Ensuring infrastructure is well-maintained, fit for purpose and able to withstand climate change impacts is one of the six pillars of the country's Climate Change Action Plan.

This policy paper describes the main climate change impacts on rural infrastructure of Bangladesh. The paper focuses on the roads and railways networks and describes possible adaptation options. The objective of this document is to explore how adaptation issues might be considered in transportation planning, project development, operations and maintenance and what are the parameters and technical requirements to support feasible and effective climate change responses. This document has been prepared for policy makers and infrastructure planners.

Due to climate change, the road and rail network will suffer from increased flood and erosion damage, increased fatigue damage (due to exposure to extreme temperatures), increased obstructions by debris after cyclones and storm surges and salinity impacts in coastal areas. As a result, the repair, operations and maintenance costs of rural infrastructure will increase due to the impacts. Also, costs of new infrastructure projects will increase due to higher design standards required to climate proof the new investments.

Roads and Highways Department, LGED, and Bangladesh Railway need to implement climate change adaptation measures smartly. For existing infrastructure, smart adaptation involves identifying key vulnerable locations, evaluating effectiveness of various adaptation options including consulting with local stakeholders, implementing the selected adaptation option efficiently and continually monitoring the performance of the adaptation

measure. Smart adaptation also involves utilizing "green infrastructure" and "no regret" measures as much as possible.

In the past decades, Bangladesh has considerably developed its rural infrastructure. This includes district, regional and national roads and inter-district railway lines (including bridges and stations). These investments have made a major contribution to alleviating rural poverty.¹ Other important rural infrastructures include electricity pylons, poles and wires, telecommunication towers and cables, flood embankments and cyclone shelters, irrigation and drainage systems, water and gas supply system. Important buildings in rural areas include: factories and industries, power stations, schools and clinics, administrative buildings, etc. This policy brief discusses issues related to rural roads and rail lines as these are the main infrastructures in rural areas. Other infrastructures in rural areas are discussed in separate policy briefs, e.g., the policy brief on the water sector addresses issues related to flood embankments, water supply, etc.

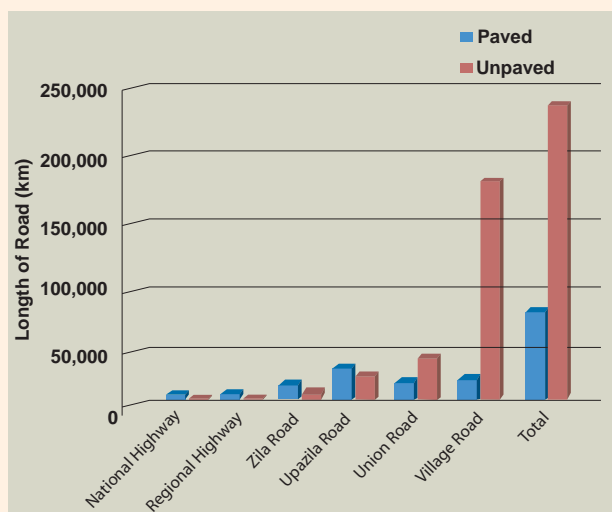


Figure: Total Road Length by Different Types in Bangladesh (2007)²

As shown in the figure above, the majority (over 60%) of road length in rural Bangladesh consists of zilla (district) roads. Therefore, this road category is likely to be impacted by climate change the most.

¹ Khandker, S.R., Bakht, Z. and Koolwal, G.N. (2006). *The Poverty Impact of Roads-Evidence from Bangladesh*, World Bank and Bangladesh Institute of Development Studies.

² Source: www.rhd.gov.bd

IMPACTS OF CLIMATE CHANGE ON INFRASTRUCTURE

Climate change will exacerbate many of the current problems and natural hazards the country faces. Floods, droughts, tropical cyclones and storm surges are likely to become more frequent and severe in coming years. The changes will threaten the significant achievements, Bangladesh has made over the last 20 years and it will make it difficult to achieve the Millennium Development Goals. According to IPCC's 4th Assessment Report, global warming will result in sea level rises between 0.18 and 0.79 meters.³ This has major implications for coastal infrastructure in relation to storm surges and salinity intrusion.

Direct Impacts

- There will be more days with extreme temperatures (hot and cold) compared to the past, which will cause existing road surfaces and materials used in railway system (tracks, signals, etc.) to be worn down more quickly.
- There will be monsoon days with more intense rainfall, which will also cause existing roads and rail tracks to weaken.
- Increased rainfall will lead to more river floods and flash floods that can damage roads and rail lines, including erosion of the embankment on which these infrastructures are located.
- Increased high winds from more frequent and more intense cyclones can cause debris (like trees and electricity poles) to damage and block roads and rail lines.
- More intense cyclones will lead to higher storm surges that can cause damage to roads and rail tracks and their embankments in coastal areas.
- Exposure to saline water from storm surges and flooding by saline river water can cause damage to road surfaces and rail tracks.

Indirect Impacts

- Use of road and rail embankments by people affected by increased natural disasters, such as floods.
- Decrease in maintenance funds due to re-allocation of central budget for other needs, e.g., disaster relief, ensuring food security, etc.
- Increased usage of groundwater, due to lack of surface water in the dry season, can lead to localized subsidence that can damage roads and railways.
- As the impacts of climate change are felt, the demands on the rural infrastructure can shift to less impacted or less vulnerable areas.

As mentioned in the 2005 NAPA, in the future, more roads and rail lines can impede natural drainage in the flood plains, worsening the impact of increased floods caused by climate change.⁴ River flooding is a widespread concern. Extreme temperature issues are expected mainly in the northwest region. Flash floods may increase in the northeast and southeast regions. Near the coast, one can expect salinity, storm surges and cyclone impacts to increase.

RESULTANT IMPACT AND ECONOMIC LOSSES

Future climate change induced high intensity events pose huge threats to existing physical infrastructure. Damage to highways due to flood alone is estimated to be around 1,011 and 3,315 kilometres by the year 2030 and 2050, respectively. The corresponding damage to embankments is estimated to be about 4,271 and 13,996 km by the year 2030 and 2050, respectively.⁵

In a recent study, it was estimated that increased storm surges and growth in the road network, will lead to additional damages of around \$239.5 million to roads, bridges, culverts, etc and a loss of about \$52.7 million in road infrastructures.⁶ These estimates are based on repair and damage costs from the 2007 Sidr cyclone.

³ IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability: Summary for Policymakers. Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report*. IPCC, Geneva.

⁴ MoEF. (2005). *National Adaptation Programme of Action (NAPA)*, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. xvi + 63 pp.

⁵ Climate Change Cell. (2009). *Economic Modeling of Climate Change Adaptation Needs for Physical Infrastructures in Bangladesh*. Climate Change Cell, DoE, MoEF; Component 4b, CDMP, MoFDM. Month 2009, Dhaka.

⁶ Dasgupta, S., Huq, M., Khan, Z.H., Ahmed, M.M.Z., Mukherjee, N., Khan, M.F., Pandey, K. (2010). *Vulnerability of Bangladesh to Cyclones in a Changing Climate: Potential Damages and Adaptation Cost* Policy Research Working Paper, 5280, World Bank.

Apart from the direct damages to infrastructure caused by climate change, there is also loss of revenue (particularly for Bangladesh Railway), cost overruns in implementing existing projects, and socio-economic impacts on staff, premises, coolies (porters), station vendors, etc. during extreme weather events. These temporary impacts can add up to be a significant issue.

In the face of future climate pressures, damage to infrastructure is expected to increase significantly. Impacts to infrastructure which previously remained unscathed by harsh weather conditions indicate that existing structures are increasingly vulnerable to changing climate.

MANAGING CLIMATIC HAZARDS

Mitigation

The government has highlighted mitigation of climate change by reducing reliance on fossil fuels and encouraging the removal of Greenhouse Gases from the atmosphere as one of the pillars of its Climate Change Action Plan.^{7,8} There is scope for incorporating mitigation measures in existing and new infrastructure. For example, to protect embankments carrying roads and railways, trees and other appropriate vegetation can be planted to prevent erosion and weakening of the embankment. These plants will help remove carbon dioxide from the atmosphere and thus contribute to the mitigation effort. This type of mitigation measure can also be a “win-win” investment as it provides other benefits, such as birds and other animals can make homes in the trees. Another mitigation measure is to restrict development of new infrastructure in areas

with high concentration of carbon, e.g., forest areas, organic rich soils, etc. If this cannot be avoided, then the carbon lost should be offset by increasing carbon stores in other areas, e.g., by planting trees.

In the long term, encouraging more passenger and goods transport by train can reduce overall carbon emissions from the transport sector. This will require a policy shift and increased investments in the railway system.

Another way to mitigate climate change is to promote decentralized development throughout the country. This will lead to less transport demand to and from Dhaka, which will reduce carbon emissions from excessive travel using rural infrastructure.

Adaptation

Due to proactive steps by national and international politicians, Bangladesh is now in the international spotlight in relation to adverse impacts of Climate Change. Therefore there is an international effort to help Bangladesh adapt to the impacts. Climate change adaptation measures aim to reduce the severity of impacts on infrastructure and to improve planning and risk management to prevent and respond to climate change effects. Adaptation measures can be physical projects (like strengthening road embankments) or non-physical initiatives (like research, policies and educational programmes). However, in the Infrastructure theme of Bangladesh’s Climate Change Action Plan, there are no specific adaptation programs for rural roads and rails. The following table 1 summarizes adaptation needs for each type of climate change impact.

Table 1: Adaptation Measures for Infrastructure

Climate Change Impact	Adaptation Measure	Additional Requirements
Extreme temperatures	Use stronger materials	Research and technology transfer
More intense rainfall	Use stronger materials Improve surface drainage capacity Increase pumping capacity at high value sites and critical infrastructures Traffic information system for the public	Modelling studies Improve design and construction standards & codes

⁷ MoEF. (2008). *Bangladesh Climate Change Strategy and Action Plan 2008*. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. xvi + 68 pp.

⁸ MoEF. (2009). *Bangladesh Climate Change Strategy and Action Plan 2009*. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. xviii + 76 pp.

Climate Change Impact	Adaptation Measure	Additional Requirements
More river flooding	Raise embankments Stronger erosion protection for embankments (geo-textiles) Increase lead-time for flood forecasting system Increase pumping capacity at high value sites and critical infrastructures Increase river conveyance capacity Increase capacity of drainage structures (culverts, regulators, bridges, etc.) Traffic information system for the public	Modelling studies
Debris damage and blockage	Use stronger material Improve storm and flood warning system Employ emergency response team in key districts	Research, training and technology transfer
Storm surges	Raise embankments Stronger erosion protection for embankments Increase river conveyance capacity Traffic information system for the public	Modelling studies
Saline intrusion	Improve embankment protection Augment dry season river flows	Integrated water resources management
Refugees during disasters	Improve early warning systems Increase shelter capacities Traffic information system for the public	Modelling studies
Localized subsidence	Improve monitoring system	Training

FINANCING ADAPTATION IN THE INFRASTRUCTURE SECTOR

Infrastructure financing will require billions of dollars (Table 2). Structuring financing will need commitment from 3 main stakeholders: the private sector, the public sector and the international development partners. The focus should be to encourage public-private partnership, both local and foreign and to ensure that the right economic and monetary incentives are created for all parties, so that they remain committed and engaged. In this regards, it is crucial to engage experienced professional teams in the early planning stages of the financing structure. The business community will be supportive of any initiative to resolve the infrastructure crisis. Local capital markets can also channel domestic liquidity to an extent if the transaction is structured properly.

There are several bi-lateral and multi-lateral development agencies that have been focusing on infrastructure development finance in Bangladesh. For example, the successful Independent Power Plant financing of Meghnaghat Power was supported by Asian Development Bank (ADB) and the Infrastructure Development Company Limited (IDCOL). Similarly,

Khulna Power Company Limited was financed by International Finance Corporation of the World Bank (IFC). Additionally, IFC, ADB, NORFUND, DEG and EIB have played key roles in financing telecom and large manufacturing setups in Bangladesh. There has also seen interest among export credit agencies like ECGD of UK, Coface of France and Hermes of Germany for implementing projects in Bangladesh. Bangladesh can also look to Middle East and Asia to tap the Islamic liquidity pool for financing infrastructure projects.

Private equity firms also invest in infrastructure development. However equity investors are generally motivated by the GDP growth prospects, government stability, transparency of pricing regime, and credit quality of major off-taker.

Donor agencies and development partners can also focus on capacity building among civil bureaucracy, for improving their understanding about project economics and execution. In a country like Bangladesh, where there is an acute shortage of power and other infrastructural facilities, ensuring transparency, execution support capability and corporate governance can significantly improve the chances of successful implementation of projects.

Table 2: Estimated Amount of Foreign Investment Required for Infrastructure (Source: LCG 2010⁹)

Department/Organization	No. of Projects	Foreign assistance to be required during 6th 5-Yr Plan period (in billion US\$)
Bridges Division	4	3.629
MOS/BIWTA	7	4.178
RHD	23	1.918
LGED	13	1.524
BR	26	3.572
DCC	3	0.47
BRTA	3	0.046
BRTC	8	0.428
MOCAT	1	7.14
Total	88	23.085

The government needs to encourage the development of insurance products by the private insurance industry, such as weather derivatives, catastrophe loss bonds, underwriting of national insurance programmes, etc. Initially, the government can subsidize insurance premiums, so that it is affordable to most businesses and people. Also, insurance policies can include the development of adaptation strategies and policies as eligibility criteria. Further discounts in premiums can be obtained with evidence of effective adaptation measures put in place.

POLICY AND INSTITUTIONAL ARRANGEMENTS

In Bangladesh, there are already several good policies and plans for developing robust and balanced rural road and railway networks that can provide a high degree of mobility, accessibility and safety.¹⁰ These include:

- National Land Transport Policy¹¹ approved in 2004;
- Draft Integrated Multi-modal Transport Policy¹² (IMTP) which covers all transport modes;
- Bangladesh Road Master Plan (RMP) 2007 which provides a physical plan for new road

construction, and rehabilitation and maintenance was prepared for future development and expansion of road network in line with the regional connectivity. Creation of a 'Road Fund' is awaiting approval of the government;

- A 20-Year Strategic Transport Plan (STP) for greater Dhaka;
- A Rural Road Master Plan (2005) is being followed by LGED, which includes the elements of strategic planning for rural road construction, rehabilitation and maintenance and resources requirements for 2005 to 2025;
- 20-year Railway Master Plan is in the final stages of preparation.

There is not sufficient attention given to climate change adaptation in the above policies and plans. Also there needs to be better integration between transport policies with other national policies such as the National Water Policy. Furthermore, there are no specific adaptation programs for rural roads and rail lines in the Infrastructure theme of Bangladesh's Climate Change Action Plan. This needs to be addressed in future updates of the Action Plan.

⁹ LCG. (2010). Development Strategies, Governance and Human Development, Bangladesh Development Forum Meeting 2010, Local Consultative Group.

¹⁰ Ibid.

¹¹ Ministry of Communication. (2005). *National Land Transport Policy*, Government of the People's Republic of Bangladesh.

¹² World Bank. (2009). *Bangladesh Transport Policy Note, Draft Final*, Transport Unit, Sustainable Development Department, South Asia Region.

Institutional Arrangement for Tackling Climatic Havoc (Current and Future Responses of Associated Institutions)

The Climate Change Unit, under the Ministry of Environment and Forest, is the main government organ administering projects financed by the Climate Change Trust Fund. The Roads and Highways Department (RHD) is a lead infrastructure network development agency, which has already established a corridor based road network throughout the country. RHD is also responsible for the operation and maintenance of an extensive ferry system which is being gradually replaced with bridges. The Local Government Engineering Department (LGED), since preparation of rural development strategy in 1985, has been developing the farm to market roads and has made significant progress in this sector. Bangladesh Railway (BR), a state-run transportation agency of the country, has approximately 2,835 km rail lines with 440 stations, 286 locomotives, 1,503 coaches and 10,226 wagons.¹³

National Policy and International Policy Responses to Climate Change

Bangladesh Government is fully committed to take all measures so that climate change is managed in a way that the people are fully protected from its adverse impacts. There are several policy response options that relate to climate change. Direct policy responses include addressing vulnerability to climate variability and extreme events through disaster risk reductions and management schemes; and mainstreaming climate change into sectoral plans and national policies. This has been done through the Bangladesh Climate Change Strategy and Action Plans 2008 and 2009 and the National Adaptation Programmes of Action 2005 and 2008. Indirect policy responses include: reducing vulnerability through poverty alleviation, employment generation, crop diversification, etc. Improving infrastructure is one of the main mechanisms for reducing vulnerability to climate change impacts.

Bangladesh has a Participatory Disaster Management Programme (PDMP) with a focus on disaster management and prevention, and also adaptation to climate change. Other national policies of relevance to climate change include: The National Water Policy (NWP), announced in 1999, followed by the National Water Management Plan (NWMP) in 2001.

Bangladesh has undertaken a number of significant projects and achieved several milestones in the area of climate change.¹⁴

- Signed the UNFCCC on 09.06.1992 and ratified it on 15.04.1994;
- Accessed the Kyoto Protocol on 21.08.2001;
- Participated in the US Climate Change Country Study Program and prepared its emission inventory and vulnerability assessment in 1994;
- Participated in the Asia Least Cost Green House Gas Abatement Strategy (ALGAS) Study in 1995-98. The ALGAS study included the formation of the national GHG abatement strategies consistent with national development priorities, and preparation of portfolio of GHG abatement projects;
- Submitted its first National Communication to the UNFCCC in 2002. Bangladesh has taken up a project titled Bangladesh: Climate Change Enabling Activity "Self Assessment Exercise" as a first step to prepare its Second National Communication in the near future;
- Completed a National Adaptation Programme of Action (NAPA) and submitted it to the UNFCCC in November 2005.

Under the Clean Development Mechanism Bangladesh has established a two tier Designated National Authority (DNA). The tiers are National CDM Board and National CDM Committee. The DNA so far has approved four projects in waste and energy sectors of Bangladesh.

The UNFCCC is an international treaty that came out of the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro in 1992. The UNFCCC addresses what can be done to reduce global warming and to cope with whatever temperature increases are inevitable.

Technology transfer is an essential component of the UNFCCC negotiations and Bangladesh must be prepared in order to maximise the benefits associated with technology transfer. The correct infrastructure and policy environment needs to be put in place in order to facilitate technology transfer and barriers minimised as

¹³ Bangladesh Railway Website, www.railway.gov.bd

¹⁴ Huq S. and Ayers J. (2008). *Climate Change Impacts and Responses in Bangladesh*. Policy Department Economic and Scientific Policy, European Union (EU).

far as possible. Some of the critical elements required for successful technology transfer are as follows:

- The technology must be needs driven and adaptable to local conditions.
- Life cycle management and full cost accounting is essential to ensure sustainability.
- Ownership by users required.
- Support infrastructure is required.

One of the main barriers to technology transfer is the high initial capital costs of many climate friendly technologies. In addition, there are a number of institutional and information barriers which the Government has to address before the deployment of climate friendly technologies will become more widespread. These additional barriers include:

- Limited number of skilled human and organizational resources needed to plan and manage the environment and operations involved in the use of technologies.
- Low technical capability of human resources to operate and maintain at reasonably efficient levels.
- Lack of a system of innovation that would allow maintaining or increasing high efficiency levels through incremental technical and organizational changes.

CONCLUSION AND RECOMENDATIONS

The consequences of damages to road and rail infrastructures have negative impacts on economic activities, transportation, income and livelihood of the affected population. The vulnerability of Bangladesh's infrastructure, the national economy, and the welfare of the people will increase if existing infrastructure is not well maintained and if proper adaptation measures are not undertaken.

It is recommended that a computer based Management Information System (MIS) is built for rural infrastructure to help monitor the impacts of Climate Change.

Infrastructure construction codes and standards need to be improved so that new investments are "climate proofed". Action needs to be taken now as the construction industry, building codes and standards change slowly. Professional bodies should be legislated to guide these changes, with guidance and assistance from international bodies (such as the International Standards Organization).



Ministry of Environment and Forests
Government of the People's Republic of Bangladesh

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