Non-structural Measures for Climate Change Adaptation of Urban Areas in Coastal Bangladesh

Disaster Risk and Flood Management in Barisal City

Michaela Fischer
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Water Management/Delta Management
Graduation Research

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Summary

Floods and cyclones are major problems at the coast of Bangladesh and expected to increase. Climate change adaptation measures therefore are urgently required. Barisal City is located in the coastal zone and plays an important role as regional centre for the surrounding. Barisal City is focus point of this research on non-structural measures to reduce flood and cyclone vulnerability in urban areas of coastal Bangladesh.

Compared to the rural surrounding – which is classified as extremely poor, Barisal is a ‘better-off’ area. However urban planning and management is challenged, frequent flooding and waterlogging affect economic growth. In order to ensure an integrated approach a holistic typology for disaster risk and flood management is introduced. The area is analysed with the help of maps and literature - current policy strategies on national and local level have been studied. Qualitative research in the form of coding was used to gain information on common problems in the field of Disaster Risk Management.

Barisal City is currently already located in a ‘high risk area’ for cyclones and storm surges, there is no big scale flood protection like polders. Disaster preparedness in the form of cyclone shelters do not exist. Frequent water logging and seasonal flooding interrupt business, school and government. Flooding occurs due to water logging in the urban center when the drainage system is blocked. The western part of the urban core is located lower and therefore more prone to flooding. The rural surrounding is located lower as well: the khals (channels) drain water from the river in the east during high discharge periods to the west, where it drains finally towards the south-west. Informal settlements are scatter but often located along the river and the khals. Embankment erosion but also channel encroachment and waste accumulation enhance flooding and water logging. Most vulnerable to cyclones and storm surges are inhabitants of informal settlements and poor housing due to a lack of shelter.

Effects of bio-physical drivers of change on the project area are currently uncertain, especially planned hydropower dams in India might change the circumstances drastically. Predictions on an increase of cyclone activity are uncertain while an increase of precipitation and cyclone induced rainfall, land subsidence and sea level rise is more certain according to scholarly literature. As a consequence the measures should be adaptive and should also contribute to other goals, e.g. poverty reduction or sanitation to improve the quality of living in poor settlements.

The Master Plan Barisal 2010 (MP2010) lists problems and points out directions to solve them according to modern urban development principles. Development control is one of the most important tools, especially for flood management, and described in the MP2010 but only for the urban core area. A higher tier authority for urban planning needs to be established in order to implement the plan. This is currently considered as a major problem for the effectiveness and efficiency of the MP2010. The flood and water logging problem and different solutions are mentioned in the plan. However, prioritized projects are to a large extent road development projects. If disaster risk and flood management is included in new road development projects is not clear but there is indication that in general in Bangladesh local road construction projects do not require any preconstruction assessments. Disaster Risk Management is missing in the plan. Participatory resettlement projects for slum areas with compensation - described very detailed -
might be a good possibility to reduce vulnerability to flooding. From the Master Plan it becomes clear that urban development and municipal services face many difficulties, institutional capacities are low. Insufficient waste management decreases drainage capacities. Commitment, time and good urban governance is needed to realize the Master Plan Barisal 2010.

The review of literature on national policies showed examples of best practice but also that mainstreaming and nationwide implementation of Disaster Risk Management remains a challenge. The insights gained, lead to the conclusions that polices to a large extent, are not implemented on the ground. Main problems are institutional capacities, funding and coordination.

Hence, additional non-structural measures to reduce flood and cyclone vulnerability are suggested which [1] introduce synergies while fostering additional benefits to justify investments under uncertainty, and [2] do not rely heavily on governmental institutions and enforcement of law, but are connected to financial incentives and revenue models.

The suggested project example is briefly explained at this place. To decrease the vulnerability especially to storms and storm surges for inhabitants of poor housing a cyclone shelter is one of the few suitable measure. As day to day use, the shelter facilitates

A) a waste transfer station: registered community members receive a voucher when dropping off source separated waste at the shelter;
B) a ‘bio-centre’, providing public toilets, warm showers and cooking facilities, off-grid solutions for energy production (biogas) and sewage treatment which have been proven a sustainable business model.

The Integrated Community Shelter is an additional measure, next to structural measures which are planned to improve flood management, and next to urban planning instruments which will improve the situation in the long run. The Integrated Community Shelter is an example of sustainable development and combines climate change adaptation with income opportunities and pro-poor urban development.

The introduced DRFM typology (chapter 3.1) can be used as a tool to identify opportunity for improvements or additional measures for urban areas in coastal Bangladesh. Chapter 3.5 presents shortcomings connected to the measures of the DRFM typology in Bangladesh, which have been assessed recently, connected to UN program. These two tables are the core elements of the scientific research, literature has been used to analyse the area (chapter 3.4) and policy strategies (chapter 3.2 and 3.3). Chapter 4 presents the reasoning for the recommended non-structural measures and an integrated project example.
Preface

Water Management has always been crucial to sustain life and - as history shows - was leading to vibrant cities such as the ancient Angkor or the ancient Rome. Nowadays the importance of Water Management increases. The different practices in Water Management are a mix between local problems and solutions, governance structures, resources and many other factors. The Netherlands are a special case and might be the most sophisticated example of Water Management.

Delta Management is a specification of Water Management and looks at the interface between human activities and the highly dynamic environment of coastal areas, especially the delta areas. The characteristics of the Dutch coast and innovative approaches such as land reclamation created a long history of Delta Management. Finding new technologic solutions and establishing suitable governance structures e.g. the Water boards, which created a unique history. Nowadays, Delta Management is required in many countries around the world, due to increasing bio-physical and socio-economic pressure on coastal environment and communities.

With my graduation research I will prove my knowledge and practical skills in the field of Delta Management which I have gained during my Bachelor studies at the Delta Academy, HZ University of Applied Science.
Acknowledgements

For the possibility to contribute to the project and for the experience gained during my Graduation Research I want to thank Manfred Wienhoven and Gerbrand van Bork for supervision, furthermore I want to thank the experts and specialists which I met at the company and in meetings for sharing knowledge and supporting me during my research and Mr. Wadud Bhuiyan for his local knowledge and his feedback. Special thanks to Pascal Sijstermans and the whole team of the Delta Academy, especially the Delta Management department. For feedback I also want to thank Kamonashish Haldar from Bangladesh and Evelien van der Kuil (Twynstra Gudde). Furthermore I want to thank prof.dr.ir. Grietje Zeeman and the ETE department of the University of Wageningen for education and inspiration in the field of Urban Environmental Management.
About Ecorys

At Ecorys we aim to deliver real benefit to society through the work we do. We offer research, consultancy and project management, specialising in economic, social and spatial development. Focusing on complex market, policy and management issues we provide our clients in the public, private and not-for-profit sectors worldwide with a unique perspective and high-value solutions. Ecorys’ remarkable history spans more than 85 years. Our expertise covers economy and competitiveness; regions, cities and real estate; energy and water; transport and mobility; social policy, education, health and governance. We value our independence, integrity and partnerships. Our staff comprises dedicated experts from academia and consultancy, who share best practices both within our company and with our partners internationally.

Ecorys Netherlands has an active CSR policy and is ISO14001 certified (the international standard for environmental management systems). Our sustainability goals translate into our company policy and practical measures for people, planet and profit, such as using a 100% green electricity tariff, purchasing carbon offsets for all our flights, incentivising staff to use public transport and printing on FSC or PEFC certified paper. Our actions have reduced our carbon footprint by an estimated 80% since 2007.

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Glossary

**Structural Measures:** Any structural construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems.

**Non-structural Measures:** Any measure not involving structural construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

United Nations Office for Disaster Risk Reduction

**Disaster Risk Management:** The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

**Disaster Risk Reduction:** Disaster Risk Reduction (DRR) aims to reduce the damage caused by natural hazards such as earthquakes, floods, droughts and cyclones, through an ethic of prevention.

United Nations Office for Disaster Risk Reduction
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<td>BCC</td>
<td>Barisal City Corporation</td>
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<td>BBS</td>
<td>Bangladesh Bureau of Statistics</td>
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<td>CCA</td>
<td>Climate Change Adaptation</td>
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<td>DM</td>
<td>Disaster Management</td>
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<td>DMC</td>
<td>Disaster Management Committee</td>
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<td>DRFM</td>
<td>Disaster Risk/Flood Management</td>
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<td>DRM</td>
<td>Disaster Risk Management</td>
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<td>DRR</td>
<td>Disaster Risk Reduction</td>
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<td>GoB</td>
<td>Government of Bangladesh</td>
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<tr>
<td>HFA</td>
<td>Hyogo Framework of Action</td>
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<tr>
<td>MLS</td>
<td>Multilayer Safety concept</td>
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1 Introduction and Background

This chapter introduces the graduation company, the project, and leads with the problem description to research objective and the research question.

1.1 Background

Most deltas are densely populated, especially in Asia where urbanisation has led to mega-cities. The frequency and strength of cyclones, torrential rain, therefore water logging and floods seem to be on the rise, while drainage systems are insufficient or non-existent (Rahamn & Tiwari, 2013). In the Ganges-Brahmaputra-Meghna Delta floods are a permanent threat. Most of the delta is still active with unstable river branches. Upgrading of the flood safety is urgently needed. On average every ten years more than 50% of the biggest delta in the world is flooded (Delta Alliance, 2010). Due to planned investments of the German Development Bank KfW in Barisal City Corporation, the consultancy company Ecorys is leading research how to reduce flood and storm vulnerability. The project area is located in the coastal zone of Bangladesh where floods and cyclones happen frequently, e.g. Sidr in 2007.

Figure 1: BCC (red), Barisal District (green),
source: Master Plan Barisal (Structure Plan, 2010)

Along with the design of different structural measures to reduce the flood risk, the expected improvements are evaluated economically with a Cost-Benefit Analysis. The project also includes the identification of cost-efficient and feasible measures in the form of non-structural interventions. Policies such as land use planning or resettlement projects can be effective approaches to reduce vulnerability of people. The topic of my graduation research is non-structural measures in urban areas for disaster risk and flood management (DRFM). At the example of Barisal City possibilities will be identified how non-structural measures can support the existing measures and new structural measures.
1.2 Graduation Company

The company - Ecorys Nederland BV - offers expertise in research, economic evaluation and advice for social or spatial developments, technical assistance and capacity building. Ecorys was founded in 2010 by a consortium of European consultancy agencies with a policy research history dating back to 1929 and is the first dedicated policy research and consultancy company in Europe. The head-quarter is located in Rotterdam, Ecorys is operating in more than 100 countries, including Russia and Asia. Clients of Ecorys are mainly from the public sector, for example institutions of the European Commission or national governments. Like in the Barisal case, often local experts from the project area are involved. Furthermore two other Dutch companies - Witteveen+Bos and Twynstra Gudde - are working in a consortium with Ecorys.

1.3 Problem Description

Barisal City Corporation (BCC) is local governmental authority of Barisal, one of the biggest cities of Bangladesh. Located in the coastal region of Bangladesh it plays an important role for the surrounding rural area. Urban development and management in BCC experiences difficulties, which results e.g. in high numbers of poor settlements. One of the main problems is waterlogging. The insufficient drainage capacities of the Kirtankhola River and the khals are further exacerbated due to channel encroachment in informal settlements and accumulation of solid waste (Rahman & Tiwari, 2013). From an economic point of view BCC experiences difficulties as well.

To improve the overall socio-economic situation the Master Plan Barisal (MP2010) was developed and published in 2010. Establishment of institutions e.g. for urban planning and capacities for urban management is required. Measures on Disaster Risk Reduction (DRR) and flood management are not included. In general and in Barisal city capacities of local governmental institutions are low and coordination of projects and funding is challenging (GoB/HFA/2015; Structure Plan/2010). To improve existing settlements, moreover for the integration of Disaster Risk Management (DRM) and Climate Change Adaptation (CCA) into new developments, coordination and institutional capacities are crucial. In the MP2010 it is stated that the implementation of the plan is only possible if a new ‘Higher Tier’ institution for urban planning is established (Structure Plan, 2010).

Thus there is an urgent problem how to reduce the vulnerability due to cyclones, extreme floods and especially the frequently occurring water logging with the required short and medium term results.

1.4 Objectives of the Research

The goal of the project of Ecorys is to tackle the problem of flooding from the river or due to water logging from monsoon rain and terrestrial rains and secondly to improve disaster risk management connected to storms and storm surges. My graduation research is linked to the project of Ecorys and therefore to the same scope.

The overall goal of this research is to improve quality of life for inhabitants of Barisal city. It is not enough to consider current basic needs, building capacities to improve livelihoods and facilitate economic growth is required. According to sustainable development and the holistic approach of my studies Delta Management, the research is conducted in an integral manner. The German Development Bank KfW, as development partner of Bangladesh and also the Government of Bangladesh (GoB) are interested in upscaling the findings to improve the situation in other coastal cities. This research therefore consist of

1.) an integrated typology to reduce urban flood and storm vulnerability at the coast of Bangladesh by using structural and non-structural measures, and
2.) a list of suitable non-structural measures and a specific project example for BCC.
1.5 Research Question

The research question has three sub-questions which will lead to the products explained above, and finally provide an answer to the main question.

<table>
<thead>
<tr>
<th>Which non-structural measures decrease vulnerability to storms and floods in Barisal City Corporation in Bangladesh?</th>
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<tbody>
<tr>
<td>1. Which are most important structural and non-structural measures to reduce storm and flood vulnerability for urban areas of coastal Bangladesh?</td>
</tr>
<tr>
<td>2. What are the most important national and local policies considering climate change, disaster risk management and development, and what can be concluded on effectiveness and efficiency?</td>
</tr>
<tr>
<td>3. Are there possibilities for alternative or complementary non-structural measures, how would a portfolio of non-structural interventions look like and what is a suitable implementation strategy?</td>
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The focus of the research concerns disaster risk and flood management (DRFM) and will result in a recommendation of non-structural intervention measures. Therefore first a typology of measures will be introduced, than the input of area analysis, policy review and an assessment framework will support the recommendation of measures and a project example.

1.6 Demarcation and Weaknesses of the research

An integrated approach requires a wide perspective and a good understanding of the area and the specific problems. However the time period for this research is limited to 4 months. Policy review and area analysis is retrieved from literature and remains on a superficial level. The policy review focuses on Disaster Risk Management (DRM). For the identification of additional non-structural measures this is a suitable method, additionally an expert opinion will be added to the research in the form of an interview.

The research seeks to identify shortcomings and room for improvement for non-structural disaster risk and flood management (DRFM) measures in Barisal City. The assessment framework is based on a document which summarizes the current situation and problems in DRM in Bangladesh, further research is required to approve the findings in the case of Barisal. Due to the short time of the research, stakeholder involvement was not possible, however this problem is tackled with interviewing and expert who is familiar with the project area.

The following elements have not or only briefly been considered during this research:

- Health Sector
- Possibilities of Funding
- Food Safety
- Measures for Rural Areas
- National Water Management Policies

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1 This research is contributing to the project of Ecorys and therefore has the same scope: river flooding and floods due to terrestrial rain and monsoon rain, water logging, cyclones and storm surges. To make it more readable the word disaster is used without any further explanation; e.g. the term 'Disaster Risk and Flood Management' (DRFM) is used
2 Research Methods and Plan of Approach

In this chapter the used research methods, sources and the operational framework are introduced.

The research is looking into non-structural measures for DRFM. Examples such as land-use planning or emergency planning are important tools to reduce damage and disaster risk. Due to severe floods and devastating cyclones in the past, policies and frameworks for DRM have been introduced and elaborated. Some of the most important guidelines and frameworks will be included in the analysis. Furthermore understanding and knowledge on the project area is necessary. Information on bio-physical and socio-economic aspects is available to a large extent online from scientific research, especially on the topic of climate change for the coast of Bangladesh, but is also covering other required knowledge areas. Local characteristics can be understood e.g. from the problem analysis in the MP2010, and from meetings and discussions with experts in the project environment.

One of the main activities for this research is consequently literature review. Furthermore secondary data analysis in the form of coding is used to create an assessment framework. Interviews with experts will be conducted afterwards in order to verify the findings or to add another perspective. Due to the scope of the research one but maximum three expert interviews will be included. The product of the research is a report showing different aspects (area analysis, current policies and problems and new structural measures) which result in recommendations for possible improvements of non-structural measures. Source investigation in form of a desk research and a detailed explanation of the operational framework are presented in App.1.

Methods:
- Qualitative Research
- Literature Review
- Expert Interview

Figure 2: Operational Framework, own drawing and content
3 DRFM Typology and Assessment of Measures

In this chapter the DRFM typology is introduced which will provide an overview of possible measures. In chapter 3.5 the findings of the qualitative research (coding) are presented: shortcomings and gaps in DRM in Bangladesh. After considering the characteristics of the project area (policy and area analysis), suggestions on possible improvements and a project example will be presented (chapter 4).

3.1 DRFM Typology

The DRFM typology is introduced for the purpose of this study, combining measures to reduce vulnerability to floods and cyclones for urban areas in coastal Bangladesh.

3.1.1 Structure of the Typology

The Dutch ‘Multi-layer Safety concept’ (MLS) was used as a starting point. The flood safety concept is highly recognized amongst experts for its completeness: the combination of probability-reduction and loss-reduction measures (Hoss, 2011). Similar to the MLS the typology provides different levels, however the situation in the two countries is not the same, which needs to be considered. While in The Netherlands land reclamation and construction of polders resulted in flood prevention, in Bangladesh monsoon climate and frequent floods require adaptation. The main difference between the MLS and the DRFM typology is the scale. While the MLS considers a larger scale and regional measures in the first layer - applicable to the situation in The Netherlands – the DRFM typology is focusing on a city scale approach. Secondly the risk of cyclones is added.

The structure is integrated and accounts for different approaches – Disaster Risk Reduction (DRR) as well as Disaster Management. Disaster Management is in particular the preparedness short before, and response and recovery after an impact (cyclones, storm surges and disaster resulting from flooding or water logging). Disaster Risk Management includes Disaster Risk Reduction and Disaster Management (DM).

The typology has two layers, structural measures and non-structural measures, disaster management is considered a non-structural measure. Furthermore a distinction between key measures (KM) and support measures (SM) was made. Key measures are directly connected to DRFM, support measures are related to implementation or necessary capacities. The research aims to recommend a suitable implementation strategy along with a project example, therefore the distinction between KM and SM is added.

An additional aspect is stressed in the typology, time: the measures need to show improvements in DRFM soon. Regional planning and land use planning as important measures for DRR/CCA in The Netherlands, do not have the same preconditions considering institutional and financial resources in Bangladesh. These instruments might need time to show results on the ground, e.g. building codes for cyclone robustness. Assumptions on the expected time span for results are added to the typology for the key measures: short/medium/long-term or n/a (not applicable) mainly for support measures.
3.1.2 Literature and Sources

Manifold guides and frameworks for measures are available from different platforms and institutions, especially on water management. Floods can be avoided, cyclones not. For cyclones mainly robust constructions and aftermaths are important. Different sources have been reviewed in order to identify suitable measures and to design the typology:

- Hoss et al. (2011): A comprehensive assessment of Multi-layered safety in flood risk management

Table 1: DRFM Typology, Structural Measures

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<tr>
<th>Layer 1: Structural Measures</th>
<th>Measures</th>
<th>Examples</th>
<th>Expected time span for results</th>
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<tr>
<td>Flood and/or Cyclone</td>
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</tr>
<tr>
<td>F</td>
<td>Structural Measures (KM)</td>
<td>-Construction of Dikes, Embankments etc. -Resettlement</td>
<td>short/med</td>
</tr>
<tr>
<td>F</td>
<td>Flow Diversion Water Retention (KM)</td>
<td>-Redistribution of Discharge Upstream -Re-Naturalization -Lowering of Urban Green Areas -Construction of Green roofs or Reservoirs</td>
<td>short/med</td>
</tr>
<tr>
<td>F</td>
<td>Increase Drainage Capacity (KM)</td>
<td>-Improve Drains &amp; Conveyance -Increase of Pumping Capacity</td>
<td>short/med</td>
</tr>
<tr>
<td>F/C</td>
<td>Robust Construction of Infrastructure / Buildings (KM)</td>
<td>-Rising of road level -Flood proving of Critical Infrastructure -Providing Suitable Building Materials -Up-gradation &amp; Retrofitting for DRR</td>
<td>med</td>
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</table>

The expected time span and the distinction of KM and SM can include different view points and are depending on certain circumstances / scenarios. I refined my distinctions after discussions with experts and according to my own insights throughout my studies and the graduation research.
Table 2: DRFM Typology, Non-Structural measures

**Layer 2: Non-Structural Measures**

### A) Flood Management & Disaster Risk Reduction

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<tr>
<th>Measures</th>
<th>Examples</th>
<th>Expected time span for results</th>
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<td><strong>Regulation &amp; Policy Frameworks</strong></td>
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| F/C Development Policies (KM) | -Land use Planning  
-Compartmentalization  
-Enforcement of Building Codes  
-Preconstruction assessment for roads | long |
| F Protection/Utilization of Ecosystem services (SM) | -Water Retention in Ponds/Nature Areas  
-Protec unsealed surface for Groundwater Management | med |
| F/C Mainstreaming of CCA (KM) | -Develop/Increase Disaster Risk Financing according to Changing Risk Profile  
-Address the DRR/CCA Intersections  
-Institutionalization, Cross-cutting Actions | long |
| **Capacity Building & Research** | | |
| F/C Institutional Capacities (KM) | -Improve Equipment/Training  
-Funding for programs/projects  
-Development of Mechanisms/Instruments, Monitoring/Assessment Procedures, Transparency/Anti-corruption | med/long |
| F Pollution Control (KM) | -Solid Waste Management  
-Waste Water Treatment, e.g. Dual-Drainage Concept | short/med |
| F/C Research and Innovation (SM) | -Use Action-based Research  
-Coordination of Research/Dissemination | n/a |
| **Coordination & Communication** | | |
| F/C Partnerships & Cooperation Stakeholder Involvement (SM) | -Improve Regional / River Basin Management  
-Use Public Private Partnerships  
-Facilitate Community Based Approaches | n/a |
| F/C Public Awareness, Education (KM) | -Information / Knowledge sharing  
-Awareness Rising  
-Facilitate Community Resilience | med |
| **Market-based Instruments** | | |
| F/C Subsidies/Taxation Income Opportunity (SM) | -Support of Low Income Families  
-Identify ‘Inclusive Business Models’ | n/a |
The DRFM typology can be used as a tool to identify opportunities for improvements or additional measures for urban areas in coastal Bangladesh. Chapter 3.5 presents shortcomings connected to the measures of the DRFM typology in Bangladesh, which have been identified in an assessment, GoB/HAF, 2015. These two tables are the core elements of the scientific research, literature has been used to analyse the area and policy strategies for further analysis and to conclude on recommended measures and a project example.

### B) Disaster Management

<table>
<thead>
<tr>
<th>Key Measures</th>
<th>Examples</th>
<th>Expected time span for results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before F/C</strong></td>
<td></td>
<td></td>
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<tr>
<td>Emergency Planning &amp; Preparedness (KM)</td>
<td>-Construction of Escape Routes &amp; Shelters (combined with Early Warning)</td>
<td>med</td>
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<tr>
<td></td>
<td>-Involve Community in Disaster Management</td>
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<td></td>
<td>-Regular check-up and Maintenance of Emergency Stocks</td>
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<td></td>
<td>-Increase Technical Solutions and Skills for Communication during Disasters</td>
<td></td>
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<tr>
<td><strong>Flood/Storm Forecasting &amp; Early Warning Messages (KM)</strong></td>
<td>-Introduce of Monitoring/Forecasting Technology/Skills and of Mass Communication Systems e.g. Radios</td>
<td>med</td>
</tr>
<tr>
<td></td>
<td>-Up to date Information for Civilians &amp; Recommendations of Actions e.g. before Event</td>
<td></td>
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<tr>
<td><strong>After F/C</strong></td>
<td></td>
<td></td>
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<tr>
<td>Response Measures (KM)</td>
<td>-Coordination of NGOs/Disaster Management Committees</td>
<td>n/a</td>
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<td></td>
<td>-Damage Assessments and Resource Allocation</td>
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<td></td>
<td>-Contingency Funding</td>
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<tr>
<td><strong>Flood and Disaster Recovery, Re-organization &amp; Rebuilding (KM)</strong></td>
<td>-Introduce Transparent and Standardized Compensation Procedures</td>
<td>med/long</td>
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<tr>
<td></td>
<td>-‘Build Back Better’</td>
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<td></td>
<td>-Resettlement Plans</td>
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</table>
3.2 National Policies and Frameworks

Literature and policy documents were reviewed and are briefly summarized below. In Bangladesh development is traditionally planned centrally. Hence, the two most important development policies are included. CCA and DRM are partly overlapping topics but due to the history of Bangladesh in disaster management, DRM is more established in public policies than CCA. The focus of the literature review is therefore on DRM, and tries to answer the question:

- What are goals and approaches of the most important national policies?
- What are the main problems in CCA and DRM according to recent policy research?
- What can be concluded on implementation, on the effectiveness and efficiency of DRM and CCA policies on the national level?

As a disaster prone country Bangladesh has extensive policies and outlines for disaster management, the climate change strategy and the current development framework are introduced as well. Five different policy studies have been used: Hedger (2011), Adaptation Partnership (2011), Luxbacher & Abu (2011), Haque and Uddin (2013), and the self-assessment of the GoB on DRM (GoB/HFA, 2015). Below the policy documents are listed:

- Outline Perspective Plan (Vision 2021)
- The Sixth Five Year Plan
- Bangladesh Climate Change Strategy and Action Plan
- Comprehensive Disaster Management Programme (CDMP)
- Standing Orders on Disasters – SOD

3.2.1 Development Policies

Two important policies for development are briefly introduced.

The Outline Perspective Plan, better known as ‘Vision 2021’ is a guideline and provides investment planning for yearly development. DRR is included and stated as a sub-goal, the document explicitly formulates the ‘need for integrated DRR and CCA in all new developments’ (GoB/HFA, 2015). According to the goals, the focus is poverty reduction:

“Access to productive asset opportunities for the property-less and marginalized groups, Corporate ownership rights for workers and the deprived, Safety nets for vulnerable groups, Ensuring gender equality, Provide minimum guaranteed employment opportunities for the resource-less, Targeted programs for the structurally challenged, Economic and social inclusion of minorities, Guaranteed access to educational and healthcare opportunities for the resource-poor and minorities, Promotion of cultural, religious and ethnic diversity as a national heritage and Reduced regional inequality” (GoB, 2010c).

The Sixth Five Year Plan (2011-2015) clarifies the operational details to reach development goals. Considering disaster management it supplies specific recommendations to include disaster risks in sectoral plans and investments. And the GoB is preparing an integrated plan, a roadmap for the coastal zone: “Through programs in agriculture, environment, climate change and disaster management, the Sixth Plan will seek to reduce the vulnerabilities of Barisal and other coastal belt regions” (GoB, 2011 p. 6).

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3 The term ‘Disaster Management’ is used in public policies in Bangladesh in the meaning of Disaster Risk Management in this research.
Currently the GoB is working on an integrated coastal zone management plan. High level development policies recognize the need of integrating DRR/CCA. It is also the goal of the Comprehensive Disaster Management\(^3\) Plan (CDMP), to integrate DRR and CCA into development policies and planning of all levels of governmental institutions (GoB/HFA, 2015) A list of policies in which DRM was included is presented in App.2, further explanations follow in chapter 3.2.4. At this stage conclusions on effectiveness and efficiency of DRM elements in development policies cannot be made.

### 3.2.2 Climate Change Adaptation

The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) from 2009 is the key policy framework for CCA, replacing all earlier policies and plans. The BCCSAP focuses on “(a) food security, social protection and health; (b) comprehensive disaster management\(^3\); (c) infrastructure development; (d) research and knowledge management; (e) mitigation and low-carbon development; and (f) capacity building and institutional strengthening” (MoEF, 2009)

The Ministry of Environment and Forest drafts policy documents and is responsible for coordination and technical lead. In 2010 a new department was established, which is planned to become the operational institution: The Department of Climate Change (MoEF, 2009).

During the 1990s first studies on climate change came up in Bangladesh, followed by early CCA projects, however policy initiatives only came into being in the 2000s (Adaptation Partnership, 2011). As mentioned before, Bangladesh has a long history of coping with disasters. Over US$10 billion have been invested in the last 30 years for more resilience against floods, river erosion, cyclones, tidal surges and other extreme weather events (CIF, 2010). In 2007 when devastating cyclone Sidr hit the coast of Bangladesh, early warning systems and cyclone shelters helped to reduce the number of fatalities (World Bank/2010a, CIF/2010).

According to the literature reviewed, the key problems are funding availability and coordination and the management between the different governmental departments.

The Adaptation Partnership (2011) reviewed projects, out of 44, 34 aim at adaptation to climate change and will be implemented in the next 10 years: Large scale and national wide programs are implemented or planned, resulting in community level pilot projects mainly on risk reduction, policy formulation, and the integration of CCA and water related topics; less focus on CCA projects in coastal zones, urban areas and infrastructure. Further results of the review: Two new funding programs are established for BCCSAP-projects: the ‘Climate Change Trust Fund’ and the ‘Bangladesh Climate Change Resilience Fund’. The government and development partners are “…on a learning curve with respect to fine tuning their operational modalities” (Adaptation Partnership, 2011p.73). The 34 CCA projects are distributed evenly (a-f), but due to lacking capacity, the processing of project applications is delayed. Furthermore a relatively low funding limit per project results in fragmentation: US$ 3.5 million per government implemented project and US$ 0.7 million for projects suggested by NGOs. The explanation of the GoB for this strategy is to improve knowledge and capacities while handling smaller projects, later on big projects can be implemented, e.g. subsidized by global funds (Adaptation Partnership, 2011).

Merylyn Hedger includes also parts of the Comprehensive Disaster Management\(^3\) Programme (CDMP), into her analysis of CCA. In the research on climate financing and development cooperation in Bangladesh from 2011, she comes to the conclusion that it is now important that CCA is supported by institutional capacities and to focus on the realization of projects. To achieve this and to avoid further fragmentation, the GoB and development partners need to work together and coordinated. Further problems identified are coherency of data collection on past and current projects, and to provide an overview what has been done so far. The prioritization of required CCA
projects is necessary to allow development partners a fast start. The inclusion of climate change into the development planning process needs to be strengthened (Hedger, 2011).

Coordination seems to be the major challenge at the moment in two ways: Firstly the management of different projects and funding - partly supplied by development partners, secondly including CCA horizontal into the different sectors, and vertical into the different levels, remains difficult. Only then CCA can be facilitated on the ground and on a countrywide scale and be effective.

3.2.3 Disaster Risk Management

Bangladesh is dealing with devastating floods and cyclones already for a long time which resulted in investments for dykes and flood management schemes, early warning systems, cyclone and flood shelters (World Bank, 2010a). Devastating floods happened in 1987 and 1988, a tropical cyclone killing 140,000 people in 1991. The first Standing Orders on Disasters (SOD) was published 1997, the latest version in 2010. The SOD coordinates roles and responsibilities of various ministries, committees and other actors and represent the legal framework (GoB, 2010b). In a self-assessment of the GoB considering progress in DRR, the Hyogo Framework of Action, it is mentioned that the SOD needs to be implemented on local level by Civil Society Organizations 4. The Ministry of Food and Disaster Management 3 is the leading agency for DRM. Due to the devastating incidents during the 1990ties a shift from reactive to proactive disaster management took place, which was stated for the first time in the ‘Comprehensive Disaster Management Programme 2003’ (CDMP). This paradigm shift was supported by United Nations Development Program (UNDP) and continued with the participation of Bangladesh at the Hyogo Framework for Action 2005-2015 (HFA), (Luxbacher&Abu, 2011). The CDMP has two phases, 2004-2009 and 2010-2014, phase I included institutionalizing of DRR and the establishment of frameworks and had a total budget of US$ 27.12. Pilots in 7 of the 64 districts were initiated, policy and planning systems were rolled out, moreover capacities were increased to support functions of several key institutions, e.g. the Ministry of Food and Disaster Management 3, Fire Service and Civil Defense and the Geological Survey Department (GoB, 2009). CDMP II is a ‘vertical and horizontal expansion’ (GoB, 2009 p.16), the mainstreaming of DRM among ministries and governmental bodies.

Luxbacher&Abu (2011) recognized the following problems for the CDMP: Natural disasters and political unrest resulted in initial problems of phase I, also phase II was delayed by the Ministry of Planning. Changes in staff and key ministry personnel affected the continuity of implementation and capacity development programs. According to the authors “a common critique of the CDMP is that it has not had enough impact on the ground to reduce Bangladesh’s vulnerability to natural hazards”. Furthermore, ownership of the project and engagement to take over the extra work required additional advocacy, due to the fact that phase I was designed by UNDP and other donors without sufficient consultation of ministries of the GoB (Luxbacher&Abu, 2011 p.8). The policy assessment of Haque&Udim - based on the response after Sidr in 2007 - questions the efficiency of Bangladesh’s disaster response approach, mainly due to the fact that main actors are NGOs 4. According to the authors, local communities should be the main actor, not only involved participatory in DRM, but be involved in decision making and planning (Haque&Udim, 2013).

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4 Civil Society Organizations include NGOs
According to the literature used for this review the CDMP had initial problems to achieve commitment amongst key actors of the GoB, and it has not enough impact on the ground, however the implementation phase only ended in 2014. The disaster response approach is questioned, citizen should be main actors in disaster preparedness and response, since they are main beneficiaries rather than NGOs/Civil Society Organizations (Haque&Udim, 2013). Further problems for effectiveness and efficiency of national DRM policies are rolled out in the Hyogo Framework of Action (HFA) 2015, summarized in the assessment framework (chapter 3.5).

The National Disaster Management Plan (2010-2015) is focusing on reducing vulnerability of the poor to effects of hazards by (i) bringing a paradigm shift in disaster management from conventional response and relief practice to a more comprehensive risk reduction culture and (ii) strengthening the capacity of the Bangladesh disaster management system by improving the response and recovery management at all levels. The plan is an implementation measure of the Hyogo Framework of Action (HFA) and the SAARC Disaster management framework (2006-2015). The National Disaster Management Plan includes the mandate to implement DRR activities (GoB, 2010a).

3.2.4 Shortly drafted Policy Documents in the field of DRM

The HFA Progress report of Bangladesh provides detailed information on progress, but also on gaps and opportunity for improvement in the field of DRM. Comparing the reports from 2013 and 2015 (the last year of the program) it became clear that a big amount of policies were issued in only two years (GoB/HFA, 2013). Between 2013 and 2015 almost no policy documents were issued in view of DRM (GoB/HFA, 2015). App.2 shows a list of 35 policy documents, published 2010-2012 explicitly on or related to DRM, such as Agriculture, Health, Environment, Livestock etc. Due to the scope of the research it could not be investigated further which of them exactly have impact on the local level. In the period between 2010-2012 a total of 35 policies were published, while during the next HFA-evaluation period 2013-2015, only very few policies considering or connected to DRM were published (GoB/HFA 2015). According to the HFA self-assessment report 2015 a 4 out of 5 was achieved on this indicator. When looking into the shortcomings it becomes clear that efforts on the national level, e.g. drafting a policy document to improve DRM has progressed, but the problem remains that on the local level nothing happens. According to the self-assessment 2015: "Many actors at the local level are not aware of either of these regulatory documents or the roles and responsibilities of various actors." "...There is still a need to raise awareness at the local level on DRR policies, as these have not been well communicated to all stakeholders." "The mainstreaming of DRR into policy has been slow among the GoB directorates and ministries, in particular the education and health sectors" (GoB/HFA, 2015).
Bangladesh is on a good path in view of integration of DRM into policy strategies, and is often mentioned as a positive example in international comparison. Mainstreaming of DRM on the local level requires time and commitment to be effective.

3.2.5 Effectiveness and Efficiency

Bangladesh provides a positive example considering holistic and advanced approaches in DRM frameworks on the national level. There have been significant achievements including institutional reforms, tools and a shift to proactive DRM (Luxbacher&Abu/2011, Bijoy & Chakraborty/2013, Shamsuddoha/2013). The ‘Directorate of Relief and Rehabilitation’ was transformed into the ‘Department of Disaster Management’ which indicates the broader scope and enables the paradigm shift from reactive to proactive. The widened concept of disasters - hazard, exposure and vulnerability - lead to the integration of DRR and CCA into different policy sectors. All this was possible due to efforts and commitments of the GoB and the support by international programs e.g. from United Nations Development Programme (UNDP), the South Asian Association for Regional Cooperation (SAARC) and other development partner.

A problem is the implementation on local level and especially improvements of local institutions, capacities, knowledge and technologies for DRM. Many high level policies were drafted in recent years and are now to come into operation. This requires awareness, knowledge and capacities and commitment amongst the local authorities. So far successful approaches and pilots are limited to only few areas and the implementation remains a challenge in many DRM aspects (GoB/HFA 2015). More detailed information is provided in the assessment framework. Nationwide implementation and mainstreaming of DRM remains a challenge, therefore national policies are not effective or efficient so far.
3.3 Master Plan Barisal 2010 (MP2010)

In order to make suggestions for new or additional non-structural measures, the local policy strategy needs to be reviewed. This short introduction of the Master Plan Barisal 2010 (MP2010) has two different perspectives: The plan was summarized with a focus on DRFM and sectors with a strong link to it, e.g. economy. The second question was “What can be said about the implementation?” Therefore a review of history of planning and own conclusions are given on the presented information.

3.3.1 Structure of the MP2010

The MP2010 is a multi-sectoral vision, highlighting needs and required planning to improve urban management and future developments for Barisal City Corporation (BCC). The objectives of the MP2010 are to “accommodate the growing population and economic activities now and in the future, to promote small and medium enterprises, to oversee and steer spatial and urban development and to improve urban services and facilities” (Structure Plan, 2010). The MP2010 consist out of three plans at different scale, figure 3.

3.3.2 Recent History of Planning

Planning in BCC has a short history, although urban and infrastructure plans existed, they have not been implemented. Barisal was declared a town and headquarter of Barisal Division in 1993. In 2001 the status of a town changed into a metropolis called ‘Barisal City Corporation’. Before the MP2010, two urban plans and two infrastructure development plans were issued. None of the former plans “… can be considered as a comprehensive urban development plan” (Structure Plan, 2010, p.3). Furthermore previous plans were not effective because it was not mentioned ‘…who and how the plan should be implemented’ (Structure Plan, 2010, p. 4). In App.4 short summaries of the former plans are provided. Only the Barisal Master Plan 1990-2010 was drawn up by the ‘Local Government Engineering Department’, other plans and programs were introduced by ministries from Dhaka.

3.3.3 Structure Plan 2010-2030

The Structure Plan is the key source for this review. According to the MP2010 (Structural Plan, 2010), the three plans together (Structure, Urban Area and Detailed Area Plan) form a framework for:

- the development of sectoral master plans
- the development of policies and
- the development of investment programs.
The list below shows the topics, the bold printed topics are related to DRFM. The most important findings are summarized below.

- Population
- Economy
- Spatial Development Strategy
- Housing and Slum
- Community Facilities
- Traffic and Transport
- Infrastructure
- Flood Control and Drainage
- Urban Land Development Policies
- Rural Land Development Policies
- Environment and Disaster Management
- Protection of Common Resources
- Institutional Issues

The Structure Plan sketches measures to facilitate economic growth, which is significant to reduce vulnerability. Economic strength is important in DRFM for two reasons: to increase capacities, especially financial resources among inhabitants and for the area as a whole. Secondly a diversification of economic activities increases resilience to storms and floods. The Structure Plan recognizes the importance of “...ensuring equitable distribution of the growth among the inhabitants” (Structure Plan, 2010, p.19). Next to increasing the agricultural output of the peripheral and rural areas, it is planned to develop farmer markets for local distribution. According to national decentralization policies, BCC seeks to attract industrialists and entrepreneurs. The Structural Plan therefore suggests to the GoB, to formulate a concrete decentralization policy. Furthermore BCC is planning to extend cooperation with the private sector, to increase job opportunities, and to improve human resource development with the means of training programs; furthermore to ensure sufficient power supply, telecommunication and internet infrastructure. Small and medium entrepreneurship will be supported by the development of the tourism sector. The tradition of street trading and services by informal entrepreneurs will be facilitated more safely by introducing growth centres for this purpose.

Spatial Development Strategy is to preserve agricultural land and to protect ecological sensitive areas. A digital elevation model will be used to steer growth pattern of the city, furthermore the plan acknowledges the importance of concentration of build-up area, in order to preserve open space. Future population will be accommodated with infill developments, urban sprawl has to be avoided. As mentioned in the Urban Area Plan 2010-2020, the reason for the “ineffective and limited form of development control” is the absence of an urban plan (2010p.18). Considering future developments and settlements, hazard safe zones are identified (Structure Plan, 2010).

Relocation and up-gradation of Housing and Slum should be realized in participatory processes and with the help of financial support. The enforcement of building codes for construction is mentioned (Urban Area Plan, 2010), however they are from 1993 and probably not sufficient anymore. Moreover “Housing provision should be available for all.” (Structure Plan, 2010 p. 28), therefore financial support should be given to low and middle income groups, to build houses.

Urban Land Development Policies: There is no planning control in BCC, the Structure Plan suggests two new control mechanisms for this purpose: issuing building-, and planning permits. Relocation and up-gradation of Housing and Slum should be realized in participatory processes and with the help of financial support. Community Facilities are envisioned to offer internet-based
information centres for citizen which could be used for communication considering DRFM, e.g. early warning. For **Flood Control and Drainage Development** a main problem is channel encroachment, e.g. due to informal settlements and activities along the channels. This is amplified by uncontrolled waste disposal which reduces the drainage capacity. Approaches to deal with this problem are: rising awareness amongst the population, the drainage channel encroachment law, and to improve waste collection. Additionally the Structure Plan suggests that roads should not block the natural flow of water. To increase storm water storage it is suggested to "identify and conserve big ponds. These water bodies will work as flood retention pond and resource for fish cultivation and vital components to retain ecological balance" (Structure Plan, 2010, p.47). In the chapter **Environmental and Disaster Management** it is only mentioned that the development of policies and regulations are required. An interesting tool for long term water storage and drainage is the obligatory construction of ponds along with new development projects (comparable to the 'watertoets' in The Netherlands): the required soil for rising the new building needs to be taken from the project area itself.

In the last chapter **Institutional Issues** are mentioned, the structuring of governmental departments in BCC is explained: Existing departments are restructured and a higher planning authority will be introduced. The 'Metropolitan Government' will be responsible for: strategic urban planning and management issues, coordination between government agencies or between government agencies and development partner; delegating, preparing and implementing of local projects, especially the one linked to the Master Plan 2010. App.5 shows an overview of the members of the Metropolitan Government, headed by the mayor. Until the Metropolitan Government is in operation, the local governments - BCC and Parisads (sub-disticts) - are responsible for the implementation of the MP2010. The Urban Development Directorate in Dhaka is “empowered to support the implementation…” of the MP2010 (Structure plan, 2010).

### 3.3.4 Urban Area Plan (2010-2020) and Detailed Area Plan (2010-2030)

The Urban Area Plan formulates guidelines and required actions for development promotion and mainly development coordination. The urban area plan is limited to the urban core, therefore does not apply to the entire project area, especially not to the area most affected by informal settlements and urban sprawl. There are two goals mentioned, connected to drainage: increasing awareness for the channel encroachment law and the improvement of waste collection. The suggested method for waste collection is door to door collection and landfilling.

The Detailed Area Plan explains problems and possible solutions for the 'Special Planning Zones'. A list of priority projects, shows a focus on road construction and improvement, two aim at drainage:

- Upgradation of Primary Road PU 01
- Development of different Intersections
- Surface Water Treatment Plant
- **River Protection Retaining Wall and**
- **Drainage Network Improvement Plan**
- Development of ESA 01 as a Multi-faceted Recreational Zone
- Road Upgradation of CU 02
- Road Upgradation of CU 01
- Road Upgradation of CU 03

### Resettlement

Guidance and tools for resettlement are added in the Appendix. By national law, relocation has to be compensated for both, formal and informal settlements. The guidelines are exhaustive, laid out on 32 pages, and even include forms to be filled in by participants.
3.3.5 Findings

The MP2010 is a comprehensive plan, and as stated - builds a framework for sectoral master plans, policies and investments. Problems in BCC are identified, and Goals stated - as briefly suggested solutions. Data collection is only partly presented, however, the MP2010 is based on 16 working paper (Structure Plan, 2010) which most likely include more data. The Plan was prepared according to modern urban planning concepts. The Creation of implementation plans however only focuses on some topics: Road construction and improvement, Resettlement, Urban development control. The last two steps of the comprehensive planning process – Adopting of the Plan and Implementation/ Monitoring of the Plan – cannot be reviewed at this stage. For the purpose of this research - suggesting new or additional non-structural measures - this is not necessarily required.

Development Control is one of the most important tools, especially for flood management and included in the MP2010 but only on the scale of the Urban Area Plan. The higher tier authority for urban planning, the ‘Metropolitan Government’, needs to be established in order to implement the plan. This is considered as a major problem for the effectiveness and efficiency of the MP2010.

In the Structure Plan the drainage problem and different solutions are mentioned. However the prioritized projects are to a large extent road development projects. If DRFM is included in these new road development projects was not investigated further, due to the limited time for the research but there is indication that in general in Bangladesh local road construction projects do not demand any preconstruction assessments (GoB/HFA, 2015). From the MP2010 it also becomes clear that the impact of road construction in general is not assessed, which causes problems during flooding (Structure Plan, 2010). Disaster Risk Management is missing in the plan. From the problem descriptions in the MP2010 it is noticeable that urban planning and municipal services face severe difficulties and institutional capacities are low. Participatory processes are explained for possible resettlements/compensation projects, which could be a good possibility to reduce flood and disaster vulnerability of inhabitants of informal settlements. Compensation is - based on national law - obtainable.

The MP2010 suggests many good solutions for urban development. The next important step for this framework is now commitment at BCC departments, establishment of institutions and further detailed regulatory documents. More participatory planning, involving stakeholder, might create synergies or release additional resources e.g. from the private sector. It is now to the local authorities to create efficient, transparent and accountable development institutions with qualified employees instead of a high amount of employees. People in Barisal city are in need for municipal services. If BCC can respond to this, the people will welcome these changes and initiatives.

Comprehensive Planning Process

Urban Planning

DRFM

Conclusion

Non-structural Measures for Climate Change Adaptation of Urban Areas in Coastal Bangladesh
3.4 Area Analysis and New Structural Measures

In order to choose for suitable non-structural measures the project area was briefly analyzed with the help of maps, literature and reports e.g. from the Bangladesh Bureau of Statistics, with maps from the MP2010 or newspaper articles. Overview maps are added in this chapter, more detailed maps are in App.6. Conclusions are provided at the end of each section, marked with a blue arrow.

3.4.1 The bigger picture

![Map of the Ganges-Brahmaputra-Meghna Basins (Wikimedia Commons, 2011)](image)

The headwaters of the Ganges River start in the Himalayas in Nepal, then pass through India before crossing the border to Bangladesh and entering the Bay of Bengal. Bilateral water management agreements between India and Bangladesh started in 1972, a treaty was signed in 1996 and a memorandum of understanding in 1985 (World Bank, 2010b). The GoB established the JRC (Joint Rivers Commission) to address problems considering trans-boundary rivers. India however uses its advantages of upstream position and does not get engaged in multilateral negotiations (World Bank, 2010b). Currently 16 different hydropower dams are planned which would alter the flow regimes and affect Bangladesh’s freshwater availability, ecosystems and livelihoods.

The Bangladesh Delta Plan 2100 is a long-term and big scale program for water management and flood safety. The GoB and the Government of The Netherlands are working together to create an adaptive plan. The inception phase of the BDP 2100 started in April 2014. The approval is planned by the end of 2016. Currently already no-regret measures are included in the 7th Five-Year Plan (2016-2020).

3.4.2 Cyclones, Floods and bio-physical Drivers of Change

Bangladesh is known as a cyclone and flood prone country. Cyclones and related storm surges are coming in two seasons, one before monsoon, April till early June, one post-monsoon: late September till November. Yearly average precipitation is 2200-2500 mm, from which 80% fall during monsoon (Hossain, 2003). Recent, sever cyclones were Sidr in 2007 and Aila in 2009. Successful approaches to deal with disaster risk are cyclone shelters. When Sidr stroke the country harm could be prevented due to the constructed cyclone shelters in rural areas (World Bank/2010a). According to the Bangladesh Bureau of Statistics (BBS, 2013) and according to Map12 (App.6) in Barisal city are no cyclone shelter. Haque&Uddin stress the point that disaster-
losses and pressure on livelihoods increase due to the fact that small and medium-scale disasters are rising (2013). Therefore the interruption of business and agricultural production due to less recognized events threaten livelihoods in coastal Bangladesh as well.

In the last years research on the impact of global warming on cyclonic storms was undertaken by different scholars. Karim&Mimura come to the result that the increase of sea level and sea surface temperature will lead to more frequent and more intense cyclones and storm surges, therefore the risk area and flood depth will increase. Hence, 320 additional shelters would be required for coastal Bangladesh (Karim&Mimura, 2008). According to IPCC, confidence on long-term changes in tropical cyclone activity is low. The increase of intensive rain which is coming with tropical cyclones is more certain (IPCC, 2013). Barisal city is located in the ‘very high risk’ area for cyclone induced storm surges (World Bank, 2010a). Projections for 2050 show - an additional 15% of coastal Bangladesh is at risk, furthermore inundation depth will increase, see figure 6.

Similar controversial are predictions considering land subsidence and geomorphology and therefore absolute sea level rise in Bangladesh. The entire country was formed by sediments, the coastal zone is still very dynamic and highly diverse in the different sub areas. Brammer describes the area as stable land area, ‘...crossed by tidal rivers and creeks, bounded by low levees with silty sediments...’ (2014 p. 54). Barisal city is positioned on the Ganges tidal floodplain and on the edge to an area where the soil is saline during dry season. It is also in a transition zone between a tidal and river flood plain (Brammer, 2014). Figure 5 shows erosion (blue) and sedimentation (red) around Barisal Division between 1984 and 2007. The project area is very dynamic due to high sediment loads from upstream. As mentioned above, India is currently planning different hydropower dams, which might alter the sedimentation load in the delta drastically.

Different studies on land subsidence show different results for Bangladesh’s coast. This has to do with the complexity of the subject. Reasons for land subsidence are often human activities, e.g. the construction of embankments which alter the flow of sediments. According to Bramer, abstraction of gas and drinking water however are not the reason for land subsidence, since most of delta is under-laid by sand and therefore compaction is not a problem (2014). Bramer suggests an average of 2 mm/year, closer to the coast subsidence rates may be up to 6 mm/year (2014). Mr Wadud Bhuiyan, a local expert, mentioned a rate of 5mm - 3mm subsidence per year for an area close to Barisal city, Bhola, which was assessed by the University in Dhaka (Expert Interview with Mr. Wadud Bhuiyan, 22.05.2015).

Climate change scenarios are available from different sources (e.g. IPCC, SAARC, NAPA) and show similar projections considering sea level rise, the increase of temperature and precipitation. Results of the National Adaptation Programme of Action (NAPA) show an expected increase of precipitation of 5% in 2030, 6% in 2050 and 10 % in 2100 in Bangladesh. Sea level rise is assumed to be 14 cm by 2030, 32 cm by 2050 and 88 cm by 2100 (MoEF, 2005). Discharge of the Ganges will increase by 10,2% yearly average by 2030 according to World Bank (2010b).
Table 3: Summary bio-physical changes, indication of confidence from literature review, own table

<table>
<thead>
<tr>
<th>Bio-Physical Change</th>
<th>Change</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical cyclone activity</td>
<td>increase</td>
<td>low</td>
</tr>
<tr>
<td>Cyclone induced rainfall</td>
<td>increase</td>
<td>medium</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>decrease</td>
<td>low</td>
</tr>
<tr>
<td>Subsidence</td>
<td>3mm/y</td>
<td>medium</td>
</tr>
<tr>
<td>Sea level rise (2030)</td>
<td>14cm</td>
<td>medium</td>
</tr>
<tr>
<td>Precipitation increase (2030)</td>
<td>5%</td>
<td>medium</td>
</tr>
</tbody>
</table>

This short presentation of bio-physical aspects of the project area and the surrounding show uncertainty in expected changes. However, disaster and flood risk exists already and will further increase. As a consequence the measures should be adaptive and should also contribute to other goals, e.g. poverty reduction to improve the quality of life in the poor areas of BCC.
3.4.3 Population, Socio-economics and Politics in Barisal city

The reason for a storm or a flood to become a disaster is the destruction of livelihoods, displacement, injuries and loss of life. In this chapter the project area is briefly introduced considering demographics, socio-economics and the political situation.

Barisal city is one of the most important coastal cities, next to Mongla, Khulna and Chittagong. Dhaka is approx. 180 km to the north. BCC is headquarter of Barisal District. According to the Bangladesh Bureau of Statistics (BBS), the city has 60.8 km² and is divided into 30 wards (Map2, App.6), the population in 2011 was 328,278, literacy was 60.9%. Similar to other areas in Barisal Division the biggest percentage of the population are Muslim: 293.155, 31.832 are Hindu and 3.228 Christian (BBS, 2013).

According to the figure below Barisal city is located on the border of high risk to very high risk (>3m) for inundation. Poverty is low compared to the neighbouring rural areas in the north and east. Migration from rural to urban areas is often recognized in developing countries. Either migration for some weeks for work, or the retrieve from coastal areas are ways of adaptation to climate change in Bangladesh. Migration to Barisal city takes place from the rural surrounding e.g. for temporary work (Azam & Falk, 2013). Further research on migration to and from BCC could not be conducted, due to the scope of the research. The population growth rate is 1.2%. Unlike than in other countries the coastal population is not expected to grow at a higher rate (World Bank, 2010a).

![Figure 7: Inundation and Population under Poverty, (World Bank, 2010a)](image-url)
Figure 8: Land-use, Elevation, Drainage and Slums

sources:
Left: Joachim Schellekens, Ecorys unpublished map, land-use 2008
Right/Below: Structure Plan, 2010 modified by the author

for bigger maps see App.6, map 3/4/9
The overview maps presented in figure 8, show the predominant land use in the peripheral area of the urban core is agriculture (green). The urban centre is located next to the Kirtonkhola river, where mixed land use (residential/shops), buildings of public administration and schools etc. are located. Population density is high in this area. The surrounding has rural character, but is impacted by uncontrolled urban sprawl with a high amount of poor housing/informal settlements, indicated in red at the map showing the ‘Slums’. The biggest slum area is located in Ward 5, see Map5 (App.6). The Ganges-Brahmaputra-Meghna delta covers a large part of Bangladesh, resulting in a very flat and dynamic coastal area. On the elevation map, yellow and green are the lower parts (0.2m-2.3m), orange and red show 2.3m-4.8m above sea level: The urban area is located on the elevated land next to the river. The Kirtonkhola River in the east of the city is connected to the rural area in the west with 4 major khals (channels), which drain the water during high discharge periods.

The area of BCC includes agricultural land, paddy production and livestock are predominant (BBS, 2013). Further economic activities are e.g. rice mills, cottage industry, tailoring shops, saw mills, oil press, bakeries, printing press and Barisal city has a harbour. The biggest sector in Barisal, as a regional center, is the service sector: e.g. health centres and schools, fire stations, police stations, public administration and financial institutions (BBS, 2013).

Competition between the two big political parties in Bangladesh turned in a political crisis, lasting for many years, in January 2015, 7000 opposition activists were arrested, in February 7 people were killed (BBC, 2015). In 2013 more than 500 people were killed during political protests, so called hartals (The Guardian, 2015). Hartals are general strikes and civil disobedience. According to The Daily Star, one of the biggest newspaper in Bangladesh, between 2001 and 2006 the opposition initiated 173 days of hartals using it as a ‘political weapon’, resulting in injuries, loss of life and economic damage for the people and the country (The Daily Star, 2013).

### 3.4.4 Layer Analysis

In this chapter important aspects of the maps are explained. The maps are presented in App.6.

There are eight major modal transfer stations (Map6) along the khals, two of them are close to the harbour in the urban centre. According to the Master Plan Barisal many roads need upgrading, there is one major road passing through Barisal city connecting the south with Dhaka in the north (Map8). Some embankments are located along the river, but most of the water side does not have embankments or they need upgrading, indicated by the red dotted line, Map2. 

BCC has many natural ponds (Map7), furthermore the map shows green structures along some of the khals. It is planned to protect the ponds and use them for aquaculture. However, at the moment waste accumulation in surface water bodies is a major problem. The city centre has a sewage system, a sewage water treatment plant is planned (Structure Plan, 2010).

Barisal city is in the ‘high risk area’ for cyclones and storm surges, there is no polder, like in other areas of coastal Bangladesh. In the 1960 polders were constructed, Map10 shows that currently many of them are likely to be overtopped (World Bank, 2010a). Rapid flooding due to a storm surge induced by a cyclone might be more than three meters for the project area, according to a map of coastal Bangladesh from World Bank (2010a). Further literature study and research might be required to specify this for the project area.
The table below shows an overview of the different reasons for flooding in the different areas, detailed description is presented below. Understanding of the specific problems resulted from project meetings with the consortium.

<table>
<thead>
<tr>
<th>Area</th>
<th>Drainage System</th>
<th>Underlying Problem, Cause and Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner City</td>
<td>Sewer &amp; Khals</td>
<td>-Sealed surfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Clogged drainage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+High water levels in river and khals and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+Rain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;&gt;Water logging</td>
</tr>
<tr>
<td>Inner City West</td>
<td>Sewer &amp; Khals</td>
<td>-Slope from inner city to west</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+Limited conveyance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;&gt;Water Logging/Flooding</td>
</tr>
<tr>
<td>Rural Area West</td>
<td>Khals</td>
<td>- lower located</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ high water levels in the river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;&gt;Frequent Flooding</td>
</tr>
<tr>
<td>Informal Settlements &amp;</td>
<td>Khals</td>
<td>- Located along river/khals and at low areas</td>
</tr>
<tr>
<td>Poor Neighborhoods</td>
<td></td>
<td>- River bank erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ channel encroachment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;&gt;Frequent Flooding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Low quality of houses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ high risk of cyclones/storm surges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;&gt;High Vulnerability and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Flood and Disaster Risk</td>
</tr>
</tbody>
</table>

The most frequent flood events occur due to river flooding, rain and water logging. Blocked drains, sedimentation and waste in the channels increase this problem. The location of the urban centre is partly at the higher areas, compared to the surrounding. The west of the city centre is lower, therefore faces an amplified problem of flooding. Waterlogging occurs 25 days in the city centre, according to a specialist from Witteveen+Bos, Ruud van der Ent (presentation, project meeting Rotterdam, 22. April 2015). Blocked and insufficient drainage, and a high degree of sealed surface are the main reasons. West, north and south of the project area are located at the low zones, resulting in flooding also due to the fact that high discharge of the river gets drained through the khals to the west. Informal settlements, e.g. ward 5 (Map5), often are positioned at the side of the river and khals, making them specifically vulnerable. Channel encroachment also decrease the drainage capacity which results in flooding. Furthermore river erosion and the low river embankments contribute to the problem.
3.3.1. **New Structural Measures**

The structural measures are currently discussed by the project partners and the local stakeholders. A more specific selection of measures is only available at a later stage of the project. Structural measures for flood management are possible in the form of city scale structural measures and in the form of water retention. Structural measures to decrease cyclone vulnerability is wind and water robust construction. An overview table is presented below.

**Table 5: Structural Measures for the project area**

| City scale structural measures | • the upgrading of the embankment  
|                              | • flood gates  
|                              | • pumping stations  
|                              | • improve of current drainage system  
|                              | • increased conveyance through the khals  
|                              | • resettlement projects for the slum areas, MP2010  
| Retention of water | • a big retention pond  
|                              | • green roofs  
|                              | • rising of land  
|                              | • lowering of green areas  
| Reduction of cyclone vulnerability | • upgrading of buildings  

**Cyclone shelters** are according to the typology a non-structural measure, due to the importance of early warning and emergency planning for successful deployment of cyclone shelters. Moreover a cyclone shelter is disaster management, rather than flood management and disaster risk reduction.

Barisal is already located in a very high risk area for *cyclones and storm surges*, there is no big scale flood protection like polders, and disaster preparedness in the form of cyclone shelters do not exist. Frequent water *logging and seasonal flooding* interrupt business, school and government. Flooding occurs due to water logging in the urban centre when the drainage system is blocked. The western part of the urban core is located lower and therefore more prone to flooding. The rural surrounding is located lower as well, the khals drain water from the river during high discharge periods to the west, where it drains finally towards the east-west. Informal settlements often are found along the river and along khals; river flooding and/or rain, embankment erosion but also channel encroachment and waste accumulation lead to flooding.

The highly frequent problem of flooding and waterlogging in BCC area is challenging livelihoods and economic growth. Numerous structural measures are suitable and currently discussed to solve the problem of flooding, however disaster risk due to cyclones is more difficult to grasp. The people most at risk are the inhabitants of poor housing.
3.5 Assessment of DRM measures: Coding

In this chapter key source and the analytical framework are explained. The most relevant findings are presented in table 6. The last paragraph concludes on the findings of the qualitative research. Further reasoning for the recommended measures for Barisal city is presented in the Discussion, chapter 4.

3.5.1 Introduction of the Assessment Framework

In this chapter the findings of the qualitative research are presented, the Hyogo Framework of Action (HFA) 2015 was used to restructure information on the DRFM measures in the form of the typology. The HFA is an international program for DRM, aiming on action with a timeframe of 10 years which ended in 2015, also Bangladesh signed the framework in 2005. The national progress report provides detailed information on developments, gaps and steps forward. The progress of each country is recorded in frequent self-assessment. App. 3 shows an overview of the ‘Strategic Goals’ and the ‘Priority for Action’.

The information from the HFA progress report 2015 was used to assess problems of the measures, defined in the typology. Therefore the HFA 2015 was restructured using the measures as codes: The HFA statements were listed, numbered (1-156), and then matched by asking ‘What does it affect in a negative way, or what does it result in?’ E.g. communication is often a problem, but it has a negative impact on, e.g. participation. After this step the statements were grouped again to identify certain problem areas, e.g. building codes, see App.8. Finally the statements were summarized, App.9. Below a short version is presented, showing the most relevant findings.

The measures are divided into two different categories, key measures (KM) and support measures (SM). The key measures are again connected to an expected time span, which is assumed before results can be expected. This is important since the research focuses on measures which will have positive effects and decrease vulnerability of people in Barisal city as soon as possible.

3.5.2 Assessment Framework

A summary of the coding, which results in the Assessment Framework is presented below (table 6), conclusions and reasoning for recommendations, based on it, are presented in chapter 4.1.
## Layer 2: Non-Structural Measures
### A) Flood Management & Disaster Risk Reduction

<table>
<thead>
<tr>
<th>Measures</th>
<th>Relevant Findings in HFA 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulation &amp; Coordination</strong></td>
<td></td>
</tr>
<tr>
<td>F C Development Policies (KM)</td>
<td>Urban Planning in general faces a lack of coordination, capacities; there are no or not many pre-construction assessments. Building Codes in general are facing problems due to a lack of awareness, capacities and skills, availability of building materials, monitoring and enforcement on the local level, furthermore they are obsolete.</td>
</tr>
<tr>
<td>F Protecting/Utilizing Ecosystem services (SM)</td>
<td>Problems for protecting and restoring regulatory ecosystem services are the lack of internal and external resources, capacities of institutions and the translation of national policies into action. Natural resource management has not been integrated into DRM initiatives at local level.</td>
</tr>
<tr>
<td>F Mainstreaming of DRR / CCA (KM)</td>
<td>Core instruments for CCA/DRR mainstreaming are regulatory documents. Institutionalization of CCA is a rather new and a demanding task. Mainstreaming DRR in policies and developments however is urgently required. HFA: e.g. there is a lack of awareness on regulatory documents, roles and responsibilities on DRR on the local level; the development plans are not designed to integrate risk management, there is no risk assessment and future possible risk is not considered. Funding for DRR is not utilized correctly due to lack of knowledge, technical and considering policies/procedures.</td>
</tr>
<tr>
<td><strong>Capacity Building &amp; Research</strong></td>
<td></td>
</tr>
<tr>
<td>F C Institutional Capacities (KM)</td>
<td>Analysis of actual losses and damage scenarios lack a uniform style, damage data bases are not maintained well on local level, and they are not acknowledged at central level. Gender and inclusion in DRM is neither acknowledged in training of governmental/non-governmental institutions, nor in the national multi sectoral platform or the local Disaster Management Committees. Resource allocation processes are not only challenged by the lack of resources but also due to flawed project documents, uncoordinated governmental agencies, lack of transparency at national/district level considering vulnerability and risk of the projects, political influence and a shortage of knowledge on Cost-benefit analysis.</td>
</tr>
<tr>
<td>F Pollution Control (KM)</td>
<td>Not explicitly mentioned in the HFA 2015</td>
</tr>
<tr>
<td>F Research and Innovation (SM)</td>
<td>More human resources for research and more research on DRR (esp. DRR on the community level and cost-effectiveness) is needed. Coordination amongst different research institutes and also between research institutes and the private sector (e.g. for funding) is missing. Dissemination of research findings amongst actors on the national level, different stakeholder/communities has not been established.</td>
</tr>
<tr>
<td><strong>Coordination &amp; Communication</strong></td>
<td></td>
</tr>
<tr>
<td>F C Partnership, Co-operation, Stakeholder Involvement (SM)</td>
<td>Public Participation: Apart from weak support mechanisms and troubled resource allocation, community participation and decentralization considering DRM is facing several challenges: Community Risk Assessments (CRA) are only conducted in a small number of areas, different guidelines are used and the local governments need to be encouraged to manifest the CRA information in the ‘Annual Development Plan’ and the ‘Risk Reduction Action Plan’ process. Similar problems exist on the district and the national level: The risk assessments are not integrated into development planning, also information sharing from local to national level remains a challenge for participation. Disaster Management Committees (DMC) do not have the capacities for DRM and have insufficient funds for regular activities. Knowledge and skills for DMC meetings with the community on how information is collected and how plans with the community can be made are missing, moreover communication between DMCs remains a problem. It is suggested to initiate DMC trainings and collect the training data. To coordinate community participation on different scales Ward-DMCs and Union-DMCs are proposed. Civil Society Organizations are needed to institutionalize the proposed Ward/Union-DMCs in order to implement the ‘Standing Orders on Disasters’ in Bangladesh.</td>
</tr>
<tr>
<td>F Public Awareness, Knowledge (SM)</td>
<td>The coordination of reliable information seems to be a key constraint, e.g. information on disasters for the public. An increase of public awareness requires resources for mass awareness campaigns or the involvement of communities into the decision making process.</td>
</tr>
<tr>
<td><strong>Market-based Instruments</strong></td>
<td></td>
</tr>
<tr>
<td>Subsidies/Taxation Income Opportunity (SM)</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Category</td>
<td>Measures</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>B) Disaster Management</td>
<td></td>
</tr>
<tr>
<td>F C</td>
<td>Emergency Planning &amp; Preparedness (KM)</td>
</tr>
<tr>
<td>F C</td>
<td>Flood &amp; Storm Forecasting, Early Warning Messages (KM)</td>
</tr>
<tr>
<td>F C</td>
<td>Response Measures (KM)</td>
</tr>
<tr>
<td>F C</td>
<td>Flood and Disaster Recovery, Re-organization &amp; Rebuilding (KM)</td>
</tr>
</tbody>
</table>

Table 6: Assessment Framework, HFA 2015
The Assessment Framework lists problems in DRM in Bangladesh. It provides valuable information for improvements and offers opportunity for the municipal governments to improve DRM. The analysis of the area and especially the literature review of policies show that there are many shortcomings and opportunity for improvement, especially development control in the form of urban planning and enforcement is weak. But also disaster preparedness and response should be strengthened to tackle the risk of cyclones. These insights lead to the conclusion, that any of the non-structural measures could be improved. The area analysis shows uncertainty in future changes. How additional measures can account for these and why the recommendation is focusing on short term measures is explained in the next chapter.
4 Discussion of Findings and Project Example

Sub-question 3:
Are there possibilities for alternative or complementary non-structural measures, how would a portfolio of non-structural interventions look like and what is a suitable implementation strategy?

The main conclusions from the assessment framework, from policy review and area analysis is that the non-structural measures need improvements or lack enforcement, therefore require time, before the municipal government can establish them. The recommendations therefore focus on measures which will decrease vulnerability in short or medium term, without relying too much on public administration and policy enforcement. Furthermore synergies will be introduced, which will help to improve quality of life in Barisal city to account for investment under uncertainty. An overview table is presented below (table 7). Chapter 4.2 introduce the project example, the ‘Integrated Community Shelter’, which combines different non-structural DRFM measures, sanitation and sustainable development.

4.1 Reasoning for the Recommendations

The findings which triggered the recommendations are presented below. The recommendations are further translated into a project example, which was discussed during an expert interview (4.3). Further stakeholder involvement and verification on the ground could not be accomplished due to a timely limitation of the graduation research to 4 months.

4.1.1 Recommendation 1: Disaster Management Committees

The focus of the policy review was effectiveness and efficiency of DRM. Scholarly policy research on DRM in Bangladesh and specific examples were used to create an overview of problems with public policies on national level and their implementation.

The reviewed literature showed that institutional capacities, coordination and a focus on realization of projects is required. Policies did not have enough impact on the ground so far, furthermore the disaster response approach is questioned in efficiency, as NGOs/Civil Society Organizations are main actors in the form of Disaster Management Committees (DMC). This problem could be found back in the Assessment Framework. Civil Society Organizations, required for the DMCs are criticized but also challenged due to lack of capacities, support and skills, connected to multiple DRM problems identified in the HFA 2015.

Consequently it is recommended to investigate the situation in Barisal City considering the DMC, solutions introduced by Haque&Udim is public participation and empowerment of stakeholder (2013). Community members are main beneficiaries and therefore motivated to contribute to disaster preparedness and response, as argued by the authors. A solutions argued in the HFA 2015 is to provide regular trainings for the DMCs, and to introduce standardized and transparent procedures for money transfer. Further research is required to verify the findings for Barisal city.

4.1.2 Recommendation 2: Reduction of Vulnerability due to Cyclones

Many different structural solutions for floods and water logging are possible and currently designed for the Barisal city. Different to floods management, only two possibilities how to avoid damage or injuries from cyclones are possible: escape routes or provision of shelter. In terms of the DRFM typology - structural measures in the form of robust construction (enforced by building codes) or - disaster management in the form of cyclone shelters (and early warning) can be realized in the city.

According to the Assessment Framework HFA 2015 building codes in general are facing problems
due to a lack of awareness, capacities and skills, availability of building materials, monitoring and enforcement on the local level; furthermore they are obsolete.

This findings result in the recommendation to introduce cyclone/flood shelter, especially in areas where the built environment is of low quality, e.g. the informal settlements. Early Warning systems and messages are required to support the use of shelters.

4.1.3 Recommendation 3: Community involvement in Waste Management

From the MP2010 and during discussion with project team members it became clear that a lack of waste management results in reduced water drainage capacity and blocked drains. The introduction of a working waste collection system which also stops disposal of solid waste into surface water bodies is crucial.

This findings result in the recommendation to introduce community based waste collection which goes along with an increase of public awareness and creates income opportunity, as explained in the project example below.

4.1.4 Time is important

As explained above the implementation of national policies often remain a challenge. Further research is required to confirm these findings for the project area in more detail, however there is strong indication that national and local policies at the current situation do not produce results on the ground to improve Disaster Risk and Flood Management. Hence, the non-structural measures suggested by the typology require improvement or further commitment and more time to obtain results. Urban planning issues in BCC are recognized by the local authorities and approached with promising attempts, as described in the MP2010. Good urban governance is required to utilize non-structural measures in the form of development policies.

Due to these insights the recommended non-structural measures are suitable to produce short term results and do not rely heavily on governmental institutions and top-down approaches, as further explained below.

4.1.5 Synergies and Support Measures:

One of the conclusions of the area analysis show uncertainty in expected effects of drivers of change, e.g. climate change. To justify investments under uncertainty the recommended non-structural measures and the project example aim at synergies. In the case of Barisal city poverty reduction and sanitation could be connected to the DRFM measures.

The project example is seeking to accompany [1] expected long-term results of development control by short-term results, and [2] to accompany the new structural measures by offering a focus on disaster management while justifying investments under uncertainty, using synergies.

Further support measures required or suitable for the implementation of the project example are: Research and Innovation, Partnerships & Stakeholder Involvement and Market based instruments mainly in the form of income opportunities.

The research findings offer opportunity to combine the different key and support measures to one project, the 'Integrated Community Shelter'. All measures explained above are integrated, except the 'Involvement of the Community into Disaster Management' (Disaster Management Committees), see chapter 4.1.1.
### 4.1.6 Recommended Non-structural Measures

The table below presents an overview of recommended non-structural measures. Chapter 4.2 explains the possibilities for synergies in more detail in the project example.

#### Layer 2: Non-Structural Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Improvement required</th>
<th>Possibility</th>
<th>Intervention</th>
<th>Synergies</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Flood Management &amp; Disaster Risk Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation &amp; Policies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Policies (KM)</td>
<td>long*</td>
<td>Development control*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecosystem services (SM)</td>
<td>med*</td>
<td>Ponds for water retention*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainstreaming of DRR / CCA (KM)</td>
<td>long</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity Building &amp; Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Capacities (KM)</td>
<td>med/long*</td>
<td>Metropolitan Government*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution Control (KM)</td>
<td>med</td>
<td>-Solid Waste Management - Waste Water Treatment</td>
<td>-Less Drainage Problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research and Innovation (SM)</td>
<td></td>
<td>Action Based Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coordination &amp; Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partnership, Stakeholder Involvement (SM)</td>
<td></td>
<td></td>
<td>-Comm. Based Waste Collect. -PPP (Sanitation)</td>
<td>-Poverty Reduction +Public awareness</td>
<td></td>
</tr>
<tr>
<td>Public Awareness, Knowledge (KM)</td>
<td>med</td>
<td></td>
<td></td>
<td>+Public Awareness increases due to community involvement</td>
<td></td>
</tr>
<tr>
<td>Market-based Instruments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Subsidies/Taxation Income Opportunity (SM)</td>
<td></td>
<td></td>
<td>-Revenue Model (Eco-center) -Financing Scheme (Waste)</td>
<td>-Shelter Management -Economic Development</td>
<td></td>
</tr>
</tbody>
</table>

#### B) Disaster Management

<table>
<thead>
<tr>
<th>Measures</th>
<th>Improvement required</th>
<th>Possibility</th>
<th>Intervention</th>
<th>Synergies</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Planning &amp; Preparedness (KM)</td>
<td>Further research required</td>
<td>med</td>
<td>-Involvement of Community into Disaster Management Cyclone Shelters ( rely on Early Warning)</td>
<td>-Public Awareness (Comm. Resilience) -Sanitation &amp; Waste Mgmt. +Reduce need for (medical) response measures -According to local Expert: Could be Used during Water logging</td>
<td></td>
</tr>
<tr>
<td>Flood&amp;Storm Forecast, Early Warning Messages (KM)</td>
<td>Further research required</td>
<td>med</td>
<td>Early warning system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Measures (KM)</td>
<td></td>
<td>n/a</td>
<td>-Involvement of Community into Disaster Management +Less medical response required due to shelter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood and Disaster Recovery, Rebuilding &amp; Re-organization (KM)</td>
<td>med/long*</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 7: Summary of Recommendations and Synergies
4.2 Description of the ‘Integrated Community Shelter’

In this chapter an integrated project and a suitable implementation strategy is briefly explained. Further description is supplied by the use of the Logical Framework (LogFrame) for project cycle management, combined to it stakeholder analysis, problem and objective trees, in App.10.

To protect vulnerable inhabitants from impacts of storms or flooding, shelters are needed, especially in areas dominated by informal settlements and poor housing. Cyclone shelters are big, robust and often elevated constructions, they need to be accessible and should provide facilities like toilets. For successful disaster management forecasting and early warning systems are required. In Bangladesh Cyclone Shelter have been proven as successful, especially in rural areas, and could prevent injuries and loss of life during Sidr (World Bank, 2010). To utilize capacities of the building, schools or community centres can be found in the shelters. In Barisal city, school buildings are existing, a different use/management approach is required, therefore two functions were identified: [1] Waste Transfer Station and [2] Sanitation and Cooking Facilities.

[1] Waste collection and management is one of the major problems in BCC, especially due to the negative impact on drainage systems and capacities. The road infrastructure to reach the Integrated Community Shelter presents good preconditions for a waste transfer station: registered community members receive vouchers when they drop off source separated waste at the shelter. The model is introduced e.g. in Coritiba, Brazil and solves not only the problem of waste collection in inaccessible slum areas but also introduces source separation and a small income for the household. Source separated waste can be recycled, plastic recycling companies already exist in Barisal city (BBS, 2011). Business and income opportunities evolve from the availability of source separated waste and reduce the need for landfilling.

[2] The lack of toilets in flood/cyclone shelters is one of the identified reasons why people refused to go there during Sidr (World Bank, 2010). This problem can be solved by building a so-called ‘bio-centre’. Bio-centres have been proven to be scalable and a sustainable business model, implemented in several developing countries. The bio-centre offers the use of public toilets, warm showers and cooking facilities for a small fee to its customers, and therefore improves living standards in poor settlements. The energy comes from anaerobic digestion, a simple and natural process of methane production from bacteria in sewage sludge. As a result a business opportunity combined with off-grid waste water treatment and energy production is created. The bio-centre is required where also the cyclone shelters are required - in poor neighbourhoods.

Strengths and Opportunities:

- Less Pollution
- Disaster Risk Reduction
- Sanitation and Public Health
- Poverty Reduction (Vouchers)
- Business and Income Opportunities
- Less Maintenance for Drainage Systems
- Improvement of Water Drainage and Quality
- Improvement of Environmental Conditions
- Decreasing the Risk of Waterborne Disease/Injuries
- Increase of Live Quality/Sense of Community
The implementation of the project needs to be supported by action research, stakeholder involvement in the form of a community-based approach for waste collection and income opportunities. Suitable partnership arrangements and payment schemes need to be determined, e.g. if the community-based waste collection needs to be subsidence or if income opportunity from waste recycling is enough. More detailed description of the implementation is not possible, the Integrated Community Shelter and the implementation strategy depends on the local preconditions and stakeholder and needs to get refined in Barisal city.
4.3. Feedback from Experts

Expert interview, 22.05.2015: Wadud Bhuiyan

Mr. Wadud Bhuiyan is a local expert and is working on the project from the beginning. Mr Wadud read the research, gave feedback on some details and his opinion on the project example.

National policies were reviewed on the topic of Development, Climate Change Adaptation and Disaster Risk Management. Mr Bhuiyan was drawing attention to several national policies on Water Management, Coastal Zone Management and Cyclone Shelters. Due to the short time span for this research additional policies can not be included into the research, however this is a weak point. Some faulty information on historical flood and cyclone events was recognised, moreover Mr. Bhuiyan mentioned some divergent data on rate of land subsidence: instead of a rate of 18 mm per year as suggested by Bramer (2014) after Syvitski et al. (2009), he mentioned a rate of 3-5 mm per year.

In general Mr Wadud Bhuiyan was positive about the idea of the Integrated Community Shelters, however they should not be implemented for the entire area of Barisal city. At some areas they might be suitable to reduce the vulnerability to cyclones and storm surges.

Next to the proposed synergies for sanitation, the Integrated Community Shelters might be suitable to be used peak water logging when monsoon season and high tide rise the water levels. The combined functions of solid waste management and sanitation and cooking facilities seem to be suitable and of high value, especially sanitation and cooking facilities during periods of water logging.

Mr. Bhuiyan suggested to present the project example at the next meeting with stakeholders and government officials of BCC.
5 Conclusions and Recommendations

The preparation of an integrated approach for a city scale project is challenging and considering the limited time, some areas could only be included briefly. The results need to be further approved, local opinions are now important - not only to prove the option of the Integrated Community Shelter but also to find inspire improvements or other integrated solutions by key stakeholder, in order to improve DRFM in Barisal city.

The approach of designing a DRFM typology to ensure completeness and to identify opportunities for an integrated solution, proved to be suitable. The assessment framework derived from the HFA 2015 was offering important insights into current DRM approaches and gaps, however a visit to the project area would have offered understanding which cannot be gained from literature.

Further research is required first of all to verify the suitability of a cyclone shelter for the project area. Stakeholder and suitable locations need to be identified. A design and scale for the cyclone shelter, next to funding possibilities is required. Action research, a community based approach and business/income opportunities as implementation strategies are good attempts to fine-tune private public partnerships or operational frameworks – subsidies, and if possible a sustainable business model for collection of source separated waste and the redistribution for recycling. The bio-centre seems to be a promising revenue model according to desk research, suitable partnerships and design would help to investigate the feasibility of the Integrated Community Shelter further.

As far as a quick desk research showed, the use of a cyclone shelter in poor urban areas for sanitation and waste management was not realized so far. Barisal city could be the first city where climate change adaptation could be combined with pro poor urban development and a sustainable business model.
References
References


Appendices