FLOOD MANAGEMENT FEASIBILITY STUDY FOR THE MSIMBAZI MIDDLE CATCHMENT AREA

Feasibility Study

C40 Cities Finance Facility

FINAL DRAFT, MARCH 2021
About the C40 Cities Finance Facility

The C40 Cities Finance Facility (CFF) is a collaboration of the C40 Cities Climate Leadership Group and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The CFF supports cities in developing and emerging economies to develop finance-ready projects to reduce emissions to limit global temperature rise to 1.5°C and strengthen resilience against the impacts of a warming climate. The CFF is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ), the Children’s Investment Fund Foundation (CIFF), the Government of the United Kingdom and the United States Agency for International Development (USAID).

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Funding partners:  
Implementing agencies:
EXECUTIVE SUMMARY

Introduction

The Msimbazi River Basin (170 km2) is located in the city of Dar es Salaam, Tanzania, and for the last decade this is the city's worst hit area by serious degrees of flooding nearly every rainy season. The floods are impacting the basin’s inhabitants and environment on different levels, like loss of lives, destroyed homes and assets, traffic interruption, siltation of areas and negative health effects of contaminated flood waters and stagnant ponding after the events. Flooding has become one of the main environmental issues in the basin and it is expected that the situation will get worse if no action will be taken.

The overall objective of this study commissioned by GIZ is to identify and analyze potential flood management and control options in order to reduce risk of flooding to the Msimbazi Middle Basin. The scope consists of i) execution of vulnerability analysis, ii) identification and pre-selection of measures and iii) development of a flood management strategy including preliminary technical and economic feasibility as well as a preliminary social, environmental and institutional assessment. This report, the Feasibility Study Report, focusses on scope iii). The Vulnerability Analysis Report includes scope i) and ii).

In the figure below the Study area is introduced highlighting the locations of the subwards, main roads and bridges.
This project contributes to a Strategy and Management Framework for the Msimbazi Basin (Msimbazi Opportunity Plan Volume A – Strategy and Management Framework (2019); hereafter referred to as SMF-MOP) developed by President's Office Regional Administration and Local Government (PO-RALG) and the World Bank.

**Feasibility Study approach**

As follow up to the Vulnerability Analysis phase of this Study, the Feasibility phase has been developed consisting of the following components (steps), which have been executed in an integrated and iterative manner:

1. **Effectiveness of prioritized sets of measures**
2. **Development of flood management strategy**
3. **Adding an urban development strategy**
4. **Concept Designs**
5. **Preliminary Cost-Benefit Analysis**
6. **Preliminary environmental and social assessment**
7. **Institutional set-up and funding options**

**Components (steps) of the Feasibility Phase**

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**Main results Vulnerability Analysis phase**

*Impact assessment and hotspots*

Generally, flooding in the Msimbazi Middle River Basin is directly caused by five main factors; i) insufficient hydraulic capacity of the Msimbazi River profile at certain locations, ii) back water effects and piling up of water upstream of structures, e.g. bridges, with an insufficient hydraulic capacity, iii) inadequate urban drainage infrastructure and inadequate solid waste management and iv) decrease of ‘green areas’ in the catchment has resulted in reduction of infiltration of precipitation and a direct run off response and v) settlement in the natural floodplain area. The Msimbazi Middle Basin is already seriously vulnerable to pluvial and fluvial flooding in the existing situation. In the future, under a do-nothing scenario, climate change and autonomous urbanisation will contribute to a substantial increase of flood risk. In 2050 about 70% of the increased hazards will be caused by urbanisation and 30% by...
climate change. The effect of urbanisation on flood risk provides insight in the potential to avoid further increase of flood risk by means of adequate, integrated multi-sectoral spatial planning.

For the Msimbazi Middle Basin the following four hotspots have been identified (from downstream to upstream):

1. Kawawa Road Bridge and upstream area affected by back waters;
2. Kigogo ward;
3. The Industrial zone;
4. Railroad Bridge and upstream area affected by back waters.

_Prioritised measures and initial identified flood management strategy_

Based on the analysis of main causes of flooding and hotspots, five potential flood mitigation measures have been identified and prioritised initially together with the stakeholders (see below table).

*Initial identified flood mitigation measures for the middle Msimbazi basin.*

<table>
<thead>
<tr>
<th>No.</th>
<th>Measure</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Widening and/or raising bridges crossing the Msimbazi River and her tributaries to increase the hydraulic capacity of the bridge.</td>
<td><img src="image1" alt="Proposed" /></td>
</tr>
<tr>
<td>2.</td>
<td>Creating a wider river bed to increase the hydraulic capacity of the river channel.</td>
<td><img src="image2" alt="Proposed" /></td>
</tr>
<tr>
<td>3.</td>
<td>Lowered flood plain with emphasised physical edge or raise terraces by reshaping valley profile. This to give room for the river.</td>
<td><img src="image3" alt="Proposed" /></td>
</tr>
<tr>
<td>4.</td>
<td>Resettlement from locations with high residual flood risk after implementation of first three mentioned measures.</td>
<td><img src="image4" alt="Proposed" /></td>
</tr>
<tr>
<td>5.</td>
<td>Re-greening of resettled areas as well as reforestation of the upper catchment sections of the Msimbazi River.</td>
<td><img src="image5" alt="Proposed" /></td>
</tr>
</tbody>
</table>
Following the SMF-MOP and based on the Vulnerability Analysis and the charrettes, an initial flood management strategy has been identified. It combines long term multi-sectoral integrated sets of measures including spatial planning and enhancing rainwater retention capacity, and short term measures focusing on removal of hydraulic bottlenecks.

**Effectiveness of measures**

The identified measures have been combined and incorporated as three schematisations in the flood model of the Modelling Consultant; Run 1 - bridge measures only, Run 2 - short term implementation measures and Run 3 - long term implementation measures. The effectiveness (with respect to reduced flood hazards) has been tested by running the schematisations with the flood model. Results reveal that significant hazard and damage reductions will be gained, viz. 5%, 21% and 23% for Run 1 to 3 respectively. However, even with the long term implementation measures a considerable level of flood risk will remain, which has been deemed unacceptable.

**Defined Flood Management Strategy**

The identified flood management strategy is based on a short term component to be implemented in the period 2021 – 2026 and a long term component (2021 – 2050). The short term implementation component focusses on removal of hydraulic bottlenecks in the Msimbazi River, whereas the long term component proposes a transformation of urban land use by making room for the river, urban regeneration to accommodate resettlements, and reforestation and re-greening of the catchment.

**Urban Strategy**

In order to take away the residual flood risk after implementation of the short term measures, it has been considered inevitable to resettle urban functions (like residential, mixed use and industries etc.) from the flood plains to flood safe areas. Since this requires solutions beyond river measures only, an urban strategy has been developed to guide sustainable urban development as part of the flood management strategy for the short and the long term component;

**Overview of short and long term component**

Based on the flood management and urban strategy the following measures are proposed for the short and the long term components:

- **Short term component (2021 – 2026):**
  a) Widen and/or raise bridges - to increase the hydraulic capacity of the bridge underpass;
  b) Widen river beds - to increase the hydraulic capacity of the river channel;
  c) River bank protection - to prevent bank erosion, to guide flow through and around bridges, minimise sedimentation issues downstream and mark the minimum river width as a boundary for urban development;
  d) Urban development - accommodate required resettlements from river
sections that need to be widened in urban regeneration areas within the subward.

- **Long term component (2021 – 2050):**
  e) Room for the River - increasing floodplain area to accommodate flood water of extreme events by retreating structures and assets;
  f) Urban development - urban re-generation in patches and area developments to i.a. accommodate resettlements;
  g) Reforestation of upper section Msimbazi catchment and re-greening of re-developed areas - Increasing the infiltration capacity by re-greening the catchment area.

**Short term – a) Widen and/or raise bridges**

Based on the hotspot locations the following 4 bridges are proposed to be adjusted in the short term: Kawawa road bridge, Nelson Mandela road bridge Railroad bridge and Kawawa road bridge crossing the Kibangu stream. Requirements for water level reduction at the location of the bridge were adopted and applied by Manning’s formula to each of the bridges resulting in total bridge spans varying between 80 and 100m (minimally doubled compared to existing situation). Besides that, Kawawa road bridge needs to be raised by about 1m. Estimated CAPEX costs are USD 42 mln.

**Short term – b) Widen river beds**

This measure includes excavation of a wider river channel and re-using of part of the excavated material to raise small embankments of about 1m height on each side of the river to achieve an hydraulic capacity to accommodate a T2yr flood event. Proposed bottom width varies between 25 and 35 meters, with gentle side slopes to the raised embankments. In total this requires a river bed width of about 50m, which is a balanced outcome to increase the hydraulic capacity of the river while minimising relocation of buildings and structures in the short term (including 250 households). Estimated CAPEX costs are USD 3 mln.

**Short term – c) River bank protection**

Riverbank protection is proposed along parts of the widened river profile depending on hydraulic loads and present assets. Natural bank protection by means of vegetation on the slope and brush packing is preferred. For locations where space is limited stacked gabions are proposed. Estimated CAPEX costs are USD 4 mln.

**Short term – d) Urban development**

For the short term the urban development component consists of resettlement of about 250 households from zones reserved for widening of the river bed, to patches of about 1 ha within the neighbourhood (subward) to be regenerated. The urban patches will be transformed to i) include a larger fraction un-paved area for water infiltration and re-greening, ii) densification of living units by multi-storey apartments and iii) a section that remains intact. Estimated CAPEX costs are USD 31 mln.
Because the flood risk to urban areas in the flood plains remains considerable after implementation of the short term measures, it is proposed to largely restore the floodplain area to a more natural state in the long term. To achieve this, a large part of the building stock will have to be replaced to areas outside the floodplain (including 15,400 households). A more vegetated floodplain with areas for farming and recreation will be created in the cleared area. Furthermore, also retention ponds can be considered within these floodplain areas, where water is temporarily retained to decrease the magnitude of the flood downstream and improve the infiltration capacity.

For the long term the urban development component is much larger to include resettlement of 15,400 households. The principle of urban patches will be extended and will be complemented with two large area developments (in Sukita and Liwiti) to cater for the resettlement demand in which affordable housing will be combined with commercial real estate. Estimated CAPEX costs are USD 719 mln for resettlement and 41 mln for urban (land) development (total USD 760 mln).

Firstly, in line with the Strategy and Management Framework it is proposed to largely restore the upper catchment (about 7,500 ha including Pugu hills) to its original natural state and start large scale reforestation programmes. Secondly, the Room for the River sections will be vegetated with lower brushes, grasses and urban agriculture.
crops to minimise reduction of hydraulic capacity of the floodplain. Finally, small natural park areas are proposed in the urban regeneration patches, thereby increasing pervious areas and buffer capacity for storm water. Estimated CAPEX costs are USD 430 mln.
Preliminary cost benefit analysis

The short-term measures have a total estimated CAPEX of USD 80 million. The main cost components are the bridge measures and urban development (value existing properties and land development costs) to meet resettlement requirements. The long-term measures have a total estimated CAPEX of USD 1.2 billion, which is substantially higher than the short-term CAPEX. Urban development (value existing properties and land development costs) for the required resettlements is the largest cost component;

Urban development can generate income from land sales, which can more than compensate the costs of urban land development. The preliminary business case models for the urban development component show a Net Present Value (NPV) of cash flows of about USD 1 million for the short term component and almost USD 40 million for the long term component. The net income generation in the long term component could be used for cross-subsidization of some other measures in the long term component.

Important benefits of both components consist of the prevention of direct damage to assets (mainly dwellings) for people living and working in the flood prone areas. Apart from this loss of economic production and livelihoods and traffic disruption is prevented. The benefits in terms of damage prevention are especially large for the long term component due to resettlement and re-greening measures. Moreover. The long term component has large (non-monetized) ecological and social benefits due to re-greening and formal urban development.

Overview Capex, results business case and preliminary cost-benefit analysis of components of the flood management strategy in million USD

<table>
<thead>
<tr>
<th></th>
<th>Investment costs (CAPEX)</th>
<th>NPV Business case urban development</th>
<th>NPV CBA Scenario RCP 8.5-High</th>
<th>NPV CBA Scenario RCP 4.5-Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short component</td>
<td>term 80</td>
<td>1</td>
<td>528</td>
<td>341</td>
</tr>
<tr>
<td>Long component</td>
<td>term 1,191</td>
<td>37</td>
<td>1,360</td>
<td>749</td>
</tr>
</tbody>
</table>

Note: Net Present Value (NPV) is the sum of discounted values of all future costs and benefits. NPV>0 implies discounted benefits outweigh the discounted costs to society.

Key conclusions from the cost-benefit analysis are that the benefits for society for both the short term component and the long term component are larger than the costs. The short term component is more efficient in terms of benefit to cost ratio (due to much lower costs), but only prevents about 25% of flood damages. In comparison; the long term component prevents about 75% of flood related damage and has very positive ecological benefits. In all scenarios (high climate change RCP 8.5- high growth and moderate climate change RCP 4.5- low growth) benefits outweigh the costs.

Preliminary environmental and social impact assessment

Key conclusions from the Preliminary Environmental and Social Impact Assessment are:

Funding partners:

Implementing agencies:
- The short term- and long term flood management components have significant beneficial long term (permanent) social and environmental impacts. Key beneficial impacts relate to reduced fatalities, reduced flood damage for vulnerable people, protection of economic livelihoods from floods, reduction of water borne diseases and avoidance of transportation disruption. The long term strategy has more major beneficial flood impacts (compared to the short term strategy) due to higher flood risk reduction, formal urban development and re-greening and reforestation (positive impacts for public space, hygiene, biodiversity and recreational functions);

- The analysis shows only one major negative impact of the long term strategy which will be caused by the proposed resettlement activities as part of the room for the river measure. However, the urban development measure will offer affordable formal housing for the resettlement affected groups within the Study area. Moreover, the other measures are expected to have mainly moderate to minor temporary impacts (during construction phase) and therefore can be included in further assessment;

- A number of mitigation measures are proposed to mitigate the negative environmental and social impacts (especially during construction phase).

Institutional set-up

For the institutional set-up for implementation of proposed flood management strategy it is advised to follow proposed Govern Strategy as part of the Msimbazi Opportunity Plan as much as possible. Key organisations in proposed structure will be the Msimbazi Special Planning Authority and the Msimbazi Development Corporation. In order to facilitate the site preparation, land development and revenue generating potential of the urban development measures, it is advised to consider the set-up of a land development unit or agency under the Msimbazi Development Corporation. This dedicated agency could have the responsibility to prepare for the urban development in the areas and organize land development (including site preparation) and land sales to real estate developers. Moreover, such a unit could facilitate apart from public funding the possibility to attract private finance.

Funding options

The short term implementation component shows an insignificant income potential for cross-subsidization (or repayable finance). Therefore, additional government funding and/ or donor grant funding (multi-lateral and bi-lateral development partners) can be considered as funding options. Important development partners to consider are World Bank Group (including GEF and adaptation fund), UNEP/UNDP, Green Climate Fund, AfDB, and several bilateral development partners (f.i. AfD France, DRIVE Netherlands, KfW Germany, Sida Sweden).

The funding strategy for the long term implementation component could be more refined (spread over long time, larger resettlement component and potential of net income generation). It is advised to explore the concept of developing a sustainable national multi-annual fund for climate adaptation investment and maintenance (including resettlement funding). This might be inescapable due to the high multi-
annual funding needs over a long time of the long term component and due to the fact that donors are in general hesitant to fund compensation cost for resettlement. Moreover, the income generating potential of the urban development measures might create the possibility to utilize income for cross-subsidization of other measures and facilitate repayable finance instruments. The latter is only possible with the appropriate institutional set-up with a dedicated land development agency (see above).

**Recommendations**

Firstly, consultants strongly advise to start the *preparation for implementation of the short-term and long-term components and its relevant measures as soon as possible*. The sooner, the better as according to this study the potential damage of flood events will increase the longer one waits and flood prone places along the river might attract new settlements. A plan and funding strategy for the process of preparatory studies and permits (final feasibility studies, detailed business case urban development, design studies, resettlement action plans and social and environmental safeguarding etc.) should be prepared. Possibilities to attract project preparation funding from Development Partners with project development windows (for instance The World Bank, Green Climate Fund (GCF), AfD France, D2B Netherlands) could be explored. Preparation of the long term component should also start already in the period 2021-2026, as it is expected this will take considerable time. This component will need multi-annual funding (of inter alia resettlement and re-greening cost) and might utilize private (repayable) finance. In order to create a national sustainable multi-annual funding structure it is advisable to explore the feasibility of setting up a multi-annual Deltafund for climate adaptation investment and maintenance (including resettlement costs funding). Experiences with such funds in the Netherlands and Bangladesh might be looked into. Moreover, it is recommended to prepare a more detailed concept and business case for the urban development measures (and areas), and to commission a plan or feasibility study for the establishment of a land development agency.

It is recommended to *discuss the results of this Feasibility Study with the PIU of the Msimbazi Opportunity Plan and its stakeholders*. Since the Dar es Salaam City Council (leading organisation in the PIU) has been dissolved in February 2021 and it is planned to upgrade Ilala Municipality as city council, coordination on inclusion of the flood management strategy for the Msimbazi Middle Basin into the Msimbazi Opportunity Plan should be done at the earliest possibility to ensure proposed developments will be taken into consideration by the newly to be installed city council.

It is advised to *share and discuss the key findings of the Feasibility Study report with key development partners already active in Tanzania (potential funding agencies/sources, also with access to GCF) and seek for their interest in funding the preparation and/or implementation of the flood management strategy components or specific measures.*

The presented flood management strategy consists of a set of different measures structured in short and long term components. If the presented strategy will be accepted by the involved stakeholders for integration in the MOP, a discussion needs
to take place to identify how subsequent Detailed Feasibility Studies (DFS) are going to be defined and by which organisation. Besides that, it is recommended that an overarching verification will be built into the DFSs to guarantee its integration as part of the overall flood management strategy/ MOP.

It is strongly recommend to continue the participatory design process in the next steps towards implementation and maintain the momentum created by the charrettes. The commitment of the stakeholders and the support from local and national politicians are an invaluable asset of the project and essential for decision making on the sensitive issues of large scale resettlement and inter-institutional coordination.

*Impression of wards Tabata, Vingunguti in the long term according to the strategy and concept designs*
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LIST OF ABBREVIATIONS

AED Annual Expected Damage
BRT Bus Rapid Transit
CDR CDR International BV.
CFF City Finance Facility
DAWASA Dar Es Salaam Water and Sewerage Authority
DCC Dar es Salaam City Consul
DTM Digital Terrain Model
EWS Early Warning System
GDP Gross Domestic Product
GIS Geographic Information System
GIZ Deutsch Gesellschaft für Internationale Zusammenarbeit
MLHHSD Ministry of Lands Housing and Human Settlement Development
MOP Msimbazi Opportunity Plan
OSM Open Street Map
pESIA Preliminary Environmental and Social Impact Assessment
PO-RALG President's Office - Regional Administration and Local Government
RAP Resettlement Action Plan
RCP Representative Concentration Pathway
TAHMO Trans-African Hydro-Meteorological Observatory
TSH Tanzanian Shilling
USD US Dollar
WEMA WEMA Consult
yr Year

Funding partners:

Implementing agencies:
INTRODUCTION

Background

The Msimbazi River Basin (170 km²) is located in the city of Dar es Salaam (see Figure 1), Tanzania, and for the last decade this is the city’s worst hit area by serious degrees of flooding nearly every rainy season. The floods are impacting the basin’s inhabitants and environment on different levels, like loss of lives, destroyed homes and assets, traffic interruption, siltation of areas and negative health effects of contaminated flood waters and stagnant ponding after the events. Flooding has become one of the main environmental issues in the basin and it is expected that the situation will get worse if no action is taken.

![Figure 1: Location of the Msimbazi River Basin (after Msimbazi Opportunity Plan Volume A – Strategy and Management Framework (2019)).](image)

The causes of the flooding of the Msimbazi River Basin are closely related to the rapid unplanned and uncontrolled urbanisation over the last few decades. Urbanisation and deforestation in the middle and upper sections on the catchment result in an increased run-off of precipitation into streams and rivers and consequently reduce the overall retention capacity of the wider basin. That also largely explains the rapid river response to heavy downpour with flood peaks in the middle and lower catchment sections within 12 hours after the rainfall event. The urbanisation also creates blockages for natural water discharge, like river crossing infrastructure and solid waste due to improper waste management. The resulting floods are further amplified by
inadequate storm water and sanitation infrastructure. With the high urbanisation rates in combination with deforestation of the upper basin, the basin has also become more susceptible to unbalanced river erosion and sedimentation processes putting structures at risk to bank erosion and undermining, causing inaccessibility to neighbourhoods and no longer functioning of certain land uses. Dar es Salaam is one of the fastest growing cities in Africa with an expected average annual population growth of 4.8%. By 2030 Dar es Salaam’s population will have exceeded 10 million inhabitants (United Nations, Department of Economic and Social Affairs, Population Division (2018)). With these projections and given the fact that the catchment’s area largely overlaps with the city centre and its densely developed urban functions around, it is very likely the urbanisation process will continue at a rapid pace in the future and will put more pressure on the Msimbazi catchment. In turn this will increase the risk to more frequent and severe flooding.

Besides urbanisation, it is expected that climate change will also be a main contributor to increased, additional flood risk in the Msimbazi catchment in the future. A moderate climate change scenario (RCP4.5) already shows an increase in precipitation of 8.4%, and an extreme climate change scenario (RCP8.5) shows an increase of 23.8% (Deltares (2021)). According to these scenarios flood risk will increase significantly in Dar es Salaam due to climate change. In combination with urbanisation of Dar es Salaam, it stands to reason that flooding conditions will worsen in the Msimbazi catchment in the future and thereby increasing the vulnerability of the Msimbazi communities and infrastructure (public and private alike) to flooding.

This study contributes to the existing Strategy and Management Framework for the Msimbazi Basin (Msimbazi Opportunity Plan Volume A – Strategy and Management Framework (2019)) developed by President’s Office Regional Administration and Local Government (PO-RALG) and the World Bank. As part of this Strategy and Management Framework, a Detailed Plan has been developed for the Lower Basin of the Msimbazi River (Msimbazi Opportunity Plan Volume B – Detailed Plan for the Lower Basin (2019)). All the volumes together are referred to as The Msimbazi Opportunity Plan (MOP). Following the principles stipulated in this Strategy and Management Framework, in collaboration with the DCC, the CFF has commissioned this Flood Management Feasibility Study for the Msimbazi Middle Catchment Area. The outcomes of this Study will be used to define measures to build flood resilience and the corresponding investments required.
Study area

In this Study the Msimbazi Middle Basin is defined as the area between Kawawa Road Bridge and Kinyerezi Bridge consisting of a total project area size of about 5,000 ha. The Msimbazi River is the main river flowing through the area with two main tributaries, namely the Kibangu River and the Tenge River (see Figure 2). Downstream of Kawawa road bridge is considered the ‘Lower Msimbazi basin’ and upstream of Kinyerezi bridge is considered the ‘upper catchment’.

Bridges

Seven bridges cross the Msimbazi River and her tributaries as critical elements in relation to flood management and hydraulic capacity of the river at those points. The bridges serve as landmarks in the dense urban fabric and form the physical demarcation of administrative boundaries such as the wards and subwards. The bridges also are important points of orientation for the communities. Because of the importance of the bridge structures in this Study, names have been given to all the bridges for clear communication between GIZ, involved Consultants and the stakeholders. The following bridges fall within the Study area for the Feasibility Consultant (from downstream to upstream as numbered in Figure 2):

1. Kawawa Road Bridge (Msimbazi River);
2. Nelson Mandela Road Bridge;
3. Railway Bridge;
4. Vingunguti Bridge;
5. Kinyerezi Bridge;
6. Kawawa Road Bridge (Kibangu tributary);
7. Kibangu Kigogo Road Bridge (Kibangu tributary).

Figure 3: Main bridges in the study area
Area characteristics

A division of the Study area has been made into three zones based on river and physical urban characteristics, zone A, B and C and are further elaborated below.

Zone A in the downstream section, between Kawawa Road and Nelson Mandela Road. This zone includes the so-called area Sukita. This area belongs to the Chama cha Mapinduzi (CCM) party and has been used for agricultural purposes including poultry farming. Nowadays it is mainly used as agricultural land. The land is still owned by CCM, and is one of the scarce green locations within Dar es Salaam.

Zone B, the transition between upstream and downstream sections: industrial and logistics area around the Nelson Mandela Road Bridge. Close to the Port of Dar es Salaam and in the vicinity of main infrastructure arteries this location has been planned and developed for this purpose. However, there is very small space for the river to run through as can be seen from the picture at the right.

Zone C, upstream section: large uncontrolled urban residential development areas from rail road bridge further upstream. In this area urban sprawl has taken place all the way down to the river banks making the dwellings very vulnerable to river flooding. In the upper reaches of the upstream section the area is constantly in development increasing the paved area fractions.

More information about the Study area including socio-economic and environmental context is reported in the Vulnerability Analysis Report as part of this Study (CDR International and partners, 2021).

Objective of this study

The overall objective of the Study is to identify and analyze potential flood management and control options in order to reduce risk of flooding for the middle part...
of the Msimbazi catchment area. The sub-objectives of the Study are to:

1. conduct a vulnerability analysis;
2. identify and pre-select flood mitigation options;
3. develop a flood management strategy including conceptual designs, cost-estimates, determination of cost-effectiveness and advice on institutional set-up and funding of the implementation.

The Study consists of 3 phases, namely Phase A – Inception, Phase B - Vulnerability Analysis and Phase C – Feasibility Study. This report focusses on sub-objectives 3) belonging to Phase C – Feasibility Study.

**Approach and Methodology**

In phase B of this Study the flood vulnerability levels have been determined, ii) the hotspots have been identified and iii) identified flood management measures and alternatives have been evaluated and prioritised together with the stakeholders during the charrettes by means of a interactive MCA. This is reported in the Vulnerability Analysis Report and has formed the basis for the development of the feasibility study (phase C).

The feasibility stage activities consisted of the following components (steps), which have been executed in an integrated and iterative manner (as follow-up of the vulnerability phase), see diagram below.

![Diagram](image)

*Figure 4: Main steps in the approach*
Step 1. Effectiveness of prioritized sets of measures;

As a first step in the feasibility study the effectiveness of prioritised sets of measures has been tested with the flood model of the Modelling Consultant. Structural measures and land use measures have been schematised into 1D and 2D modelling components for incorporation into the hydrological and hydraulic flood model. Resulting output has been processed in the flood hazard analysis and damage model for evaluation of effects on hazards and damage.

Step 2. Development of flood management strategy

Based on the effectiveness of the tested measures, and in conjunction with results of the vulnerability analysis and the MCA conducted during the charrette, a flood management strategy has been defined for the short and the long term focussed on a combination of structural measures and spatial planning measures while taking into account future climate variability and socio-economic development.

Step 3. Adding an urban development strategy

As it became evident that resettlement of dwellings is inevitable to adequately reduce the vulnerability of the Msimbazi Middle Basin to flooding, especially in the long term, an urban strategy has been developed as add-on to the overall strategy to include this as part of the feasibility;

Step 4. Concept Designs

The measures of the strategy have been detailed to Concept Designs following basic design principles and in adherence to common practices and international design standards. Details of dimensions, materialisation, functionality and constructability etc. have been drawn up for confirmation of the technical feasibility, and Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) of respective measures has been determined;

Step 5. Preliminary Cost-Benefit Analysis

A preliminary cost-benefit analysis (CBA) has been executed for three defined flood management strategies (bridges only, short term and long term strategy). CAPEX and OPEX figures serve as main cost inputs and the prevented damage and economic disruption costs comprises the main monetized benefits of the strategies to determine the economic feasibility of the three strategies. Apart from this, a business case model was developed in order to estimate the potential revenues and costs of the involved urban development strategy to accommodate resettlement and housing demand.

Step 6. Preliminary environmental and social assessment

For the flood management strategy a preliminary environmental and social assessment has been performed following IFC performance standards to indicate positive and negative effects of the measures in the short and the long term, and for the construction and operational phase.
Step 7. Institutional set-up and funding options

Options for an institutional set-up for implementation, management and maintenance of the measures have been explored. The PIU as proposed for the Msimbazi Strategy and Management Framework as part of the Msimbazi Opportunity Plan has been taken as basis and recent administrative changes in Dar es Salaam have been taken into account. Based upon the financial feasibility (business case) of the strategies funding options have been identified for coverage of investment costs and O&M costs. Bi-lateral donors, climate funds and IFI’s have been considered as well as local and national resources to define a preliminary financing strategy.

Process and Teams

On 1st November 2019 a Contract for Consultancy Services to undertake the Flood Management Feasibility Study for the Msimbazi Middle Catchment Area was signed between Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and CDR International B.V. (CDR).

Main beneficiary of this Project is the Dar es Salaam City Council (DCC). The C40 Cities Finance Facility (CFF) is supporting Dar es Salaam to prepare the project on Flood Management in the middle catchment area of the Msimbazi river. The project is implemented through a partnership of the C40 Cities Climate Leadership Group (C40) and the GIZ.

For this Study, CDR has teamed up with WEMA Consult Ltd. (WEMA), a national consultant in the field of water and environment and based in Dar es Salaam, Tanzania, and DASUDA, an urban planning alliance in the field of sustainable integral urban development in Africa.

Table 1: Project partners

<table>
<thead>
<tr>
<th>Partner</th>
<th>Business / Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR International B.V.</td>
<td>CDR International provides consulting services in the field of engineering coast, deltas, rivers, water resource engineering and ports. Based in The Netherlands.</td>
</tr>
<tr>
<td>WEMA Consult Ltd.</td>
<td>Water and Environmental Management Consultancy. Based in Tanzania.</td>
</tr>
<tr>
<td>DASUDA</td>
<td>Alliance for Sustainable Urban Development in Africa. Based in the Netherlands.</td>
</tr>
</tbody>
</table>

For this Study, the above-described consortium will be referred to as the ‘Feasibility Consultant’, whereas the consultant commissioned by GIZ for the flood modelling activities is referred to as the ‘Modelling Consultant’. The Modelling Consultant is represented by Deltares from the Netherlands in association with OpenMap Development Tanzania.
On 28th November 2019 a joint kick-off call between teams of GIZ and the Feasibility Consultant took place. The kick-off meetings in Tanzania were held in the week of 13th to 17th January 2020. The Draft Reporting by the Modelling Consultant was submitted on 20th August 2020, after which the main technical assessments of Feasibility Consultant’s Study could commence.

A design charrette for this Study took place on 13th and 14th of January 2021 to complete Phase B, of which all relevant methods and results have been reported in the Vulnerability Analysis Report. This report is on the Feasibility Study and completes the Study.

**Content of this Report**

This Draft Feasibility Report includes the following items:

- Flood management strategy;
- Technical feasibility;
- Preliminary cost-benefit analysis;
- Environmental and social assessment;
- Institutional set-up and funding options;
- Conclusions and recommendations.
FLOOD MANAGEMENT STRATEGY

Main findings Vulnerability Analysis

This section presents the main findings of the Vulnerability Analysis and Charrettes conducted (Phase B) to provide a proper context to the feasibility study. Throughout this report, reference is made to Vulnerability Analysis Report (CDR International and partners for CFF, 2021).

Causes of flooding

Generally, flooding in the Msimbazi Middle River Basin is directly caused by five main factors; i) insufficient hydraulic capacity of the Msimbazi River profile at certain locations, ii) back water effects and piling up of water upstream of structures, e.g. bridges, with an insufficient hydraulic capacity, iii) inadequate urban drainage infrastructure and inadequate solid waste management and iv) decrease of ‘green areas’ in the catchment has resulted in reduction of infiltration of precipitation and a direct run off response and v) settlement in the natural floodplain area. For most of the river stretches and tributaries in the project area the hydraulic capacity is too small, so with events with a high frequency, the river can already overflow over the riverbanks and embankments. During these events, the flood depth increases upstream of the bridges mainly because of the backwater curves. Also, gradients in flow velocity are observed at these locations because of the limited hydraulic capacity thereby triggering erosion and sedimentation processes. By addressing the hotspots, a large share of the flood risk could be potentially mitigated. Urban drainage infrastructure has been taken into account, however in this Study focus is on fluvial flooding and flood mitigation strategies have been framed as such.

![Figure 5: Vulnerability of buildings to a flood event with a 10yr return period, for climate change scenario RCP8.5 projected to 2050, high urbanization scenario, zoomed in to Vingunguti ward. Main direct causes of flooding in this area are insufficient hydraulic capacity of river channels and the bridges](image-url)
The Msimbazi Middle Basin is already seriously vulnerable to pluvial and fluvial flooding in the existing situation. In the future, under a do-nothing scenario, climate change and autonomous urbanisation will contribute to a substantial increase of flood risk. By 2050 about 70% of the increased hazards compared to the scenario of 2020 will be caused by urbanisation and 30% by climate change. The effect of urbanisation on flood risk provides insight in the potential to avoid further increase of flood risk by means of adequate, integrated multi-sectoral spatial planning.

**Hotspots**

Based on the vulnerability analysis so-called hotspots have been determined where the intensity and impact of flooding are highest. By choosing the hotspots, possible effects downstream and upstream of bottlenecks, obstructions and (limited) flood plain area have been taken into account. On a catchment wide level it is observed that the vulnerability to flooding increases from upstream to downstream; most vulnerable is the Lower Basin, followed consecutively by the downstream section and the upstream section of the Msimbazi Middle Basin. For the Msimbazi Middle Basin the following four hotspots have been identified (from downstream to upstream):

5. Kawawa Road Bridge and upstream area affected by back waters;
6. Kigogo ward;
7. The Industrial zone;
8. Railroad Bridge and upstream area affected by back waters.

**Figure 6: Hotspot map**
**Identified measures**

Based on the analysis of main causes of flooding and hotspots, five potential flood mitigation measures have been identified initially (see below table).

*Table 2: Initial identified flood mitigation measures for the middle Msimbazi basin.*

<table>
<thead>
<tr>
<th>No.</th>
<th>Measure</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Widening and/or raising bridges crossing the Msimbazi River and her tributaries to increase the hydraulic capacity of the bridge.</td>
<td><img src="image1" alt="Proposed" /></td>
</tr>
<tr>
<td>2.</td>
<td>Creating a wider river bed to increase the hydraulic capacity of the river channel.</td>
<td><img src="image2" alt="Proposed" /></td>
</tr>
<tr>
<td>3.</td>
<td>Lowered flood plain with emphasised physical edge or raise terraces by reshaping valley profile. This to give room for the river.</td>
<td><img src="image3" alt="Proposed" /></td>
</tr>
<tr>
<td>4.</td>
<td>Resettlement from locations with high residual flood risk after implementation of first three mentioned measures.</td>
<td><img src="image4" alt="Proposed" /></td>
</tr>
<tr>
<td>5.</td>
<td>Re-greening of resettled areas as well as reforestation of the upper catchment sections of the Msimbazi River.</td>
<td><img src="image5" alt="Proposed" /></td>
</tr>
</tbody>
</table>

The initially identified measures have been discussed and evaluated together with the stakeholders (including governmental institutions, private stakeholders and community representatives) during the charrettes held in Dar es Salaam in January 2021. The following points capture the main results from the charrettes:

- Reduction of flood impact was found to be the most important criterium for a flood mitigation measure. Second is Social acceptance, underlining the sensitivity and severity of the flooding issues in the study area. During the second day, with the community representatives, Political acceptance scored very high. The principle behind is without political acceptance there will not be a significant transformation to increase the resilience to flooding.

- Out of the initially identified, measures raising and widening of bridges scored highest, followed by measures which include dredging and excavation activities to provide room for the river. Resettlement scored lowest for all criteria, thereby clearly marking this as a very sensitive topic.

- From the spatial design session, the following general conclusions can be drawn:
• All groups indicated to widen/raise some of the main bridges, especially Kawawa road bridge and Nelson Mandela road bridge;
• Even though the resettlement scored quite negative in the scoring sessions, all groups indicated that in some locations resettlement might be the best choice, especially in Buguruni;
• Most groups were in favour of several forms of dredging the river channel, with potential increased floodplains and/or terraces;
• Most of the groups proposed nature-based solutions, such as rainwater harvesting, reducing paved areas and reforestation/planting more trees as measures for the entire catchment area. Generally, re-greening of the study area was considered to be the most sustainable solution in view of flood risk reduction as well as potential (co-) benefits like reduced heatstress, food production and a pleasant and aesthetically attractive living environment.

Initial identified flood management strategy

The flood management strategy developed for this Study fits into the Strategy and Management Framework of the Msimbazi Opportunity Plan (MOP). The main principle adopted from the MOP is that (hydraulic) river measures with a direct effect on the hydraulic regime should be implemented sequentially from down- to upstream. By doing so, a chain effect of increased discharges by removed bottlenecks upstream affecting downstream bottlenecks even harder is avoided. The MOP also stipulates that in the downstream sections of the catchment area the flow conveyance of the river should be increased, whereas in upstream sections the water retention capacity is to be increased. The strategy for The Msimbazi Middle Basin is located in the transition of these zones, so should take into account these main principles.

![Figure 7: Main MOP principles – right image: remove hydraulic bottlenecks from downstream to upstream. left image: retain water upstream and increase flow conveyance capacity downstream. Images after Msimbazi Opportunity Plan.](image_url)

As part of the MOP, the Refined Special Planning Area boundary has been developed and serves to guide the development of a detailed low flood risk planning scheme for the Msimbazi River including some tributaries (CDR International and partners, 2018). The boundary has no legal implementation status yet. However, with more feasible planning schemes and flood mitigation measures being developed within this boundary also more substance is created to get the boundary approved and in turn

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**Funding partners:**

![Funding partners logos]

**Implementing agencies:**
enable implementation of the plans. For this Study, the Refined Special Planning Area boundary is considered an important anchor for justification of measures that will affect the areas adjacent to the river courses.

![Figure 8: Refined Special Planning Area Boundary. Image after CDR Int and partners, 2018](image)

Following previously developed strategy and plans and based on the Vulnerability Analysis and the charrettes, a hybrid flood mitigation strategy has been developed. It combines long term multi-sectoral integrated sets of measures and short term measures focusing on removal of hydraulic bottlenecks. The results of the break-out sessions during the charrettes have been duly taken into account in the development of this strategy.

**Long-term components** consist of measures with longer implementation schedules with basin-wide long-term positive effects. This part of the strategy should be managed on a multi-sectoral integrated level with impact on the urban tissue and is expected to require a longer implementation time. The measures of the long-term components are focused on increasing infiltration and retention capacity and greening of the Middle Basin by Nature-Based Solutions and Spatial Planning including resettlements on the most critical locations. Creating more room for the Msimbazi River and its tributaries also belongs to these measures. Planning and design of such measures and resettlements should be conducted the soonest to prevent further increase of flood impacts due to climate change and further urbanization in the future.

**Short-term components** - Short-term measures, mostly on a sectoral level, with immediate positive effects. These are measures that focus on infrastructural works and do not require large-scale resettlements. It is expected that both political and social acceptance for these measures will be high, which is likely to enable rapid implementation. The short-term measures focus on removing hydraulic bottlenecks like raising and widening bridges, localized dredging/excavation activities and small-scale resettlements. After implementation of the short-term measures a residual flood risk will remain, hence the reason to start planning and implementation of the long-term measures simultaneously.
To conclude the Vulnerability Analysis it was highly encouraged that the City Administration pursues both the short- and long-term components to safeguard the lives and livelihoods of communities from future floods.

**Effectiveness of prioritised measures**

The effectiveness of the identified strategy has been tested by incorporating of the prioritised measures and simulation of floods with the hydro-dynamic flood model of the Modelling Consultant commissioned for this specific work. The effectiveness has been determined by comparisons of the resulting damages against the base cases – i.e. do nothing scenarios. A limited amount of runs (flood simulations with different sets of implemented measures) could be executed, hence several combinations of measures have been made per run, resulting in the three runs as presented in Table 3.

**Table 3: Three runs for testing measures with the flood model**

<table>
<thead>
<tr>
<th>Run</th>
<th>Measures incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>Widening and raising of 5 bridges</td>
</tr>
<tr>
<td>Run 2</td>
<td>Widening and raising of 5 bridges, and Widening and Deepening of river channel</td>
</tr>
<tr>
<td>Run 3</td>
<td>Widening and raising of 10 bridges (3 of them located outside the study area), and Widening of river channel (updated after run 2), and Reforestation of upper catchment sections, and Room for the River in Middle Basin (reduction of paved fraction and roughness), and measures as proposed in the Detailed Plan for the Lower Basin as part of the MOP, including the widening/raising of the Jangwani bridge, the dredged river channel and terraces in the floodplain.</td>
</tr>
</tbody>
</table>

The schematisations of the measures have been prepared in close cooperation with the Modelling Consultant. More information on the schematisation and other details of the runs are presented in the Flood Modelling Report (Deltares, 2021).

**Hazard Reduction**

On the following pages the hazard reduction is visualised on maps. Figure 9 and Figure 10 show the flood extents and maximum water depts for an event that in theory will occur once in 10 years (10 year return period) in case of climate change scenario RCP8.5 and urbanisation in 2050, for do nothing and run 3 respectively.

Figure 11, Figure 12 and Figure 13 show the spatial distribution of change in flood extent per subward for a 10 year return period (T10) for the projection year 2050, climate change scenario RCP8.5 as the reduction in percentage between the situation with and without the measures. The darker the green area of a subward is shown, the
larger the reduction of the flood extent. In case the subward is white, there is no significant change in the hazard. The flood extent increases in subwards with a reddish colour (the darker the more severe).

Figure 9: maximum flood depth T10yr condition with do nothing scenario and, RCP8.5 in 2050
Figure 10: Maximum flood depth T10yr condition with run 3 measures, with RCP8.5 in 2050

Figure 11: Run 1 hazard reduction map for T10 yr condition with RCP8.5 in 2050
Figure 12: Run 2 hazard reduction map T10 yr condition with RCP8.5 in 2050

Figure 13: Run 3 hazard reduction map for T10 yr conditions with RCP8.5 in 2050

Funding partners:

Implementing agencies:
Run 1 - As can be observed, the largest share of prevented hazards are around the locations of the bridge measures. Especially just upstream the bridge measures, a hazard reduction up to max 30% is achieved in subward Kombo, ward Vingunguti. Because of the increased hydraulic capacity of the bridges, it can also be observed this causes a chain effect of increased hydraulic capacity in the Middle Basin resulting in increased hazard levels in the Lower Basin. The Lower Basin receives more water from upstream in the same timeframe compared to the do nothing. This stresses the importance of implementing measures from downstream to upstream.

In run 2 it is clearly visible that the distribution of prevented hazards is more widespread and also the magnitude of reduction (percentage) has increased. Compared to the bridge measures the implementation of deepened and widened channels contributes significantly in reducing hazard levels. This results in prevented hazard levels up to 80% in wards Tabata and Vingunguti. The downside is that the chain effect is larger compared to Run 1, so the Lower Basin receives even more water in the same time frame. Here it needs to be noted that the channel design included in run 2 has been improved for run 3 from a deeper channel to a wider channel.

Run 3 includes the highest number of measures, both structural and non-structural, with a larger distribution of hazard reduction over the Study area. This is clearly reflected in the effectiveness map by a reduction of hazard levels in 75% of all subwards in the Study area. This spread of reduced hazards to a large extent gained by the Room for the River and reforestation measures. The magnitude of reduced hazards is a bit lower than run 2, which is mainly attributed to an optimised channel design. For run 3 the channel design has been changed to widening the channel rather than deepening it, anticipating undesired morphological response and effects on groundwater by deepening the river channel. The MOP Lower Basin measures (to increase the hydraulic capacity of rivers, flood plains and bridges) were included in this run. It can be observed that this area now also experiences a reduction of hazards compared to the do nothing scenario. This underlines the importance of following the MOP principle of implementing (structural) measures from downstream to upstream.

Prevented damage

The prevented damage for the three runs has been calculated by deducting the total damage for a run from the total damage in the do-nothing scenario. These percentages are based on damage to all buildings in the project area, which represents >95% of the total damage (see Vulnerability Report) and is therefore considered representable for the total damage reduction. Table 4 shows an overview of the prevented damage for the events that will occur theoretically every 2, 10 or 50 years (return periods) based on climate change scenario RCP 8.5 in 2050.

Table 4: Prevented damage of runs based on flood modeling for 2050, RCP8.5 flood conditions for the theoretical events with return periods of 2, 10 and 50 years

<table>
<thead>
<tr>
<th></th>
<th>T2</th>
<th>T10</th>
<th>T50</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damage Do Nothing (in million USD)</td>
<td>263</td>
<td>485</td>
<td>661</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

**Prevented Damage in million USD**

| Run 1 | 16  | 26  | 20  |
| Run 2 | 31  | 100 | 117 |
| Run 3 | 62  | 109 | 109 |
| Run 3 + resettlement | 178 | 329 | 426 |

**Prevented Damage as percentage to Damage Do Nothing**

| Run 1 | 6%  | 5%  | 3%  |
| Run 2 | 12% | 21% | 18% |
| Run 3 | 24% | 23% | 16% |
| Run 3 + resettlement | 68% | 68% | 64% |

Generally, run 1, 2 and 3 show an increasing magnitude of prevented damage compared to each other, which is logical as flood mitigation measures have been added in the runs sequentially. Based on relative damage prevention run 1 (bridge measure) is most effective for the lower return periods (6% for T2yr vs. 3% for T50yr), whereas run 2 (bridge measures + dredged channel) seem to be more effective for higher return periods (T10 and T50).

Run 2 shows a substantially higher effectiveness than run 1 based on the relative prevented damage (max 21% and max 6% respectively) which can be attributed to the significant increase of the hydraulic capacity of both the rivers and the bridges.

Run 3 shows the highest effectiveness. Particularly for higher frequency events (low return periods) the re-greening measures of run 3 seem to delay and flatten peak flow resulting in significant lower hazards. Here it needs to be noted that in run 3 the channel has been designed from a deeper channel (run 2) to a wider channel.

Even though aggregated prevented damage in absolute monetary terms USD) in Run 1, 2 and 3 is considerable, the residual damage (damage experienced even after the implementation of the flood mitigation interventions) remains relatively high (over 75%). See also Figure 9 and Figure 10. The damage prevention of run 3 has been based on hazard reduction only (‘Run 3’ in the table). Therefore, in addition, a scenario has been assessed in which the modelled damage to building and structure stock within the room for the river sections has been added to the prevented damage (‘Run 3 + resettlement’ in the table). This scenario shows the highest prevented damage (between 60% and 70%) and is representative for a long term implementation.
schedule that includes room for the river and relocation of building and structure stock from this area. It is expected that the residual damage of Run 3 including resettlement is mainly caused by pluvial flooding. In addition, it is likely this is an overestimation due to the coarseness of the grid cells and the omitted drainage infrastructure in the flood model.

**Defined Flood Management Strategy**

Following the results from the Vulnerability Analysis and the calculation of the effectiveness of the prioritised measures, the initially identified flood management strategy has been refined and has been structured to a short and long-term implementation schedule. The following measures are proposed in these schedules:

**Short term component (2021 – 2026):**

a) Widen and/or raise bridges  
b) Widen river beds  
c) River bank protection  
d) Urban development

**Long term component (2021 – 2050):**

e) Room for the River  
f) Urban development  
g) Reforestation of upper section Msimbazi catchment and re-greening of re-developed areas

In the following images on the following pages the flood management strategy is visually explained.

**Current Situation**

- Bridges too narrow
- Riverbed too narrow
- River blockage by buildings
- Current situation
- Current flood extent stretches far into the urban tissue
Short term (2021-2026)

- a) Widen and raise
- b) Widen riverbed
- c) River Bank Protection
- d) Relocate and regenerate

Transition of an existing urban patch to include multi-storey housing units and increased pervious, green areas

Long term (2021-2050)

- e) Create a wider green floodplain
- f) Resettle all built structures
- g) Co-use of room for the river by green functions

1. Transition of an existing urban patch to include multi-storey housing units and increased pervious, green areas
2. Denser urban areas for resettlement and more forest along the floodplain

Funding partners: [List of logos]
Implementing agencies: [List of logos]
Figure 14 shows in a conceptual manner how the measures will be implemented in the short and the long term. In the short term main hydraulic bottlenecks will be removed and required resettlement will be accommodated with the initiation of the urban regeneration through urban patch development.

After the implementation of the short term measures a residual flood risk remains, which is the reason why the long term measures need to be implemented as well, mainly consisting of making Room for the River and re-greening of the area. For the Room for the River to work, this requires to resettle all the built structures within the defined floodplain area. The required resettlement will be organised via continuous regeneration of urban patches as well as larger urban area developments.

Further detailing and explanation of the various measures is given in the next chapter on Technical feasibility.

Because the scale of resettlement is considered substantial, an urban strategy has been developed as an add-on to the flood management strategy and is explained in the next sub-chapter.

**Urban development strategy**

The urban development strategy developed for the Msimbazi Middle Basin has the objective to resettle those households that are affected by the river measures within the area and besides that develop space for commercial real estate as well. This resettlement should occur in a manner that enhances the sustainability and liveability standard. The two phases defined for the river measures are also applied to the resettlement solution and the urban development strategy for this matter: short term and long term. For that matter the urban development strategies should be considered as an integral part of the overall Flood Management Strategy for the Msimbazi Middle Basin. The main principles of the urban development strategy are elaborated below per short and long term component.

**Short term component**

The short-term urban development strategy entails the transition of a number of patches of approximately 1 hectare within existing neighbourhoods to fit the resettlement requirements in the short term. The patches are indicatively located in
the urban tissue, based on the number of households that need to be resettled per subward. In this way, the resettlement can be accommodated in the same social environment and area. The implementation of a patch could be performed on a ten cell scale level, which is based on an informal subdivision of the subward (Mtaa), which could increase social acceptance and coherence.

The main spatial layout components of a regenerated patch consist of:

i. a section that has a very low paved fraction to increase storm water infiltration capacity and which will be re-greened (about 40% of the area);
ii. a section that will be densified with multi-storey apartments (about 10% of the area)
iii. a section which remains largely intact with existing dwellings (50% of the area)

**Long term component**

The long-term urban development strategy component extends the principle of transforming patches by increasing the number of patches to meet long term resettlement requirements. However, the magnitude of resettlement in the long term is relatively large, which will result in a limited efficiency to accommodate all resettlements through patches. Therefore, the long term urban strategy component also includes a number of larger mixed-use urban development combining accommodation of resettlements, affordable housing and commercial real estate. The mixed-use urban development concerns an area size of 50-100 ha each, a size that should be planned, coordinated and managed on higher administrative levels ranging from Mtaa to ward to municipality.

Overall, it is important and anticipated that both the short and the long term urban developments will be coordinated from the Msimba Special Planning Authority and The Msimba Area Development Corporation as stipulated in the Govern Strategy in the Strategy and Management Framework and further elaborated upon in the chapter Institutional set-up and funding options.

In the chapter Technical Feasibility the urban developments are elaborated as concrete solutions for short term measure d) Urban development and long term measure f) Urban development. In the chapter Preliminary Cost Benefit Analysis business cases are reported on the viability of the urban development strategy.
**TECHNICAL FEASIBILITY**

**Concept designs short term component**

The short-term strategy focuses on increasing the hydraulic capacity of the river system by removing the bottlenecks that are present in and near the mainstream particularly at the hotspots. To achieve this the following measures are proposed for the short term:

a) **Widen and raise bridges** to increase the hydraulic capacity of the bridge underpass;

b) **Widen the river bed** to increase the hydraulic capacity of the river channel;

c) **Apply bank protection** to prevent bank erosion, to guide flow through and around bridges, minimise sedimentation issues downstream and mark the minimum river width as a boundary for urban development;

d) **Urban development**; accommodate required resettlements from river sections that need to be widened in urban regeneration areas within the subward.

Figure 15 shows a schematisation of these measures and their locations in the project area. In Appendix I, large-scale vision maps include the proposed measures on a higher level of detail.
a) Widen and or raise bridges

The bridges and the embankments of the bridge approach through the floodplain reduce the hydraulic capacity of the river significantly. Because the capacity of the bridge is insufficient, the water level upstream to the bridge rises (back water curve) and increases the flood risk to upstream areas mainly expressed with higher flood depths. Besides additional flood risk to the surroundings, insufficient hydraulic capacity of the bridges also lead to overtopping of the bridge decks of Kawawa road bridge and Nelson Mandela road bridge and in turn causes traffic and economic disruption.

Based on the hotspot locations the following 4 bridges are proposed to be adjusted in the short term (see also Figure 15):

1. Kawawa road bridge;
2. Nelson Mandela road bridge;
3. Railroad bridge;
4. Kawawa road bridge over the Kibangu stream;

For this study phase, the concept design focuses on the mainstream bridges (1 – 3).

To reduce the flood risk in the surrounding areas and prevent overtopping of the bridges, the flow capacity through the bridges should be increased. This can be done by elevating the bridge deck as well as by increasing the width of the bridge opening. To achieve a smaller flood extent upstream the water level of the flow through the bridges should be lower which is done mostly by widening the bridges. This will also decrease the potential for overtopping. Therefore the future desired water level has been taken as the input parameter that is used to determine the required width of the bridges.

The following water level requirements have been adopted to determine the required width of the bridges:

- The water level should decrease to such extent that a T10 event for a situation with an adapted bridge will result in the water level of a T2 event without bridge adaptation;
- The T10 water level for a situation with the adapted bridge should be at least 0.5 m below the present bridge level;
- The hydraulic gradient (water level slope) should be equal to the bed level slope from downstream to upstream.

Calculation of required width for the bridges

The required width of the bridges, replacing the present bridges with insufficient capacity, has been calculated using Manning’s formula. This formula is described as follows:

\[ Q = \frac{R^2 \cdot A \cdot i^2}{n} \]
For this approach the following assumptions are made:

- The bed level is determined by the lowest point in the surveyed cross-sections directly upstream of the bridge. Around Nelson Mandela bridge, interpolation is done for the bed levels approximately 1000 m upstream and downstream of the bridge to remove the sill in the bed level that is currently present due to the bridge structure;
- The gradient in bed level is determined based on the thalweg of the surveyed cross-sections;
- The design discharges are based on 2050 events with RCP 8.5 climate change and high urbanisation scenarios. The maximum discharge upstream of the bridge (at any point in the mainstream) is taken as the design discharge to avoid including the present insufficient capacity of the river and bridges;
- For the manning’s roughness coefficient, the values of the flood model have been adopted;
- The formula assumes a steady-state equilibrium flow, for which the gradient of the water surface is equal to the gradient of the bed level;
- A rectangular river profile is adopted within the formula.

It is also determined whether the bridged should be elevated with the new design width. For this, it is determined whether during a T50 event, the water does not reach the bottom of the bridge deck. This check showed that Kawawa road bridge should not only be widened but also raised by approximately 1.0 meter.

Table 5: Results for widening and raising the bridges using mannings formula

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Existing width [m]</th>
<th>Proposed width [m]</th>
<th>Raise bridge deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kawawa road bridge crossing Msimbazi River</td>
<td>45</td>
<td>100</td>
<td>~1 m</td>
</tr>
<tr>
<td>Nelson Mandela road bridge</td>
<td>25</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Rail road bridge</td>
<td>40</td>
<td>80</td>
<td>-</td>
</tr>
</tbody>
</table>
Design of bridge structure

Several types of bridges can be considered. The existing Kawawa road bridge is a box culvert bridge. Nelson Mandela road bridge is a simply supported bridge with a shallow foundation. The railroad bridge is a truss bridge, where the structure is supported at the bridgeheads only.

In this Study no further advice is given on structural type of bridge. In the concept designs piled simply supported bridges have been developed (see Figure 16 and Figure 17) as optimal solutions based on hydraulic and morphological criteria. Box culvert bridges are mostly used in Dar es Salaam, however, main disadvantage of such a structure is that it interrupts the natural bed sediment transport which can cause a natural sill upstream of the bridge and erosion downstream of the bridge. Geomorphologically, a piled bridge would be more beneficial because it maintains the natural sediment regime and reduces the risk of structural instability, erosion and washing away of backfill and undermining of structures.

To conclude on most optimal bridge structure other main criteria for bridge design should be studied and assessed, like geotechnical aspects, and envisaged or expected future traffic modalities and capacity.

The present truss of the railroad bridge seems to be in relatively good conditions and could be re-used and integrated into the design. Hence it could be possible to extend the bridge by replacing one of the bridgeheads with a piled support, excavate part of the bridge approach and increase the span with an extra truss with similar dimensions as the existing one (see Figure 18).

![Figure 16: Existing (upper image) and proposed future situation (lower image) at Kawawa road bridge](image-url)
b) Widening the river

To accommodate most of the water during extreme events within the river channel, it is required to increase the capacity. The capacity increases by widening or deepening of the river bed. It has been chosen to widen the river bed rather than deepening it. Deepening the river channel may lead to environmental impacts like lowering of groundwater tables and it is expected that the morphological response and tendency to reinstate to the original river bed geometry is more extreme and therefore undesirable.

The widening of the river will increase the hydraulic capacity and will therefore reduce the water levels and flood risk. On the other hand, the widening of the riverbed will cause conflict with existing buildings at some locations. These locations are now considered as bottlenecks that locally reduce the hydraulic capacity. The strategy in the short term is focussed on removing these bottlenecks. In determining the width of the new river profile it was needed to find a balance between the minimum desired hydraulic capacity and the amount of resettlement that is required to reach that width. For the implementability of the short-term measures, large scale resettlement is considered not feasible.
Based on the flood model results presented in the Vulnerability Analysis, areas with an insufficient flow capacity of the channel are identified. These are the areas along the mainstream downstream of the Vingunguti bridge as well as the area of Kigogo around the Kibangu and Tenge tributaries. Because the available area around the Kibangu and Tenge is very limited, such that it will be difficult to reach with dredging equipment, the short-term widening of the river will focus only on the Msimbazi mainstream.

The Msimbazi mainstream is divided into 4 different stretches, based on the river characteristics such as design discharge, bed level gradient and the elevation difference between the banks and the riverbed. These are as follows:

1. Kawawa road bridge to the confluence with the Tenge river;
2. Confluence of the Tenge river to the railroad bridge;
3. Railroad bridge to Vingunguti bridge;
4. Vingunguti bridge to the confluence with the Kinyerezi river.

To maintain a sufficient width of the river and prevent uncontrolled building closer to the river, the proposed river area should be marked clearly. This can be achieved with small embankments in the order of 0.5 to 1m in height. This way also a part of the material to be removed from the river bed can be re-used in the construction of embankments.

**Hydraulic capacity**

For the design river profile, the flow capacity should be sufficient to accommodate for events that occur at least 1 time per year or more frequent in the future. For the initial calculation of the required river width, a discharge of a T2 event with the scenario in 2050 with high climate change is adopted, which is in line with the design requirements of the river channel designs for the Lower Basin (Detailed Plan for the Lower Basin as part of the MOP).

A similar approach using manning’s formula for equilibrium depth is used as for the required bridge width is adopted, assuming:

- A T2 discharge is retrieved from the model results per stretch based on the highest discharge upstream of a stretch for a 2050 event in combination with RCP 8.5 and high urbanisation;
- The gradient in bed level is determined for each section based on the thalweg of the surveyed cross-sections;
- For the manning’s roughness coefficient, the values of the flood model have been adopted;
- The formula assumes a steady-state equilibrium flow, for which the gradient of the water surface is equal to the gradient of the bed level;

The mainstream river area will have a trapezoidal profile, in which the gradient of the slope has been determined following an iterative process and based on the available area for the river width and the required flow area.
The available water depth is determined as the level difference between the lowest point of the survey and the levels of the surrounding banks that are covered in the DTM. The available water depth decreases from downstream to upstream from approximately 1.8 m to 2.5 m. Because small embankments of approximately 0.5m height will be implemented along the river to mark the river area it is estimated that the available depth is 2.3 m along the entire river. It should be noted that the amount of surveyed cross-sections is limited and large spatial variations are present. Instead of increasing the elevation of the bank, the bed level can be lowered compared to the present situation in these cases.

Based on a T2 discharge, 1:3 side slopes and an available water depth of 2.1 m for Section 1 and 2 and 2.3 m for section 3 and 4, the following bottom widths are calculated for each stretch:

<table>
<thead>
<tr>
<th>Design discharge (m³/s)</th>
<th>Bottom river width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretch 1 Kawawa road to Tenge confluence</td>
<td>180</td>
</tr>
<tr>
<td>Stretch 2 Tenge confluence to Railroad bridge</td>
<td>150</td>
</tr>
<tr>
<td>Stretch 3 Railroad bridge to Vingunguti bridge</td>
<td>150</td>
</tr>
<tr>
<td>Stretch 4 Vingunguti bridge to Kinyerezi confluence</td>
<td>140</td>
</tr>
</tbody>
</table>

In case of a reduced available water depth of approximately 30 – 40 cm, at least 75% of the T2 discharge can be accommodated. It is expected that this will be sufficient to prevent flooding for events that occur every year.

**River training**

Besides increasing the width of the river channel, small changes are proposed to be made to the natural river course. This entails mainly decreasing the curviness of the river upstream of the railroad bridge. This has the following effects:

- A slightly steeper gradient results in a lower water depth;
- The morphodynamic activity will reduce due to fewer sharp bends, which will reduce sediment depositions;
- Smaller hydrodynamic loads on the bends will decrease the risk of instability of the existing bends and result in higher feasibility for natural solutions for bank protection.
At the sharp bend just upstream the railroad bridge the flood risk increases considerably. In case of an extreme event, the river overflows upstream and along the railroad bridge embankment into a relatively low lying area away from the bridge opening. This causes a significant potential for flooding of the subward Kombo with events with relatively high frequency. It is proposed to straighten this stretch of river to guide the flow towards the bridge instead of towards Kombo.

For most of the river sections re-profiling fits within the existing river bed. To fix the location of the banks properly, riverbank protection will most likely be required. In the next paragraph, suitable solutions for riverbank protection will be discussed.

**Potential for river width and resettlement along the river**

In most of the area >60m of width is available between the buildings on both sides of the river. However, several locations can be identified as a potential hydraulic bottleneck showing a reduction in the discharge along the mainstream and directly downstream. At these spots, the width of the river between the buildings is generally smaller, around 40-45m. Especially in the industrial zone in Buguruni the available width between the warehouses is considered very small (e.g. ~30 m) to create a sufficiently wide channel with suitable river banks. Considering i) the different river profiles in the Study area, ii) the determined hydraulic capacity of widened rivers, and iii) keeping the amount of resettlement in the short term limited, it has been determined that the total width of the river (including the banks) should be widened to a min of 50m. The river widening has been planned mainly within the existing river profile to avoid resettlement of existing buildings as much as possible.

Figure 19 shows the situation with and without the implementation of the short term measures around the railroad bridge. For this situation, the new river course is designed such that it integrates into the urban tissue as much as possible to avoid unnecessary resettlements. Just upstream of the railroad bridge where the bend is straightened, several houses are proposed to be resettled. At the industrial zone, some warehouses are indicated to be resettled due to the widening and locally small numbers of houses that are built directly on the current banks.
For the short term, the following indicative number of buildings per building category are expected to be resettled within the Study area:

Figure 19: Topviews present situation (upper) and proposed short term situation (lower) around the railroad bridge
Table 7: Number of buildings per category to be resettled from the river in the Msimbazi Middle Basin in the short term

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business &amp; Offices</td>
<td>1</td>
</tr>
<tr>
<td>Health &amp; Sanitation</td>
<td>2</td>
</tr>
<tr>
<td>Industrial</td>
<td>16</td>
</tr>
<tr>
<td>Mixed Use</td>
<td>4</td>
</tr>
<tr>
<td>Residential</td>
<td>250</td>
</tr>
</tbody>
</table>

Dredging profile and volumes

Based on the calculated bottom width, the total river width and the topography of the banks, the river profile has been determined.

The river bed will be dredged at the level of the deepest surveyed point with a width as per Table 6. For most profiles the lowest point is approximately 20 cm lower than the average point in the profiles. More importantly, the river will become wider at most stretches, where an overall width of 50m is reserved. A small embankment (~0.5 m above the present survey level), will be present at the edges of the 50m river width. The slopes are preferably as gentle as possible because this enables natural solutions for the bank protection as discussed in the next paragraph. In Figure 20, the present situation and proposed future situation of the river profile is depicted upstream of Kawawa road bridge (exact location of the cross-section indicated on the map), with on the right bank the open Sukita area.
The dredged material can be used locally for the fill of the small embankments that are proposed to mark the river area. Dredged material can also be used as fill material for the planned terraces in the Lower Msimbazi basin. The dredging volume is determined based on some representative cross-sections per stretch. Due to the uncertainties in the riverbed topography between the measured cross-sections, the total required dredging volume are estimated conservatively. The following indicative volumes are applicable for the different sections:

Table 8: Estimated dredging volumes per stretch

<table>
<thead>
<tr>
<th></th>
<th>Volume (m$^3$) per m$^2$</th>
<th>Length (m)</th>
<th>Volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretch 1</td>
<td>20</td>
<td>2,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Stretch 2</td>
<td>40</td>
<td>1,200</td>
<td>48,000</td>
</tr>
<tr>
<td>Stretch 3</td>
<td>20</td>
<td>2,200</td>
<td>44,000</td>
</tr>
<tr>
<td>Stretch 4</td>
<td>12</td>
<td>5,600</td>
<td>68,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

c) Riverbank protection

Riverbank protection is proposed along parts of the widened river profile. The type of riverbank protection will vary because of different loads (e.g. flow velocity) and the type of assets that should be protected. Preferably and where possible, natural solutions will be adopted because these are less expensive compared to structural solutions. Natural solutions have also beneficial side effects such as the increase of livelihood with larger green areas.

Natural bank protection solution

The most common natural solution is slope protection with vegetation. The roots of the vegetation will increase the resistance against erosion significantly compared to exposed soil.

At the moment, many of the banks that are prone to erosion are already quite steep (e.g. steeper than 1V:2H). For slopes protected with vegetation, the maximum slope should be 1V:3H. Based on the designed river profile and topography, this is possible for the larger part of the Msimbazi mainstream.
To enable a vegetated slope protection, the slopes will be reshaped to a suitable gradient as per the designed river profile. The subsoil should be compacted properly. A layer of fertile topsoil is applied and revegetated with indigenous vegetation. Over the topsoil and vegetation, erosion control blankets will be applied. This is to prevent erosion before the vegetation is matured. Figure 21 shows a schematisation of the riverbank with slope protection.

It is important to monitor and maintain the vegetation on the slope. This prevents the formation of weak spots in the vegetation layer due to erosion or alien species. This should be done at least annually and after each severe event. The embankments that are proposed to mark the alignment of the river ensure proper access for small vehicles and persons to the riverbanks.

![Figure 21: Schematisation of reshaping the natural profile to a slope protected with natural vegetation (source: CFF, 2020)](image)

To improve the resistance against erosion further, so-called brush packing can be applied in combination with the vegetated slopes. This can be done for examples in the outer bends where the flow velocity is generally lower. In this case, dead stakes that are secured with wire are used to increase the stability of the slope even further. This is combined with vegetation that creates a protective blanket on the slope. Figure 22 shows a schematisation of the concept for brush packing. Similar to the vegetated slopes, regular monitoring and maintenance of the condition of the protection are required.
Structural bank protection solution

In locations where the flow velocities are generally higher, the natural solutions might not be sufficient to prevent bank erosion. In this case, structural solutions for bank protection should be applied. These locations are identified as follows:

- Around bridges, approximately up to 200 m upstream and downstream as flow guidance structures;
- In areas that are morphologically active and sharp river bends are present;
- Areas where valuable assets are located close to the new riverbank and steeper slopes might be required.

Several types of structural solutions for bank protections are considered. However, not all of them can be considered suitable for the implementation in the Msimbazi River.

Rip-rap slope protections are very common to protect coastlines as well as riverbanks. For Msimbazi River the flow conditions during extreme events are very high (exceeding 3m/s) which results in a costly heavy armour stone gradation, therefore deemed not suitable.

Concrete mattress slope protections and Gabion boxes (see Figure 23) or gabion mattresses are more suitable with high flow velocities. Transportation of the smaller grade rock material will be more feasible compared to the rip-rap slope protection. From these options, gabion boxes or mattresses are considered the preferred solution for the following reasons:

- Material costs are lower compared to concrete mattresses. The concrete mattress will require a geotextile formwork which should be supplied from abroad compared to the mesh boxes. Besides, small rock sizes that are used as fill for the gabion box are less expensive compared to concrete;
Gabion boxes are considered to be more sustainable because of the flexibility of the boxes. In the case of small installation errors of subsidence/erosion from underneath, the gabions will reshape themselves without causing potential risk to the structural integrity of the solution. Concrete mattresses are more vulnerable because the concrete slab can break easily if the support of subsoil reduces;

- Gabion boxes are more easily adaptable to future situations by placing an extra box or mattress compared to the concrete solution;
- The amount of man labour is more or less equal for both solutions.

Figure 23: Schematisation of gabion bank protection

For gabion structures, different configurations can be applied, such as a gabion mattress or stacked gabion boxes as displayed in Figure 23. Stacked gabions can be constructed on a steep slope and are therefore suitable for areas where the space is limited. One of these locations is the logistic area of Buguruni, where warehouses are constructed close to the existing bank and bank erosion causes significant damage to the industrial plots.

For the design of the gabion slope, it is proposed that mainly the upper part of the slope is protected. This is the area where the highest erosion risk can be expected. Gabion boxes of 1m width are proposed because these are most suitable for the high flow velocities. The gabions are stacked in a 1V:1H slope, resulting in sufficient overlap for stability. At the lowest gabion, two gabions will be placed in front of each other, so that in case of erosion occurs downslope of the protection the first gabion protects the stability of the gabion slope. The slope below the gabions will be covered with vegetated protection. Figure 24 shows a schematisation of the existing and future scenario with the proposed gabion bank protection at the Buguruni logistic area.
For the bridgeheads, stacked gabions solutions are proposed as well, but in this case, the protection should cover the entire slope from the riverbed to the bridge deck. This is because the flow through the opening accelerates and erosion could potentially cause very high damage to the bridge structure.

Figure 24: Existing (upper profile) and proposed situation (lower profiles) at the logistic area of Buguruni, including gabion boxes as bank protection

d) Short-term urban development

To enable the removing of the hydraulic bottlenecks and widen the river, small scale resettlement is inevitable. Resettlement of buildings within the same ward/subward is preferable to minimise social impact and maintain existing communities structures.
This would imply that densification of the buildings stock in these subwards around the river is required. Since the building density is already very high re-developments would need to have multi-storeys (higher FSI), as indicated in Figure 25.

Figure 25: Schematization of the concept of densification of the urban tissue to enable short term resettlement

Along all stretches of the river the households affected have been counted based on GIS analysis to determine the resettlement requirement per subward. The transition entails 22 patches of approximately 1 hectare within existing neighbourhoods to fit the resettlement of 250 dwellings. Within each of these patches, part of the existing buildings need to be regenerated as well. The 22 patches are indicatively located on the map, based on the number of households that need to be resettled per subward. In this way, the resettlement can be accommodated in the same social environment and area. A series of tests on these patches have been made to consider the situation, urban pattern, building typology and density. Average density for the urban typologies in most of these patches is 50 dwellings per ha (floor space index (FSI) of around 3).

Whether people actually will make the choice for resettlement or for a compensation agreement will be part of a Resettlement Action Plan (RAP) linked to detailed planning in a later stage. For this study the calculations are based on a 100% resettlement base.
Concept designs long-term component

The long-term strategy focuses mostly on decreasing the high flood risk in the project area based on the following principles:

- **Room for the river** – increasing floodplain area to accommodate flood water of extreme events by retreating structures and assets;
- **Urban development** – urban re-generation in patches and area developments to i.a. accommodate resettlements;
- **Reforestation and re-greening**; Increasing the infiltration capacity by regreening the catchment area.

Even though these measures are referred to as long-term measures, the planning and implementation should start in the short term. The implementation period is expected to be much longer compared to the short-term measures. Also it will take more time to gain the effectiveness of the long-term measures. However, the long-term measures are of a transformative nature providing a considerable increase in flood resilience and sustainable urban development in the long term.

**e) Room for the river**

In the short-term measures, the first steps towards the Room for the river were made. By removing the hydraulic bottlenecks and widening of the riverbed, high-frequency discharges are accommodated within the river channel. However, the flood risk for low-frequency events is still considerable. Due to rapid urbanisation over the last decades run-off has increased (increased flood hazards) and settlements have expanded up to the river banks (increased exposure), which resulted in floodplains which are very vulnerable to flooding. Therefore, it is proposed to largely restore the floodplain area to a more natural state. To achieve this, a large part of the building stock will have to be replaced to new areas as explained in the Flood Risk Strategy. A more vegetated floodplain with areas for farming and recreation will be created in the cleared area. Furthermore, also retention ponds can be considered within these floodplain areas, where water is temporarily retained to decrease the magnitude of the flood downstream and improve the infiltration capacity.

The alignment of the proposed floodplain area is based on flood extents for the situation with the measures included (tests with flood model), topographic analysis and the present urban tissue (e.g. clear boundaries such as road network). Figure 26 shows the area in the project area that is proposed for the floodplain area.

As visible in Figure 26, the area is varying in width and covers the area around the mainstream as well as areas around the tributaries. It should be noted that this area also includes areas that are already open (e.g. no buildings), such as the Sukita area between Nelson Mandela road bridge and Kawawa road bridge and further upstream smaller parts along the river. It is important that these areas are included in the plans to prevent further urbanisation here. In the lower basin, the area is wider and further upstream the area becomes less wide except for the areas that are green at the moment, similar as to a natural floodplain topography.
As can be observed in Figure 27, a floodplain area is proposed on both sides of the river. At this location between Kawawa road bridge and Nelson Mandela road bridge, this means that only buildings on the north bank are to be resettled, due to the open area at Sukita. Based on the natural topography the floodplain width is determined. On the South side, a clear natural terrace is already present. This will be extended over a larger part of the Sukita by developed terraces, similar as in the Lower basin is proposed. These terraces should be at a level that prevents flooding during more severe events. On the North side, the natural boundary of the floodplain is less evident, in this case it is proposed to implement a small embankment that marks the alignment of the floodplain (and no-building zone) as well as functions as a flood barrier hereby reducing the flood risk. The slopes of these embankments can be rather gentle to enable natural vegetation for the slope protection.
At the logistics area in Buguruni, the proposed width of the floodplain is smaller, seeking a balance between room for the river and retaining valuable logistic assets that should otherwise be resettled. As shown in Figure 28, the floodplain will in this case be extended mainly to the north side of the river following the realigned river course just upstream the railroad bridge. Some floodplain lowering might be required to align with the wider floodplains upstream and downstream of the Buguruni area. This will increase the flow conveying area during the extreme events significantly and thereby reducing flood risk.

Similar to the North bank at the Sukita area, small embankments at the floodplain edges are proposed with natural slope protection. The gabion bank protection that was applied in the short-term is not considered necessary because of the more gentle slopes and lower flow velocity and can be removed with recycling of the material.
Figure 28: Existing situation (upper profile), proposed short term (middle profile) and long-term river area (lower profile) for the Buguruni logistic area

In the short-term, widening of the riverbed was only proposed for the mainstream and not for the tributaries. Implementability of widening the tributaries is low given the deep incisions of the channels of the tributaries. However, for the long term it is proposed to consider room for the river in combination with the recreation for both the main river Msimbazi as well as the tributaries.
Overall, the room for the river area requires to resettle over 16,000 buildings of which the largest share is residential, see below table.

**Table 9: Number of buildings per category to be resettled from the floodplain area in the long term**

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business &amp; Offices</td>
<td>242</td>
</tr>
<tr>
<td>Gouvernment &amp; Schools</td>
<td>44</td>
</tr>
<tr>
<td>Health &amp; Sanitation</td>
<td>74</td>
</tr>
<tr>
<td>Hotels &amp; Restaurants</td>
<td>21</td>
</tr>
<tr>
<td>Industrial</td>
<td>154</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>12</td>
</tr>
<tr>
<td>Mixed Use</td>
<td>306</td>
</tr>
<tr>
<td>Religion &amp; Heritage</td>
<td>29</td>
</tr>
<tr>
<td>Residential</td>
<td>15,400</td>
</tr>
</tbody>
</table>

**Figure 29: Overview of long-term component measure of the Room for the River principle around Nelson Mandela road bridge and the Railroad bridge with implications on resettlement.**
f) Long-term urban development

For the objective of the long-term urban development strategy aim is to develop space and affordable housing in safe areas for resettlement of people from flood-prone river areas within the middle Msimbazi floodplain. The key difference is the scale of households that need to be resettled over time from the areas where room for the river needs to be made. With a total of 15,400 existing dwellings that need to be resettled, it is not possible to develop it by means of patched regenerated areas only. Therefore, in addition, it is proposed to develop additional areas for housing and commercial activities to accommodate about 15,400 dwellings for resettlement, but also to accommodate new housing demand around the river area due to the fast-growing population in Dar es Salaam. Two larger areas for mixed urban development are proposed; 96 ha in Kisiwani (Sukita area) and 67 ha at Liwiti sub-ward. These areas will both be a full area regeneration development, but both with a different identity and density. For the long term implementation the number of patches could be developed gradually over time while at the same time the two mixed use development areas could be developed. Figure 30 and Figure 31 show an overview of the measures and its locations.

Figure 30: Overview map of locations for resettlement in the patches and the location of the larger urban development areas
The cost of resettlement needs to be covered in an integrated manner, combined with other urban development and infrastructure plans. Therefore, affordable housing has been combined with commercial real estate development in mixed density locations (with FSI of 3 in existing patched areas and higher in the new areas). Because of the amount of resettlement needed in the long run, the need for affordable urban housing and the vision to support this development with cross-subsidy elements, a second strategy for a larger scale on the long term might be more suitable than small scale patch transformations only.

Next to the development of housing in patched areas, a mixed urban development is proposed in two main areas. Approx. 97 hectares (gross existing area) positioned in Kisiwani (Sukita area) and approx. 67 hectares is located in the riverbend in Liwiti sub ward (both North and South).

A total potential capacity of 35,755 dwellings can be housed in the two main regeneration areas of Sukita and Liwiti as mentioned. Theoretically, all resettlement can be placed here but of course the changes in the floodplain areas won’t all happen at the same time, people might want to live close to their existing communities. Moreover, a larger number of real estate need to be realised in order to serve as cross-subsidy of the total resettlement task. Furthermore, an important aspect of the urban improvement and a resilient urban environment also includes 25 hectares of green
public space within the large regenerated neighbourhoods of Sukita and Liwiti together. This opens the opportunity to detail these neighbourhoods with green infrastructure, park spaces and natural cooling for heat stress effects and stormwater collection, infiltration and contribution to a robust river basin system besides the room for the river flood plain space and its measures.
Table 10: Overview Long Term urban development plan: patched areas, Sukita and Liwiti

<table>
<thead>
<tr>
<th>Development component</th>
<th>No. of dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resettlement from river area</td>
<td>15,400</td>
</tr>
<tr>
<td>Regeneration of existing dwellings</td>
<td>7,921</td>
</tr>
<tr>
<td>New commercial housing (for new housing demand)</td>
<td>17,134</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patched areas</th>
<th>Sukita</th>
<th>Liwiti</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross ha for new development</td>
<td>10</td>
<td>85</td>
<td>46</td>
<td>141</td>
</tr>
<tr>
<td>Public space, green, infra</td>
<td>2</td>
<td>34</td>
<td>16</td>
<td>52</td>
</tr>
<tr>
<td>Net sellable ha plots (for sale to real estate</td>
<td>8</td>
<td>51</td>
<td>30</td>
<td>89</td>
</tr>
<tr>
<td>developers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of dwellings</td>
<td>3,200</td>
<td>22,423</td>
<td>6,911</td>
<td>32,534</td>
</tr>
<tr>
<td>No. of commercial buildings</td>
<td>0</td>
<td>448</td>
<td>69</td>
<td>518</td>
</tr>
<tr>
<td>FSI (floor space index)</td>
<td>4</td>
<td>4,5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

So, while about 23,000 units are resettled (15,400) and regenerated (7,900), about 17,000 units are developed as potentially new commercial residential real estate.

For the Sukita area further future densification might be realistic, because the dense Dar es Salaam city centre could be extended in the coming period with for instance the Transit Oriented Development along the Bus Rapid Transport infrastructure and the urban development along the terraces of the Msimbazi Lower Basin area. Sukita is one of those areas where over time the adjacent neighbourhoods would further influence densification and increase of land and property values. This might lead to a higher FSI while not influencing the actual balance in footprint and green space of the Sukita neighbourhood.
g) Reforestation and re-greening of the catchment area

Regreening of the catchment areas has a multifold of benefits to the project area. The most important are listed as follows:

1) Retention of rain water - The infiltration capacity of the catchment area is significantly higher for vegetated areas compared to bare soils.
2) Retaining soil material – Vegetation reduces the susceptibility of soils to erosion.
3) Socio-environmental benefits such as:
   a. Improvement of air quality;
   b. Reduction of heat stress;
   c. Aesthetically pleasing environment;
   d. Improvement of the living environment in general.

The following areas are considered for regreening:

- Upper catchment areas outside the Study area;
- The created floodplain areas;
- The open spaces created in the patches for urban development.

The upper catchment section of the Msimbazi River is the least developed area of the catchment in terms of infrastructure and building densities. Pugu hills, originally a densely forested area, is located in the upper section but has also been subject to large scale forest clearing for i.a. charcoal production. In line with the Strategy and Management Framework it is proposed to largely restore this area to its original natural state and start large scale reforestation programmes. It is estimated that approximately 7,500 ha of the catchment area can be reforested. From a flood risk and hydrological perspective, a multi-layered forest with large trees, brushes and underlayers will be most optimal because it has a large infiltration and evapotranspiration capacity which will significantly reduce the runoff for higher frequency events. For lower frequency events the effect of the reforestation becomes smaller due to saturation of the vegetation and soil.

Another area where regreening is proposed is in the created open river floodplains. These should be mainly lower brushes and grasses in order to prevent a reduced capacity of the floodplain. Besides, part of the floodplain areas can be established for urban agriculture.

Finally, also the urban development patches create space for regreening. These can be small natural parks. In these areas some trees would be very suitable to reduce the heat stress in the city and create shadow areas for outdoor gatherings and meetings. Besides some lower pond areas can be created in the open areas of the patches with an increased infiltration capacity. This will reduce the rainfall discharge towards the river systems.
**Impression long term**

On the next page a bird’s eye view artist’s impression shows how the wards Vingunguti and Tabata, close to the railroad bridge, could look like according to the concept designs envisioned for the long term.
Figure 33: Existing situation at wards Tabata, Vingungut

Figure 34: Impression of wards Tabata, Vingungut in the long term according to the strategy and concept designs
Cost estimates

CAPEX

The Bill of Quantities (BoQ) of the construction materials, resettlement components and re-greening in combination with the corresponding unit rates form the basis for the cost estimates of the implementation of the short and the long term measures (Capital Expenditure, CAPEX). Besides the BoQ costs the following additional costs are included in the CAPEX estimation:

- Mobilization and demobilization costs – These costs depend significantly on the selected contractor, the type of contract, the available resources and the expected construction period. For this project, it is expected that small to medium size equipment will be required. It is estimated that Mobilisation and Demobilisation will cost about 20% of the BoQ costs;
- Contingency – A contingency is included as common practice to ensure that there is a buffer during the execution of the project and includes costs for items/ aspects that were unforeseen or underestimated during the design stage. For Contingency 20% of the BoQ costs has been estimated;
- Design – Costs for updating and/or further detailing of the tender designs of the measures need to be added. It is noted the Msimbazi River is a very dynamic river, viz. changing topography and bathymetry but also migrating channels, which requires an update of the designs just before construction. An estimate of 5% over the BoQ costs has been made to account for design costs;
- Supervision – Cost for supervision strongly depend on type of contract, duration of construction period, complexity of the design and possible application of international licenses for construction materials. For this project a budget of 5% over the BoQ costs has been estimated.
- Structure removal cost – Costs for removal of existing bridge structures has been included for Kawawa Road Bridge crossing the Msimbazi River, Kawawa Road Bridge crossing the Kibangu tributary River and Nelson Mandela Bridge with a fixed unit rate. Removal costs of building structures and land remediation is included in the resettlement costs for the short and the long term by applying a factor of 1.5 to the resettlement costs.

Appendix II shows a detailed breakdown of the BoQ and cost estimation for the short and long term measures. In the two tables below a summary of the CAPEX estimations is presented for the short and the long term component schedule.
### Table 11: CAPEX estimation for the short term component measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Measure specifics</th>
<th>CAPEX in million USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) bridge measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kawawa Road Bridge Msimbazi</td>
<td>14.7</td>
<td></td>
</tr>
<tr>
<td>Nelson Mandela Bridge</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>Railroad bridge</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Kawawa Road Bridge Kibangu</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td><strong>42.1</strong></td>
<td></td>
</tr>
<tr>
<td>b) widening river channels</td>
<td>widening river channels</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td><strong>3.0</strong></td>
<td></td>
</tr>
<tr>
<td>c) riverbank protection</td>
<td>riverbank protection</td>
<td>3.8</td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td><strong>3.8</strong></td>
<td></td>
</tr>
<tr>
<td>d) urban development</td>
<td>value existing properties</td>
<td>30.3</td>
</tr>
<tr>
<td>land development costs</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td><strong>30.9</strong></td>
<td></td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>79.8</strong></td>
<td></td>
</tr>
</tbody>
</table>

The short-term measures have a total estimated CAPEX of USD 79.8 million. The main cost components are the bridge measures (more than half of the total sum) and urban development. The river measures b) and c) together have a CAPEX lower than 10% of the total CAPEX.

### Table 12: CAPEX estimation for the long term component measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Measure specifics</th>
<th>CAPEX in million USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) room for the river and regreening</td>
<td>regreening, parks</td>
<td>60</td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td></td>
<td><strong>60</strong></td>
</tr>
<tr>
<td>f) urban development</td>
<td>value existing properties</td>
<td>720</td>
</tr>
<tr>
<td>land development costs</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td></td>
<td><strong>761</strong></td>
</tr>
<tr>
<td>g) reforestation upper section</td>
<td>reforestation upper section</td>
<td>370</td>
</tr>
<tr>
<td><strong>subtotal</strong></td>
<td></td>
<td><strong>370</strong></td>
</tr>
<tr>
<td><strong>total</strong></td>
<td></td>
<td><strong>1,191</strong></td>
</tr>
</tbody>
</table>

The long-term measures have a total estimated CAPEX of USD 1,191 million, which is substantially higher than the short-term CAPEX. Urban development (value existing properties and land development costs only) is the main cost component. For the reforestation costs it needs to be noted that in the strategy an area of nearly 7,500 ha in the upper catchment section has been reserved for reforestation, which is an area
outside the Study area. CAPEX of long-term measures planned to be implemented within the Study area is USD 821 million.

**OPEX**

Operational expenditure are the operational costs to manage and maintain the implemented measures and are expressed as a percentage of the CAPEX annually. Since the short- and long-term implementation consist of sets of measures with different operational requirements an average OPEX for e.g. inspection, debris cleaning, etc., has been determined: 1.5% for the short term and 1 – 1.5% for the long term.
PRELIMINARY COST BENEFIT ANALYSIS

The objective of an economic cost-benefit analysis (CBA) is to estimate the (likely) costs and benefits of proposed strategies aiming at reducing flood risks in the Middle Msimbazi area. This CBA should be regarded as a preliminary CBA; due to constraints in data, time and budget it was not possible to undertake a detailed CBA. The aim of this preliminary CBA is to provide preliminary insights in the advantages and disadvantages of the proposed strategies for people, communities, assets and the environment.

Methodology and assumptions

During the development of the preliminary CBA, a number of assumptions have been made which are described below.

Alternative strategies

In the preliminary CBA three alternatives (one measure and two components) have been modelled based upon the outcomes of the three hydraulic model runs for the impacts of the flood management schemes on the hydraulic system of the river basin. In the table below, the measure and two components of the flood management strategy assessed in the preliminary CBA are presented.

Table 13: Flood mitigation strategies included in CBA for the middle Msimbazi basin.

<table>
<thead>
<tr>
<th>No.</th>
<th>Measure/ component</th>
<th>Implementation period</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Bridges only</td>
<td>2024-2025</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Widening and/or raising bridges crossing the Msimbazi River and her tributaries to increase the hydraulic capacity of the bridge.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Short term component</td>
<td>2024-2025</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Raising &amp; widening bridges and creating a wider river bed to increase the hydraulic capacity of the river channel. Small scale resettlement and urban regeneration and development in patched areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Long term component</td>
<td>2030-2050</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Re-greening of resettled areas as well as reforestation of the upper catchment sections of the Msimbazi River. Resettlement at locations with unacceptable residual flood risk after implementation of first three mentioned measures. Urban development (including affordable housing for resettlement) in three large scale areas: Liwiti, Sukita and patched areas.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Funding partners:    Implementing agencies:
Time horizon and timing of implementation

Water management infrastructure often has a lifetime of 20 to 100 years and climate change is a long-term phenomenon. In this feasibility study, the protective measures have been designed for a technical lifetime of 50 years. It was estimated that about 2 years will be necessary for the preparatory activities such as agreement on funding, detailed design studies, procurement and contracting of the works (2022-2024). The implementation (construction and supervision of the works) for the bridges only and short-term strategy could start in 2024 and be finalized end of 2025 (2 years). For the long-term component implementation of re-greening, urban development and resettlement is foreseen between 2030 and 2050. Hence, the operational phase of measure bridges only and for the short term component would earliest start at the beginning of 2026, while for the long term component it would start 2031. Given a technical lifespan of 50 years, this implies the year 2075 is the time horizon in the CBA; a residual value is used for the assets at the end of the period.

Social discount rate

Because people tend to value current expenditures or benefits higher than an equal benefit (or expenditure) in the future, a discount factor is used in CBA’s to discount future values to today’s value (and make flows over time comparable). The discount rate also reflects the opportunity costs of undertaking investments in protective measures (what would be the real return on any other alternative investment). We estimated a potential discount rate based upon four different sources/methods from literature for estimating the discount rate. These methods are i) opportunity costs of capital, ii) the view of climate economists\(^1\) \(^2\), iii) social time preference and iv) other CBA climate adaptation studies in Africa (e.g. HKV, 2017 which uses a real discount rate of 4,5% for Ghana). Based on a combination of these methods we have assumed a real discount rate of 4,8% in this CBA, as this rate is most comparable to the results of different methods and sources and still gives weight to impacts for future generations. In the sensitivity analysis we also show the results on outcomes of the CBA with lower or higher discount rates.

Climate change

Two climate change scenarios (extreme RCP 8.5) and modest (RCP 4.5) have been modelled in the CBA model. Climate change mainly influences the extent of the rainfall, and therefore flooding and damage. The scenario with extreme climate change results in higher inundation levels over time and therefore increasing flood asset damage and indirect damages over time (period 2020-2075). Lower climate change will result in a more moderate increase in flood damages over time.

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\(^1\) Stern, 2007  
\(^2\) Fleurbaey, 2010

Funding partners: 

Implementing agencies:
Socio-economic development and urbanization

Two socio-economic development scenarios have been developed for the baseline scenario calculations of assets and damage. The real annual growth of GDP ranges in the scenarios on average between 3% and 5% for the period until 2075. The implied real economic growth per capita rates in the scenarios affect the quality of buildings and content (quality improvement over time) in the damage and CBA models (see Appendix on Damage model in vulnerability report). Basically, a higher growth of income and therefore quality of buildings (dwellings etc.) and its content, results in higher flood asset damage over time.

Basically, the climate change and socio-economic scenarios have been combined in an upper and lower bandwidth of scenarios (RCP-8.5 high growth-urbanization and RCP 4.5 low growth-urbanization). However, the hydraulic model runs for impacts of the proposed strategies have been presented by Modelling Consultant for only the upper scenario (RCP 8.5- high growth & urbanization). Therefore, CBA model had to estimate RCP4.5-low growth impacts from the factors derived from the baseline runs of the hydraulic and damage models. Therefore, the results of the CBA will be presented for the two scenarios, but results for the lower scenario should be regarded as an indicative estimation.

Business case of urban development

A preliminary business case (financial analysis) has been developed for the urban strategies which are part of the short- and long-term strategy. A financial model has been constructed, based upon the urban strategies as described in Flood Management Strategy. In the financial model (cash-flow model) the land development costs and revenues from land sales from the perspective of a land development authority are estimated. For land sale revenues a residual value method was used for calculation of the land sale prices of land authority. Moreover, the construction costs and revenues from sales of real estate for the real estate developer are also modelled. For the CBA only the profits from land development and real estate development are included in the net welfare impacts.

Costs

The costs of the strategies consist of investment costs (Capex) and operating & maintenance costs (Opex). Regarding investment costs, the following components are included:

- Implementation costs (construction, land development, resettlement etc.) based upon the estimations as included in the section on Technical Feasibility. The justification for the estimation of land development costs of the urban

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3 The business case therefore only shows direct financial costs (site acquisition and preparation) and revenues (from land sales or lease) of urban development from the perspective of a urban (land) development initiator (agency or invesitor). Prevented flood asset damages are not included in such a business case as these accrue to other actors in society (home owners, other). Therefore, these societal impacts are included in the societal cost-benefit analysis.
development strategies is provided in a separate subsection in this chapter on the business case of urban development;

- Indirect costs of studies, management, supervision (a mark-up of 10% on implementation costs);
- Mobilisation/demobilisation (20%);
- Contingencies (a mark-up of 20% of construction costs).

Indirect taxes such as VAT are excluded in the cost and benefit estimations. It is prescribed in recent CBA guidelines in some countries (Netherlands) that VAT should be included. However, international CA guidelines still advise to exclude VAT. Therefore, the VAT will be excluded, but will be shown in a sensitivity analysis what the impacts are of 20% higher Capex and Opex on outcomes of the CBA.

The Opex starts for the bridges only and short-term strategies in 2026 (and last until 2075). For the long-term strategy Opex starts in 2032. For inclusion in the economic analysis the below financial costs have been corrected to the economic costs based upon the Standard Conversion Factor (SCF) of 0.92. The standard Conversion Factor (SCF) is the ratio or economic price value of all goods in the economy at their border price equivalent values to their domestic market price value. This factor converts financial values to economic values, as some goods are imported and some costs (such as construction costs) have benefits in terms of (temporary) employment benefits in case of unemployment (structural imbalances on the labour market). In the table below, the Capex and annual Opex for the three strategies are shown.

Table 14: Investment (Capex) and operation & maintenance (Opex) costs in CBA

<table>
<thead>
<tr>
<th>Measure/ Components</th>
<th>Capex</th>
<th>Converted Capex</th>
<th>Opex (annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million USD (current prices)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Short-term Bridges only</td>
<td>42</td>
<td>39</td>
<td>0.6</td>
</tr>
<tr>
<td>Short-term component (bridges, river widening, urban development)</td>
<td>80</td>
<td>73</td>
<td>1.1</td>
</tr>
<tr>
<td>3. Long-term component (re-greening, resettlement &amp; urban development)</td>
<td>1,191</td>
<td>1,096</td>
<td>11</td>
</tr>
</tbody>
</table>

**Business case of urban development**

The urban development strategy developed for the Msimbazi Middle Basin has the objective to resettle those households that are affected by the river measures and to develop additional commercial real estate. The two phases defined for the river measures are also applied to the resettlement solution and the urban development strategy for this matter: short term and long term (‘bridges only’ strategy does not include a resettlement & urban development component).
Urban development will result in costs and revenues for a potential land development authority (or municipality) and the developers of real estate. To capture these potential financial flows a preliminary business case model was developed.

Short term

The widening of the riverbed of the Msimbazi river and its tributaries affects settlements that are in the zones that are too close to the river. The number of current households concerns 250 units that need to be resettled at another, safe, location on the short term. To resettle these households in an appropriate way, an urban development strategy has been developed as part of the plan for river adjustments. Along all stretches of the river the households affected have been counted in each subward in that part of the river. Development will have a significant share of affordable housing at reasonably low densities (FSI around 3), which implies limitations on the earning potentials for land development and real estate construction.

Long term

The same strategy applies for the Msimbazi river Middle Basin on the long term measures as on the short term. Different is the scale of households that need to be resettled over time on the long term from the areas where room for the river is required. With a total of 15,400 existing units that need to be resettled from the river areas and another 8,000 units which need to be regenerated from other areas, a total of 23,300 units need to be accommodated on other locations. For this reason, three main type of areas are considered: development in patched areas across the overall middle Msimbazi project area, development in the Sukita area and in the Liwiti area. Approx. 97 hectares of the total area is positioned in Kisiwani (Sukita area) and approx. 67 hectares is located in the river bend in Liwiti sub ward (both North and South). These areas will both be a full area regeneration development with a substantial share of affordable housing, but both with a different identity and density. Densities for the long term urban strategy are slightly higher (FSI around 4).

In below table the assumptions regarding the urban development strategies are shown.

<table>
<thead>
<tr>
<th>Component</th>
<th>Area development</th>
<th>Resettlement and regeneration</th>
<th>Development new dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gross ha</td>
<td>No. dwellings</td>
<td>Total no.</td>
</tr>
<tr>
<td>Short term component (bridges, river widening, urban development)</td>
<td>5</td>
<td>690</td>
<td>690</td>
</tr>
</tbody>
</table>
Costs and revenues of urban development

The costs for the land development authority consist of acquiring land, developing land for public space and plots ready for construction and costs for utility infrastructure (water, electricity etc.), green etc. Revenues consist of sales of sellable plots to real estate developers. Based upon various sources, land development costs are assumed at USD 29 per m² gross area (including land acquisition), while (residual) land sale prices for residential sellable plots are calculated in the model at USD 150-170 per m² of sellable plot area (depending on a housing mix with 40% affordable housing and FSI for the areas between 3 and 4.5).

Based on the assumptions regarding the volume and costs and price parameters of urban development, the costs and revenues are calculated in the discounted cash-flow model. The results of the business case are presented in the table below.

Table 16: Results of business case of urban development measure in the two components i (short and long term)

<table>
<thead>
<tr>
<th>Component</th>
<th>Land development costs</th>
<th>Land development costs</th>
<th>Land development revenues</th>
<th>NPV land develop</th>
<th>NPV real estate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mln USD</td>
<td>Discounted</td>
<td>Discounted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short term component (bridges, river widening, urban)</td>
<td>0.6</td>
<td>0.4</td>
<td>2.0</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Long term component (greening, urban dev. &amp; resettlement)</td>
<td>41.0</td>
<td>15.0</td>
<td>52.0</td>
<td>37.0</td>
<td>22.0</td>
</tr>
</tbody>
</table>

NB. NPV = Net Present value of cash flows (discounted future revenues minus discounted future costs); Cash flows are defined as incomes (from land sales or land lease to real estate developers) minus all expenditures (costs for land acquisition, site preparation etc.). If the NPV>0 it implies discounted revenues are larger than discounted costs and the investment is worthwhile for the initiator and could in principle be financed by private finance (repayable finance).

4 The land development cost are based upon Samwel Alananga and Charles Lucian (2016): Cost Shares and Factor-Cost Ratios in Owner-Built Incremental Housing in Dar Es Salaam, Tanzania. Out of the 29 USD land development costs (site preparation, site clearing and levelling, cables, electricity, etc.) about 3 USD per m² is assumed as land acquisition costs (based upon Numbeo and Zoom for land transactions in Dar Es Salaam). Average sales price of commercial apartments was assumed of 26,000 USD per apartment and for affordable dwelling units of USD 13,000 per unit.
The discounted costs for land development amount to about USD 0.5 million for the short term component and about USD 15 million for the long term component. Discounted revenues from land sales or lease to real estate developers are estimated at about USD 2 million (short term) and respectively USD 52 million (long term).

This implies Net Present Values of the land development amount to about USD 1 million for the short-term component and about USD 37 million for the long-term component. This means that the investments in area development are commercially worthwhile to undertake from the perspective of a land developer or initiator.

Real estate developers will also raise earnings from construction and sales of apartments and commercial buildings, with an estimated Net Present value of cash flows of USD 0.4 million for the short-term strategy and USD 22 million for the long-term strategy. If the benefits of land development (land sales to the private real estate developers) could be captured by a land development authority (as part of the institutional set-up of the middle Msimbazi flood management), it could be possible to use these earnings to cross-subsidize other measures in the plan or cross-subsidize the regeneration and development of low-cost housing in the areas.

**Potential other business cases: sediments, sand mining**

The river widening will generate potential sediment (including sand). This sand could be sold on the sand market, while sediments could (if not polluted) also for river protection works and creating the safe terraces for urban development. However, at this stage the precise amount and quality of the sediments was not known. Therefore, this separate business case could not be developed. It is advised to explore the quality of the sediment, potential re-use and other potential income generating activities further in a feasibility or design phase of the project.

**Benefits for society**

**Direct asset damage reduction**

In the vulnerability report asset damage costs for flood events (T2, T10, T50) were estimated for the baseline (do nothing) scenario. As shown in the figure damage costs of the floods could go up to a maximum of USD 875 million in 2075 for a T50 event in the worst case (extreme climate change- high growth) scenario. In 2050 the bandwidth is about USD 300 million (RCP 4.5- low) up to almost USD 500 million (RCP 8.5-high) for a T10 event. More than 90% of the damage consists of damage to residential assets. In the figure below total expected asset damages in the do-nothing scenarios are shown for the period 2020-2075.

---

5 See for an explanation of the damage calculation in the baseline scenario (do nothing) Chapter 4 of the Middle Msimbazi Vulnerability Report. On average USD 13,000 was used in the damage model for the average value of residential dwellings in the project area. Based upon the derived damage curves (damage % of buildings at different inundation levels) for different type of assets damage values were modelled for each type of flood event (T2, T10, T50).
Damage of floods to critical infrastructure (such as bridges, power stations and water supply) was not assessed and is therefore not included in the above damage estimations.

The three strategies all reduce damage to assets in the Msimbazi basin to some or large extent. The bridges only strategy (A) reduces asset damage with about 5%, strategy (B) bridges & river widening reduces asset damage between 12-18% and the long-term strategy (C) reduces asset damage with 65-70% (see also Flood Management Strategy subsection Effectiveness). In the table below, the asset damage reduction is shown for the three strategies for the two scenarios (2050 and 2075).

Table 17: Direct asset damage reduction in million USD by measure a and two components of the flood management strategy in two scenarios (2020-2075)

<table>
<thead>
<tr>
<th></th>
<th>2050</th>
<th>2075</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T2</td>
<td>T10</td>
</tr>
<tr>
<td>RCP 8.5 – High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Bridges only</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>Short term component (bridges &amp; river widening)</td>
<td>31</td>
<td>100</td>
</tr>
<tr>
<td>C) Long term component (re-greening, resettlement, urban dev. )</td>
<td>179</td>
<td>329</td>
</tr>
<tr>
<td>RCP 4.5 – Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a Bridges only</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Short term component (bridges &amp; river widening)</td>
<td>17</td>
<td>62</td>
</tr>
</tbody>
</table>

Figure 35: Asset damage costs of flood events (T2, T20, T50) in the baseline (do-nothing) scenario, 2020-2075
As shown in Table 17 the highest asset damage reduction is accomplished by the long-term strategy C (up to USD 365 million prevention of damage for a T50 event in 2075). The ‘bridges only’ strategy has a more modest impact on residential and other damage reduction: up to USD 17 million in 2075 (T50). The reduction of asset damages in the year of an event by the strategies have been used for the calculations of average annual expected damage reductions (AED). However, unfortunately for these calculations, only 3 types of hydraulic model runs for the probabilistic flood events (T2, T10 and T50) were available. This is limited information for the cumulative probability of all possible flood events. For this reason, a cumulative estimation of probabilities was made to calculate the annual expected damage reductions (AED), with probabilities ranges of 0.7 for T2, 0.24 for T10 and 0.06 for T50. From these calculations the annual flow of AED between 2020 and 2075 has been estimated for the baseline (do nothing scenario), measure a and the two components i (see Figure 36).

Figure 36: Average Expected Damage (AED) for the baseline scenario (do nothing) and measure a) bridges only and the short and long term components (RCP 8.5-high scenario) in million USD, years 2020-2075

Reduction of economic disruption

The disruption of economic activities during and just after the flood events (temporary impact) was described in the Vulnerability Report. Especially unprotected economic activities near the river are suspended during these events. The more extreme the event (T10, T50), the higher the negative economic impacts on the economic production and therefore livelihoods of people affected. It was shown that informal
unprotected activities (such as informal markets, food stalls) and places catering for visitors are mostly affected. For this feasibility report, it was not possible due to various reasons to undertake an extensive survey in the area among economic enterprises and informal workers. Therefore, no precise estimation of forgone production could be made. In this study, ratios were used that were available in the literature for indirect damages. In a number of other studies, ratios are used with an average of indirect damage as % of direct damage of 18%. See for example: Briene et al (2002); Yangtze River Flood Control and Management Project (2003), HKV (2018).

Table 18: Prevention of economic disruption for lower and higher scenario for all return periods, 2050, 2075 in million USD

<table>
<thead>
<tr>
<th></th>
<th>2050</th>
<th>2075</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T2</td>
<td>T10</td>
</tr>
<tr>
<td><strong>RCP 8.5- High</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a Bridges only</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Short term component (bridges &amp; river widening)</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>C) Long term component (re-greening, resettlement, urban dev.)</td>
<td>32</td>
<td>59</td>
</tr>
<tr>
<td><strong>RCP 4.5 – Low</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a Bridges only</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Short term component (bridges &amp; river widening)</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>C) Long term component (re-greening, resettlement, urban dev.)</td>
<td>20</td>
<td>47</td>
</tr>
</tbody>
</table>

Reduced traffic disruption

All three strategies include the widening of the four key bridges. Therefore, all strategies will reduce the disruption of traffic during (and just after) floods due to the overtopping of the bridge decks (see the vulnerability report for more information on these damages in the baseline scenario). In Table 19, the impacts in terms of traffic benefits are shown for the three strategies for the different return periods of flood events for the years 2025 and 2075. These impacts are small compared to the direct asset damage prevention, which are presented in Table 17. The main reason for this is that the traffic disruption is a temporary effect which only takes place for maximum several days in the year of a flood event.
Table 19: Reduced traffic disruption costs lower and upper scenario for the strategies in million USD (2050 and 2075 in case of an event, in current prices)

<table>
<thead>
<tr>
<th></th>
<th>2050</th>
<th></th>
<th>2075</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t2</td>
<td>t10</td>
<td>t50</td>
<td>t2</td>
<td>t10</td>
<td>t50</td>
</tr>
<tr>
<td>RCP 8.5 – High – All components</td>
<td>0</td>
<td>6</td>
<td>24</td>
<td>0</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>RCP 4.5 Low - All components</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
<td>0</td>
<td>2.5</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Social and health impacts

According to the preliminary Social & Environmental Impact Assessment (pESIA), the strategies and underlying measures have positive and negative impacts on social aspects and health. The S&E assessment (see next chapter) defines temporary impacts during implementation and more permanent impacts during the operation phase after implementation. The impacts are briefly summarized in the table below.

Table 20: Social and health impacts of measure a and the two components

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Temporary impacts (due to construction activities)</th>
<th>Permanent impacts (operational phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Bridges only</td>
<td>-Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
<td>-Reduced flooding along bridges (with multiple effects such as saved lives, properties protection and enhanced economic activities)</td>
</tr>
<tr>
<td></td>
<td>-HIV/ AIDS increased cases (construction phase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Employment Opportunities (construction phase)</td>
<td></td>
</tr>
<tr>
<td>Short term component (bridges, river widening,…)</td>
<td>Impacts bridges only, plus:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Reduction of land used for vegetable farming</td>
<td>-Enhanced accessibility due to reduced flood risk (improved transportation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Improved living &amp; environmental standards (sanitation) due to formal affordable housing for</td>
</tr>
</tbody>
</table>
resettlement (about 1000 units in urban strategy)

Long term component
- Resettlement of peoples and properties (social)
- Occupational Health and Safety (Accidents and Ergonomics hazards)
- Improved living & environmental standards (sanitation) due to formal affordable housing for resettlement (for about 23,000 units in urban strategy)

No quantification of social impacts was estimated in the pESIA. Therefore, it was not possible to quantify and monetize these impacts in the preliminary CBA. Regarding prevention of economic and traffic disruption by the flood management strategies CBA consultant has made a separate quantification in this section (see subsections before). It is to be expected that especially the health and sanitation benefits of the long term strategy could be significantly positive. This is due to the relocation of people from river areas to the urban development areas where formal affordable housing offers improved sanitation conditions. Moreover, the reduction of water-borne diseases could be substantial for especially the long term strategy, because of the reduction of people in flooded areas and reduction of inundation levels.

Environmental impacts

According to the pESIA the defined strategies and underlying measures have positive and negative impacts on social aspects and health. The S&E assessment (see next chapter) defines temporary impacts during implementation and more permanent impacts during the operation phase after implementation. The impacts are briefly summarized in the table below.

Table 21: Environmental impacts of measure a and two components

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Temporary impacts (due to construction activities)</th>
<th>Permanent impacts (operational phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Bridges only</td>
<td>- Water pollution (turbidity and Hydrocarbons pollution)</td>
<td>- Reduced flooding along bridges with favorable effects on solid waste and river pollution</td>
</tr>
<tr>
<td></td>
<td>- Hydro modification⁶</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Air, Noise Pollution and Vibration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Disturbances to nearby residents (accessibility and safety)</td>
<td></td>
</tr>
</tbody>
</table>

⁶ Hydro modification encompasses the systematic response to alterations to riverine and non-riverine water bodies such as coastal waters (estuaries and bays) and lakes.

Funding partners:  
Implementing agencies:
| **Short term component (bridges, river widening... )** | **Idem, but more negative due to larger construction areas due to excavation for river widening and mob/demob** | **-Reduced flooding along wider river areas with favorable effects on solid waste and river pollution by waste**

-Improved living & environmental standards (sanitation) due to formal affordable housing for resettlement (about 1000 units in urban strategy)** | **Reduced flooding along wider river areas with favorable effects on solid waste and river pollution by waste**

-Improved living & environmental standards (sanitation) due to formal affordable housing for resettlement (about 1000 units in urban strategy)** |
| **Long term component (re-greening, resettlement, urban development)** | **-Water pollution (turbidity and Hydrocarbons pollution)** | **-Biodiversity conservation and addition due to reforestation of Pugu forest and surrounding areas (ecological benefits)**

-Improved environmental standards (sanitation) due to formal affordable housing for resettlement (about 23,000 units in urban strategy)** |

No quantification of social impacts was undertaken in the pESIA. Therefore, it was not possible to quantify and monetize these impacts in the preliminary CBA. However, it is to be expected that especially the ecological benefits of the long-term strategy due to re-greening are substantial.

**Overview of monetized impacts**

In the table below, an overview of discounted costs and benefits of the strategies is presented. The discounted benefits from asset damage reduction (mainly residential damage for residents in the project area) are dominant. The damage reduction benefits in the long-term strategy are substantial by resettling people from risk-prone areas along the river. Due to the temporary nature of prevention of traffic disruption on and along the bridges these benefits are small compared to the other benefits.

The urban development strategy net revenues mainly add to the benefits in the long term strategy (about USD 60 million discounted in total).

And as can be regarded, although the costs of the long-term strategy are substantially higher compared to the other strategies, the monetized benefits to society are also substantially larger and outweigh the costs. It should be noted that
the benefits of the long-term strategy are even larger due to the potential for significant permanent ecological & health benefits of this strategy.

Table 22: Overview of monetized impacts of measure a and two components (discounted costs and benefits 2020-2075 in 2020) in million USD.

<table>
<thead>
<tr>
<th>Bridges only</th>
<th>Short term</th>
<th>Long term</th>
<th>Bridges only</th>
<th>Short term</th>
<th>Long term</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP 8.5- High</td>
<td>RCP 8.5- High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Discounted costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discounted Costs (Capex and Opex converted)</td>
<td>35</td>
<td>71</td>
<td>595</td>
<td>35</td>
<td>71</td>
</tr>
<tr>
<td><strong>Discounted benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discounted direct asset damage reduction</td>
<td>145</td>
<td>494</td>
<td>735</td>
<td>106</td>
<td>341</td>
</tr>
<tr>
<td>Discounted reduction asset damage due to resettlement</td>
<td>-</td>
<td>-</td>
<td>972</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Discounted land development revenues</td>
<td>-</td>
<td>3</td>
<td>52</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Discounted real estate development profits</td>
<td>-</td>
<td>0.4</td>
<td>22</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td>Discounted reduced economic disruption damage</td>
<td>26</td>
<td>89</td>
<td>132</td>
<td>19</td>
<td>61</td>
</tr>
<tr>
<td>Discounted traffic disruption damage (bridges)</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Discounted ecological benefits</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Discounted other benefits (residual value)</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total discounted benefits</strong></td>
<td>187</td>
<td>603</td>
<td>1,929</td>
<td>127</td>
<td>409</td>
</tr>
</tbody>
</table>

Preliminary CBA results

In Table 23, the results of the preliminary CBA are shown for the three alternatives assessed. The Net Present Value (NPV) presents the discounted value of all monetized benefits and costs (discounted at a real discount rate of 4.8%). It should be noted that intangible costs and benefits (such as life prevented, health benefits, biodiversity, cultural assets and critical infrastructures) were not included in the monetized benefits. In this respect, the NPV is underestimating benefits as intangibles are not included. The benefit-cost (BC) ratio is a better indicator to compare between
measures, as the NPV is sensitive to the overall size of the measures. A B-C ratio higher than 1, implies the discounted (monetized) societal benefits outweigh the discounted (monetized) costs of the measures.

Table 23: Results of preliminary cost-benefit analysis for measure a and two components in million USD

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Capex</th>
<th>NPV RCP 8.5-High</th>
<th>NPV RCP 4.5-Low</th>
<th>Benefit-cost ratio high</th>
<th>Benefit-cost ratio low</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Bridges only</td>
<td>42</td>
<td>150</td>
<td>91</td>
<td>5.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Short term component (bridges, river widening, urban)</td>
<td>80</td>
<td>528</td>
<td>341</td>
<td>8.9</td>
<td>6.1</td>
</tr>
<tr>
<td>Long term component (greening, urban dev. &amp; resettlement)</td>
<td>1,191</td>
<td>1,360</td>
<td>749</td>
<td>3.4</td>
<td>2.3</td>
</tr>
</tbody>
</table>

As shown in Table 23 the benefits of all alternatives outweigh the costs for all alternatives. The long-term component has the highest costs, but also the highest monetized and non-monetized (saved lives, ecological) benefits. The benefits of the short-term component are significantly smaller, but so are the costs. The measure ‘bridges only’ has the lowest costs and modest benefits, but this measure only reduces the damages of floods in the baseline with about 5%. The short term component has the highest benefit-cost ratio (8.4-5.7) (and thus the highest value for money). However, the long term component reduces the damages in the baseline with about 70% and the benefits outweigh the high investment costs of this strategy.

Sensitivity analysis

There are a number of uncertainties relevant for the outcomes of the CBA analysis, especially given the long time horizon until 2075. Relevant uncertainties are:

- Growth of the economy and demography for Tanzania and further urbanization of Dar Es Salaam. The upper and lower bandwidth of scenarios regarding economic growth, demographic development and urbanization. All results are presented for these scenarios in the upper and lower scenarios (see before and in the table below).
- The extent of future climate change. This is also already modelled and already shown in the RCP 8.5 and RCP 4.5 scenarios (see also the table below). Lower climate change results in lower flood damage in the do nothing scenario and therefore more moderate flood damage prevention benefits of all alternatives.
- The level of the discount rate in relation to social time preferences and/or future interest rates. Below CBA results are presented for a real discount rate of 3.8% and 7.8% (3% is close to the Stern rate advised for climate change).
• Actual costs of construction (Capex) and operation and maintenance (Opex). Costs might be higher or lower than expected. Below we present CBA results for +/- 20% of Capex and Opex.

Table 24: Sensitivity analysis of Net Present Value (NPV) results in CBA

<table>
<thead>
<tr>
<th>Measure/ component</th>
<th>Base case RCP 8.5- high</th>
<th>RCP 4.5- low scenario</th>
<th>Discount rate 7,8 %</th>
<th>Discount rate 3,8%</th>
<th>Costs +20%</th>
<th>Costs -20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Bridges only</td>
<td>150</td>
<td>91</td>
<td>95</td>
<td>268</td>
<td>143</td>
<td>157</td>
</tr>
<tr>
<td>Short term component (bridges, river widening, urban)</td>
<td>528</td>
<td>341</td>
<td>333</td>
<td>892</td>
<td>515</td>
<td>542</td>
</tr>
<tr>
<td>C. Long term component (greening, urban dev. &amp; resettlement)</td>
<td>1,191</td>
<td>749</td>
<td>793</td>
<td>2,488</td>
<td>1,248</td>
<td>1,472</td>
</tr>
</tbody>
</table>

It can be concluded that for all sensitivity analyses net present values (NPV) stays positive. This implies that the results (benefits of all alternatives outweigh cost for society) are robust for uncertainties (changes in key assumptions). The results are quite sensitive to changes in the assumptions such as the climate change scenario, socio-economic development (including urbanization) and the discount rate.

Conclusions

The main conclusions from the CBA are that the benefits for society of measure a and the two strategy components I are larger than the costs. Even in the scenarios with moderate climate change and lower urbanization, benefits more than compensate the costs. The monetized benefits of the long-term component are by far the largest due to the combination of reduction of asset damage by flood inundation level reduction and by resettlement of people from flood risk-prone areas. Asset damage is reduced by about 5% by the bridges only measure, 25-30% by the short-term component and 70% by the long term component. The urban development measures mainly add to the benefits in the long-term strategy (about USD 60 million discounted in total). The revenues from the business case of the urban development measure could be used for cross-subsidization of specific other measures in the flood management strategy (or to obtain higher shares of affordable housing in the housing mix). However, this would require the set-up of specific institutional structures (including a land development authority), which will be discussed in more detail in the section regarding institutional set-up and funding options.
PRELIMINARY ENVIRONMENTAL AND SOCIAL ASSESSMENT

The preliminary Environmental and Social impact Assessment (pESIA) study was carried out to incorporate environmental and social considerations into the project design. The main objective of the pESIA was to predict and forestall potential environmental and social impacts and propose mitigation measures to lessen any impacts to the environment and communities in project’s area of influence that may arise from the development and operation of the proposed road project. The overall objective is therefore to ensure that the project delivers minimum disruption to the environment and social settings. Specifically, the objectives of this study were:

- To establish biological and physical baseline conditions of the project area;
- To predict any adverse (negative) and/or beneficial (positive) environmental and social impacts associated with the project;
- To propose appropriate mitigation measures and recommend ways in which the proposed mitigation measures could be incorporated into designs;
- To provide cost estimates required to cover the proposed mitigation measures;
- To provide environmental and social management and monitoring plan.

This pESIA has been prepared to support a major project application as provided in the Tanzania Environmental Impact Assessment and Audit Regulations of 2005/2018. This pESIA focusses on impacts identification and mitigation measures only.

Flood management strategy

In pSEIA the short and long term flood management components as part of the identified flood management strategy are considered. The impacts were identified at the level of the measures. For each of the measures the environmental and social impacts were identified: temporary impacts (during construction) and permanent impacts (in operational phase of the measures).

<table>
<thead>
<tr>
<th>Measures</th>
<th>Implementation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term strategy component</td>
<td></td>
</tr>
<tr>
<td>a) Widening and/or raising bridges</td>
<td>2024-2025</td>
</tr>
<tr>
<td>b) River widening</td>
<td>Operational phase from 2026 onwards</td>
</tr>
<tr>
<td>c) Bank protection</td>
<td></td>
</tr>
<tr>
<td>d) Urban development</td>
<td></td>
</tr>
<tr>
<td>Long term strategy component</td>
<td></td>
</tr>
<tr>
<td>e) Room for the river</td>
<td>2030-2050</td>
</tr>
<tr>
<td>f) Urban development</td>
<td>Operational phase from 2032 onwards</td>
</tr>
</tbody>
</table>
Significance of identified impacts

Through project components or execution of the project related-activities changes may occur on the environment or socio-economic aspect, these impacts can be either positive or negative. Environmental impacts embrace both physical impacts of the Project such as variations in air quality and land based habitats. The socio-economic impacts are special effects of the Project on people and their livelihoods. The following aspects as shown in the figure below were considered when determining the significance of identified impacts.

![Figure 37: Significance of identified impacts](image)

**Nature of Impacts**

There are two basic natures of Environmental impacts, there are impacts which tend to be beneficial or useful to the environment or social-economic aspects which are termed as Positive Impacts and those which tend to affect the environment or social-economic aspects in a negative way are termed as Negative Impacts.

**Spatial Scale of Impact**

The Spatial scale defines the extent or area over which the impact will take place. Environmental Impacts due to the proposed construction of e.g. bridges, bank protection or patch regeneration can affect the environment or social-economic aspects at Household level, Localized, at a study area, District, Regional, National or International Level, see table below.

<table>
<thead>
<tr>
<th>Table 25: Spatial scales pESIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
</tr>
</tbody>
</table>

Funding partners: [Image]
Household  Households in the area could be affected.

Localized  A few hectares in extent. The specific area to which this scale refers is defined for the impact to which it refers.

Study Area  Includes the entire Msimbazi Middle Catchment area.

District  Includes area within Kinondoni, Ilala and Temeke Municipalities.

Regional  The impacts will be of such a nature that it may affect the Dar es Salaam Region.

National  The impacts will be of such a nature that it may affect the entire country (Tanzania).

International  The impact would affect resources and processes outside the borders of Tanzania.

### Intensity of the impacts

To ensure a direct comparison of various studies, a standard assessment methodology was used to assess the significance level of the identified impacts at construction, operation and decommissioning phases of the project development. The table below shows the definitions of significance levels.

**Table 26: Definition of significance levels**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGLIGIBLE</td>
<td>The existing environmental and social conditions will not be affected or the effect is not detectable. A negligible impact is likely to be of no concern to the government, communities and organizations.</td>
</tr>
<tr>
<td>MINOR</td>
<td>The environmental and/or social conditions will be affected, but the impact is small enough that it is unlikely to be a concern to the government, communities and organizations.</td>
</tr>
<tr>
<td>MODERATE</td>
<td>An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impact is on signifying that the impact has been reduced to a level that is as low and reasonably practicable</td>
</tr>
<tr>
<td>MAJOR</td>
<td>A major impact is one where there will be a large change to communities or the natural environment. The aim of the EIA is to provide ways to stop these large impacts from occurring. At times this is not possible and it is up to the government to decide if this is acceptable when considering the benefits of the Project.</td>
</tr>
</tbody>
</table>

### Identified environmental and social impacts

#### Environmental impacts

The identified environmental impacts of the strategies are shown in below tables. The temporary impacts are impacts during the construction period, while the permanent impacts are impacts arising during the operational phase. Negative short term impacts are mainly arising during the construction period because of the construction activities...
due to disturbance of the river water system and noise and air quality impacts of construction vehicles. The positive impacts on the environment are mainly caused by reduced flooding (and reduced traffic congestion during floods), less solid waste in and around the river (also related to less flooding and resettlement of people to more formal urban developments).

Table 27: Environmental impacts of short term strategy component

<table>
<thead>
<tr>
<th>Measures of short term component</th>
<th>Negative (N)/ Positive (P)</th>
<th>Temporary impacts (due to construction activities, 2024-2025)</th>
<th>Permanent impacts (operational phase)</th>
</tr>
</thead>
</table>
| Measure a: Widening and/or raising bridges | N -Vegetation clearance  
-Water pollution (turbidity and Hydrocarbons pollution)  
-Hydro modification⁷  
-Air, Noise Pollution and Vibration  
-Disturbances to nearby residents (accessibility and noise during construction phase)  
-Disturbances of aquatic ecosystem along Msimbazi river | P -Reduced flooding along bridges with favorable effects on solid waste and river water pollution |
| Activities:  
✓ Civil works on clearing river bank, excavation and protection works,  
✓ Bridge construction (Civil works)  
✓ Will involve Design, Mobilization, construction and operation | |
| Measure b: River widening and c: bank protection | N -Air, Noise Pollution and Vibration  
-Disturbances of aquatic ecosystem along Msimbazi river  
-Vegetation clearance  
-Water pollution (turbidity and Hydrocarbons pollution)  
-Hydro modification⁶  
-Disturbances to nearby residents (accessibility and noise during construction phase) | P -Reduced flooding along wider river areas with favorable effects on solid waste and river water pollution by waste  
-More room for the river enhancing ecological succession and biodiversity |
| Activities:  
✓ Civil works involving extensive earth work for widening and deepening of river  
✓ Edge protection (Embankment protection)  
✓ Will involve Design, Mobilization, construction and operation | |
| Measure d: Urban development | N -Disturbances to nearby residents (accessibility and noise during construction phase) | |

⁷ Hydro modification encompasses the systematic response to alterations to riverine and non-riverine water bodies such as coastal waters (estuaries and bays) and lakes.

Funding partners:  
Implementing agencies:
Activities:
- Removal of existing buildings
- Land acquisition & development (site preparation)
- Development of real estate (formal affordable housing etc.)

<table>
<thead>
<tr>
<th>Positive/Negative</th>
<th>Temporary impacts (due to construction activities 2030-2050)</th>
<th>Permanent impacts (operational phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>-Air, Noise Pollution and Vibration</td>
<td>-Reduced flooding along wider river areas with favorable effects on solid waste and river water pollution by waste</td>
</tr>
<tr>
<td></td>
<td>-Disturbances of aquatic ecosystem along Msimbazi river</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Vegetation clearance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Water pollution (turbidity and Hydrocarbons pollution)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Hydro modification-Disturbances to nearby residents</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>-Planned green areas, more biodiversity in formally planned urban areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Better prospects for solid waste collection in more formal urbanized areas</td>
<td></td>
</tr>
</tbody>
</table>

The long term strategy has overall a longer duration of negative short term impacts during construction (but at different locations) (due to the longer implementation period). The positive impacts on the environment are larger compared to short term and mainly caused by reduced flooding (and reduced traffic congestion during floods), less solid waste in and around the river (also related to less flooding and resettlement of people to more formal urban developments). The resettlement and urban development measure will result in more formal living areas with better prospects for sanitation and solid waste collection. Moreover, green areas are foreseen as part of the formal urban development areas. Finally, the re-greening & reforestation measure implies a large area will be developed and protected, which will increase biodiversity and reduce heat stress in the area.

Table 28: Environmental impacts of long term strategy component

<table>
<thead>
<tr>
<th>Measures of long term component</th>
<th>Positive/Negative</th>
<th>Temporary impacts (due to construction activities 2030-2050)</th>
<th>Permanent impacts (operational phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure e: room for the river</td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Activities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil works involving extensive earth work for widening (and deepening) of river</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge protection (Embankment protection)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will involve Design, Mobilization, construction and operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>-Air, Noise Pollution and Vibration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Disturbances of aquatic ecosystem along Msimbazi river</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Vegetation clearance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Water pollution (turbidity and Hydrocarbons pollution)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Hydro modification-Disturbances to nearby residents</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>-Planned green areas, more biodiversity in formally planned urban areas</td>
<td></td>
</tr>
</tbody>
</table>

| Measure f: Urban development   |                   | N                                                           |                                      |
| Activities:                   |                   |                                                             |                                      |
| Removal of existing buildings  |                   | -Disturbances to nearby residents (accessibility and noise during construction / removal phase) |                                      |
| Land acquisition & development (site preparation) | |                                                             |                                      |
| P                               |                   | -Planned green areas, more biodiversity in formally planned urban areas |                                      |
✓ Development of real estate (formal affordable housing etc.)

- Improved solid waste management possible due to formal settlements

Measure g: Re-greening & reforestation

Activities:

✓ Civil works involving earth work for lowering flood plain
✓ Flood plain excavation
✓ Removal of existing objects/ earth works
✓ Vegetation seeding & planting
✓ Will involve Design, Mobilization, construction and operation

N - Water pollution (turbidity and Hydrocarbons pollution)
- Disturbances to nearby residents (accessibility and noise during construction phase)

P - Higher biodiversity (and less heat stress, improved air quality, CO₂ storage)
- Reduced flooding along project area (with multiple effects such as save lives, properties protection and enhanced economic activities)
- Enhanced accessibility due to reduced flood (improved transportation)

Social impacts

The identified social impacts of the strategies are shown in below table. The temporary impacts are impacts during the construction period, while the permanent impacts are impacts arising during the operational phase. The construction activities offer positive temporary employment opportunities for construction workers. Negative short term impacts are mainly arising during the construction period because of the construction activities of the construction workers (related to occupational safety and health). The positive impacts on social aspects (social gatherings, health) are mainly caused by reduced flooding (and reduced traffic congestion during floods). Because of flood prevention, measures reduce fatalities, social damage (damage to social and religious buildings) and outbreaks of water borne diseases during flood events. Resettlement interventions can cause negative impacts for households related to disturbance of social structures and costs related to the relocation. Finally, some land related to vegetable farming might be temporary lost or affected due to the river widening activities. But on the other hand, there is the potential to regain more agricultural land after implementation.

Table 29: Social impacts of short term component

<table>
<thead>
<tr>
<th>Measure of short term component</th>
<th>Positive/Negative</th>
<th>Temporary impacts (due to construction activities, 2024-2025)</th>
<th>Permanent impacts (operational phase), 2026 onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure a: Widening and/or raising bridges</td>
<td>N</td>
<td>- Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
<td>- Reduced flooding along bridges (with multiple effects such as saved lives, properties protection,</td>
</tr>
<tr>
<td>Activities:</td>
<td></td>
<td>- HIV/ AIDS increased cases (construction phase)</td>
<td></td>
</tr>
<tr>
<td>✓ Civil works on clearing river bank, excavation and protection works,</td>
<td>P</td>
<td>- Employment Opportunities (construction phase)</td>
<td></td>
</tr>
<tr>
<td>Measure</td>
<td>Activities</td>
<td>Positives</td>
<td>Negatives</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Bridge construction (Civil works)</td>
<td>Will involve Design, Mobilization, construction and operation</td>
<td>Prevented repair costs and enhanced economic activities/protection of informal economic activities, reduced disturbance of social gatherings during floods, improved health due to less waterborne diseases etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Enhanced accessibility due to reduced flood risk (improved transportation)</td>
<td></td>
</tr>
<tr>
<td>Measures b: River widening and c: bank protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities:</td>
<td>Civil works involving extensive earth work for widening and deepening of river</td>
<td>Resettlement of peoples and properties (social)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edge protection (Embankment protection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Will involve Design, Mobilization, construction and operation</td>
<td>Employment Opportunities (construction phase)</td>
<td></td>
</tr>
<tr>
<td>Measure d: Urban development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities:</td>
<td>Removal of existing buildings</td>
<td>Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land acquisition &amp; development (site preparation)</td>
<td>HIV/ AIDS increased cases (construction phase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Development of real estate (formal affordable housing etc.)</td>
<td>Employment Opportunities (construction phase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved living &amp; sanitation conditions with improved health</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved gender equality for children, elderly and indigenous people by formulating and operationalizing Grievance Redress Mechanism (GRM) Committees (related to 70% less flood risks)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhance accessibility due to reduced flood (improved transportation)</td>
<td></td>
</tr>
</tbody>
</table>

8 However, no indigenous people have been identified within the project area

---

8 However, no indigenous people have been identified within the project area

---

Funding partners:

Implementing agencies:
While the long term strategy might have a longer implementation period and therefore longer durations of positive (employment opportunities) and negative social impacts (f.i. health, occupational safety) during construction, the positive flood prevention social impacts of the long term strategy are larger compared to the short term strategy. The first reason is that the long term flood management strategy will reduce about 70% of flood damages for residents and economic activities (while the short term strategy reduces about 20-25% of flood damages). Apart from saving lives, this will safeguard economic activities (including more informal unprotected economic activities of the poor). Secondly, the large urban development component in the long term strategy will ensure more formal (affordable and commercial) housing and improved living conditions (including sanitation and hygiene). The main negative social impact is related to resettlement activities and is regarding disturbance of existing social structures in resettlement areas and tangible and intangible moving costs. Finally, the re-greening & reforestation measures can result in more biodiversity, but also in more space for recreation and less heat stress for citizens.

Table 30: Social impacts of long term strategy component

<table>
<thead>
<tr>
<th>Component of long term strategy</th>
<th>Positive/Negative</th>
<th>Temporary impacts (due to construction activities, 2030-2050)</th>
<th>Permanent impacts (operational phase), 2032 onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure e: Room for the river</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Removal of existing buildings in room for the river sections</td>
<td>N</td>
<td>-Resettlement of peoples and properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-HIV/ AIDS increased cases (construction phase)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>-Employment Opportunities (construction phase)</td>
<td>-Reduced flooding along bridges (with multiple effects such as saved lives, properties protection and enhanced economic activities/ protection of informal economic activities, reduced disturbance of social gatherings during floods, improved health due to less waterborne diseases)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Enhanced accessibility due to reduced flood risk (improved transportation)</td>
</tr>
<tr>
<td>Measure f: Urban development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Land acquisition &amp; development (site preparation)</td>
<td>N</td>
<td>-Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
<td></td>
</tr>
<tr>
<td>✓ Development of real estate (formal affordable housing etc.)</td>
<td></td>
<td>-HIV/ AIDS increased cases (construction phase)</td>
<td>-Occupational Health and Safety (Accidents and Ergonomics hazards)</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>-Employment Opportunities (construction phase)</td>
<td>-Improved living &amp; sanitation conditions (improved health due to</td>
</tr>
</tbody>
</table>
Impact magnitude and significance

A project impact matrix helps to identify the potential areas of impact and screens the project for environmental and social soundness. The matrix has been constructed to quantify and evaluate the expected changes in the project site during project construction/dredging phase.

The significance of impact on physical, biological and social components was evaluated based on the criteria outlined in Table 31. Evaluation of impacts signifies the potential impacts in terms of its likelihood as per the following criteria:

- The impact is further classified based on spatial distribution, i.e. local, when impact is on an area of approximately 1 km radius from the project area, moderately spread, when impact is on an area of one to two km radius and regional when influence is there beyond 2 km;
- The impact is classified as short term, moderate and long term on the basis of their existence in temporal scale. Impact that lasts for less than one-year is termed as short term, while those which last for one to three years are termed as moderate and if impact lasts for more than three years it is considered to be long term.
- The negative impact is termed as adverse impact while positive impact is termed as beneficial impact

Table 31: Impact Significance Criteria and Color Coding

<table>
<thead>
<tr>
<th>Impact Significance</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major (Significantly) Adverse</td>
<td>When the impact is of high intensity with high/low spread and for longer duration or of high intensity with medium spread and medium duration</td>
</tr>
<tr>
<td>Moderately Adverse</td>
<td>When the impact is of moderate intensity with high spread and longer duration or of high intensity with low/moderate spread and of short duration</td>
</tr>
<tr>
<td>Nature of Likely Impact</td>
<td>Impact Significance before Mitigation Measures</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Intensity Spread Duration</td>
<td>Beneficial Insignificant Minor Moderate Major</td>
</tr>
<tr>
<td>Low Moderate High Local Moderate Regional Short term Moderate term Long term</td>
<td></td>
</tr>
</tbody>
</table>

### Table 32: Evaluation of Potential Impacts and Significance of the Project

#### Construction Phase

- Occupational Health and Safety (Accidents and Ergonomics hazards)
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Beneficial

- Water pollution (turbidity and Hydrocarbons pollution)
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Insignificant

- Hydro modification
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Minor

- HIV/AIDS increased cases (construction phase)
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Moderate

- Air, Noise Pollution and Vibration
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Major

- Employment Opportunities (construction phase)
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Beneficial

- Vegetation clearance
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Insignificant

- Disturbances to nearby residents (accessibility and noise during construction phase)
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Minor

- Impact on gender, children, elderly and indigenous people
  - Nature of Likely Impact: Low  Moderate  High
  - Impact Significance before Mitigation Measures: Moderate
## Impacts enhancments and mitigation measures

The Project is first sought to avoid impacts to the extent practical. If impacts cannot be avoided they will be mitigated through modifying the design or implementing mitigation at the impacted site. In cases where these first two mitigation strategies will not be possible, the Project would aim at remediating impacts wherever possible and finally investigate options for compensation or offsets were necessary or required. The Project philosophy regarding mitigation is outlined in the hierarchy (see Figure 38).
Figure 38: Mitigation Hierarchy for planned project activities. Source: (Adopted from Impacto, 2014)

Based on the assessed impacts that are more likely to occur as the result of implementing this project in project site, the mitigation measures for all the negative impacts are presented in Appendix III.

Most critical mitigation measures to highlight are the short term measure d) urban development and long term measure f) urban development. These measures have been developed following a mitigation by design philosophy, anticipating that the need for resettlements requires solutions to enable functioning of the overall flood management strategy. Said measures will offer a room to implement Urban development strategies with better and integrated planning. To enhance this positive, major and long-term impacts, the implementing agencies shall apply integrated urban development strategies which will integrate among others, improved sanitation (wastewater management, solid waste management and provision of water supply), climate change resilience measures, and services provision.

Conclusions

Key conclusions from the preliminary Environment and Social Impact assessment are:
- The short term- and long term flood management strategies have significant beneficial long term (permanent) social and environmental impacts. Key beneficial impacts relate to reduced fatalities, reduced flood damage for vulnerable people, protection of economic livelihoods from floods, reduction of water borne diseases and avoidance of transportation disruption. The long term strategy has more major beneficial flood impacts (compared to the short term strategy) due to higher flood risk reduction, formal urban development and re-greening and reforestation (positive impacts for public space, hygiene, biodiversity and recreational functions);

- The analysis shows only one major negative impact of the long term strategy which will be caused by the proposed resettlement activities as part of the room for the river measure. However, the urban development measure will offer affordable formal housing for the resettlement affected groups. Moreover, the rest had mainly moderate to minor impacts and of short term and therefore can be included in further assessment;

- A number of mitigation measures are proposed to mitigate the negative environmental and social impacts (especially during construction phase), details are provided in Appendix III
INSTITUTIONAL SET-UP AND FUNDING OPTIONS

Institutional Set-Up

General

An adequate institutional set-up is essential for implementation of the short and long term components of the strategy. The challenge to achieve this is the requirement to organise and coordinate this type of developments in an inter-governmental manner including stakeholder engagement. The Msimbazi Opportunity Plan has laid the basis for this via an integrated, multi-disciplinary and participatory design project. It is proposed that the Govern Strategy (No 4) as part of the Strategy and Management Framework of the Msimbazi Opportunity Plan (hereafter referred to as SMF-MOP) forms the basis for the required institutional set-up for implementation, management and maintenance of the flood management strategy and respective measures for the Msimbazi Middle Basin.

According to the SMF-MOP coordinated planning, cooperation and communication are required at three administrative levels: the Msimbazi catchment area, the Msimbazi Special Planning Area and the Detailed Plan for the Lower Basin. The originally planned short term coordination arrangements have been partly implemented with the establishment of a Program Implementation Unit (PIU) under the Dar es Salaam City Council (DCC) in August 2018.

According to the SMF-MOP a steering committee and the PIU should have been established by now, under Permanent Secretary Tamisemi and in cooperation with DCC, PO-RALG, RAS and WRBO. In the long term the PIU needs to be transformed to the Msimbazi Special Planning Authority (MSPA) for overall management of the Msimbazi Basin and the Msimbazi Opportunity Plan. Besides this, the Msimbazi Area

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**Figure 39: Coordination arrangements as proposed in the SMF-MOP**

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Funding partners: [List of funding partners]
Implementing agencies: [List of implementing agencies]
Development Corporation (MADC) is planned to be established with the objective to attract private capital for the planned developments.

For the long term, the urban development measure in the Msimbazi Middle Basin, and particularly the development of patches, requires a refinement of the governance strategy to focus at the ward level, sub-ward level (Mtaa) and ten cell level. Thereby various scales of administrative boundaries are covered down to community level. At the ward level the already existing Ward Development Committee is largely composed of government officials. Wards can formally and informally engage with the Mtaa level, and is the potential entry point for community engagement of the project in the short and the long term via the MSPA. The Mtaa is the lowest level of government administration and is informally subdivided into ten cells. Majority of the formal committees are not functional at these level but people are closer to each other and are committed to work together. All engagements here must go through the Mtaa Executive Officer and the Mtaa Development Committee. The involvement of the communities at this scale level is paramount for sustainable development and social acceptance of resettlement within the neighbourhood to patches. Overall coordination of the patch developments will be from the MSPA, for which it is thus recommended to adequately secure coordination and engagement between the various municipal entities from municipality, ward to subward.

The area developments of Sukita and Liwiti are on a larger scale and include next to affordable housing (for resettlement) a substantial amount of commercial real estate. Therefore, these developments will specifically require coordination at the level of the MADC. The MADC function is to manage the investment zone in line with investment regulations, planning and building guidelines. Main tasks of the MADC include to prepare the land with basic infrastructure and facilities, market the plans, attract investors, lease the land or provide concessions, and generate annual revenues to maintain the urban and green areas and pay taxes.

Over the course of this Study some changes in administration took place. In February 2021 DCC had been dissolved by the President and Ilala municipality has been upgraded as city council. At the date of this report it has not been confirmed yet if the PIU will be moved under Ilala municipality. As soon as there is clarity on the updated administrative setting it is recommend to evaluate the institutional set-up of the SMF-MOP and the Msimbazi Middle Basin and adjust accordingly if necessary.

**Dedicated unit or agency for urban development**

The urban development measure (part of short term and long term development strategy) is an essential component of the flood management strategy. Especially, in the long term strategy it is proposed to develop about 140 ha land in patched areas, Sukita and Liwiti for affordable housing (for resettlement) and commercial real estate. As shown in the business case in the Section on Cost–benefit analysis, it could be possible to generate net income from urban development and use this for cross-subsidization of the other measures in the flood management strategy (or increase the share of affordable housing in the real estate mix).
In order to facilitate the site preparation, land development and revenue generating potential of the urban development measure, it is advised to consider the set-up of a land development unit or agency under the Msimbazi Development Cooperation. This agency could function as special purpose vehicle (SPV) to manage the urban development process, attract private (repayable) and public and donor finance and organize the land sales, land lease or concessions to private real estate developers. Key functions of this unit are to organize the development of urban development plans for respective areas (plots in the three main areas: patched areas, Sukita and Liwiti), acquire the land, organize site preparatory works and organize the strategy and process regarding real estate development and finance (including affordable housing). In below figure this possible set-up is shown.

![Figure 40: Urban development entity as part of Msimbazi Development Corporation](image)

**Funding options**

The three strategies vary in their amount of funding required. Due to the nature of the strategies (mainly non income generating) and size of involved investment costs, grant funding is the first key type of funding to consider. The possibilities to attract repayable funding are only to be considered for a minor part of the long term strategy (the urban development strategy). Because, the only income generating part of the strategies is the urban development concept (revenues from land sales or land lease to real estate developers) as part of the long term component.

In below table the main investment costs and timing of capex of the three strategies are summarized.

<table>
<thead>
<tr>
<th>Measure/ component</th>
<th>Capex in USD mln</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure a. Bridges only</td>
<td>42</td>
<td>2024-2026</td>
</tr>
<tr>
<td>Short term component (bridges, river widening, urban)</td>
<td>80</td>
<td>2024-2026</td>
</tr>
<tr>
<td>Long term component ( greening, urban dev. &amp; resettlement)</td>
<td>1,191</td>
<td>2030-2050</td>
</tr>
<tr>
<td>Long term of which land development for urban development</td>
<td>41</td>
<td>2030-2050</td>
</tr>
</tbody>
</table>

**Funding partners:**

[Logos of various funding partners]

**Implementing agencies:**

[Logos of various implementing agencies]
Funding options short term component

The amount of funding needed for strategy A or B (short term component) varies between USD 42 and 80 million (excluding 1 million land development costs). The business case of the urban development strategy (patched areas) as part of the short term strategy showed an insignificant income potential for cross-subsidization (or repayable finance). Therefore, only (central) government budget funding or donor grant funding are means to consider as funding options.

Central government budget funding

Some countries (Netherlands, Bangladesh) allocate specific funding from the central government budget for flood safety to a dedicated multi-annual government fund (Deltafund). In the Netherlands such a fund is arranged legally as part of the Delta act, while in Bangladesh such a fund is currently being set-up. A % of GDP (tax income) is allocated to a Deltafund as part of the Bangladesh DeltaPlan 2100. Often such central government funding mechanisms requires a system of multi-annual budgeting with the necessary legal provisions. This could be a system to explore for the long term flood safety in Tanzania, but might be less feasible for the short run. Also to be explored is if specific Ministries (or agencies) could finance or partially finance (co-finance) the bridges only or short term strategy⁹.

Multilateral development partners

In below table a number of multi-lateral International Finance Institutions (IFIs) are shown relevant for climate adaptation grant funding. The table shows some elements of these funding agencies.

<table>
<thead>
<tr>
<th>Multilateral partners</th>
<th>development</th>
<th>Typical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Climate Fund (GCF)</td>
<td>GCF has several windows: project development window and climate adaptation project implementation. Official application through GCF Accredited Entities (IFIs, other). National accredited authority should be involved. Large scale grant applications possible (appraised through GCF appraisal criteria) <a href="https://www.greenclimate.fund/areas">https://www.greenclimate.fund/areas</a></td>
<td></td>
</tr>
<tr>
<td>World Bank Group (IBRD, GEF, PPIAF)</td>
<td>The World Bank Group (WBG) has a variety of mechanisms and funds. While IBRD often works with concessional loans to central governments, WBG also has a number of specific funds with grants and calls for proposals, such as the Global Environment Facility (GEF) Trust Fund and under GEF Special Climate Change Fund (SCCF), Least Developed Countries Fund (LDCF) and the Adaptation Fund (for innovative adaptation projects &lt; USD 10 million). World Bank PPIAF instrument is a potential</td>
<td></td>
</tr>
</tbody>
</table>

⁹ Exploration of central government possibilities needs to be considered anyway as many bi-lateral and multi-lateral donors require national co-finance as part of the funding of programmes or projects.

Funding partners: [Image] Implementing agencies: [Image]
Bi-lateral development partners

In below table a number of bi-lateral International Finance Institutions (IFIs) are shown relevant for climate adaptation grant funding. The table shows some elements of these funding agencies.

Table 34: Potential bilateral development partners as funding sources

<table>
<thead>
<tr>
<th>Bilateral donor / IFI</th>
<th>Country</th>
<th>Typical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agence Francaise de Developpement (AFD)</td>
<td>France</td>
<td>Climate change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very active in Africa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project development &amp; project implementation</td>
</tr>
<tr>
<td>French Facility for Global Environment (FFEM)</td>
<td>France</td>
<td>Innovative solutions in the fields of biodiversity, climate, international waters, land degradation, including deforestation</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="https://www.ffem.fr/en">https://www.ffem.fr/en</a></td>
</tr>
<tr>
<td>DRIVE (RVO Netherlands Enterprise Agency)</td>
<td>Netherlands</td>
<td>Application through Dutch embassy / representation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum Euro 60 million (co-finance required)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RVO DRIVE application form including feasibility &amp; CBA study needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TA available for project application (or through RVO Develop to Build (D2B) instrument)</td>
</tr>
<tr>
<td>KfW Development Bank group</td>
<td>Germany</td>
<td>KfW supports climate resilient urban development, see</td>
</tr>
<tr>
<td>Sida (Swedish International Development Cooperation Agency)</td>
<td>Sweden</td>
<td>Sida has inter alia a focus on environment and climate change in Tanzania, including reforestation projects.</td>
</tr>
</tbody>
</table>
Foreign, Commonwealth & Development Office UK (formerly DFID) | United Kingdom | Regional Infrastructure Programme for Africa. To improve the quality of electricity, transport, water and telecommunications infrastructure for households and businesses across Africa. This programme could be interesting as funding source for the bridges and river widening measures.

https://www.gov.uk/international-development-funding/regional-infrastructure-programme-for-africa

Some of the mentioned development partners also have funding windows for project development (project preparation facilities), such as GCF, AFD France, D2B of RVO Netherlands etc. It is advisable to explore these further for funding of preparatory studies in the next years (final feasibility, design studies, urban development plan and business case of urban development etc.).

**Funding options long term strategy**

The funding strategy for the long term strategy could be more refined (based upon various financing instruments) and spread over a much longer time compared to the short term. First of all, there is more time to prepare for funding (needed earliest 2030), which allows for a wide range of options and the possibility to develop central government funding mechanisms (such as a Deltafund in the Netherlands and Bangladesh). Secondly, the components of resettlement (compensation of households) and land development will require different funding means. Thirdly, the urban development measure (land development) creates the potential for net income generation (from land sales) and therefore possibilities to cross-subsidize other components of the long term strategy. Finally, this income generating potential of the urban development measure might create the possibility to utilize repayable finance instruments.

*Developing a sustainable central government funding mechanism*

The long term strategy needs a sustainable source for long term funding of the resettlement and re-greening measures. Due to this long term nature of implementation and the often required national co-funding principle of many development partner organizations, a sustainable (multi-annual) central government funding source is strongly advisable. Resettlement costs are often not eligible for funding from IFI’s. Moreover, long term maintenance and enforcement of the (protection) of the green areas also needs to be ensured. This implies it is strongly advisable to explore a sustainable central government funding instrument for climate resiliency investments and asset maintenance. The structure of the DeltaFund in the Netherlands and Bangladesh or water safety taxation instruments could be further explored in the next years regarding the feasibility of potential sustainable long term funding instruments for climate resiliency in Tanzania.
Delta Funds in the Netherlands and Bangladesh

The Delta Fund has been established in the Netherlands to ensure that in the long-run sufficient funds are available to ensure realization of necessary measures regarding flood protection and freshwater supplies. The Delta Fund has its own budget which is an independent part of the national budget. Its average annual budget is 1.2 billion euros up to and including 2028. The estimated expenditure of the Delta Fund in 2016 is 1,211 million euro. The Minister of Infrastructure and Water manages the fund. The Delta Fund is fed by contributions from the budget of the Ministry of Infrastructure and Water and other budgets that are part of the national budget. The Water Boards provide an annual contribution to the Delta Fund.

Currently, a Delta Fund is being set-up as part of the Bangladesh Delta Plan project. The idea is to allocate around 2% of GDP of Bangladesh to a dedicated multi-annual fund for investment and maintenance of water sector projects and to reduce the dependency of Bangladesh for development partner funding in its path to a middle income country.

Cross-subsidization and repayable finance

The preliminary business case of the urban development measure (within the long term strategy) shows a positive result (Net Present Value) of about USD 40 million. The revenues from land sales can outweigh the costs of land development in case of a mixed affordable and commercial urban development plan.

This principle is shown in below figure.

![Figure 41: Principle of cross subsidization: business case of urban development and cross-subsidization of other measures](image-url)
This implies that the costs of the specific urban development measure (land development costs of about USD 40 million\(^{10}\)) could be financed by a repayable financing scheme. A project finance mechanism would require the set-up of a dedicated land development entity (special purpose vehicle, either public, private of public-private, see also the earlier paragraph in this section). A private (or public-private) entity could also make use of funding sources aimed at enhancing private sector participation and public-private partnership such as PIDG\(^{11}\).

**Grant development partner funding**

Grant donor funding could be used for specific period(s) of funding for the re-greening measure of the long term strategy. See for an overview of interesting development partners the tables above. Often grant funding from multi- or bilateral development partners is available for specific periods only (f.e. 2-3 years). Generally, most funding institutions adopt ticket sizes for individual grants between USD 2-30 million, implying several funding sources need to be explored for the long term strategy. An exception is the Green Climate Fund (GCF), which has higher ticket sizes. This implies that these sources are especially interesting for covering specific shares and components (for example 2 yearly batches) of the investment costs of the re-greening & reforestation measures (for instance of the total costs 2030-2050 of USD 370 million). Interesting sources to explore further regarding funding re-greening & reforestation measures are GCF, GEF, UNEP and Sida. Apart from this, there are numerous NGOs (such as WWF) and private initiatives with support (including grants) for greening & reforestation projects\(^{12}\).

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\(^{10}\) Costs of land development include land acquisition costs, site preparation, public space & facilities, infra & cables etc. in order to prepare sites for sale or lease of land to real estate developers. See the appropriate section on urban development business case in the Section Preliminary Cost Benefit Analysis.

\(^{11}\) See for example the Private Infrastructure Development Group (PIDG). PIDG also has a project development support mechanism for private development or PPP projects (through InfraCo). [https://www.pidg.org/](https://www.pidg.org/) and its Emerging Africa Infrastructure Fund (EAIF): [http://www.eaif.com/](http://www.eaif.com/)

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- The presented flood management strategy for the Msimbazi Middle Basin should be seen as a refinement of the Msimbazi Opportunity Plan for the concerned Study area;

- Several combinations of preferred structural solutions that were identified in the Vulnerability Analysis have been incorporated in the hydraulic model. Based on effectiveness calculations with the flood model, it can be concluded that significant reductions in hazards and damage will be gained with the proposed structural river measures (viz. widening and raising of bridges, wider river channels and river bank protection). However, after implementation of the structural measures a substantial residual flood risk remains. It is deemed not feasible to take away this residual risk with other structural (protection) measures. Therefore, resettlement of people and assets from the floodplains is deemed inevitable to reduce flood vulnerability of the Msimbazi Middle Basin to acceptable levels;

- The identified flood management strategy is based on a short-term component to be implemented in the period 2021 – 2025 and a long-term component (2021 – 2050). The short-term implementation component focuses on removal of the hydraulic bottlenecks in the Msimbazi River. The residual flood risk after implementation of these measures requires a more rigorous approach, hence the long-term component proposes a transformation of urban land use by making room for the river to recreate a natural floodplain area, urban regeneration to accommodate resettlements and reforestation and regreening of the catchment;

- To accommodate the required resettlements, an urban strategy has been developed as part of the overall flood management strategy. Urban patch regeneration transformations are proposed in the short term to meet a resettlement requirement of about 250 households. In the long-term patch developments will be extended and complemented with two large area development combining affordable housing to cater for a resettlement requirement of 15,400 households and commercial real estate;

- Based on the flood management and urban strategy the following measures are proposed for the short and the long-term components:
  o Short-term implementation (2021 – 2025):
    a) Widen and/or raise bridges - to increase the hydraulic capacity of the bridge underpass
    b) Widen river beds - to increase the hydraulic capacity of the river
channel
c) River bank protection - to prevent bank erosion, to guide flow through and around bridges, minimise sedimentation issues downstream and mark the minimum river width as a boundary for urban development
d) Urban development - accommodate required resettlements from river sections that need to be widened in urban regeneration areas within the subward
  o Long term implementation (2021 – 2050):
    e) Room for the River - increasing floodplain area to accommodate floodwater of extreme events by retreating structures and assets
    f) Urban development - urban regeneration in patches and area developments to i.a. accommodate resettlements
    g) Reforestation of upper section Msimbazi catchment and re-greening of re-developed areas - Increasing the infiltration capacity by regreening the catchment area

- The developed concept designs of the proposed measures are considered easily constructable by commonly used construction materials and it is expected most of the works can be performed by local contractors. Also in view of the identified effectiveness, the proposed measures are considered technically feasible;

- The short-term measures have a total estimated CAPEX of USD 79.8 million. The main cost components are the bridge measures and urban development (value existing properties and land development costs) to meet resettlement requirements;

- The long-term measures have a total estimated CAPEX of USD 1,191 million, which is substantially higher than the short-term CAPEX. Urban development (value existing properties and land development costs) for the required resettlements is the largest cost component;

- The preliminary business cases for the urban development measures show that the discounted potential income from land sales (to real estate developers) outweigh the costs of land development (site preparation etc.). The Net Present Value (discounted future revenues minus discounted future cost) are USD 1 million for the short term component and USD 37 million for the long term component. This implies that especially the urban development in the long term component is commercially worthwhile from the perspective of an initiator or investor.
- Key conclusions from the cost-benefit analysis are that the benefits for society for both the short-term component and the long-term component are larger than the costs. Even in other scenarios with more moderate climate change and lower socio-economic development (performed sensitivity analysis), benefits more than compensate the costs. This implies all components are feasible from a societal and tax payers perspective. The benefit-cost ratio is higher (more efficient) regarding the short term component, however this component only reduces flood damages with about 25% while the long term component significantly reduces flood damages (up to 75%)

- Key conclusions from the Preliminary Environmental and Social Impact Assessment are:
  o The short term- and long term flood management components have significant beneficial long term (permanent) social and environmental impacts. Key beneficial impacts relate to reduced fatalities, reduced flood damage for vulnerable people, protection of economic livelihoods from floods, reduction of water-borne diseases and avoidance of transportation disruption. The long term strategy has more major beneficial flood impacts (compared to the short term strategy) due to higher flood risk reduction, formal urban development and re-greening and reforestation (positive impacts for public space, hygiene, biodiversity and recreational functions);
  o The analysis shows only one major negative impact of the long term strategy which will be caused by the proposed resettlement activities as part of the room for the river measure. However, the urban development measure will offer affordable formal housing for the resettlement affected groups within the Study area. Moreover, the rest had mainly moderate to minor impacts and of short term and therefore can be included in further assessment;
  o Several mitigation measures are proposed to mitigate the negative environmental and social impacts (especially during construction phase).

For the institutional set-up for implementation of the proposed flood management strategy, it is advised to follow the proposed Govern Strategy as part of the Msimbazi Opportunity Plan as much as possible. Key organisations in the proposed structure will be the Msimbazi Special Planning Authority and the Msimbazi Development Corporation. To facilitate the site preparation, land development and revenue generating potential of the urban development measures, it is advised to consider the set-up of a land development unit or agency under the Msimbazi Development Corporation. Moreover, such a unit could facilitate apart from public funding the possibility to attract private finance.
- The short term implementation component shows an insignificant income potential for cross-subsidization (or repayable finance). Therefore, additional government funding and/or donor grant funding (multi-lateral and bi-lateral development partners) can be considered as funding options.

- The funding strategy for the long term implementation component could be more refined (spread over long time, larger resettlement component and potential of net income generation). It is advised to explore the concept of developing a sustainable national multi-annual fund for climate adaptation investment and maintenance (including resettlement funding). This might be inescapable due to the high multi-annual funding needs over a long time of the long term component and due to the fact that donors are in general hesitant to fund compensation cost for resettlement. Moreover, the income generating potential of the urban development measures might create the possibility to utilize income for cross-subsidization of other measures and facilitate repayable finance instruments.
Recommendations

- Firstly, consultants strongly advise to start the preparation for implementation of the short-term and long-term components and its relevant measures as soon as possible. The sooner, the better as according to this study the potential damage of flood events will increase the longer one waits and flood prone places along the river might attract new settlements. A plan and funding strategy for the process of preparatory studies and permits (final feasibility studies, detailed business case urban development, design studies, resettlement action plans, social and environmental safeguards etc.) should be prepared. Possibilities to attract project preparation funding from Development Partners with project development windows (for instance Green Climate Fund (GCF), AfD France, D2B Netherlands) could be explored.

- Preparation of the long term component should also start already in the period 2021-2026, as it is expected this will take considerable time. This component will need multi-annual funding (of inter alia resettlement and re-greening cost) and might utilize private (repayable) finance. In order to create a national sustainable multi-annual funding structure it is advisable to explore the feasibility of setting up a multi-annual Deltafund for climate adaptation investment and maintenance (including resettlement costs funding). Experiences with such funds in the Netherlands and Bangladesh might be looked into. Moreover, we recommend to prepare a more detailed concept and business case for the urban development measures (and areas), and to commission a plan or feasibility study for the establishment of a land development agency.

- It is recommended to discuss the results of this Feasibility Study with the PIU of the Msimbazi Opportunity Plan and its stakeholders. Since the Dar es Salaam City Council (leading organisation in the PIU) has been dissolved in February 2021 and it is planned to upgrade Ilala Municipality as city council, coordination on the inclusion of the flood management strategy for the Msimbazi Middle Basin into the Msimbazi Opportunity Plan should be done at the earliest possibility to ensure proposed developments will be taken into consideration by the newly to be installed city council;

- It is recommended to share this Feasibility Study report with potential funding sources and seek for their interest in funding of the implementation of the measures;

- The presented flood management strategy consists of a set of different measures arranged in a short and a long term components.
strategy will be accepted by the involved stakeholders for integration in the MOP, a **discussion needs to take place to identify how subsequent Detailed Feasibility Studies (DFS) are going to be defined and by which organisation.** Besides that, it is recommended that an overarching verification will be built into the DFSs to guarantee its integration as part of the overall flood management strategy/ MOP;

- It is strongly recommended to **continue the participatory design process** in the next steps towards implementation and maintain the momentum created by the charrettes. The commitment of the stakeholders and the support from local and national politicians are an invaluable asset of the project and essential for decision making on the sensitive issues of large scale resettlement and inter-institutional coordination.
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APPENDIX I – VISION MAPS

Short term vision map:
https://cdr-international.box.com/s/n5v5envmvpwnd8m47ooax47bgqoedf4v

Long term vision map:
https://cdr-international.box.com/s/dcw0mzzw2b8utqn532zqtm1eah4ahoiu

Long term vision map – urban development:
https://cdr-international.box.com/s/hszenmom1uvvziin6piycjyu4hfkdye1
APPENDIX II – COST ESTIMATIONS

Cost estimations short term

a) widen and raise bridges

Unit rate for BoQ costs new road bridge: USD 3,000/m²
Unit rate for removal costs: USD 700/m²
Quantities (bridge surface area) based on existing configuration of lanes and corresponding width.

Cost overview per bridge:

<table>
<thead>
<tr>
<th>New span widening</th>
<th>Kawaza Road Bridge Msimbazi</th>
<th>Nelson Mandela Bridge</th>
<th>Railroad bridge</th>
<th>Kawaza Road Bridge Kibangu</th>
</tr>
</thead>
<tbody>
<tr>
<td>cost fraction</td>
<td>100m</td>
<td>80m</td>
<td>80m</td>
<td>100m</td>
</tr>
<tr>
<td>Raising bridge deck/embankment</td>
<td>Yes, ¬1m</td>
<td>No, maintain same level</td>
<td>No, maintain same level</td>
<td>Yes, ¬1m</td>
</tr>
<tr>
<td>BoQ costs bridge</td>
<td>$ 7,200,000</td>
<td>$ 5,760,000</td>
<td>$ 2,000,000</td>
<td>$ 7,200,000</td>
</tr>
<tr>
<td>mob demob (20%)</td>
<td>0.2 $ 1,740,000</td>
<td>$ 1,112,000</td>
<td>$ 400,000</td>
<td>$ 1,740,000</td>
</tr>
<tr>
<td>contingency (20%)</td>
<td>0.2 $ 1,740,000</td>
<td>$ 1,112,000</td>
<td>$ 400,000</td>
<td>$ 1,740,000</td>
</tr>
<tr>
<td>design (5%)</td>
<td>0.05 $ 435,000</td>
<td>$ 288,000</td>
<td>$ 100,000</td>
<td>$ 435,000</td>
</tr>
<tr>
<td>supervision (5%)</td>
<td>0.05 $ 435,000</td>
<td>$ 288,000</td>
<td>$ 100,000</td>
<td>$ 435,000</td>
</tr>
<tr>
<td>removal costs</td>
<td>$ 1,680,000</td>
<td>$ 1,344,000</td>
<td>$</td>
<td>$ 1,344,000</td>
</tr>
<tr>
<td>sub-total</td>
<td>$ 14,730,000</td>
<td>$ 9,844,000</td>
<td>$ 2,000,000</td>
<td>$ 14,394,000</td>
</tr>
<tr>
<td>total 4 bridges</td>
<td>$ 42,108,000</td>
<td>$ 28,558,000</td>
<td>$ 8,000,000</td>
<td>$ 42,108,000</td>
</tr>
</tbody>
</table>

b) dredging wider channel

Unit rate based on assessed dredging and excavation costs in MOP.

Cost overview:

| Quantity (m³) | 200,000 |
| Unit rate ($/m³) | $10 |
| BoQ costs | $ 2,000,000 |
| mob demob (20%) | 0.2 $ 400,000 |
| contingency (20%) | 0.2 $ 400,000 |
| design (5%) | 0.05 $ 100,000 |
| supervision (5%) | 0.05 $ 100,000 |
| total | $ 3,000,000 |

C) bank protection

Cost per linear meter based on expected average cost for combinations of three types of bank protection proposed for Msimbazi Middle Basin.

Cost overview:

| Quantity (length in linear m') | 5,000 |
| Unit rate ($/m') | $500 |
| BoQ costs | $ 2,500,000 |
| mob demob (20%) | 0.2 $ 500,000 |
| contingency (20%) | 0.2 $ 500,000 |
| design (5%) | 0.05 $ 125,000 |
| supervision (5%) | 0.05 $ 125,000 |
| total | $ 3,750,000 |

Funding partners: [List of logos]
Implementing agencies: [List of logos]
d) Short term Urban development

Costs are based on the value of existing properties to be resettled. Structure removal and clearing costs are included by applying a factor of 1.5 to the value of the property.

Cost overview:

<table>
<thead>
<tr>
<th>Category</th>
<th>amount of buildings</th>
<th>average footprint size per unit</th>
<th>value per m² 2020</th>
<th>factor</th>
<th>resettlement costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business &amp; Offices</td>
<td>1</td>
<td>100</td>
<td>$689</td>
<td>1.5</td>
<td>$103,313</td>
</tr>
<tr>
<td>Health &amp; Sanitation</td>
<td>2</td>
<td>100</td>
<td>$385</td>
<td>1.5</td>
<td>$115,500</td>
</tr>
<tr>
<td>Industrial</td>
<td>16</td>
<td>550</td>
<td>$689</td>
<td>1.5</td>
<td>$9,091,500</td>
</tr>
<tr>
<td>Mixed Use</td>
<td>4</td>
<td>110</td>
<td>$275</td>
<td>1.5</td>
<td>$181,500</td>
</tr>
<tr>
<td>Residential</td>
<td>250</td>
<td>80</td>
<td>$251</td>
<td>1.5</td>
<td>$7,524,911</td>
</tr>
<tr>
<td>Residential existing location patches</td>
<td>440</td>
<td>80</td>
<td>$251</td>
<td>1.5</td>
<td>$13,243,843</td>
</tr>
<tr>
<td>sub-total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$30,260,566</td>
</tr>
<tr>
<td>Residential plot land development cost (excl real estate dev costs)</td>
<td>21,563</td>
<td></td>
<td>29</td>
<td></td>
<td>$630,973</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$30,891,539</td>
</tr>
</tbody>
</table>

Cost overview measures a), b), c) and d):

Total investments (incl. plot development) $79,749,539
Total investment government (excl. land development) $79,118,566

Cost estimations long term

e) Room for the River

Costs include preparation of land for regreening and planting. Unitrates have been deduced from rates applied to park costs in the MOP. Green in patches is more costly than green in the Room for the River section because envisioned quality standard of open space/ green in the urban patch will be higher.

Cost overview regreening:

<table>
<thead>
<tr>
<th>Area (m²)</th>
<th>USD/m²</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room for the River</td>
<td>5,223,668</td>
<td>$10.00</td>
</tr>
<tr>
<td>Long term patches</td>
<td>400,000</td>
<td>20.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

f) Long term Urban development

Costs are based on expected value of existing properties to be resettled in 2030. Structure removal and clearing costs are included by applying a factor of 1.5 to the value of the property.

Cost overview:
g) reforestation upper sections Msimbazi catchment

Unit rate is based on estimation of 3$/m² for land acquisition (source: Samwel Alananga and Charles Lucian (2016) and 2$/m² tree planting (deduced from MOP rates for reforestation).

Cost overview:

<table>
<thead>
<tr>
<th>Financials</th>
<th>area (m²)</th>
<th>USD/m²</th>
<th>Land acquisition and regreening</th>
</tr>
</thead>
<tbody>
<tr>
<td>reforestation</td>
<td>74,072,398</td>
<td>$</td>
<td>$ 370,861,490</td>
</tr>
</tbody>
</table>

Cost overview measures e), f), and g):

- Total investments (incl. plot land development): $1,191,274,657
- Total investment (excl. land development): $1,150,105,706
- Investment plot land development: $41,168,951

Funding partners: [List of logos]

Implementing agencies: [List of logos]
APPENDIX III – PRELIMINARY ENVIRONMENTAL AND SOCIAL ASSESSMENT

Impacts implementation phase

Assessment of the impacts during mobilization and construction/implementation phase has been based on transportation of construction equipment to the site, measures implementation, actual works during measures implementation including associated structures. In the course of construction/implementation, the following impacts are anticipated:

i. Occupational Health and Safety (Accidents and Ergonomics hazards)
ii. Water pollution (turbidity and Hydrocarbons pollution)
iii. Hydro modification\(^\text{13}\)
iv. HIV/ AIDS increased cases (construction phase)
v. Air, Noise Pollution and Vibration
vi. Employment Opportunities (construction phase)
vii. Vegetation clearance
viii. Disturbances to nearby residents (accessibility and noise during construction phase)
ix. Reduction of land used for vegetable farming
x. Disturbances of aquatic ecosystem along Msimbazi river

Occupational Health and Safety

The proposed measures are associated with activities which may cause accidents or injuries. Accident is something that happens unexpectedly, because of the intensive engineering and construction activities. During construction/implementation, workers will be subjected to situations that could be detrimental to their health and safety. The main concern in this regard is the occupational welfare of the construction workers their exposure to various hazards which can lead to injuries including machine operations and working at height. Such injuries can result from accidental falls, injuries from hand tools and construction equipment cuts from sharp edges of metal sheets. Also workers face exposure to various exhaust and particulate emissions from vehicles and other machineries operation. Moreover exposure to Noise and vibration from construction equipment and other activities. Workers safety on site will be endangered as a result of missing appropriate protective gears i.e. safety shoes, helmets, groves, ear plugs, grasses and by eventual accidents at work.

*This impact is considered to be NEGATIVE, cumulative, SHORT-TERM and of MODERATE significance.*

Water pollution

All proposed measures will be implemented within the catchment, closer to the rivers and exactly within the rivers. The activities will include construction activities, earth works and protection works, which will disturb the soil (make it more loose) and use machines and construction materials which can possibly pollute water due increased turbidity, construction waste, and accidental spill of petroleum products in project rivers.

\(^{13}\) Hydro modification encompasses the systematic response to alterations to riverine and non-riverine water bodies such as coastal waters (estuaries and bays) and lakes.
This impact is considered to be NEGATIVE, cumulative, SHORT-TERM and of MODERATE significance.

Hydro modification

Hydromodification is the alteration of the natural flow of water through a landscape, and often takes the form of channel modification or channelization. A broader definition of hydromodification covers not just channel modification but also changes in land use or cover. Conversion of the open landscape to features such as roads, buildings, houses, sidewalks, parking lots, and flood control channels adds impervious surfaces and modifies runoff patterns, causing rainfall to run off into streams more quickly with higher energy, and large flow events to occur more frequently.

These changes can cause problems such as changes in flow, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, loss of fish and other aquatic populations, and decreased water quality.

This impact is considered to be NEGATIVE, cumulative, LONG-TERM and of MODERATE significance.

Spread of HIV/ AIDS and Other STIs

Construction or implementation activities of the proposed measures will add to the already existing influx of people from various places in search for jobs and other opportunities that come from construction activities. The project may facilitate interaction of people of different sex which may lead to sexual relationships and eventually spreading of HIV and other Sexually Transmitted Infections.

This impact considered NEGATIVE, cumulative and of LONG-TERM duration and of MODERATE significance.

Air, Noise Pollution and Vibration

Exhaust Emissions

The trucks used to transport various construction materials from their sources to the project’s construction sites and movement of earth materials (spoil soil) as well as diesel-powered construction equipment will contribute to increases in emissions of exhaust gases which have harmful effects. Including Carbon dioxide (CO₂), Carbon monoxide (CO), Nitrogen Oxides (NOₓ), Sulfur Oxides (Sox), Benzene (C₉H₆) and particulates (airborne particles of black soot and metal). Such combination of emissions (exhaust fumes) and particulates are the major factors of global warming and exposure to these fumes can cause range of health problems, from allergies and skin irritation to heart disease and respiratory problems such as asthma.

This impact is therefore considered to be NEGATIVE, cumulative and of SHORT-TERM duration and of MODERATE significance.
Dust Emission

Dust emission may arise from the construction/implementation of proposed measures. Construction works would include site formation, piling and foundation work, concreting work, and to a small extent transport vehicles delivering building materials (mainly for measures a) and b)). Dust Particles contains microscopic solids that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter (PM$_{10}$) can get deep into lungs when inhaled and some may even get into your bloodstream. Of these, particles less than 2.5 micrometers in diameter, also known as fine particles or PM$_{2.5}$, pose the greatest risk to health. Emission of large quantities of dust may lead to significant health impacts on construction workers which will be accentuated mostly during dry weather conditions.

The impact is considered to be NEGATIVE, SHORT-TERM duration and of MODERATE significance.

Noise (social disturbance due to noise)

The potential source of noise during the construction phase will include powered mechanical equipment (PME) for numerous construction activities such as metal grinders and concrete mixers and movement of trucks loaded with construction materials such as sand and aggregates, cement, steel and roofing sheets etc. The noise levels measured at the site was on average 54dB during the environmental air quality baseline study. Therefore, it is expected that according to the given size of the proposed project, the average noise level will be way above normal during construction phase. Noise is unwanted/undesirable sound that can affect job performance; safety, and health of humans. Psychological effects of noise include annoyance and disruption of concentration. Physical effects include loss of hearing, pain, nausea, and interference with communications when the exposure is severe.

This impact is NEGATIVE, SHORT TERM and of MINOR significance

Vibration

Operation of construction/implementation equipment might cause ground vibrations, which may also spread into all areas around site that depending on the strength, the vibration will diminish inversely proportional with distance. However, within Msimbazi Middle Catchment there are houses with compromised structural stability and the impact might be significant.

This impact is therefore considered to be NEGATIVE, cumulative and of SHORT-TERM duration and of MINOR significance.

Employment Opportunities

One of the positive impacts of the proposed project during measures implementation is availability of jobs surrounding local community. The phase is likely to boost other investments, provide trading opportunities and spur local business such as Mama lishe and other food vendors. For construction/implementation of the proposed measures labour force will be comprised of skilled and unskilled labours. It is anticipated that all unskilled labourers will be recruited locally. Recruitment of skilled labours will vary; some from the area but mostly
people of the contractor’s choice. Employment opportunities during construction work will increase the income, skills and knowledge to local labour force. Mostly men will benefit in this respect. Furthermore, the construction of this project will require supply of construction materials that will provide an opportunity/market for building material suppliers such as quarries suppliers, hardware suppliers and other construction materials suppliers.

This impact considered POSITIVE, cumulative and of SHORT-TERM duration and of MODERATE significance.

Vegetation clearance

Proposed flood management measures will involve vegetation clearance except for measure g) (Re-greening). However, the impact will be limited due to the nature of proposed activities.

This impact considered NEGATIVE, cumulative and of SHORT-TERM duration and of MINOR significance.

Disturbances to nearby residents

Proposed flood management measures will involve civil works and the use of heavy equipment and these in turn will leads noise and vibration which will disturb nearby residents. The impact will be significant for areas with houses closer to the project area.

This impact considered NEGATIVE, cumulative and of SHORT-TERM duration and of MINOR significance.

Reduction of land used for vegetable farming

Part of Msimbazi Middle Catchment is used for vegetable farming; the proposed flood management measures will lead to acquisition of extra land to accommodate those measures. This will also lead to reduction of income of the affected people.

This impact considered NEGATIVE, cumulative and of LONG-TERM duration and of MODERATE significance.

Disturbances of aquatic ecosystem along Msimbazi river

Proposed flood management measures will involve various activities such as construction of bridges and protection works, river widening and deepening of which all together modifies river morphology and possible pollution of the same. These changes of river morphology and pollution will disturb existing aquatic ecosystem within the project area.

This impact considered NEGATIVE, cumulative and of SHORT-TERM duration and of MODERATE significance.

Impacts on gender, children, elderly and indigenous people
Proposed flood management measures will involve various activities such as construction of bridges and protection works, river widening and deepening, resettlement and re-vegetation. These activities will likely impact negatively women, children and elderly people including gender discrimination, child abuse and unfavorable condition for elders in terms of limited access to services, noise and air pollution. The group can even further be affected in wide range of social economic dimension including limitation in participating in religious activities.

*This impact considered NEGATIVE, cumulative and of SHORT-TERM duration and of MODERATE significance.*

**Impacts operational phase**

**Resettlement of People and Properties**

Measures b) requires limited resettlement for implementation, however, measures no. e) (Room for the River) will have significant impact on the resettlement of peoples and properties. The measure is aimed at creating a room for water by allowing part of human settlement to be covered by water. This impact has multiplier effect in the sense that people will be away from the site, and the properties as well, but for the properties will only for those which can be moved but the rest will be abandoned (total loss). The measure will lead to relocation of peoples, properties and utilities as well.

*This impact is NEGATIVE, LONG TERM and of MAJOR significance.*

**Reduced flooding along project area**

All proposed measures are aimed at reducing or preventing flooding within Msimbazi Middle Catchment area. The measures if implemented will have positive impact as flood prevention measures with several multiplier benefits such as;

i. Protection of properties and utilities from flooding damage
ii. Save human lives at risk during flooding events
iii. Reduced cases of water related diseases which have high occurrence during flooding
iv. Improved services delivery such as sanitation, water supply, solid waste management and electricity
v. Reduced disturbance of social gatherings or assets during flood events

*This impact is POSITIVE, LONG TERM and of MAJOR significance.*

**Improved transportation (reduced transportation disturbance)**

The proposed measures once implemented will improve transportation within Dar es Salaam region and country at large. During heavy rains, some parts of Msimbazi Middle Catchment become flooded which also causes damage of bridges and culverts and therefore impair transportation network within Dar es Salaam. The interventions will also improve accessibility to residential area, business areas and services such as schools and hospitals.

*This impact is POSITIVE, LONG TERM and of MAJOR significance.*
Reforestation/ Re-greening

Flood management measure g) is reforestation of Pugu forest and re-greening of part of Msimbazi catchment. The measure is anticipated to have several linked benefits such as reducing runoff and hence reduce flood impact severity, regulating macro climate of the area, enhance environmental conservation including provision of habitat for various fauna and flora species.

This impact is POSITIVE, LONG TERM and of MAJOR significance.

Urban Development

Flood management measure g) includes resettlement of people and properties within Msimbazi Middle Catchment area. Apart from the negative impact of removing people, the measures will offer a room to implement Urban development strategies with better and integrated planning. The areas set aside to accommodate resettled communities will be undeveloped and open for the implementation of integrated urban development strategies which will integrate among others, improved sanitation (wastewater management, solid waste management and provision of water supply), climate change resilience measures, and services provision. Therefore, this is positive impact that will improve the health, security and overall wellbeing of affected communities.

The new resettled areas will be properly planned, accessible and provided with all necessary services such as proper drainage infrastructures and therefore, flooding which causes loss of properties and lives to be the history.

This impact is POSITIVE, LONG TERM and of MAJOR significance.

Impacts on gender, children, elderly and indigenous people

All proposed flood management measures aim at one common goal of reducing or eliminating floods within affected wards in Msimbazi Middle Catchment area. During operation phase, regardless which measures will be implemented, women, children and elderly will be positively impacted in number of ways including improved heath, security, stable economic activities including religious matters and easy access to services.

This impact considered POSITIVE, cumulative and of LONG-TERM duration and of MAJOR significance.

Improved Solid Waste Management

Solid waste management will be improved after the implementation of Flood management measures due to the fact that, existing situation hamper effective management. After project implementation, flood will be minimized and solid waste management will be improved as a result of improved accessibility. Furthermore, a sustainable community-based solid waste management model for the area has been developed which, after implementation, will greatly reduce solid waste pollution.
This impact considered POSITIVE, cumulative and of LONG-TERM duration and of MAJOR significance.

Mitigation measures construction phase

Occupational health and safety of construction workers

In order to minimize potential health impacts that may result from the construction activities the following mitigation measures shall be implemented:

- Establish Workers Safety Management Systems
- Formulate Occupational Health and Safety Policy
- Workers at the site will be provided with appropriate protective gears such as boots, helmets, masks, etc.
- The contractor shall insist workers to use the Personal Protective Equipment properly
- Putting in place the First Aid Kit and trained first aider
- Construction site shall be fenced and hygienically kept with adequate hygienic facilities including waste disposal receptacles, sewage, firefighting equipment, clean and safe water supply

Water Pollution

- The Contractor is responsible for compliance with the relevant Tanzanian legislation relevant to wastewater discharges into watercourses.
- Portable or constructed toilets must be provided on site for construction workers.
- Using techniques such as flow diversion during construction to limit the exposure of disturbed sediments to moving water
- Provide service area that will be far from construction site,
- Make appropriate arrangements for collecting, diverting or intercepting wastewater from households to ensure minimal discharge or local clogging and flooding.
- Before construction, obtain all necessary wastewater disposal permits/licenses and/or finalize all necessary wastewater disposal contracts.

Hydro modification

To mitigate this impact, initial hydromodification assessment should be done that examines the hydromodification impacts related proposed measures, including erosion, sedimentation, and alteration to storm water flow, volume and duration that may cause or contribute to water quality degradation.

Spreading of HIV/AIDS and other STIs

In order to address and alleviate spreading of HIV/AIDS among construction/implementation crew, sensitization campaigns against the dangers of HIV/AIDS shall be organized including voluntary Counselling and Testing programs in collaboration with agencies dealing with control of HIV/AIDS.

Funding partners:

Implementing agencies:
Emission and dust Minimization

The proponent is committed to implementing measures that shall reduce air quality impacts associated with measures implementation. To reduce exhaust emission, the following mitigation measures shall be implemented:

- Equipment and machines shall be properly maintained
- Maintain equipment that are in a good running condition - no vehicles to be used that generate excessive black smoke.
- Enforce vehicle load restrictions to avoid excess emissions from engine overloading.
- Where practical, switch off engines when not in use.
- Avoid burning of solid waste at the site.

To mitigate dust associated with transportation of construction materials,

- The contractor should cover well all trucks with sand when transported from sources to the proposed site.
- Water shall be sprayed on unpaved surfaces used by such equipment to suppress dusts during construction followed by paving of surfaces at the project site.

Minimizing vibration and noise pollution

The Contractor shall put in place several measures that will mitigate noise pollution arising during the construction phase. The following noise-suppression techniques will be employed to minimize the impact of temporary construction noise at the project site as highlighted below.

- Low noise construction equipment shall be used.
- Drivers shall be trained on proper driving practices to minimize/avoid example unnecessary racing of truck engines at site.
- Periodic maintenance of machines and vehicles will be done to minimize the presence of noise and emissions from engines.
- Furthermore, the construction during the night will be avoided to ensure quietness in the neighbourhoods at night.

Employment Opportunity

All proposed measures will create temporary employment to locals and international experts during implementation phase. This is positive impact and should be enhanced by employing locals and other on job training. Furthermore, the following should be done:

- The contractor has to be encouraged to employ local, unemployed yet willing to work hard, man-or womenpower to the extent viable subject to a maximum of 50% unskilled labour. This will ensure that local people are more benefited out of the project.
- Employment should be on equal opportunities for both gender (male and female).
- Contractor has to provide on the job training to all employee, especially for specialized tasks.
- Local communities have to be encouraged to produce quality goods and services in the shops surrounding the project site.

Vegetation clearance
The proposed measures will involve vegetation clearance except for Measures no. 5, the following should be done as mitigation measures;

- The Contractor shall prepare a Clearance, Re-vegetation and Restoration Management Plan for areas to be cleared; the areas shall be minimized as much as possible.
- The Contractor shall remove topsoil from all areas where topsoil will be impacted by construction activities, the stripped topsoil shall be stockpiled in areas agreed with the Construction Supervision Consultant for later use in re-vegetation; it shall be adequately protected while it is stored.
- The contractor shall not apply chemicals during vegetation clearing.
- Cutting of any tree is prohibited unless explicitly authorized in above-referred plan.
- No area of potential importance as an ecological resource should be disturbed unless there is prior authorization from NEMC.

Reduction of land used for vegetable farming

During measures implementation, some of the vegetable growers along Msimbazi Catchment area will be affected, they will be identified and existing Laws and Regulations will be followed to assist their relocation.

Disturbances of aquatic ecosystem along Msimbazi river

Measures implementation will disturb existing aquatic ecosystem due associated activities, the following should be done;

- Inventory of existing ecosystem.
- Preparation of fauna and flora management plan.

Impacts on gender, children, elderly and indigenous people

To protect these vulnerable groups, project implementation should focus on the following:

- Identify these vulnerable groups
- Formulate and operationalize Grievance Redress Mechanism (GRM) Committee
- Institutionalize Gender Based Violence (GBV) awareness and committee for receive and address related cases
- Operationalize contractor’s Policies on related matters.

Mitigation measures operation phase

During operation phase, there is only one major negative impact which is relocation of peoples and properties, the rest are positive which only need enhancement measures to fully realize the benefits.

Relocation of People and Properties
The impact is negative and MAJOR, it has to be avoided to a greater extent, however, if Measure no. 4 will be implemented then a fair and prompt compensation and reallocation should be done by governing laws and regulations.

Urban Development

Flood management measure no. 4 is purely resettlement of people and properties within Msimbazi Middle Catchment area. The measures will offer a room to implement Urban development strategies with better and integrated planning. To enhance this positive, major and long-term impacts, the implementing agencies shall apply integrated urban development strategies which will integrate among others, improved sanitation (wastewater management, solid waste management and provision of water supply), climate change resilience measures, and services provision.

Impacts on gender, children, elderly and indigenous people

All proposed flood management measures aim at one common goal of reducing or eliminating floods within affected wards in Msimbazi Middle Catchment area. During operation phase, regardless which measures will be implemented, women, children and elderly will be positively impacted in number of ways including improved heath, security, stable economic activities including religious matters and easy access to services. To enhance this, any measure that will be taken, shall engage all these groups and get their comments and concerns to fit in design and implementation.

Improved Solid Waste Management

Solid waste management will be improved after the implementation of Flood management measures due to improved accessibility. To enhance this, project design and implementation should consider solid waste management as an integral part of flood management, furthermore, collection and disposal of solid wastes has to be formalized to enhance its effectiveness (see also Sustainable community-based solid waste model developed within the framework of this project for the midsection of the Msimbazi river).
Funding Partners:

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