



# Project Plan Uganda 2022

*Enhancing resilience to climate change-induced flooding and drought through the implementation of Flood Intelligence Software (FIS) and a water-filled barrier called SLAMDAM.*

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Zephyr Consulting | Omar Saleh  
The Netherlands, Nov. 2022



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# About the flood resilient measures called “SLAMDAM”

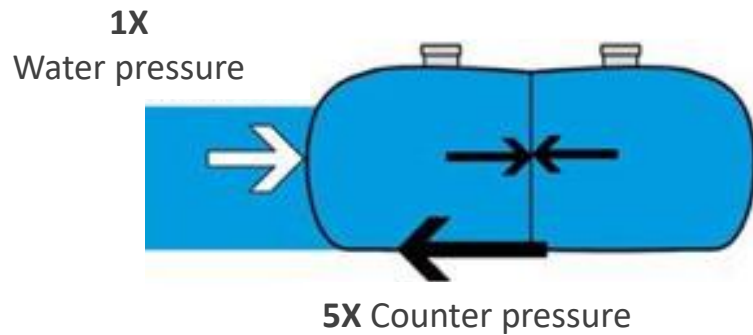
*SLAMDAM is an easily deployable water-filled barrier that effectively enhances resilience to flooding*

## Design and Material

- › SLAMDAM is made of EPDM (flexible rubber)
- › SLAMDAM consists of two compartments
- › Standard models or tailor-made

## Unique Selling Points

- ✓ Easily deployed\*
- ✓ Lifespan 50+ years
- ✓ Effective (TÜV-certified)
- ✓ 100% recyclable
- ✓ Multi-functional
- ✓ Easy to use



# How to operate the SLAMDAM-technology

## Simplicity

- › The beauty of this technology lies in its simplicity as it is easy to operate, maintain and store.

## Capacity building

- › It takes little effort to train people on how to operate the technology, there is no need for (advanced) degrees.



Store in boxes



Transport boxes



Rollout dams



Connect hoses & pumps



Fill with water

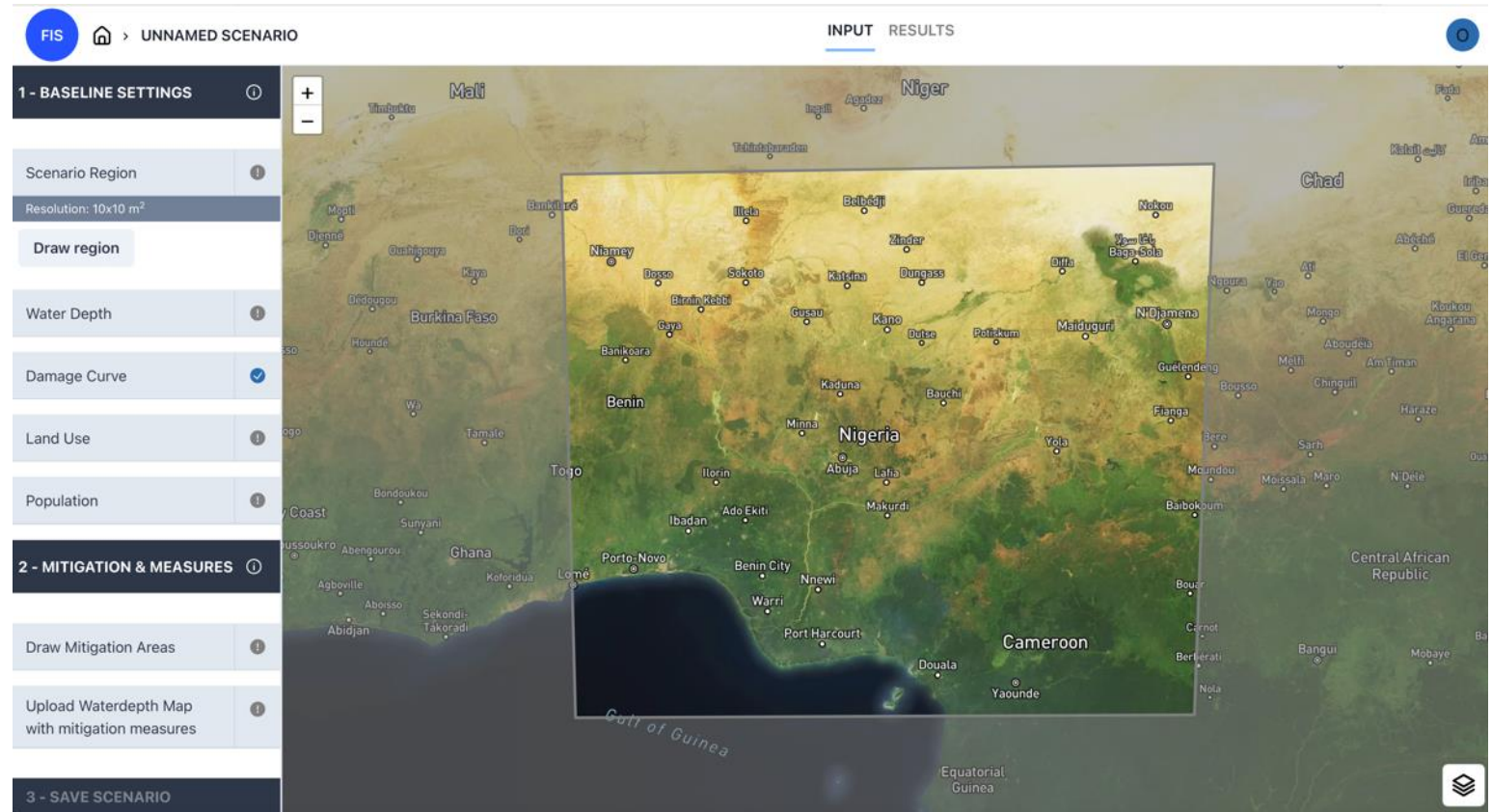


Empty and dismantle



# Flood Intelligence Service (FIS)

- › FIS uses state-of-the-art 3Di hydrodynamic modelling.
- › The tool compares a flood event **with** and **without** resilient measure.
- › FIS calculates the anticipated benefits expressed in pre-defined indicators.



# Project Overview (1/2)

## 1. Background and Introduction

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The visible and measurable effects of climate change across Uganda have become more apparent over the last two decades. There is a direct linkage between climate change and the intensity and frequency of flooding. Uganda can benefit greatly from innovative and effective solutions aimed to strengthen resilience to floods.

A Consortium of companies led by Zephyr Consulting, including a Uganda-based partner and Nelen & Schuurmans will implement a project comprising of data-driven flood and drought analyses using innovative software and the implementation of water-filled flood barriers.

The Consortium will implement **SLAMDAM** to strengthen Uganda's resilience to climate change. Newly **Food Intelligence Software (FIS)** is used to analyse flood hazards and adaptation benefit scenarios. SLAMDAM is a climate resilient technology being water-filled flood barrier that can easily be deployed to prevent damage from flooding.

## 2. Project Objective

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The key objective is to demonstrate FIS, a flood intelligence tool, and SLAMDAM, a mobile flood barrier, as effective measures to adapt to climate change by enhancing resilience to (climate change-induced) flooding and drought in Uganda.

## 3. Scope

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### *In scope of this project*

- Flood risks will be analysed using FIS and 3Di.
- SLAMDAM will be deployed during a real-life threat of flooding.
- Capacity building related to climate change and SLAMDAM.

### *Out of scope of this project*

- Implementation of an advanced flood early warning system.
- Providing transportation means to transport SLAMDAM.
- Implementation of an irrigation system.



# Project Overview (2/2)

## 4. Key Requirements

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In order to showcase FIS and SLAMDAM as effective climate adaptive measures that can be scaled-up across Uganda, the technologies must:

- Produce reliable flood scenarios using hydrodynamic modelling.
- Produce analyses on adaptation benefit scenarios.
- Produce readable reports on flood risks and benefit scenarios.
- Effectively prevent flood damages in line with the targets.
- Take little time to build up and dismantle.
- Be able to be reused after dismantling it.
- Be operated by well-trained teams independently.

## 5. Proposed Solution

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The proposed solution is to implement and demonstrate FIS and SLAMDAM as effective measures to adapt to climate change-induced flooding and drought at the Obongi District in Uganda.

## 6. Key Project Deliverables

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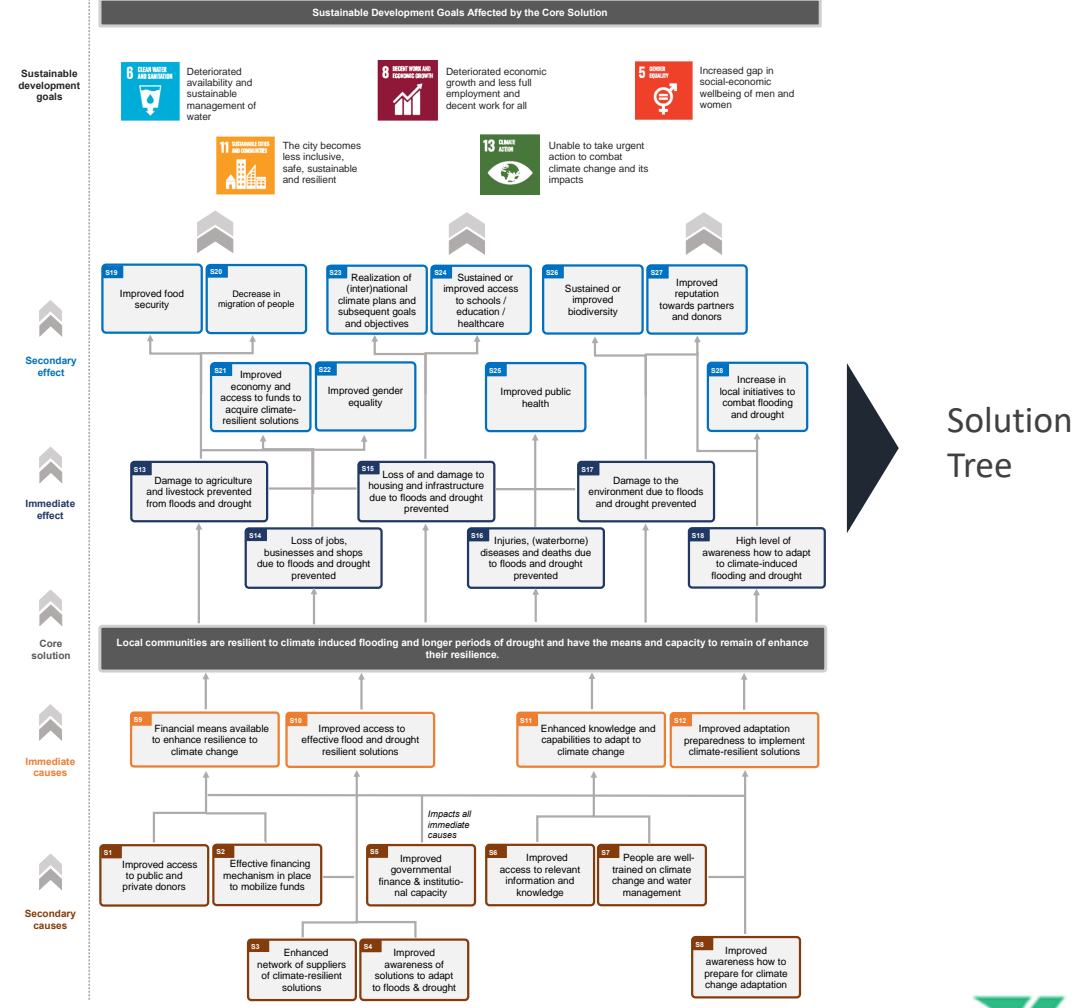
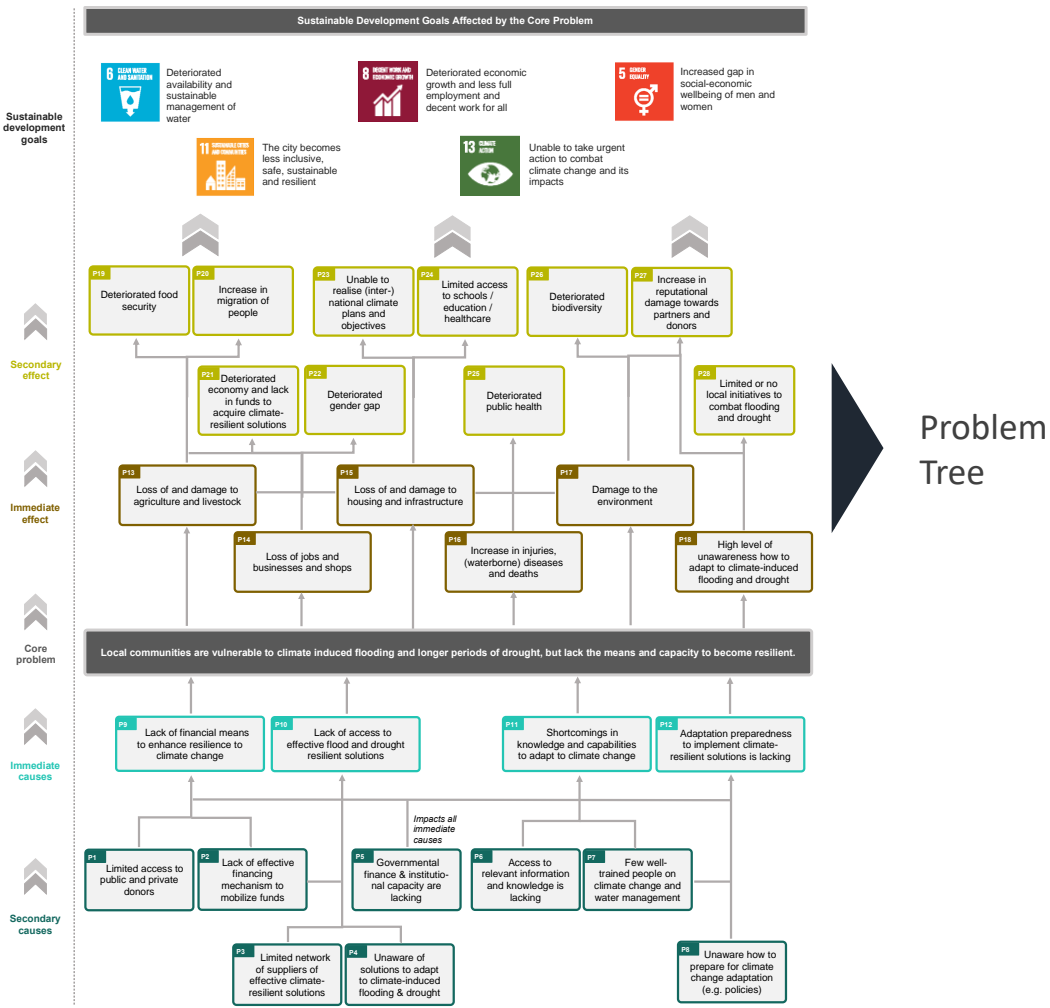
- Flood risk assessment report.
- Flood adaptation benefit report.
- Mobile flood barrier suitable for the pilot location.
- Well-trained people to operate FIS and SLAMDAM.
- Successful demonstration of FIS and SLAMDAM.
- Various Reports (Inception, progress, closure etc.).
- M&E plan and report.
- Roadmap to scale-up SLAMDAM across Uganda.

## 7. Impact Project Result (Key Benefits)

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- Enhanced understanding of flood risks and adaptation benefits.
- Prevented (in)direct / (in)tangible damages caused by flooding.
- Enhanced capabilities of flood response team and community.
- Enhanced resilience to floods.
- ***Contribution to SDGs: 5, 6, 8, 11 and 13***

# Theory of Change





# Project Benefits

Sustainable development goals



Deteriorated availability and sustainable management of water



Deteriorated economic growth and less full employment and decent work for all



Increased gap in social-economic wellbeing of men and women



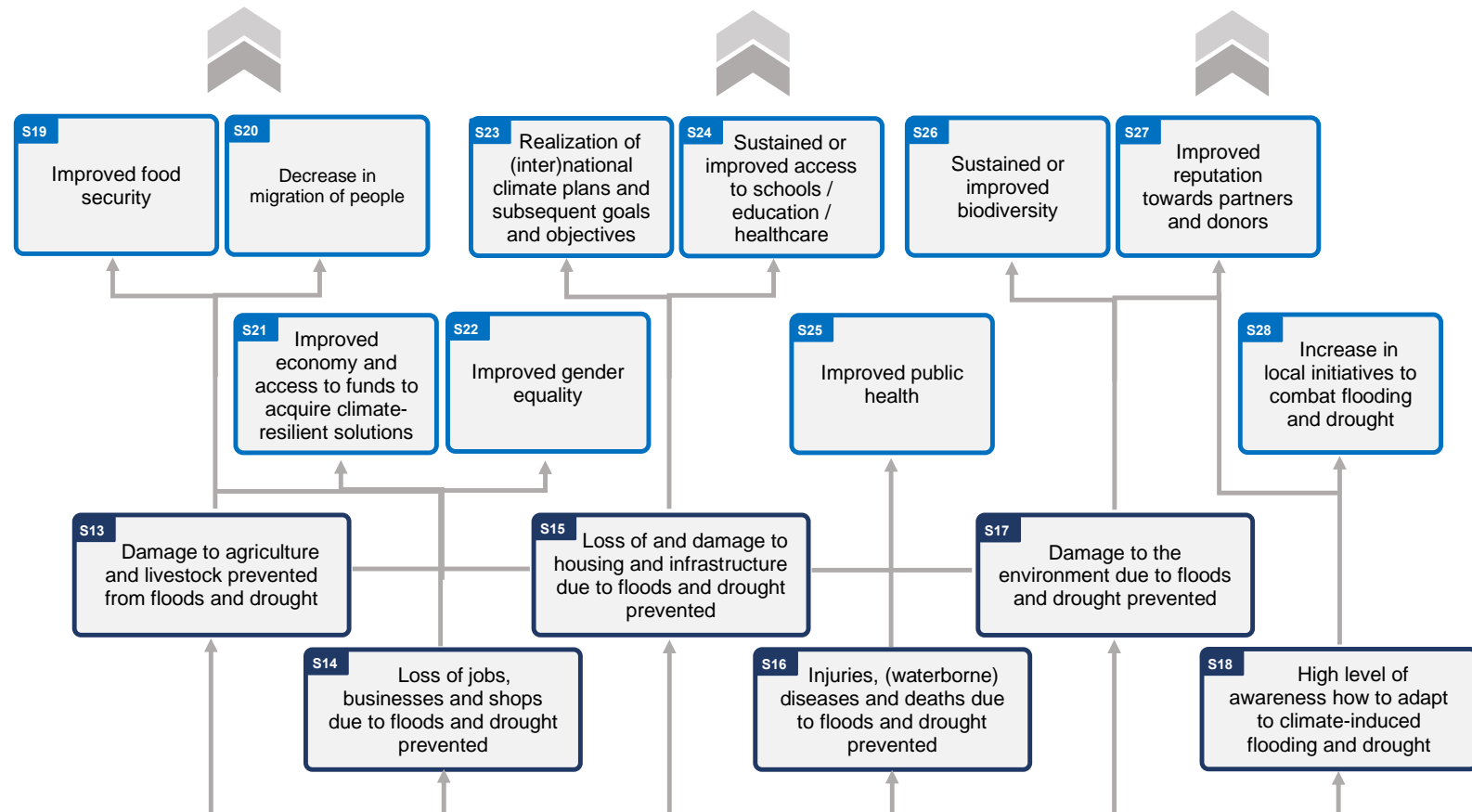
The city becomes less inclusive, safe, sustainable and resilient



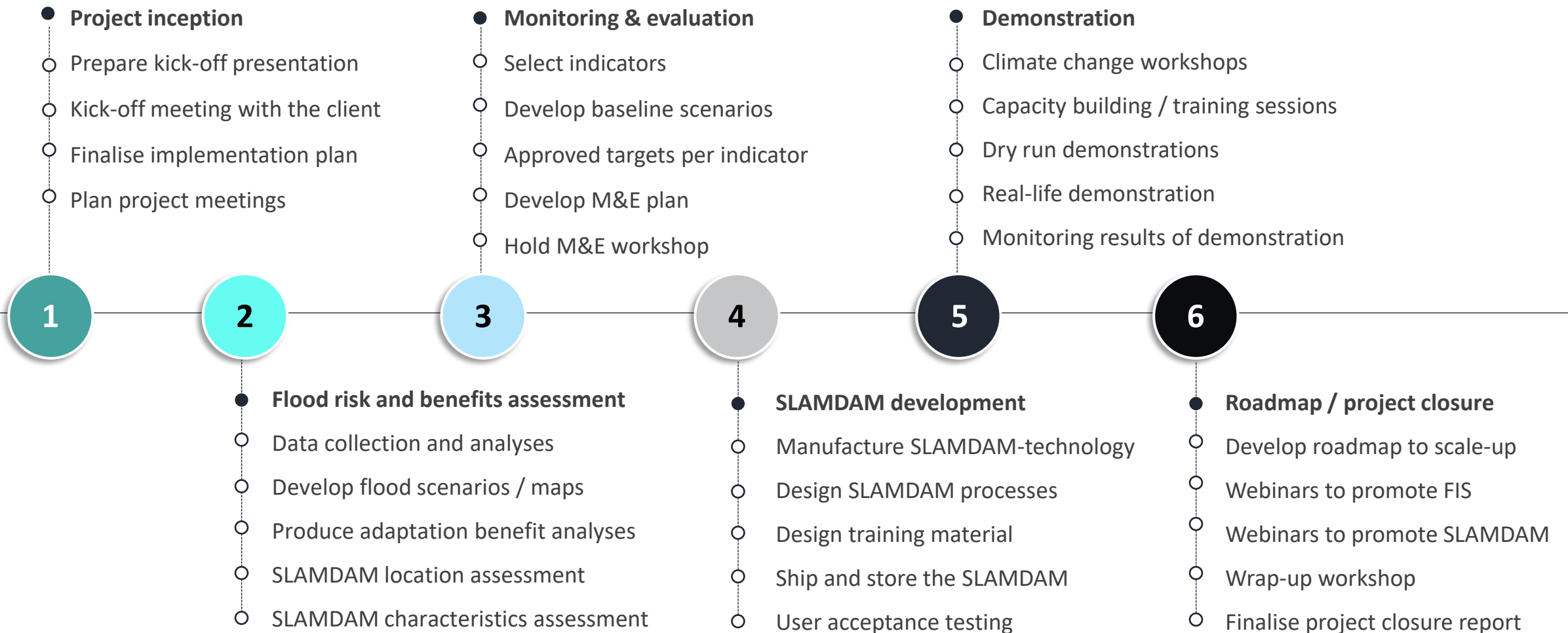
Unable to take urgent action to combat climate change and its impacts

Secondary effect

Immediate effect



# Project Approach



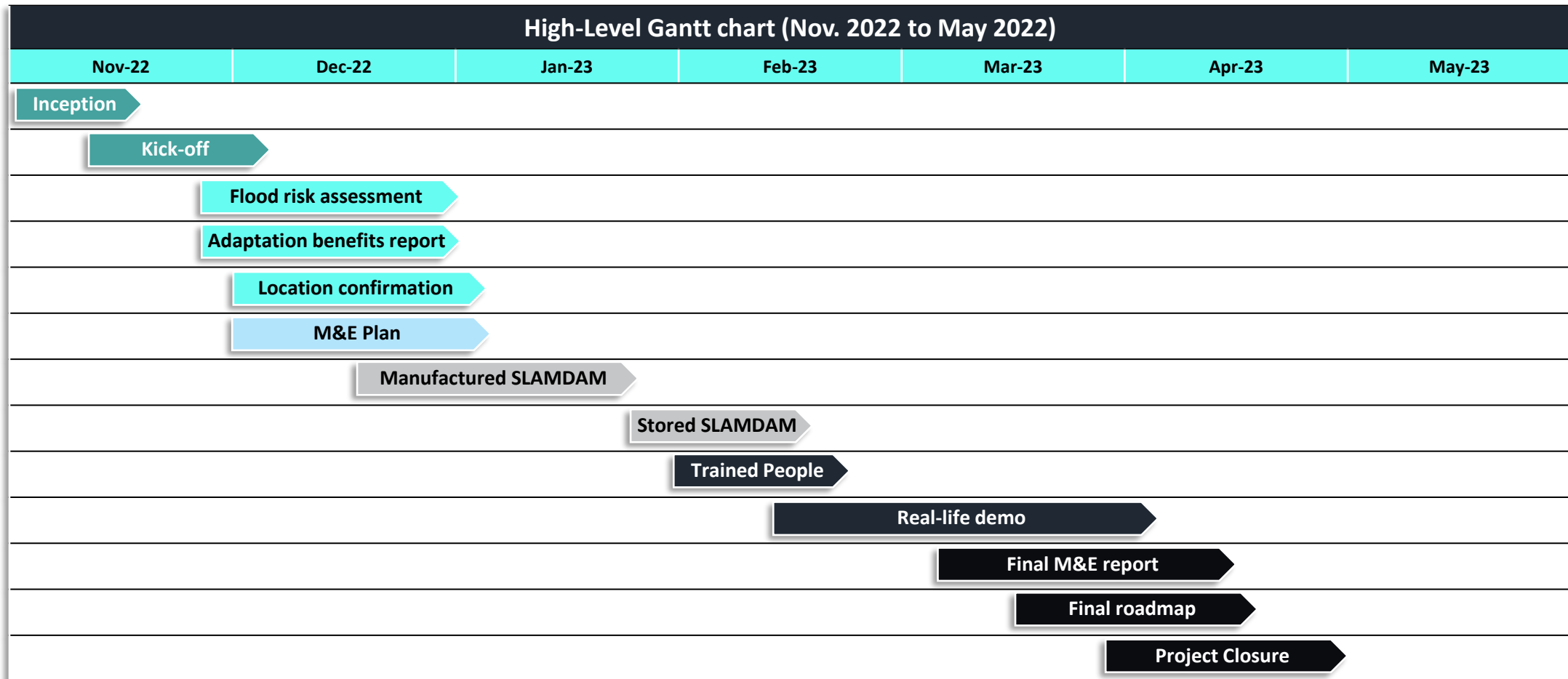


# Key Project Deliverables

Task	Deliverable	Timeline
<b>Phase 1 – Project inception</b>		
Prepare implementation	Project implementation plan	Week 4
Kick-off meeting	Kick-off presentation	Week 4
Prepare M&E plan	M&E plan	Week 5
Stakeholder mapping	A complete stakeholder list	Week 5
<b>Phase 2 – Flood risk and adaptation benefits assessment</b>		
Data exploration	Collected data incl. field visit(s)	Week 8
Store and publish data	Flood scenarios and flood risk maps	Week 10
Develop flood scenarios	Adaptation benefit analyses	Week 10
Flood risk assessment	Workshop flood risk and benefit analyses	Week 11
Flood barrier design	Assessment barrier design and location	Week 11
Local implement. plan	Implementation workshop and final plan	Week 13
<b>Phase 3 – Monitoring and evaluation</b>		
Develop M&E plan	M&E plan: logical framework, ToC etc.	Week 6
Baseline setting	Baseline scenarios	Week 11
Prelim. target setting	Completed logical framework	Week 11
Communication strategy	Communication plan	Week 12

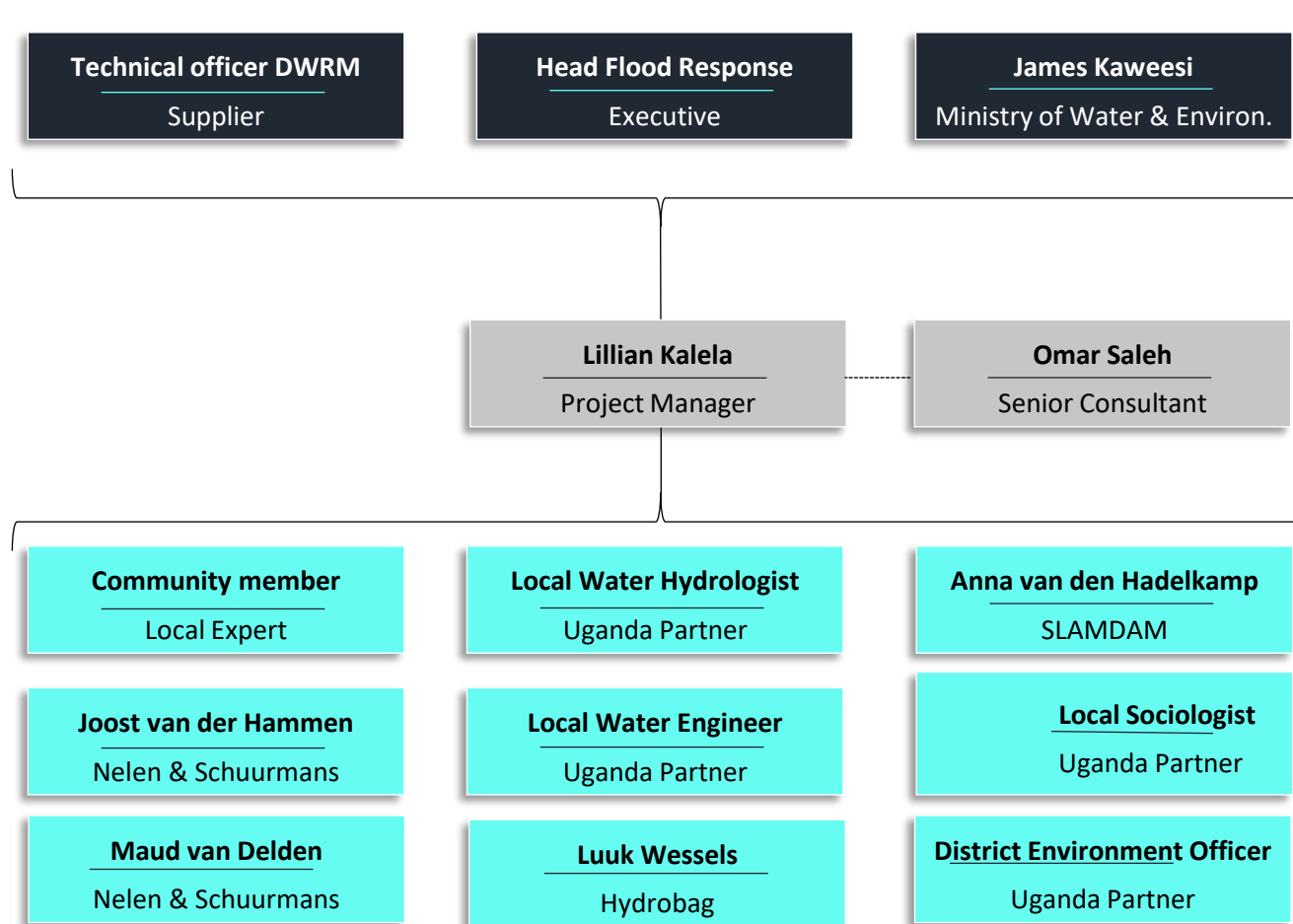
Task	Deliverable	Timeline
<b>Phase 4 – SLAMDAM development</b>		
Manufacture SLAMDAM	SLAMDAM barriers and accessories	Week 12
Ship & store SLAMDAM	SLAMDAM stored in Uganda	Week 17
Design training material	Training material (manual / procedures)	Week 15
<b>Phase 5 – Demonstration</b>		
Climate change workshop	Report outcome workshops	Week 16
Training people/authorities	Training sessions & sign-off document	Week 18
Dry run demonstrations	Report deployment SLAMDAM	Week 18
Stakeholder consultation	Stakeholder workshop and report	Week 18
Real-life demonstration	Recording / report of demonstration	Week 26
<b>Phase 6 – Roadmap and project closure</b>		
Make draft M&E report	Draft M&E report	Week 27
Finalise M&E report	Workshop and final M&E report	Week 28
Prepare roadmap	Draft roadmap to scale-up in Uganda	Week 28
Finalise roadmap	Workshop and final roadmap	Week 29
Project completion	Closure report and lessons learned	Week 30

# Project Planning





# Project Organisation (1/2)



## Steering Committee (meets every 4 weeks)

- Has final responsibility for the outcome of the project
- Ensures coherent steering of the project
- Delegates decisions & tasks effectively
- Convenes once every month

## Project Management

- Is central point for daily lead of the project
- Is responsible for proper project execution
- Ensures collaboration between team members
- Heads project delivery team meeting and guides steering committee meeting

## Project Delivery Team (meets every week)

- Delivers project results according to planning
- Actively collaborates
- Adheres to decisions made by the steering committee
- Convenes once every week

## Project Organisation (2/2)

Project Team's Roles & Responsibilities			
Project Team Member		Role	Responsibilities
1	James Kaweesi	Senior User	Proposed requirements of the outcome of the demonstration project to determine whether the project is successful or not.
2	Technical officer DWRM	Senior Supplier	Is responsible for clear and timely communication with local authorities and companies and the coordination of locally performed activities.
3	Head Flood Response Team	Senior Executive	Is ultimately responsible for a successful outcome of the project and they have significant decision power – supported by the senior supplier and senior user.
4	Lillian Kalela	Project Manager	Is central point for daily lead of the project and is authorised to execute the project on behalf of the steering committee.
5	Omar Saleh	Senior Consultant	Support the project manager
6	Community representative	Project Team	Is responsible for deploying the flood barrier and collecting local data
7	District Environment Officer	Project Team	Is responsible for storage of the flood barrier
8	Maud van Delden	Project Team	Is responsible for hydrological data gathering and supporting software analyses
9	Joost van der Hammen	Project Team	Is responsible for overseeing data-driven flood risk assessment
10	Luuk Wessels	Project Team	Is responsible for evaluating suitability of SLAMDAM for the pilot location
11	Anna van den Hadelkamp	Project Team	Is responsible for designing and manufacturing the SLAMDAM-technology
12	Local hydrologist	Project Team	Is responsible for data gathering and using FIS
13	Local Water Engineer	Project Team	Is responsible to monitor any water environment issues that might arise from project
14	Local Sociologist	Project Team	Is responsible for monitoring the effects of the project on community

# Project Risks (1/2)

1. Key Risks						
#	Risk description	Chance	Impact	Mitigation	PTA	Due date
R1	<ul style="list-style-type: none"> <li>Risk that the selected pilot location is not suitable for the SLAMDAM-technology.</li> </ul>	M	C	<ul style="list-style-type: none"> <li>Urgently collect flood data to assess whether SLAMDAM is a suitable measure and use SLAMDAM suitability matrix.</li> <li>Find other suitable locations in case the initial location is deemed not suitable.</li> </ul>	T.b.d.	T.b.d.
R2	<ul style="list-style-type: none"> <li>Risk that there is no flood during the demonstration.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Ensure we have the best location to do the demonstration i.e. <b>highest chance of flood</b></li> <li>Have close conversations with local stakeholders to help select the proper location</li> <li>Plan an option to simulate a flood event</li> </ul>	T.b.d.	T.b.d.
R3	<ul style="list-style-type: none"> <li>Risk that SLAMDAM works but doesn't save a lot of houses / people to meet the targets.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Ensure we have the best location to do the demonstration i.e. <b>highest estimated damages using FIS</b></li> </ul>	T.b.d.	T.b.d.
R4	<ul style="list-style-type: none"> <li>Risk that we don't see the floods ahead of time.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Ensure adequate flood forecasting is in place</li> </ul>	T.b.d.	T.b.d.
R5	<ul style="list-style-type: none"> <li>Risk that staff locally cannot operate FIS or SLAMDAM timely and adequately.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Have a training program for people and authorities who need work with FIS and SLAMDAM</li> <li>Create processes / manuals / procedure / working instructions and visual aids</li> </ul>	T.b.d.	T.b.d.

## Project Risks (2/2)

### 1. Key Risks

#	Risk description	Chance	Impact	Mitigation	PTA	Due date
R6	<ul style="list-style-type: none"> <li>Risk that FIS or SLAMDAM don't work effectively to enhance resilience to flooding.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Make a detailed description of the problem situation (previous floods, surroundings, houses, people etc.)</li> <li>Ensure SLAMDAM is designed to help with the anticipated flood situation</li> </ul>	T.b.d.	T.b.d.
R7	<ul style="list-style-type: none"> <li>Risk there is insufficient financing for the project.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>Budget the costs for this project</li> <li>Get co-financing from The Netherlands and other parties</li> </ul>	T.b.d.	T.b.d.
R8	<ul style="list-style-type: none"> <li>Risk that there is not enough water available to fill the dams.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>See mitigation R1</li> </ul>	T.b.d.	T.b.d.
R9	<ul style="list-style-type: none"> <li>Risk that there is no appropriate infrastructure and equipment to position the dams in case of a flood.</li> </ul>	M	H	<ul style="list-style-type: none"> <li>See mitigation R1</li> </ul>	T.b.d.	T.b.d.
R10	<ul style="list-style-type: none"> <li>Risk there is a significant delay due to obstructions when transporting flood barrier to Uganda caused by excessive bureaucracy</li> </ul>	H	H	<ul style="list-style-type: none"> <li>Plan the shipment well in advance and identify all requirements to transport and clear the goods</li> <li>Manufacture and ship the goods as early as possible by not waiting till the final outcome of the risk assessment. Instead, start manufacturing when we already have a certain degree of certainty of the length and height of the barrier.</li> </ul>	T.b.d.	T.b.d.



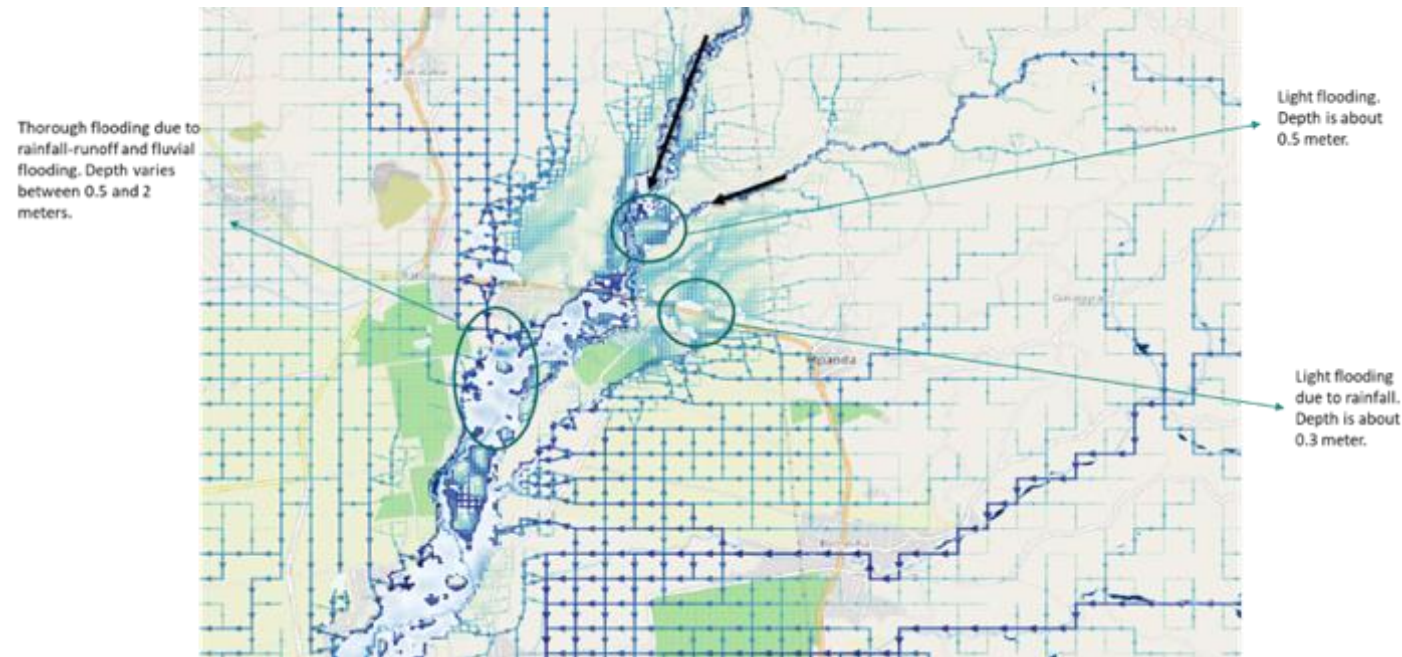
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# *Appendices*



# Data-driven analysis to study flood and drought risks

- › Field studies and state-of-the-art hydrodynamic modeling software allowed us to understand flood risks and how to enhance resilience to these risks using SLAMDAM.



*Figure: severity of flooding in Gahwazi*



## Pictures of the demonstration of SLAMDAM at Bujumbura in Burundi



*Figures: Various pictures when SLAMDAM was deployed at the project location at Bujumbura in Burundi*



## Pictures of SLAMDAM being used to enhance resilience to drought in Burundi



*Water is stored vapor tight in SLAMDAM and can be used during dry season*



## Selection suitable location

- › Field visits helped the project understand the flood scenarios and where SLAMDAM would be a suitable solution.



*Figures: Various pictures of the possible locations where SLAMDAM could be deployed*

## Pictures of the demonstration of SLAMDAM at Passu in Gilgit-Baltistan



*Figures: Various pictures when SLAMDAM was deployed at the project location at Passu in Pakistan*

# **Supervision Report**

Enhancing Resilience to Climate-Induced Flooding and Drought through the Deployment of a  
Water-Filled Barrier in Obongi District in Northern part of Uganda

**Ministry of Water and Environment**  
**Adaptation Fund Implementing Entity (NIE)**  
**P.O box 20026**  
**Kampala**

**Zephyr Consulting Limited,**  
**Executing Entity**  
**Netherlands**

**January, 2023**

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### Executive Summary

#### **1. Introduction**

##### **1.1 Context**

Climate and Hydrology

Climate change in Uganda

##### **1.2 Uganda Flood Strategy**

##### **1.3 Objectives**

About SLAMDAM and FIS

Study Area

- i. Upper Nile Management zone (climate)
- ii. Albert Nile (climate, hydrology, catchment)

Significance

- iii. Current flood/drought challenges

Objectives of the project

- iv. Mobile barriers
- v. Flood and drought risk assessment
- vi. FRT

Involved parties and funding

#### **2. Flood Risk Assessment**

Objective

- i. FRA
- ii. determine potential site
- iii. proposed FEWS/FRT

Flood and drought risk assessment, including lead time (for each sub catchment describe/visualize the field visit, validation session i.c.w. 3Di modeling and data sources)

- iv. General overview of locations
- v. Waka
- vi. Yachinemiji
- vii. Elgeu

Potential Sites SLAMDAM and expected benefits, summarize in multicriteria analysis

- viii. Waka
- ix. Yachinemiji
- x. Elgeu

Proposed FEWS (data sources, lead time, FRT)

- xi. Waka
- xii. Yachinemiji
- xiii. Elegu

#### **3. Recommendation and Conclusion**

Site selection SLAMDAM



when to deploy SLAMDAM  
data/model improvement

**4. *Next Steps/Way Forward***

Configure FRT and FEWS

**5. *Next Field Visit***

[Annexes](#)

## Executive Summary

The Ministry of Water and Environment as a National Accredited Implementing Entity (NIE) for Adaptation Fund is implementing a project on Enhancing Resilience to Climate-Induced Flooding and Drought through the Deployment of a Water-Filled Barrier in Obongi District in collaboration with the Zephyr Consulting Limited FZCO the Executing Entity (EE). The project is funded by the Adaptation fund under the Small Innovation Grant and will be executed within six months.

The project objective is to increase the resilience of communities to the risk of floods and droughts in a district through flood intelligence software and the deployment of a scalable water-filled barrier (SLAMDAM) to prevent flooding and simultaneously store and harvest water. The flood intelligence software piloted at the Obongi District to assess the impact of climate change-induced flood and drought events and the anticipated benefits from resilient solutions such as a mobile flood barrier is a new innovation tool. It can be used all over Uganda and at different levels and can benefit when more local communities / hydrological departments use the tool.

The Obongi district was identified as one of the prone districts to flooding, in 2020 More than 23,000 residents of Obongi District in West Nile were displaced from their homes as the sub-region experienced severe flooding caused by rising River Nile waters. It is envisaged that once the project is successfully implemented in northern Uganda, it will be scaled-up to other flood prone areas especially in the west and eastern parts of Uganda. It should be noted that the adaptation activities do not only increase the resilience of ecosystems and agricultural production systems to the risk of floods, but also enhance the food security and the livelihoods in the project area during drought seasons.

This is the first supervision report on the “Enhancing Resilience to Climate-Induced Flooding and Drought through the Deployment of a Water-Filled Barrier in Obongi District” project. The mission was composed of consultants from Zephyr Consulting Limited namely; Omar Saleh (Team Leader), Ms. Maud van Delden (Hydrologist), Ms. Lillian Kalela (Project Manager), Mr. James Kaweesi (Assistant Commissioner, MWE), Mr. Richard Musota (Principal Water Officer, UNWMZ), Mr. Robert Bogere (Senior Hydrologist, WMZ-North) and Mr. Dominic Ilenya Deo ( DWO-Obongi District).

The purpose of the mission was three fold;

- i) To validate the flood extents of the proposed areas as were produced from the 3Di hydraulic model.
- ii ) To select the best demonstration site for the SLAMDAM technology
- (iii) To carry out the feasibility study of the flood control in Obongi town proposed project area and ascertain the suitable site for the project
- (IV) To engage with national and regional stakeholders;

During the visits, the team interacted with the CAO Obongi, the deputy CAO in charge of production in the district, the Obongi Town Council, the Mayor, Elegu Town Council, and community representatives. The results of the field visit and hydrological analyses are included in this risk assessment report. The report reflects the flood risk characteristics and a decision matrix that justifies the next actions in the project such as the deployment of SLAMDAM.

Prior to the field visit, the mission team held a half day meeting with technical staff of the MWE, on 9<sup>th</sup> January 2023, to brief on the project objectives and its benefits. The team visited flood hotspots of Obongi Town Council , Waka, Yachinemij, Foligo in Obongi district and Elegu Town Council in Amuru district. At each of these hotspots, the project and implementation modalities of the project activities was discussed with the relevant district political leaders, technical staff, and direct project beneficiaries.

At the end of the mission, a technical wrap-up meeting chaired by Mr. Richard Musota on 12th January 2023 was held during which the findings of the field trip were discussed and a way forward was reviewed and agreed upon. The team held a debriefing meeting with the Permanent Secretary MWE, Mr. Alfred Okot Okidi.

## Context

Climate change has greatly impacted Uganda's rainfall intensities over the years. The country has been experiencing increased frequency and severity of extreme weather events. Some of these events include erratic heavy rainfalls. Increased intensity of heavy rainfall has led to greater impact of floods and are causing more damage due to expanded infrastructure, human settlement and general development of the country. Uganda experiences both flash floods and slow-onset floods, which are common in urban areas, low-lying areas, areas along river banks and swamplands.

The SLAMDAM-technology is a flood prevention measure that can effectively control the flow of flood water and protect communities from devastating flood events. In addition, SLAMDAM can be used as a water storage facility to harness flood-/rainwater. The SLAMDAM-technology has significant benefits for people and the environment:

1. Environmental: SLAMDAM conserves water resources and reduces the risk of water-related environmental problems such as soil erosion and groundwater depletion.
2. Social: SLAMDAM will help improve the livelihoods of communities and farmers by enhancing food and water security. This will contribute to poverty reduction and improved health and well-being.
3. Economic: Improved food and water security will help to boost agricultural productivity and food production, which will contribute to economic growth and job creation.

The mobile flood barrier will be implemented together with the Flood Intelligence Software (FIS) tool to determine the costs and benefits of the SLAMDAM implementation in the Obongi District, Uganda. FIS conducts a comparative analysis between a flood event without and with one or more flood resilient measures. The difference in damages are the anticipated adaptation benefits from the implementation of flood resilience measures at a particular location.

The project components and expected results include the following;

Project Component	Expected Results
Assessment of flood and drought risk profile and anticipated benefits from flood resilient solutions using innovative intelligence software	<ul style="list-style-type: none"> <li>Appropriate Flood and drought risks response strategy and framework developed</li> </ul>
The development and implementation of the SLAMDAM-technology to manage the identified flood and drought risks effectively	<ul style="list-style-type: none"> <li>Flood and drought risks are managed at the Obongi District using the developed SLAMDAM-technology</li> </ul>

Developing and strengthening climate change adaptive capacities of institutions and communities	<ul style="list-style-type: none"> <li>Community having an increased understanding of the root cause and impact of climate change up skilled</li> <li>Adaptive capacity of communities and other stakeholders to climate change impacts by using the SLAMDAM-technology strengthened</li> </ul>
Promoting the SLAMDAM-technology as an effective climate-resilient measure	<ul style="list-style-type: none"> <li>Adaptation benefits mechanism for climate resilient technology strengthened</li> <li>Resilience to floods and droughts using a scalable innovative climate adaptive solution increased</li> </ul>

### ***Findings and recommendation***

In Obongi district, three locations were considered vulnerable to flooding regularly i.e., Waka, Foligo, and Yachinemiji. The fourth equally vulnerable location was identified in Elegu Town Council in Amuru district close to the border of South Sudan. A flood risk assessment for the proposed project SLAMDAM Uganda was undertaken following the field/site visit as recommended by the project team.

All the proposed project sites were subjected to a decision matrix to confirm the most feasible site to deploy SLAMDAM. The decision matrix was based on four independent criteria, namely’;

- i. Suitability of the SLAMDAM in relation to its surroundings,
- ii. Effectiveness of the SLAMDAM in decreasing flooding,
- iii. Impact of the SLAMDAM, and
- iv. Presence of a flood response team (FRT).

Based on the above criteria, completing the decision matrix led to the conclusion that the Waka area was the most suitable site to deploy SLAMDAM as part of this project. It was further observed that the Elegu area is equally prone to severe floods and would benefit greatly from project interventions to mitigate the risk of floods. However, the pilot project in Obongi District doesn’t have enough resources to implement another SLAMDAM at the Elegu area to mitigate flood risks adequately. The Permanent Secretary, MWE suggested writing a proposal to scale-up similar interventions and build resilience to floods at the Elegu area considering the associated socio-economic benefits to the communities in that area.

In conclusion, the team recommends the pilot project to be executed in the Waka area while Elegu area as sites for the proposed upscale project in future. Specifically, the team will first develop an adaptation benefits report using the FIS tool for the Elegu area followed by a proposal to mitigate flood risks at Elegu.

# 1.Introduction

## 1.1 Context

Uganda is a landlocked country that occupies a total area of 241,038km. Agriculture is a critical part of Uganda's economy; it accounts for 25.8% of Gross Domestic Product (GDP), employs 72% of the population and accounts for over 50% of total export.

Uganda lies within a relatively humid equatorial climate zone, but the topography, prevailing winds and water bodies cause large differences in rainfall patterns across the country.



Map of Uganda

## Uganda Climate and Hydrology

Uganda is a landlocked country located in East Africa, bordered by South Sudan to the north, Kenya to the east, Tanzania to the south, Rwanda to the southwest, and the Democratic Republic of the Congo to the west. The climate and hydrology of Uganda are strongly influenced by its location near the equator and its varied topography.

**Climate:** Uganda has a tropical climate with two distinct seasons. The dry season, from December to February and from June to August, is characterized by low humidity, clear skies, and warm temperatures. The wet season, from March to May and from September to November, is characterized by heavy rainfall, high humidity, and cooler temperatures. The amount of rainfall varies depending on location and altitude, with the highest rainfall occurring in the western and central parts of the country. The average temperature in Uganda is around 26 degrees Celsius, with some regional variation due to altitude.

**Hydrology:** Uganda is a water-rich country with numerous lakes, rivers, and wetlands. The country is home to the largest lake in Africa, Lake Victoria, which is shared with Kenya and Tanzania. Lake Victoria is a major source of water for the country, supplying the majority of the water used for domestic and agricultural purposes. The Nile River also flows



through Uganda, providing additional water resources. Other significant rivers include the Kagera, the Murchison, and the Semliki.

Uganda has a high potential for hydropower generation, and there are several hydroelectric power stations located in the country, including the Owen Falls Dam and the Kiira Dam. However, access to clean water remains a challenge for many Ugandans, particularly in rural areas where water sources may be contaminated or unreliable.

In summary, Uganda has a tropical climate with two distinct seasons and a varied topography that influences local weather patterns. The country is water-rich, with numerous lakes, rivers, and wetlands, and has a high potential for hydropower generation. However, access to clean water remains a challenge for many Ugandans.

Four of East Africa's Great Lakes--Lakes Victoria, Kyoga, Albert and Edward lie within Uganda or on its borders. Lake Victoria dominates the southeastern corner of the nation, with almost 10,200 km<sup>2</sup> lying inside the Ugandan territory. Similarly, substantial amounts of groundwater are in aquifers found in rocks at different depths below the ground surface. Occurrence of water resources depends principally on the rainfall pattern, topographic and geological conditions among other factors. Thus, surface and groundwater resources of Uganda are not uniform both in space and time due to changes in the factors that determine their occurrence.

Currently, there is a regional level top-down framework through which water resources are managed and developed. Uganda is made up of 8 hydrological basins (Figure 1) each with different catchments. Based on the 8 basins, Uganda has been divided into four Water Management Zones (WMZs) namely Victoria, Albert, Kyoga and Upper Nile WMZs (Figure 2). WMZ offices are operational in the 4 WMZs. WMZs are permanent operational arrangements for effective water resources management and development in Uganda. The main purpose of the WMZs is to de-concentrate WRM services closer to where action is needed. Currently 17 catchments have been demarcated in Uganda where integrated planning, development and management of water and related resources will be undertaken. This helps to mobilize local community and other stakeholders' efforts to achieve catchment based IWRM and ensure effective coordination with other water resource related activities being implemented at district level such as environment, forestry and water supply.

Although Uganda is considered well-endowed with water resources, these resources exhibit both seasonal and spatial variability. The Water resources in Uganda are stored in both open and underground reservoirs. Nearly one-fifth of the total area of Uganda, or 44,000 km<sup>2</sup>, is open water or swampland implying that the country is fairly well endowed with surface water resources.

Four of East Africa's Great Lakes--Lakes Victoria, Kyoga, Albert and Edward lie within Uganda or on its borders. Lake Victoria dominates the southeastern corner of the nation, with almost 10,200 km<sup>2</sup> lying inside the Ugandan territory. Similarly, substantial amounts of groundwater are in aquifers found in rocks at different depths below the ground surface. Occurrence of water resources depends principally on the rainfall pattern, topographic and geological conditions among other factors. Thus, surface and groundwater resources of Uganda are not uniform both in space and time due to changes in the factors that determine their occurrence.

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According to the Water Resources analysis which was made in the Aswa Catchment Management Plan 2021, the sub-catchments have a generally very low rate of gross water demand compared to water resources. However, the projected water uses and demand from different economic sectors

Agago sub catchment shows a water deficit due to the impacts of climate change hence this calls for a holistic integrated Management of the water Resources in the sub catchment

### ***Climate change in Uganda***

Climate change has also greatly impacted the country's rainfall intensities over the years. The country has been experiencing increased frequency and severity of extreme weather events. Some of these events include erratic heavy rainfalls.

Increased intensity of heavy rainfall has led to greater impact of floods and are causing more damage due to expanded infrastructure, human settlement and general development of the country.

Uganda experiences both flash floods and slow-onset floods, which are common in urban areas, low-lying areas, areas along river banks and swamplands.

According to a World Bank report published in 2020; each year floods impact nearly 50,000 Ugandan people and cost over \$62 million in damages.

Areas most prone to floods are the capital city, Kampala, as well as the northern and eastern areas of the country.

Obongi District is one of the areas in the northern area of Uganda that has been experiencing devastating floods. The complete district has 50,000+ inhabitants divided over 3 sub counties, 14 Parishes and 60 villages.

In 2020 more than 23,000 residents of Obongi District in West Nile were displaced from their homes as the sub-region experienced severe flooding caused by rising River Nile waters. This left Obongi Landing Site and the Liri Trading Centre, Namisambya Town East and Kilamin village neighboring Obongi Landing Site as well as parts of Palorinya refugee settlement camp were among the affected parts by the floods.

Data from the Adjumani District disaster management committee indicates that Okusijoni and Arinyapi sub-counties were the worst hit while thousands of residents in Pakele and Dzaipi sub-counties struggle to cope with the floods after Tete River that drains into the Nile River burst its bank.



*Floods victims in Obongi after river Nile burst its banks:  
(File Photo courtesy of **THE INDEPENDENT**)*

The whole of Obongi District is flood prone; however, there are hotspots that are least prepared for and most affected by the floods.

## **1.2 Uganda Flood Strategy**

The Uganda flood strategy aims to reduce the impacts of floods and improve resilience in vulnerable communities. The strategy involves a multidisciplinary and integrated approach, encompassing various sectors such as early warning systems, infrastructure development, health, and livelihoods. The goal is to improve preparedness and response to flood events, as well as reduce the vulnerability of communities to future floods.

The strategy includes the development of early warning systems, such as flood forecasting and risk assessment, to provide timely information to communities and local authorities. Additionally, there is a focus on infrastructure development, including the construction of flood protection structures, such as embankments and drainage systems, to reduce the impacts of floods.

The strategy also addresses health issues related to floods, such as the spread of water-borne diseases, and aims to improve access to safe drinking water and sanitation facilities. Livelihoods support is another crucial aspect of the strategy, including measures to help communities recover from the impacts of floods and build resilience to future events.

Overall, the Uganda flood strategy is designed to be flexible and adaptable to changing circumstances, and seeks to bring together a range of stakeholders, including government agencies, NGOs, and local communities, to implement effective and sustainable solutions.

### 1.3 Objectives

Project SLAMDAM Uganda seeks to provide a mobile flood barrier as a flood mitigation measure to the people of Obongi district. The overall goal of the project is to strengthen resilience and reduce vulnerability of communities to the risk of climate change-induced floods and droughts within the Obongi District through data-driven risk analyses and the deployment of a scalable water-filled barrier to prevent flooding and optionally store and harvest water that will be repurposed for a drought event.

The specific objectives of the project are to:

1. Demonstrate the effectiveness of FIS to enhance resilience to floods
2. Demonstrate the effectiveness of SLAMDAM to enhance resilience to floods
3. Generate awareness and capacity building

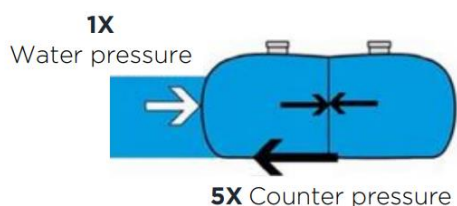
#### **About SLAMDAM and FIS**

SLAMDAM-technology is an innovative and low-cost technological solution developed in conjunction with the University of Delft in the Netherlands to enhance resilience against floods. The product is movable water-filled flood barrier, which can easily be deployed as soon as there is a threat of flooding and that can also easily be dismantled when the flood risk has subdued.

#### **SLAMDAM is an easily deployable water-filled barrier to effectively prevent flooding**

##### **Design and Material**

- SLAMDAM is made of EPDM (flexible rubber)
- SLAMDAM consists of two compartments
- Standard models or tailor-made



##### **Unique Selling Points**

- |                             |                    |
|-----------------------------|--------------------|
| ✓ Easily deployed*          | ✓ 100% recyclable  |
| ✓ Lifespan 50+ years        | ✓ Multi-functional |
| ✓ Effective (TUV-certified) | ✓ Easy to use      |



*Deployment of the mobile flood barrier the pilot project in Burundi in 2022*

The mobile flood barrier will be implemented together with the Flood Intelligence Software (FIS) tool to determine the costs and benefits of the SLAMDAM implementation in the Obongi District, Uganda.

The Flood Intelligence Software (FIS) is a tool developed by Nelen & Schuurmans for Zephyr Consulting. It was launched in August 2022 and this project is one of the first projects which uses this tool. With the water depth distribution from 3Di hydrodynamic model one can calculate in the FIS Tool the amount of damages and casualties a flood has on a certain area. These 'Initial' damages can be divided in the following subjects:

- Residential damage
- Agricultural damage
- Affected people (number of people)
- Affected residential area (in m2)
- Affected agriculture area (in m2)

Next to calculating the amount of Initial damages, one can also measure damages of the same area when a mitigation measure has been implemented for example SLAMDAM.

This pilot project has been funded by Adaptation Fund, is being implemented by the Uganda Government through the Ministry of Water and environment (MoWE) and executed by Zephyr Consultants Limited, which leads the project management and coordinates the execution of the project activities.

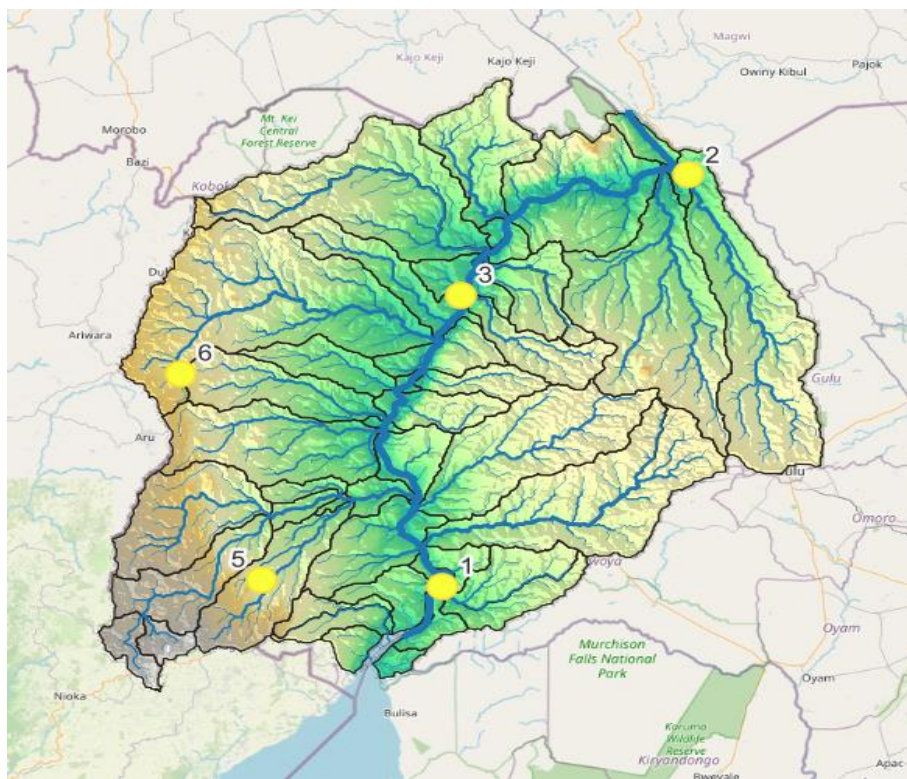
A team from Zephyr Consultants Limited and their partner Nelen and Schuurmans visited Uganda to conduct the first field mission of the project. The consultants' team during the mission was composed of Ms. Lillian Kalela, Project Manager and Mr. Omar Saleh, Senior Project Consultant and Ms. Maud van Delden, Lead Hydrologist. The consultants' team worked in



close collaboration during the field mission with the Uganda project team; Mr. James Kaweesi, Mr. Richard Musota and Mr. Robert Bogere.

The objectives of the field mission were to: (i) visit possible SLAMDAM deployment locations in Obongi district (ii) confirm SLAMDAM deployment location (iii) confirm and collect data needed for the FIS tool (iv) evaluate the current progress of the project, constraints encountered and corrective measures (v) Courtesy and progress meetings with Uganda PS MoWE and the project team.

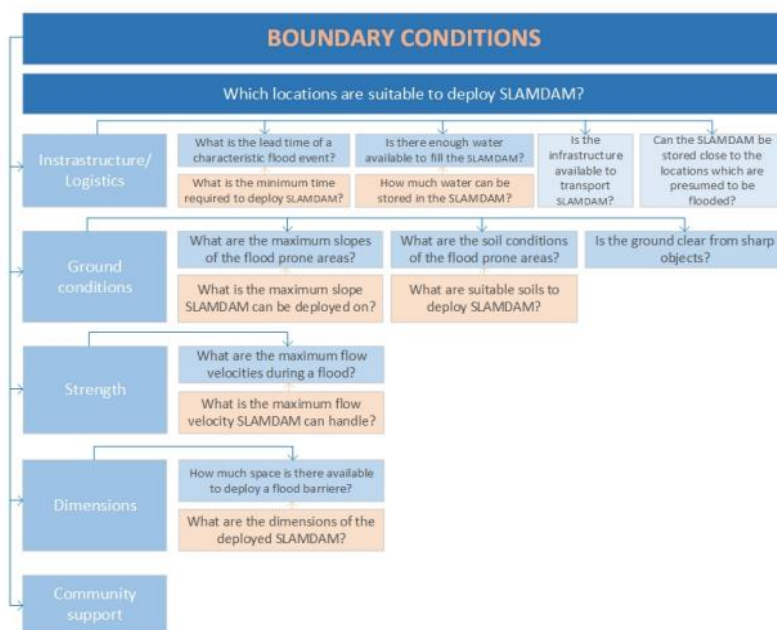
To achieve the objectives of the mission, the team used formulated questions during the field sessions to collect relevant data; (i) socioeconomic (ii) boundary conditions for SLAMDAM (because besides the classic benefits of the deployment of SLAMDAM the effectiveness and feasibility of deployment of the dam needs to be investigated prior to deployment). From the initial hydrodynamic modeling prior to the site visits, five possible locations for the deployment of the SLAMDAM were selected as seen in below figure.



These sites were visited. Further to the location visits, the type of rain event, the depth of the flood water and the type of land was factored in.

The boundary conditions as shown in the image below for the SLAMDAM together with the site investigation provided an insight on whether the deployment is really possible on the proposed locations.





This debrief report discusses the sites visited, the main observations/results and recommendations made by the field mission team and integrates comments and proposals made by all the stakeholders interviewed.

### Study Area

Obongi is a district located in the Northwest of Uganda, about 20 km South to the border of South Sudan and 50 km to the East of Democratic Republic Congo. The region in the north is home to refugees as well as to transboundary tribes. The district headquarters are Obongi, located along the White Nile and is part of the greater Albert Nile catchment. This Chapter describes the relevant hydrological institutions, the hydrology of the Albert Nile catchment, and the Obongi sub-catchment.

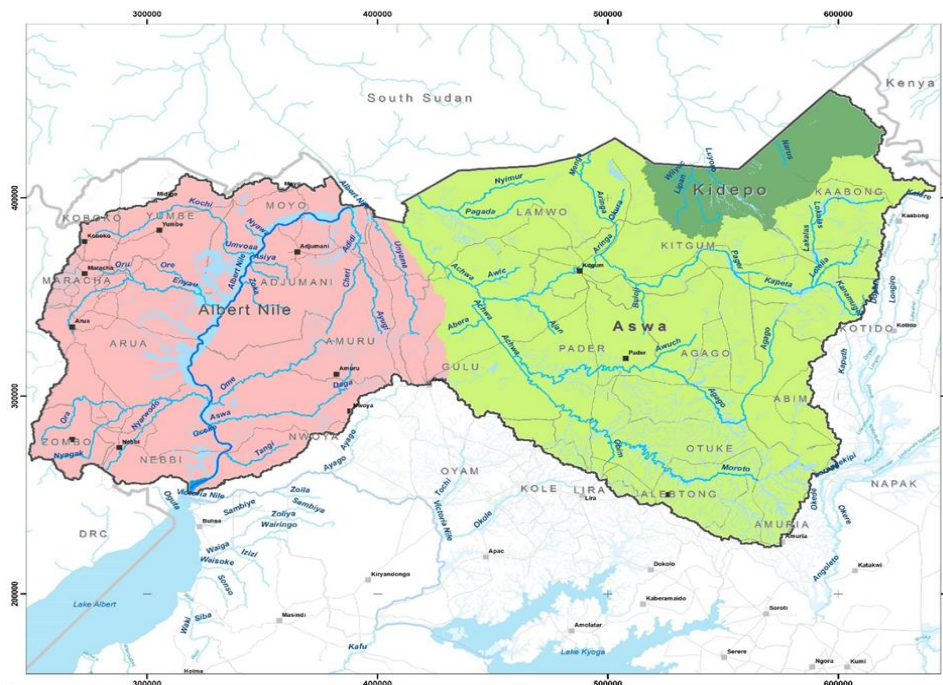
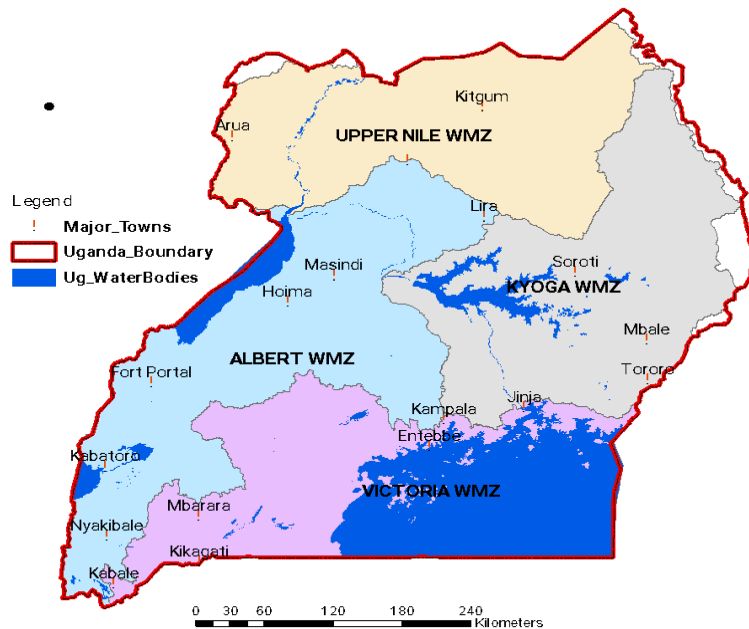
### Water Resource Management in Uganda

Although Uganda is considered well-endowed with water resources, these resources exhibit both seasonal and spatial variability. The Water resources in Uganda are stored in both open and underground reservoirs. Nearly one-fifth of the total area of Uganda, or 44,000 km<sup>2</sup>, is open water or swampland implying that the country is fairly well endowed with surface water resources.

The ministry of Water and Environment has the overall responsibility of development, management & regulation of water and environment resources in Uganda. Four separate Water Management Zones (WMZ) consist within the ministry, to know:

- 1) Albert Water Management Zone (AWMZ) : Fort Portal
- 2) Kyoga Water Management Zone (KWMZ) : Mbale
- 3) Upper Nile Water Management Zone (UNWMZ) : Lira
- 4) Victoria Water Management Zone (VWMZ) :Mbarara

The Upper Nile Water Management Zone has an approximate Area of 50,000 km<sup>2</sup>, hence encompasses almost entirely Northern Uganda. In total, 26 districts are present with a total population of 4.83 million people. The three major catchments in the Upper Nile Water Management Zone are Aswa, Albert Nile, and Kidepo. Extensive wetland systems are present along the banks of the Albert Nile and the Aswa rivers for the Albert Nile and Aswa catchment respectively. The wetlands have a permanent as well as a seasonal component. The catchments ultimately contribute to flow northwards to South Sudan.



## Hydrology of Albert Nile catchment

## Climate

The UNWMZ generally experiences a main rainy season in the months from May to October with average annual rainfall ranging from below 600 mm in the eastern portion of the Karamoja region to 1000 – 1200 mm along the course of Albert Nile, reaching highest values (1400 – 1600 mm) in the central part of the zone. See Figure 1, left. The monthly values of minimum daily temperature vary from 16 to 20 °C, See Figure 1, right, with maximum daily temperature range between 28 and 34 °C during the year. Due to high temperatures, high evaporation rates have a marked effect on the hydrology and use of water resources within the zone. Potential evaporation rates almost linearly decrease from 1800 to 1300 mm/year from East to West of Upper Nile WMZ. Only in a small zone in the southwestern part of Upper Nile WMZ (Zombo district) annual rainfall exceeds potential evaporation. The high rates of evaporation reduce runoff, groundwater recharge and dry season flows, while they increase drought risks.

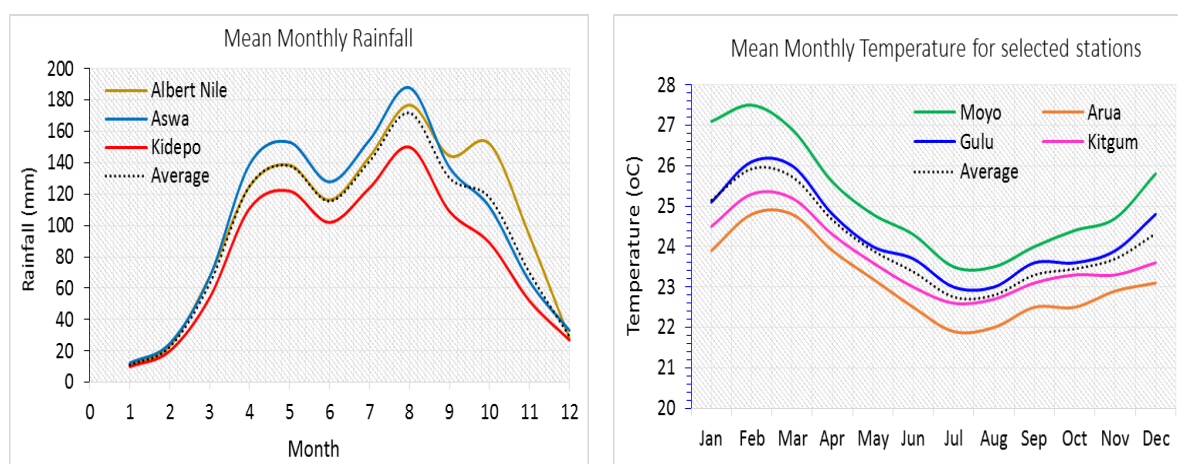


Figure 1 left: the mean monthly rainfall in mm for the three catchments in the Upper Nile Water Management Zone. Right: mean monthly temperature for selected stations. Moyo, Gulu, and Arua are located in the Albert Nile catchment.

## Rivers and hydrology

The Albert Nile is the main river in the Albert Nile catchment. It originates from Lake Albert and flows to the north through northern Uganda, then at the South Sudanese border it becomes the Bahr el Abyad, or the White Nile. The table below gives the yearly mean discharges along the Nile's tributaries.

GAUGING STATIONS ALONG ALBERT NILE'S TRIBUTARIES - FLOW (m <sup>3</sup> /s)					
MONTH	R. Achwa at Kilak County	R. Ora at Inde - Pakwach Road	R. Enyau at Arua - Moyo Road	R. Kochi at Yumbe - Moyo Road	R. Ayugi at Atiak - Laropi Road
1	1.0	9.3	1.6	1.4	1.3
2	0.7	7.6	1.3	0.7	1.0
3	0.8	9.5	1.8	1.1	2.0
4	2.9	12.5	2.7	2.0	4.9
5	6.3	13.5	3.1	1.9	18.6
6	8.0	11.0	3.9	2.2	9.0
7	9.9	16.8	6.0	7.2	14.2
8	17.2	25.6	10.8	14.1	24.3
9	23.6	31.8	10.7	14.1	22.0
10	22.0	31.9	10.8	14.3	23.2
11	13.3	31.8	8.5	5.1	14.1
12	3.5	15.5	3.9	1.5	3.4
<b>AVG</b>	<b>8.7</b>	<b>18.1</b>	<b>5.4</b>	<b>5.7</b>	<b>11.6</b>
Period	1969 - 1982	1956 - 1978	1955 - 2015	1955 - 1978	1955 - 2000
Area (km <sup>2</sup> )	536	2,775	749	838	1,066

Figure 2 Discharge measurements along the Albert Nile

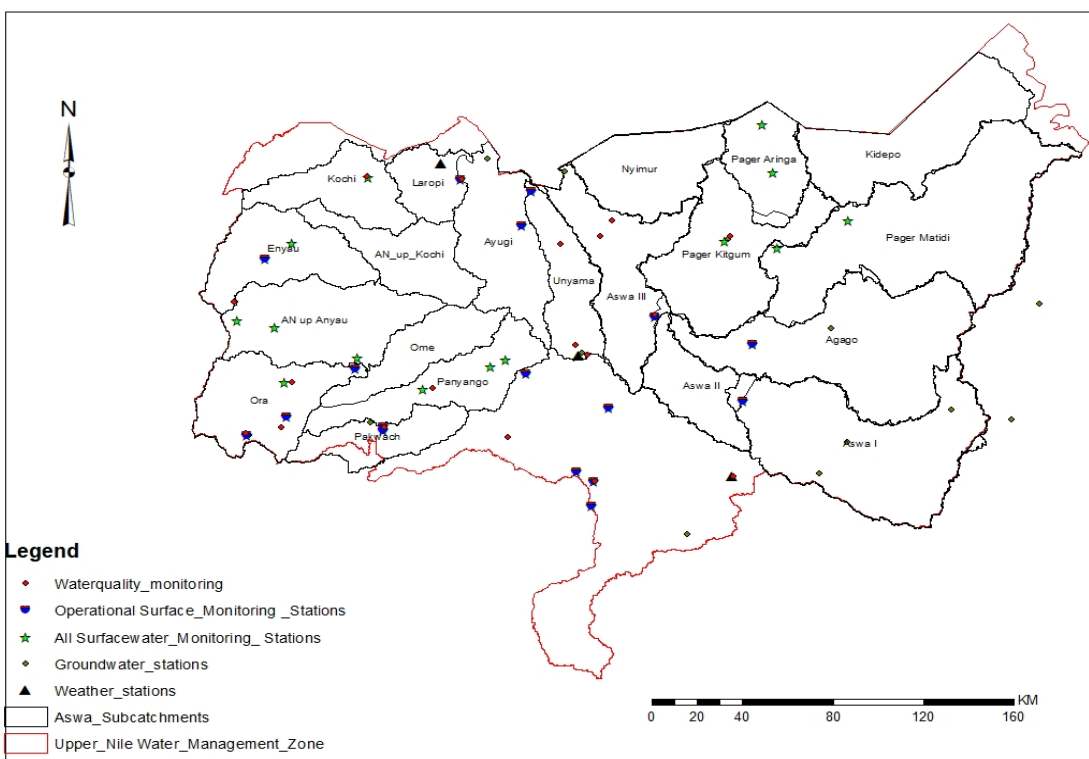


Figure 3 Monitoring stations in the UNWMZ

### Flood vulnerabilities

The Albert Nile catchment is vulnerable to flood events, especially in the area of Maracha, Arua and Zombo Districts with several towns and villages vulnerable to flooding (Arua, Nebbi major town). These towns have a high population density and existing infrastructures. High risk to flood can occur also with reference to considerable rivers slope and high value of surface runoff.



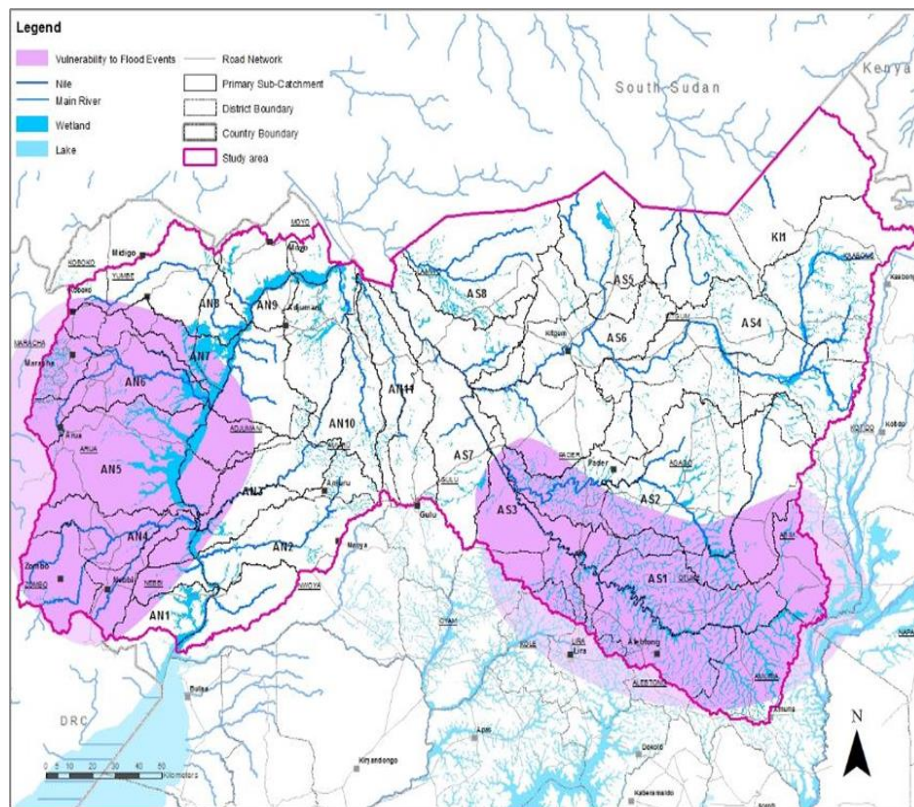


Figure 4: Flood vulnerability UNWMZ

No.	Issue	Causes	Possible Solutions
1	Flooding of farmlands and destruction of farm crops	Heavy/intense rainfalls and communities cultivating within the floodplains.  Lack of biophysical conservation structures on agricultural landscapes	<ul style="list-style-type: none"> <li>- Floodplain mapping and zonation</li> <li>- Demarcation of 30-100m buffer zone for riverbanks and wetlands protection</li> </ul>
2	Flooding of roads and destruction of road infrastructure (bridges and culverts)	Heavy/intense rainfalls and improper design of bridges and culverts	<ul style="list-style-type: none"> <li>- Adopt proper designs of box culverts/bridges to allow for proper drainage</li> <li>- Replace Irish type of bridges with box culverts</li> </ul>
3	Flooding of settlements and displacement of communities/destruction of households	Heavy/intense rainfalls and communities settling in floodplains and flood prone areas	<ul style="list-style-type: none"> <li>- Flood plain mapping and zonation</li> <li>- Enforcement of 30-100m buffer zone for riverbanks and wetlands protection</li> </ul>

4	Soil erosion and concomitant sediment deposition in rivers and reservoirs	Heavy/intense rainfalls over the entire catchment	<ul style="list-style-type: none"> <li>- Check dams</li> <li>- Sand dams</li> <li>- Terracing and contour bunding</li> <li>- Percolation pits</li> <li>- Grass strips</li> <li>- Agro forestry/tree planting</li> </ul>
5	Siltation of water harvesting and flood control structures – sand dams, valley tanks and earth dams	Heavy/intense rainfalls over the entire catchment	<ul style="list-style-type: none"> <li>- Terracing and contour bunding</li> <li>- Percolation pits</li> <li>- Grass strips</li> <li>- Water sources Protection</li> <li>- Desilting of water harvesting and flood control structures</li> <li>- Tree planting/agro forestry</li> </ul>

## 2. Flood risk assessment

The project aims to increase the resilience of communities to the risk of floods and droughts at the Obongi district through the deployment of SLAMDAM to prevent flooding and simultaneously store and harvest water. In the project we answer the following question:

### ‘Where and when to deploy SLAMDAM?’

A team of Dutch consultants, Dutch hydrologists, local hydrologists of the Ministry of Water and Environment in Uganda, and the community of Obongi collaborate to determine the most effective site to deploy SLAMDAM and hand over the responsibility to a Flood Response Team. This chapter elaborates on the selection of a (sub-)catchment where the mobile flood barrier is expected to be effective and suitable through a flood risk assessment. The approach of flood risk assessment advances from general analyses on catchment scale to more detailed analyses on community level. The analysis covers the flood challenges four locations in the sub-catchments of Obongi and Elegu are facing, and concludes on the potential pilot locations for SLAMDAM. In consecutive consultations with the Flood Response Team, the actual sites and conditions will be discussed.

In the assessment multiple sources are considered. Namely, hydrodynamic modeling, data collection by fieldwork, and interviews with the town councils and communities. The main focus of the risk assessment is to determine the functioning of the water system in the context of the catchment; what are the main sources of flooding? What are the weakest locations in the water system? What is the lead time in case of flooding? And what are the consequences of flooding? Based on this analysis, the team determines the most feasible location for SLAMDAM.

### General overview of locations

From the five potential areas for SLAMDAM as mentioned in the previous chapter, Obongi district and Elegu are indicated as vulnerable to flood and droughts by the ministry of Water and Environment. In these districts and towns flooding frequently occurs but with magnitudes considered suitable for SLAMDAM. In Obongi district, three locations are considered vulnerable to flooding : Waka, Foligo, and Yachinemiji. Close to the border of South Sudan, Elegu, the fourth vulnerable location can be found.



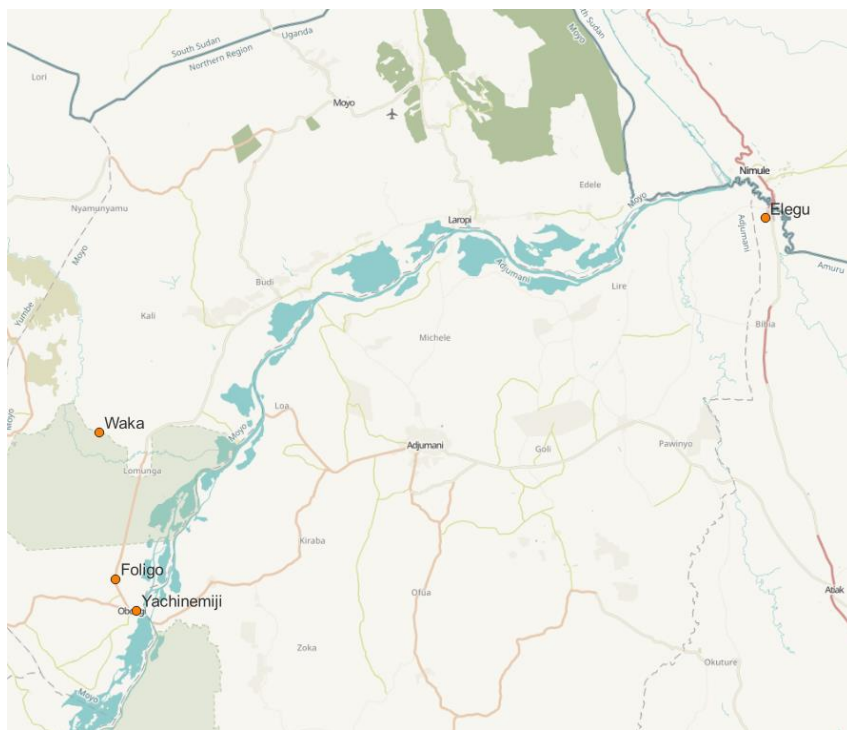


Figure 2.1 Flood prone locations in the Obongi district (Waka, Foligo, Yachinemiji) and Elegu

## Waka

The most important river flowing through Waka is the Kochi river as part of the Kochi sub-catchment. In total, the sub-catchment covers an area of about 1600 km<sup>2</sup>. The majority of the tributaries of the Kochi river originate from the East side, all the way up to the border of DRC. On the west side of the catchment, the elevation reaches up to 1200 m AMSL, while 70 km to the East, at the outflow of the Kochi into the Nile, elevations of around 600 m AMSL are found. Hence, on average, over 117 meters the elevation drops 1 meter. The area of the Waka community is part of a depression in the landscape. It is bounded by the Kochi river on both the Western side and the Southern side. Besides, the elevation decreases by around 70 meters from Ombechi in the North to Waka in the Southern part of the sub-catchment.

The river course of the Kochi is a meandering river from North to South until it flows in the Eastern direction and discharges into the Nile. As a result of high discharges in the Kochi, the outer bends of the river are impacted by the high flow velocities perpendicular to the banks and experience soil erosion. This soil erosion is even worsened by animals and pastoralists crossing the banks and eroding the banks even more, see Figure 2.2.



*Figure 2.2: erosion of the Kochi river banks as a result of high flow velocities and crossing herds. On the right, Reparations of the river bank were not sufficient.*

In case of a rainfall event in the sub-catchment, the Kochi river receives the water through surface runoff. Only a small share of the sub-catchment is not directly draining into the Kochi, but flows directly to the Nile, or joins the Kochi at the last 5 kilometers. The bottom right simulation in Figure 2.3 shows the dominant flow pattern of the Kochi river in case of a rainfall event.

As a result of the rather steep gradient in the sub-catchment, the response time of the catchment is fast. Hence, water levels in the Kochi rivers rise normally within 3 hours. Figure 2.3 shows the response time of the catchment based on modeling results of simulation with a forcing of 50 mm/h for two hours. One hour after the rainfall event, the catchment starts to drain into the larger streams. The Figure still shows a diffuse pattern becoming more distinct over time. After 12 hours, the majority of the rainfall has drained to the channels and rivers, and it is expected that the highest discharges occur, as indicated by the deep blue flowlines. The modeled response time of 12 hours deviates from the indicated response time of the community. Therefore, one of the recommendations is to monitor the catchment by rainfall and water level/discharge measurements.

The drainage of the catchment leads to rising water levels in the Kochi river. When water levels in the river rise, riverbanks overflow the lowest and most deteriorated locations. According to the water and environment officers, this happens at three locations along the Kochi, see Figure 2.4.

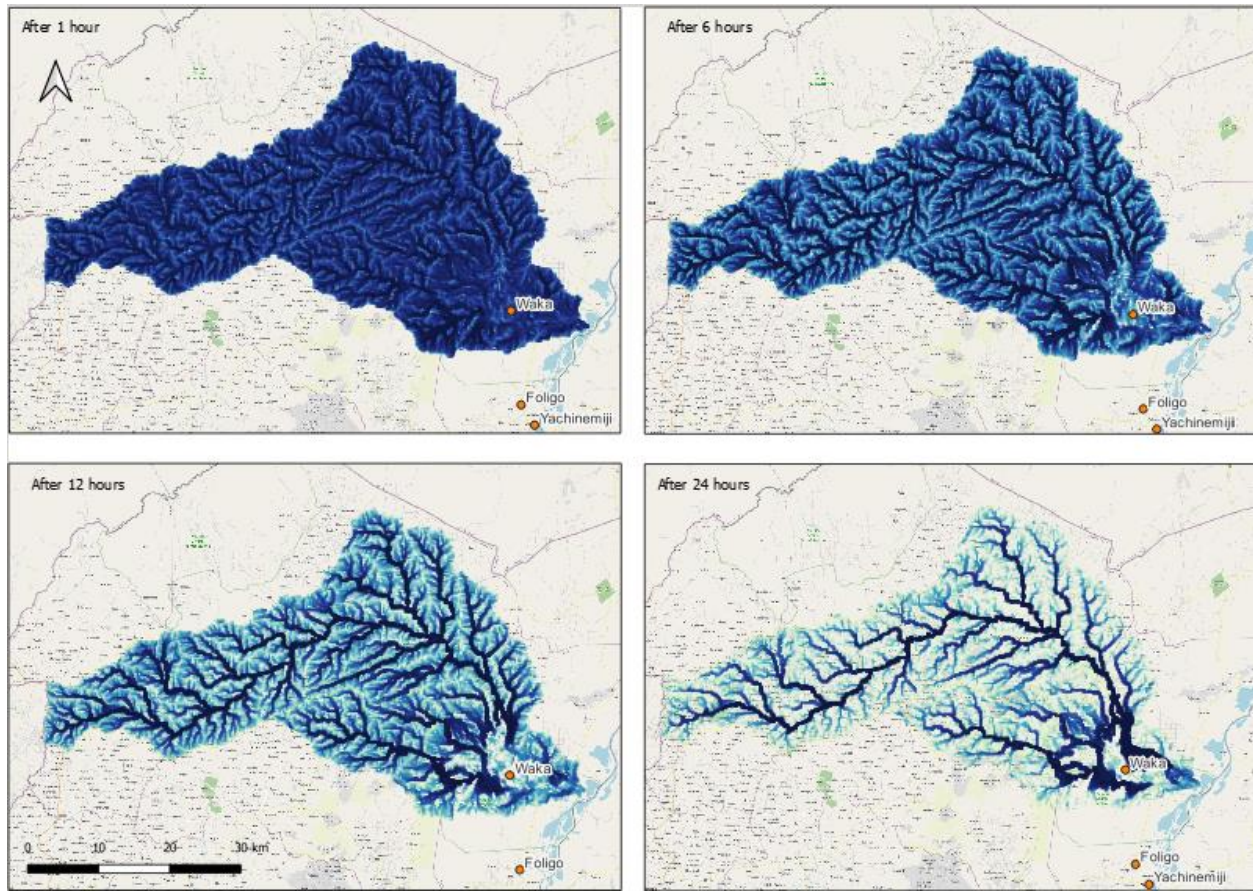
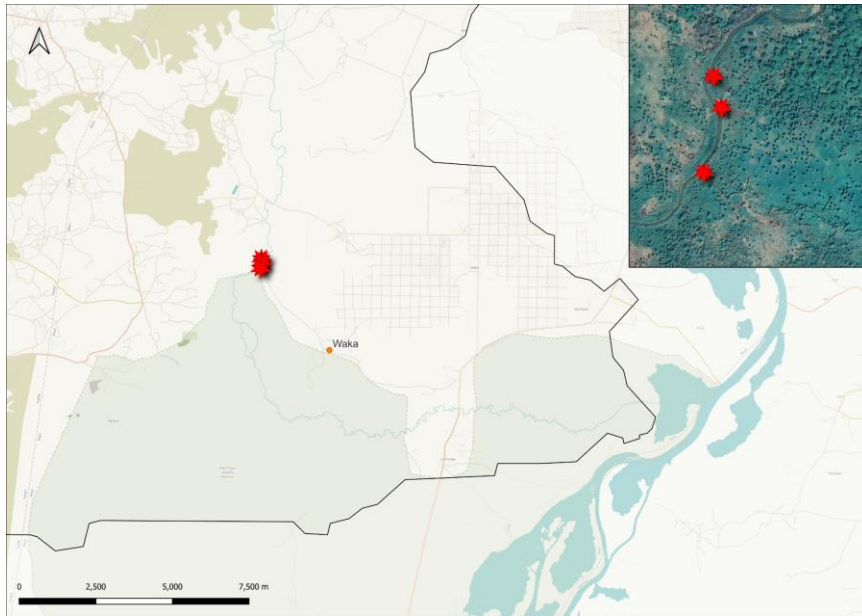


Figure 2.3: The response time of the Waka catchment of a simulation with a rainfall event of 50 mm/h for 2 hours. The pictures show the flow pattern of the simulation 1, 6, 12, and 24 hours after the rainfall event.





*Figure 2.4: Breach locations along the Kochi river, resulting in inundation of the entire area from the breaches up to Waka.*

When exiting the breaches, the water follows an incised stream for approximately 150 meters. Thereafter the stream continues its course by draining into an excavated channel, constructed by the Danish Refugee Council (DRC), see Figure 2.5. The purpose of this channel is to divert the water from flowing to Waka to flow to the South and join the Kochi river. However, due to the limited capacity of the stream, the stream does not discharge entirely into the constructed channel, but spills water into the direction of gravity, which is towards Waka in the (South)east. The water flows through the ditches parallel to the road, where they increase in size from 30 cm depth close to the Kochi to 50-100 cm depth closer to the Nile. Both sides of the road are connected with large culverts of around 1.5 m and the water continues its flow over land. As a result, the entire area from the breaches up to Waka gets inundated, including the main road from Kochi-Waka-Moyo.



*Figure 2.5: An excavated channel, constructed by the Danish Refugee Council to drain water towards the South instead of into the direction of Waka*

The flow directions, as described by the water and environmental officers of Obongi district, are also shown in Figure 2.6. At the locations of the breaches, water can drain outside the river course towards Waka. Currently, the coarse model

does not capture the breaches very well as a consequence of data lacking and poor data quality. However, the model already shows the tendency of draining towards Waka. Furthermore, the Kochi becomes indistinct when it drains into the wetland area to the south. A few kilometers to the East, the river picks up its course again and flows to the Nile. It should be noted water also flows around the community on both the Northern and the Southern side. Hence, when considering Waka as a potential SLAMDAM location, one should be certain that these two drainage directions do not lead to any additional nuisance.

The flood observations of the community are confirmed by model simulations with the hydrodynamic modeling software 3Di as well. Figure 2.7 shows a large flood extent around Waka, as a result of the flows from the Kochi side as depicted in Figure 2.6. Besides the river flooding, Waka experiences local flooding due to poor drainage. The inundations in Waka range from the breaches to the road on the Eastern side and cause hindrance to the community.

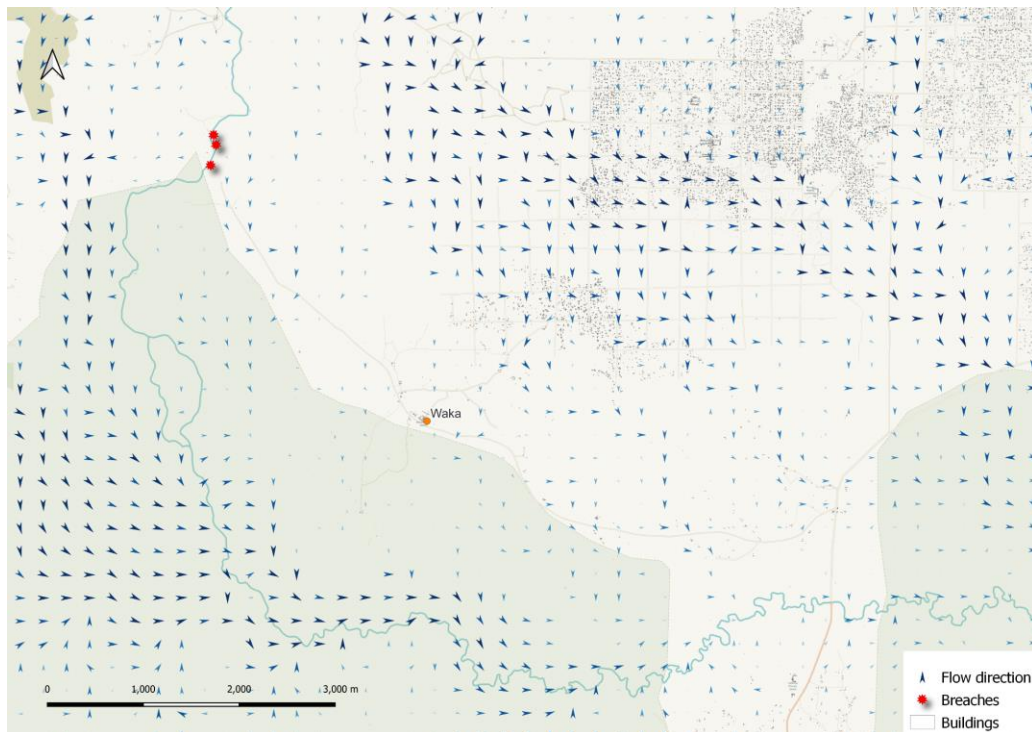


Figure 2.6: Flow directions around Waka

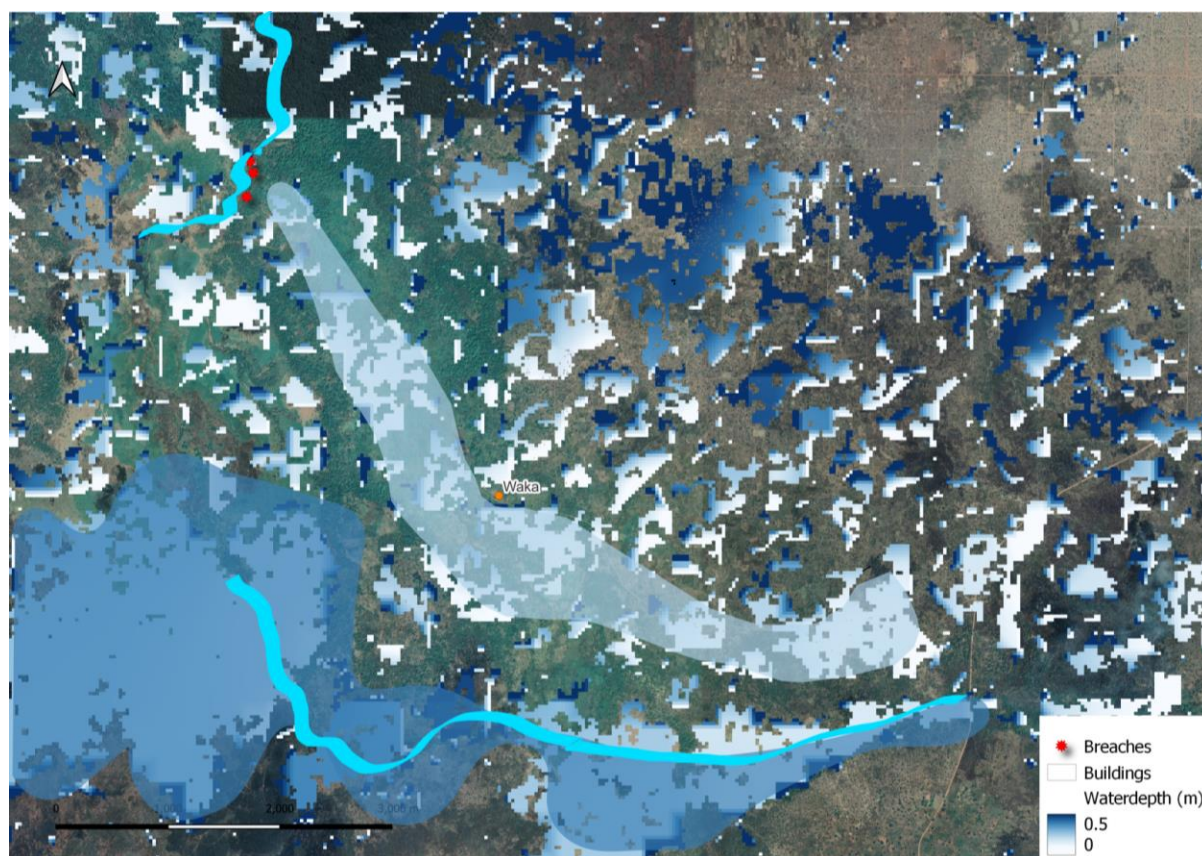


Figure 2.7: Flood

extents and water depths around Waka

Especially in Waka, 4 km downstream of the breaches, the consequences are high. Each year, this area experiences flooding. However, during the floods of 2020, 10 buildings experienced inundations of +/- 50 cm for almost six months according to the community. As a result of the flooding, water entered some of the buildings, including school buildings. Furthermore, sanitary was malfunctioning, crops were destroyed, and trees from the reforestation project were destroyed. One of the mitigation measures taken by the community was the construction of a ditch on the northern side of the sanitary. The purpose of this ditch is to convey the water, coming from the North and West, around the community and drain it into the Kochi on the south eastern side of the community. However, inspections on the ditch showed that this channel was no longer operable and entirely covered with vegetation.





*Figure 2.8: Visit of the team to the Waka community*



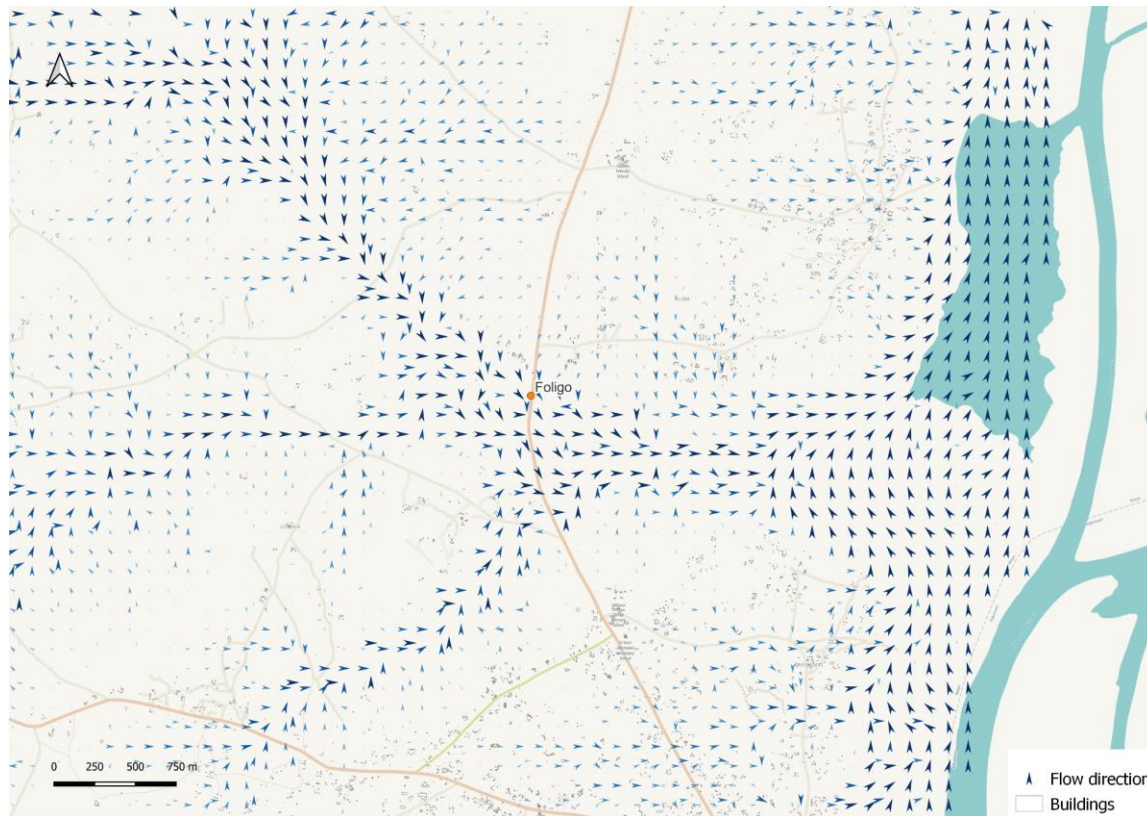
*Project members with the stakeholders during a fact finding session.*

### **Foligo and Yachinemiji**

Foligo and Yachinemiji are located in the same sub-catchment, which is diverted into two equal pieces by the Nile. The western part of the catchment has a surface area of 150 km<sup>2</sup> with elevations ranging from 700 m AMSL in the West to 600 m AMSL 20 kilometers to the East. Hence, on average, over 200 meters the elevation drops 1 meter. The main road between Foligo and Moyo goes from North to South and crosses an important location of the sub-catchment just at Foligo. In case of a rainfall event, the water in the upstream part of the sub-catchment drains to the lower areas and is conveyed through a depression stretching from the road at Foligo to the Nile on the eastern side, see Figure 2.10.

In total, more than half of the sub-catchment drains through this depression as no distinct rivers are present in the sub-catchment. Hence, in case of a rainfall event, Foligo located in the depression with elevations of around 620 m AMSL is expected to experience flooding. This is confirmed by both the water and environment officers as by a 3Di hydrodynamic model, see Figure 2.10. The annual flood depths are around 0.5 m, while the floods with a recurrence time of 40 years, like in 2020, have a depth of 2 meters. As a consequence of the flooding, crops get lost, vehicles are damaged and the (main) roads are inaccessible. The flood depths are also visible in Figure 2.12, as part of a hydrodynamic simulation. Especially the large water depths of more than 0.5 m are also found in the model simulations. After 1-2 days the flood reduces and after 1 week the floods have retreated.

Along the Nile, the area is characterized by wetlands and has rather low elevations. We can find Yachinemiji close to the wetlands. According to the water and environment officers, the lowest point around Yachinemiji is around the mango tree, a few hundred meters to the west of Yachinemiji. From here, water drains through a small stream just to the North of Yachinemiji. This is confirmed by a 3Di model, see Figure 2.11. The Figure also shows that flood waters originate only from a small part of the sub-catchment and are drained by a stream into the Nile. Besides this stream coming from the west and causing inundation, inundation from the eastern side happens as well. According to the water and environment officers, this water either originates from high water levels in the Nile or flows counterclockwise around Obongi town, causing inundation from the eastern side. It causes yearly flooding of around 1 meter, as confirmed by model simulations (Figure 2.13)



Flow directions around Foligo

Figure Figure 2.10:



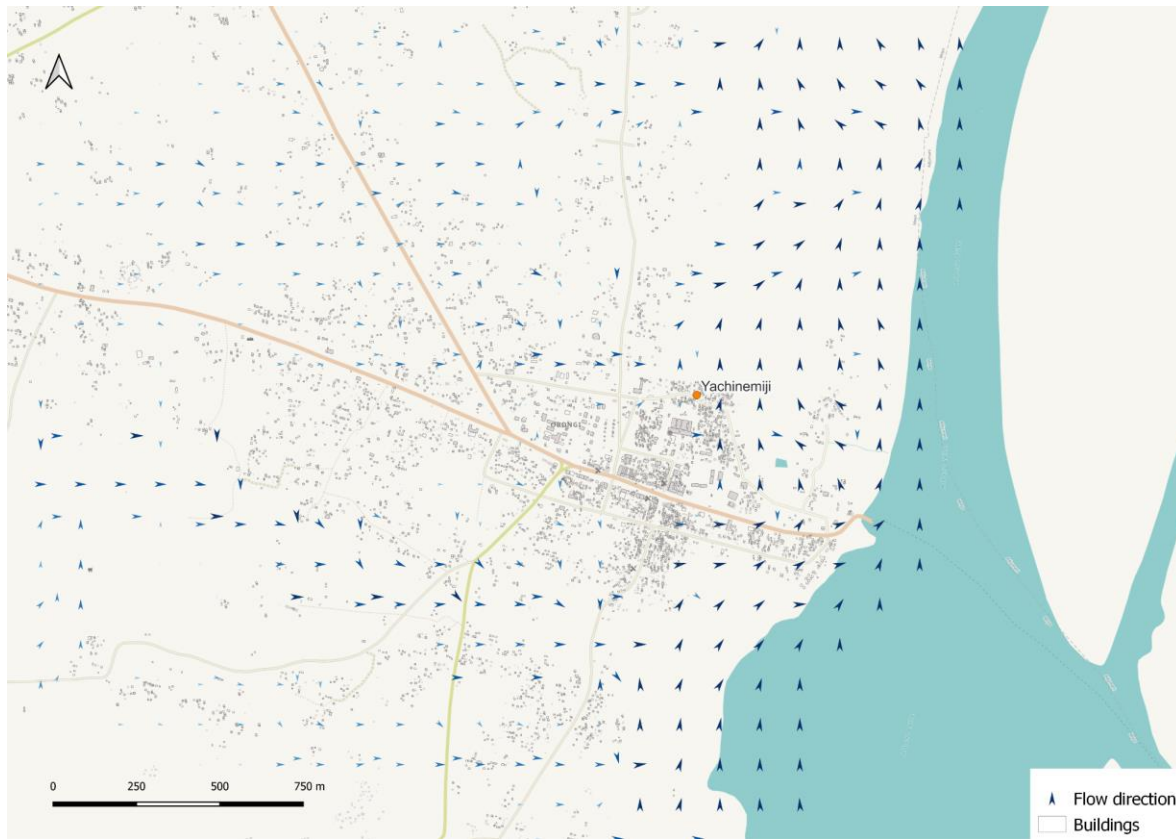


Figure 2.11: Flow

directions around Yachinemiji



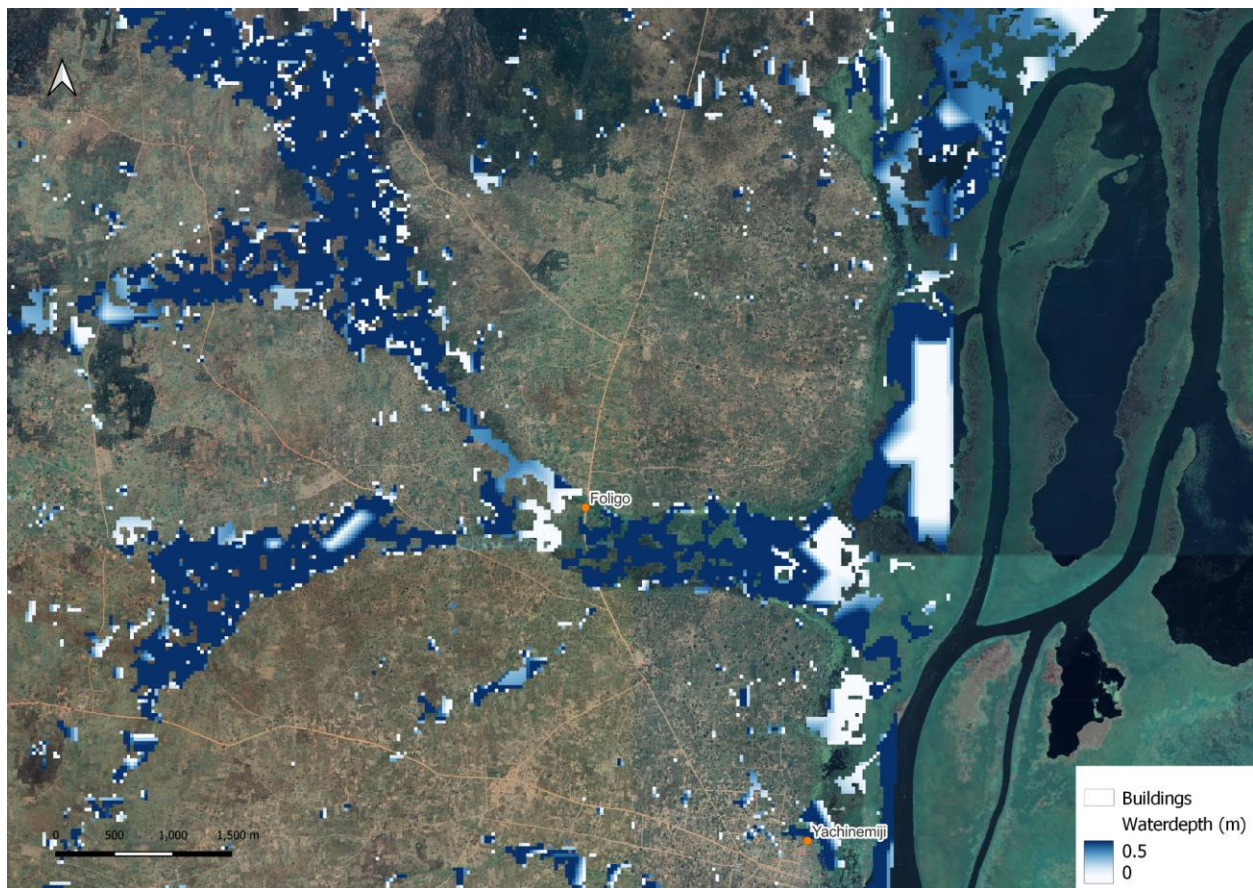


Figure 2.12:

Water depths around Foligo



Figure 2.13:

*Water depths around Yachinemiji*

The impacts of the flood reached up to the market in Obongi town, 200 meters to the South of Yachinemiji. Here, schools, houses and institutions are flooded. During the flood of 2020, houses were submerged but the community went back after the floods were gone. However, it should be noted that the vulnerable locations in Yachinemiji are at the lowest elevation levels. Therefore, the Ministry of Water and Environment had designated buffer zones around the Nile. These buffer zones are part of spatial planning and prohibit constructions in this area.





Figure 2.14: Images of the depression around Foligo



Figure 2.15: The affected houses in Yachinemiji during floods.



Figure 2.16: Pictures taken from the buffer zone in the direction of the marketplace. This area is inundated during floods



## Elegu

Elegu is located in a sub-catchment stretching from Gulu in the South and crosses the South Sudanese border in the North. In total the catchment area has a surface of 1680 km<sup>2</sup>. The main river in the catchment is the Unyama river, flowing from Gulu to Elegu. The southern part of the sub-catchment is the higher elevated part, with elevations up to 1060 m AMSL. In the downstream part of the sub-catchment, around 100 km downstream in Elegu, elevations of 630 m ASML are present. Hence, on average, over 232 meter the elevation drops 1 meter

Elegu is especially prone to riverine flooding from the Unyama river, which flows one kilometer from Elegu town. The entire sub-catchment drains to the Unyama and its tributaries and in case of rainfall in Gulu, the water levels in Unyama rise within a few hours. The community describes several breakage points that exist along the river from where Elegu town is flooded. An important element in the landscape is the road, constructed in 2015 by the world bank. Below the road culverts of 1-1.5 m are present, assuring a connection of the water system between both sides of the road.



The Unyama river is a river with high gradients and sharp bends. It is still an active river, meaning that the river still meanders through the floodplain. The two Google earth screenshots below show an example. The left screenshot shows an image of the Unyama in 2016. The outer bend of this river experiences soil erosion as a result of the high flow velocities in the river. In 2018, the first image on Google earth is captured where the bend became so extreme, it was even isolated from the river, resulting in a horseshoe lake, see Figure 2.18.



*Figure 2.18: Left: February 2016 where The outer bend of this river experiences soil erosion as a result of the high flow velocities in the river. Right: October 2018 where the bend becomes isolated from the river resulting in a horseshoe lake*

This extreme soil erosion along the river banks was also observed during the field visit. At several locations we distinguished calving of the banks, see Figure 2.19. The left picture clearly shows soil erosion on the left inner bank and erosion on the river bed in an oval shape as a result of high flow velocities and low soil cohesion. At these locations SLAMDAM is at risk of collapsing together with the river banks.



*Figure 2.19 Calving of the river banks*

Riverine flooding is simulated with the hydrodynamic model as well. Figure 2.20 shows the flow directions after a simulation with rainfall of 50mm/h for 2 hours. From the results it becomes clear that the flow does not remain within the river course, but overflows the river banks. As a result, the water continues its flow on the Western side of the Unyami river towards the Nile. This results in high water depths around Elegu, see Figure 2.21. Flooding around Elegu is extensive and inundation levels are higher than 0.5 m. When considering measures to decrease the effects of flooding, the large flood extents should be considered carefully.

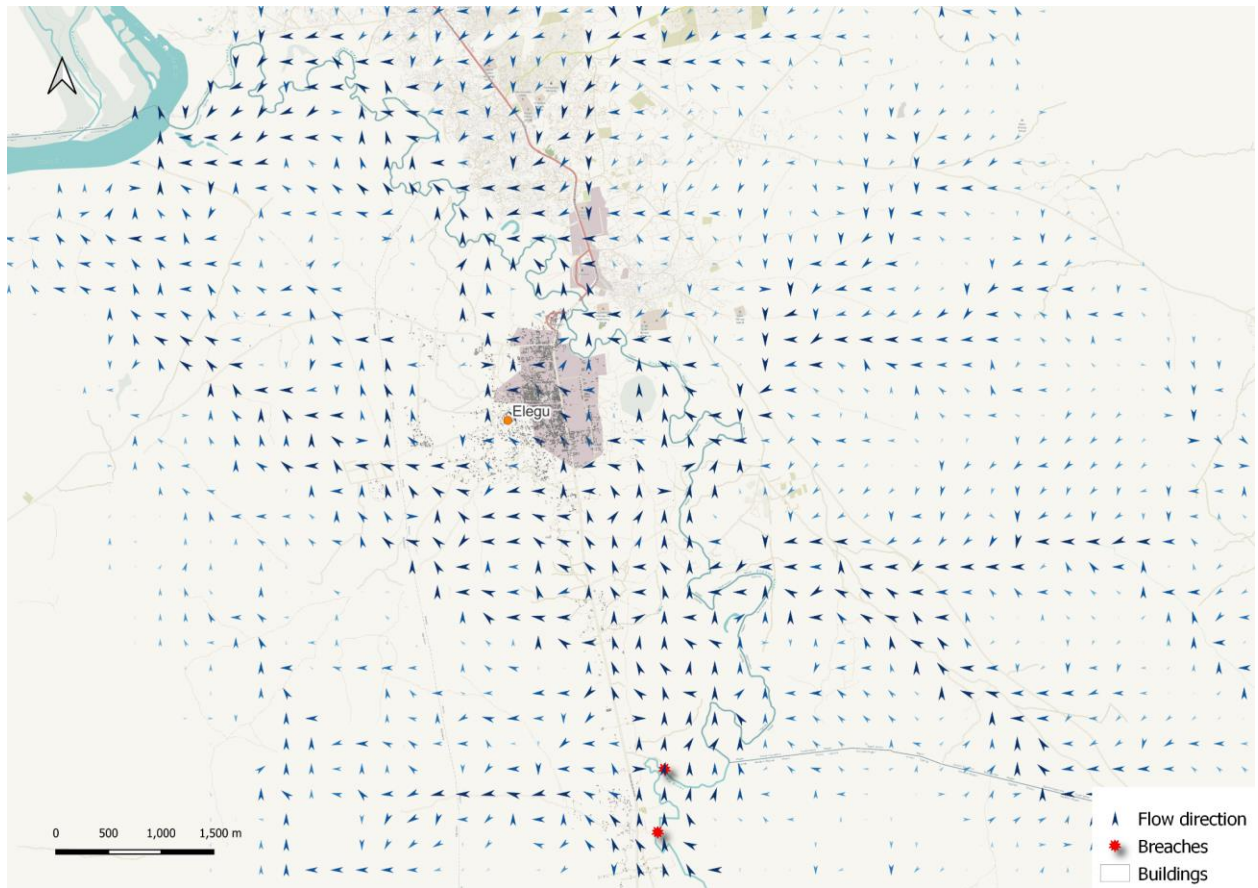


Figure 2.20: Flow directions around Elegu



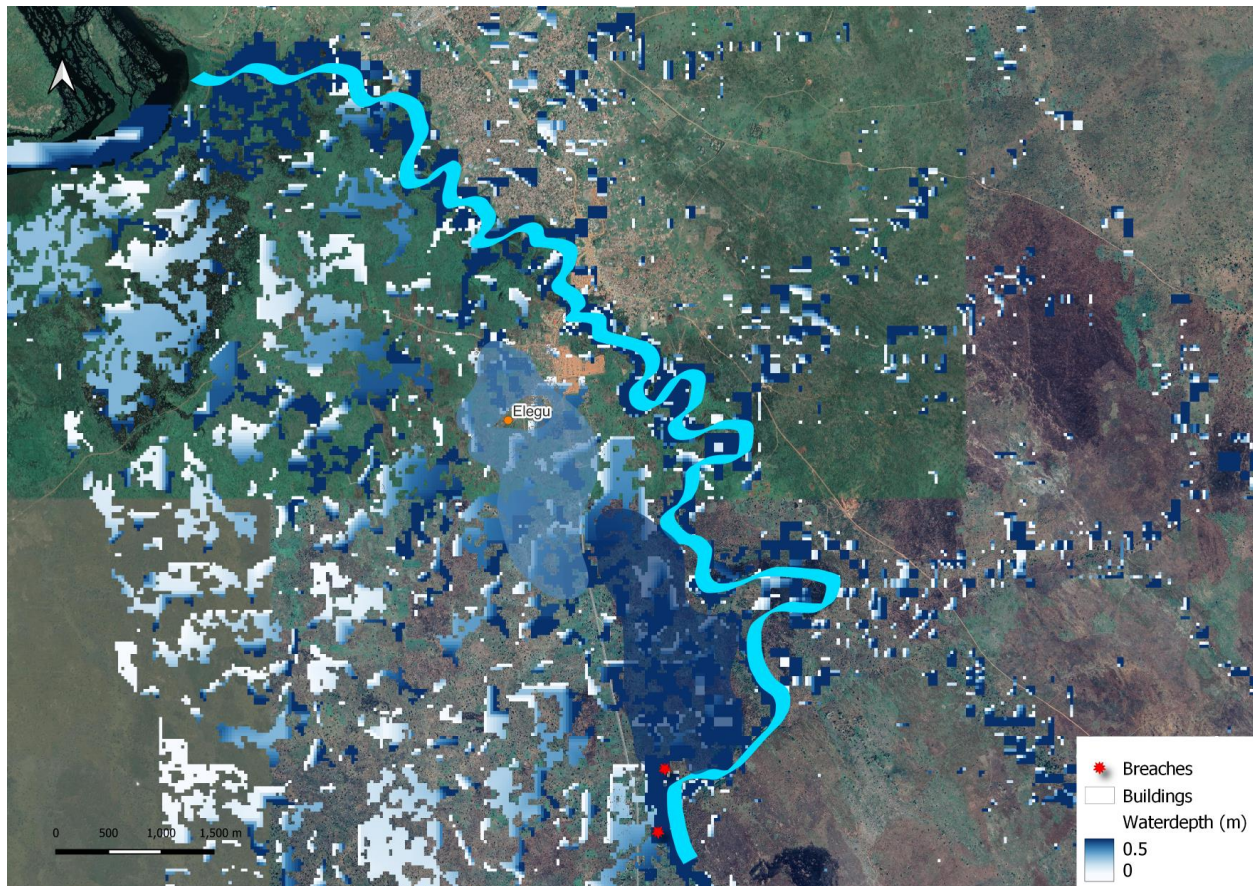


Figure 2.21:

Water depths around Elegu

In 2018, Elegu counted 18.000 inhabitants and the mayor estimates Elegu accommodates 35.000 people nowadays. Hence, the impacts of the floods on the Elegu community are very high and the entire town is usually flooded. In 2017, when a severe flood occurred, the community indicates that a depth of even 1.5 m was observed. Normally, floods occur between August and November and last for +/- 3 days. In these months, floods occur very regularly, namely four to five times a month. During the flood period all business activities, which are the main activities in this area, are disrupted. About 80% of Elegu consists of business and South Sudan a few directly bordering Elegu is an important market.

Besides business interruption, the community is risking diseases from malaria, due to stagnant water. Furthermore, boreholes get flooded by the water, complicating the access to drinking water and increasing the risks to waterborne diseases more. During the most severe floods in 2017, 15-20 people have died, according to the community. Furthermore, agricultural lands are present between Elegu town and the Unyama river. The main crops grown here are sweet potato, cassava, banana, and sesame which are destroyed when the area gets flooded.

Besides some trenches, there are no mitigation measures currently taken by the community and people shelter in the higher elevated storage areas in case of flooding.



Figure 2.22: Pictures of the Unyami river

### Potential sites

For each of the locations, the project team determines potential sites to deploy SLAMDAM. To select the most feasible deployment site, we make use of a decision matrix. Within this matrix we distinguish between four independent criteria. Namely, suitability of the SLAMDAM in relation to its surroundings, effectiveness of the SLAMDAM in decreasing flooding, the impact of the SLAMDAM, and the presence of a flood response team (FRT). The paragraphs below explain the four criteria which are being used to score the potential sites. The expected effect of the SLAMDAM determine the granted score and is based on (coarse) simulation results and observations from the field with the help of the software <https://floodintelligence.lizard.net/>

### Suitability

The SLAMDAM has several physical suitability criteria which should be met. We consider the following suitability criteria:

- Expected flood depth < 1 m
- Expected flow velocity (m/s)
- Type of ground surface: The soil can only contain a small sand fraction, due to risks of soil erosion.
- Slope of ground surface: the slope to place SLAMDAM should be limited
- Amount of debris / sharp objects (++/--): sharp objects, like sharp rocks are a risk for punctuation of the SLAMDAM
- Accessibility (++/--): vegetation, steep slopes, and infrastructure can decrease the accessibility to the site
- Distance to water source (m): to fill the barrier with water a natural water source of 20.000 L should be closed.

### Effectiveness



The location where SLAMDAM is placed determines the effectiveness of the mobile barrier. A site is considered effective, when the SLAMDAM is able to divert the flow, or to prevent river banks from breaching/overtopping to stop the hinterland from being flooded. When flooding originates from multiple sources e.g. pluvial and fluvial flooding, the SLAMDAM should be situated such that it does not hinder drainage from the area itself. To estimate the effectiveness, we make use of multiple flood sources (if applicable) and flood scenarios.

## Impact

The expected impact of the SLAMDAM on flooding is determined by the following criteria:

- Number of people protected from flooding (men / women)
- Number of buildings protected from flooding
- Number of households protected from flooding
- Reduction of agricultural areas with critical flow velocities (m2): high flow velocities can cause land degradation as fertile soil is washed away or damage to crops.
- Reduction of agricultural areas with water depths > 0.5 m (m2)
- Reduction of settlements with water depths > 0.5 m (m2)
- Avoided damage to agricultural land (USD / Km2). Please, specify per crop type
- Possible indirect damages that can be prevented (such as blocked roads, electricity network, important buildings (schools, community buildings, religious buildings, ...) (USD)
- Risk of waterborne diseases
- Area of agricultural area able to irrigate during dry season (m2)

## Flood response team

The Flood Response Team is responsible for the deployment of SLAMDAM in case of a threat of flooding. Their response and their effort is dependent on:

- Flood arrival time/lead time (h): how long in advance does the FRT receive a warning in case of flooding?
- Travel distance to SLAMDAM location (km): how long does it take for the FRT to travel to the site
- Speed of deployment (h):
- Duration of deployment (permanently/short event)
- Risk of theft or vandalism
- Trigger (++/--): is there a clear trigger to deploy the SLAMDAM? Think of rising water levels or rainfall forecasts.

## Decision matrix Potential

			Obongi T=1 year				Elegu T=1 year	Obongi T=40 years (like flooding in 2020)			Elegu T=40 year
		Location number	1	2	3	4		1	2	3	4
		Location name	Waka	Foligo	Yekenimiji	Elegu		Waka	Foligo	Yekenimiji	Elegu
general	Characteristics SLAMDAM	Location	Kochi river banks								
		Length (m)									
		Height (m)	1								
Suitability	Flood characteristics	Expected flood depth (m)	0.5	0.5	1	1.5		2	2	1	
		Expected flow velocity (m/s)	The velocity is much less in the floodplain	The velocity is much less in the floodplain	The velocity is much less in the floodplain			The velocity is high is the main channel	The velocity is high is the main channel	The is much less in the main channel	
		Return time flood (T)	1	1	1	1		40	40	40	
		Duration of flood (d)	14	7	7	2		90	90	14	4

		Expected effectiveness (++)/--)	+							
	Suitability of location	Type of ground surface	+	+	+	+	+	+	+	+
		Slope of ground surface	+	++	++	+	+	++	++	+
		Amount of debris / sharp objects (++)/--)	+	+	+	+	+	+	+	+
		Accessibility (++)/--)	+	++	++	+	+	++	++	+
		Distance to water source (m)	0	20	15	20	0	20	15	20
Impact	Expected benefits	Number of people protected from flooding (men / women)	30	15	29	1600	27	14	20	1450

	Number of buildings protected from flooding	150	90	230	2500	135, community buildings, schools	81	207	2250
	Number of households protected from flooding as percentage of buildings	70	70	50	20	70	70	50	20
	Reduction of affected agricultural areas (m2)	9,000	3800	900	7000	9,000	3800	900	7000
	Reduction of affected settlements (m2)	5,000	200	2700	14000	5,000	200	2700	14000



		Possible indirect damages that can be prevented (such as blocked roads, electricity network, important buildings (schools, community buildings, religious buildings, ...)) (USD)	education, latrines, blocked roads			collapsing of pit latrines, conservation of boreholes (drinking water), habitations, roads, bridges, schools and health centres, malaria	education, latrines, blocked roads	Blocked road		
		Risk of waterborne diseases	high	medium	high	high	high	medium	high	high
		Area of agricultural area able to irrigate during dry season (m2)	1000	1000	1000		1000	1000	1000	
Capacity	Flood	Flood arrival	3	4	6		2	3	4	

	response team	time/lead time (h)								
		Travel distance to SLAMDAM location (km)								
		Speed of deployment (h)								
	Operational criteria	Duration of deployment (permanently/short event)								
		Risk of theft or vandalism								
		Trigger (++/--)								

### 3. Recommendations and Conclusion

#### Recommendation

A flood risk assessment for the proposed project slamdam Uganda was undertaken following the field/site visit methodology recommended by the project team. The proposed project site is in Obongi district. The Obongi is a district located in the Northwest of Uganda, about 20 km South to the border of South Sudan and 50 km to the East of Democratic Republic Congo.

The region in the north is home to refugees as well as to transboundary tribes. The district headquarters are Obongi, located along the White Nile and is part of the greater Albert Nile catchment. This Chapter describes the relevant hydrological institutions, the hydrology of the Albert Nile catchment, and the Obongi sub-catchment.

The team completed the set field mission to identify the best site to deploy SLAMDAM in Obongi district between the dates 16<sup>th</sup> to 18<sup>th</sup> January 2023 visiting several sites including Waka, Foligo, Yakinemiji and Elegu areas.

Our main findings included that Waka and Yakinemiji areas in Obongi district and Elegu town are both vulnerable to flood and droughts on a regular basis. In these districts and towns flooding frequently occurs but with magnitudes considered suitable for SLAMDAM.

For each of the locations mentioned above, the project team visited them and subjected them to a decision matrix to confirm the most feasible site to deploy SLAMDAM. The decision matrix distinguished between four independent criteria. Namely, suitability of the SLAMDAM in relation to its surroundings, effectiveness of the SLAMDAM in decreasing flooding, the impact of the SLAMDAM, and the presence of a flood response team (FRT).

From the completed decision matrix Waka area was the most feasible site to deploy SLAMDAM followed closely by Elegu area. Following these results, the team recommends the pilot project to be conducted in the Waka area and Elegu area to be one of the sites for the proposed upscale project. Specifically, we will develop an adaptation benefits report using the FIS tool for the Elegu area.

It is recommended to perform further research on the exact site of the SLAMDAM. This additional research can be obtained by fieldwork as well as additional modeling work. During the fieldwork, the focus should be focussing on the implementation of the SLAMDAM. For instance, obtaining the lead times during a flood event to know how much time a Flood Response team has to fill up the barrier. Furthermore, the FRT should be trained on decision making where and when to deploy the SLAMDAM, for instance with the help of a Flood Early Warning System (FEWS).

Additional modeling work can help the FRT to show the flood mechanisms under various circumstances, like varying rainfall events and the placement of SLAMDAM on different locations. To increase the accuracy of the model, it is recommended to gauge the catchment with water level, discharge, and rainfall data. Besides, the model can be significantly improved by including roads, elevated elements, trenches, friction, and channels manually.

## Conclusion

Waka area, the recommended SLAMDAM deployment site is located in open agricultural ground with local inhabitants of a population of (get the data from Robert), with an area of approximately .....

The main source of flood in this area is from seasonal rain. When water levels in the river rise due to high levels of rain, riverbanks overflow the lowest and most deteriorated locations. According to the water and environment officers, this happens at three locations along the Kochi River. 4 km downstream of the breaches, the consequences are high. Each year, this area experiences flooding. Buildings including homes and schools are flooded with water and the residents including their livestock have to wade through the water.

One of the mitigation measures taken by the community with the help of the Danish refugee Council was the excavation of a water channel. However, due to the limited capacity of the channel, the water does not discharge entirely into the constructed channel, but spills water into the direction of gravity, which is towards the Southeast.

The water flows through the ditches parallel to the road, and they increase in size from 30 cm depth close to the Kochi to 50-100 cm depth closer to the Nile. Both sides of the road are connected with large culverts of around 1.5 m and the water continues its flow over land.

As a result, the entire area from the breaches up to Waka still gets flooded despite the intervention. Therefore, SLAMDAM will come in the area as an additional measure to strengthen the already existing channel. This will have a great impact on reduction of flood induced damages to crops and infrastructure for the community in Waka area.

Further we will develop an adaptation benefits report using the FIS tool for Elegu.



#### 4. Next Steps/Way forward

To ensure smooth project coordination and management, the MoWE is expected to establish a project steering committee that provides policy guidance and oversight for the SLAMDAM pilot project. It is composed of the Permanent Secretary of MoWE, the Director, and Directorate of Water Resources Management, a representative from the Ministry of Finance, Planning and Economic Development (MFPED) and the CAO Obongi district. The steering committee is expected to meet at least twice during the entire project period, to review progress of project implementation and perform other functions it will be mandated to undertake. Going forward, the Project Technical Support Team (TST) from the MoWE and Zephyr Consulting Limited is required to brief the PS-MoWE on the outcome of the first supervision mission visit plus the need to urgently arrange for the first the project Steering Committee meeting which can be either virtual or physical. The Technical Support Team will provide secretarial services to the Steering Committee and also ensure that background technical documents are prepared in advance for the guidance and consideration of the steering committee.

Likewise, the project Technical Support Team (TST) shall continue to follow-up on the overall project implementation, assess the progress in line with expected results, challenges/risks, propose mitigation measures to address the challenges and also prepare regular progress reports to the PS-MoWE or any other person on his behalf.

The Team further agreed on the following next steps:

Action	Responsibility	PTA	Deadline
Prepare a scale up full proposal	Project Team	LK/OS/JK	Tbd
Prepare an adaptation benefits report for Elegu using FIS tool	Project Team	LK/OS/MvD	Tbd

#### 5. Next Field Visit

The next mission visit is scheduled for the month of April in the year 2023.

## Annexes

### Annex A-Stakeholders Meeting at MoWE Offices attendance list

#### ENHANCING RESILIENCE TO CLIMATE CHANGE INDUCED FLOODING AND DROUGHT USING SLAMDAM AND FOOD INTELLIGENCE SOFTWARE

16<sup>TH</sup> JANUARY 2023, NILE BOARDROOM

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#### ENHANCING RESILIENCE TO CLIMATE CHANGE INDUCED FLOODING AND DROUGHT USING SLAMDAM AND FOOD INTELLIGENCE SOFTWARE

16<sup>TH</sup> JANUARY 2023, NILE BOARDROOM

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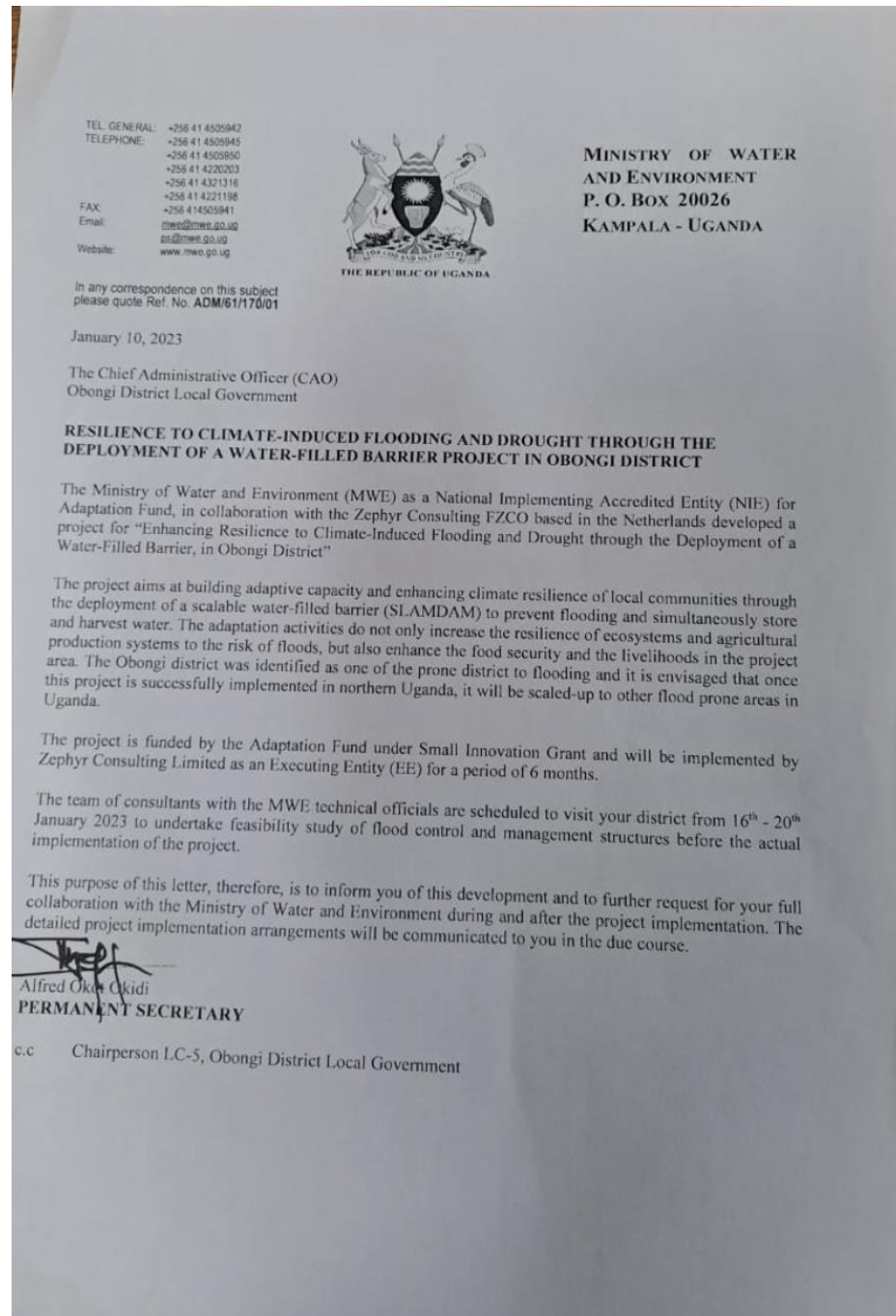
**ENHANCING RESILLIENCE TO CLIMATE CHANGE INDUCED FLOODING AND  
DROUGHT USING SLAMDAM AND FOOD INTELLIGENCE SOFTWARE**

**16<sup>TH</sup> JANUARY 2023, NILE BOARDROOM**

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## Annex B-Official letters





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MINISTRY OF WATER  
AND ENVIRONMENT  
P. O. BOX 20026  
KAMPALA - UGANDA

In any correspondence on this subject  
please quote Ref. No. ADM/51/17001

January 10, 2023

Mr. Omar Saleh  
Executive Director  
Zephyr Consulting FZCO  
16<sup>th</sup> Floor the L. Plaza 367-375  
Queens Rd, Central Sheung, Hong Kong

**Invitation for Initial Project Implementation Arrangements: Enhancing Resilience to  
Climate-Induced Flooding and Drought through the Deployment of a Water-Filled Barrier,  
Project, Obongi District**

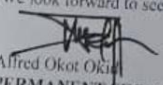
As you may know, the Ministry of Water and Environment (MWE) as a National Implementing  
Accredited Entity (NIE) for Adaptation Fund, developed a project for "Enhancing Resilience to  
Climate-Induced Flooding and Drought through the Deployment of a Water-Filled Barrier, in  
Obongi District"

The project is funded by the Adaptation Fund under Small Innovation Grant and will be  
implemented by Zephyr Consulting Limited as an Executing Entity (EE) for a period of 6 months.  
This is in fulfilment of the AF project implementation procedures.

The Ministry of Water and Environment, is pleased to invite your organisation as an Executing  
Entity to Uganda on 15<sup>th</sup>-26<sup>th</sup> January 2023 to discuss and consolidate the project implementation  
arrangements and also use the opportunity to visit the project area to undertake feasibility study of  
flood control and management structures in Obongi district before the actual implementation of  
the project.

In case of any consultations please contact [jkwesesi11@gmail.com](mailto:jkwesesi11@gmail.com), Telephone: +256785800094

We look forward to seeing you soon.

  
Alfred Okot Okia  
PERMANENT SECRETARY

## 1. Minutes previous meeting

### Opening

- Lillian opened the meeting and noted not everyone had attended the meeting from the Uganda team; only James and Richard were in attendance. After a discussion with members present it was agreed enough members were present who can convey any information/decisions if needed and so the meeting to continue as planned.

### Action list

- P1.1 It was agreed that the Project Organization Team would be discussed in the next meeting to enable appointment of people who will be in charge of the actioning of the action list and approval of the same.
- P1.2 It was agreed that the team will look at the data requirements template and give their comments on the same in the next meeting i.e. which data is readily available and which data will require time. Maud will also initiate a meeting with Richard to discuss further the data requirements as well as to learn more about the Obongi area.
- P1.5 Richard was requested to identify a list of possible stakeholders and take the same to Dr. Callist for approval. Lillian will send a guideline for the same to assist the team further for this action.
- P1.6 Lillian will send a guideline on how to go about coming up with an M&E plan
- P1.7 Omar will initiate a call with James to discuss possible members of the steering committee and the timings for the meetings.
- P2.7 James proposed we apply for a tax exemption immediately as the process is usually long. It was agreed that Omar will send a proforma invoice and an estimate packing list to kickstart the process

## 1. Minutes previous meeting

### Opening

- Lillian opened the meeting and it was noted that James might not be able to attend the meeting due to an ongoing meeting he could not avoid. In attendance from Uganda team was Robert and Richard; Joost and Maud from Nelen and Schuurmans and Lillian and Omar from Zephyr Consulting. Omar pointed out that a key objective of the project is to test the Flood Intelligence Service tool. To test the tool appropriately, it is best to use it at a data rich environment. Should the Obongi District not have a data rich environment, the tool can be used elsewhere e.g. Kasese. Even if the FIS tool is used for a different location, SLAMDAM will still be used at Obongi or any other place in the North of Uganda.

### Action list

- P1.1 Richard had added some names to the existing project organization team and had sought approval from Dr. Callist and James on the amendments. We will receive an update on this action next week during the meeting for a possible adoption of the structure by the team.
- P1.8 Joost recommended we add first configuration of the FIS tool as an action
- P2.9 Omar asked Richard whether there are other projects planned ongoing in Uganda related to flood risk management. The reason Omar asked this is because it might be worth involving these people in our project organization or perhaps holding webinars to people involved in these projects. We can introduce other projects to SLAMDAM/FIS to see how it can help in the future. Both Richard and Robert know projects related to flood risk management in Uganda. We will add an action in the action list to identify and involve people from other projects in Uganda.
- P3.2 Omar recommended we add FIS/Adaptation Benefits report as an action
- Robert asked whether we he can receive a demonstration of FIS. Joost mentioned he will ask Maud to give a demonstration before next week's meeting.
- Maud will do a short presentation on Lizard and 3Di during the next meeting

# 1. Minutes previous meeting

## Opening

- In attendance in today's meeting from Uganda team was Dr. Callist, Mr. James, Robert and Richard ; Maud from Nelen and Schuurmans and Lillian and Omar from Zephyr Consulting.

## Action list

- P1.8 Joost and Maud to give a presentation on the FIS tool in the next meeting
- The proposed Project Organization Team (with amendments by Richard) was adopted with the understanding that the community would be involved at all levels with two community leaders (a man and a woman for gender equality); the Chief Administration Officer will be incorporated in the steering committee as well as Head of Department at the District level will be incorporated at the Project Management level.
- Robert and Richard have already sent information on flood risk analyses to Maud. She received the information, expressed her thanks, and mentioned this is valuable to understand the dynamics in the region. We need to build upon this information and enrich it with data from, amongst others, field visits.
- Maud will provide access details to the data portal for the team and how to use the portal
- Maud to give a FIS demonstration in the course of next week.
- James recommended the use of existing data/hydrodynamic model if a current one exists seeing that the project is time constrained a point that was affirmed by Dr. Callist. Richard commented that the existing data might be old data dating to the 1980s.
- It was agreed that Maud would give data requirements for the hydrodynamic model to Richard and Robert to provide to enable fast tracking of the model.
- James is following up on the first installment disbursement of funds for the project and will give an update to Omar
- Maud did a presentation of 3Di and Lizard. Richard asked whether the data in the presentation was both meteorological and hydrological to which Maud answered it was both indeed. Robert requested to be involved in the hydrodynamic modelling of Obongi District from the inception and the team was in agreement. Maud will add his email to the team handling the hydrodynamic modelling .

# 1. Minutes previous meeting

## Opening

- In attendance for today's meeting from Uganda team was Richard Musota and Robert Bogere; Maud from Nelen and Schuurmans and Lillian and Omar from Zephyr Consulting.

## Action list

- P2.1 The proposed dates for the project field visit are 15<sup>th</sup> January 2023 to 19<sup>th</sup> January 2023 with Monday 16<sup>th</sup> January 2023 morning set aside for official meetings with ministry officials and other stakeholders including members of other projects that we might partner with in the future. The project team will give out presentations in this meeting on what we are doing and what we are planning to do in Uganda to mitigate climate induced flooding (and drought). Lillian will send a proposed itinerary for the days for approval by the team members. Once an approval is achieved there will be a further itinerary for the actual field visits by Lillian and Richard.
- P1.8 Joost gave a presentation on the FIS tool. Omar added that the tool could be used to deduce benefits derived from all flood measures deployed and not only SLAMDAM. Richard commented it was a good tool and would help justify flood measures financing to authorities. He further asked Joost to give out data requirements for the tool specific for Uganda Obongi area for them to be able to provide the same to get improved results from the tool specific to the area.
- From the data Robert and Richard sent to Maud, she was able to locate a proposed 6 locations that could be possible project site locations and could form part of the hydrodynamic model. She presented these locations to the team for further discussion during the meeting. From the locations, Richard proposed a round trip during the field visits in the following order; locations 2-3-6-5-1. Maud will do an email to the project team with details on all the locations and summary details of the same.
- Robert answered the followed up queries Maud had expressed in her email regarding the data had been provided earlier for purposes of the hydrodynamic model. Richard and Robert asked to be given time to confirm exactly how flooding occurs in Obongi area.
- Maud confirmed she already gave access details to the data portal for the team and how to use the portal as well
- Omar confirmed that the first funds installment disbursement issue had been resolved.



# 1. Minutes previous meeting

## Opening

- In attendance for today's meeting from Uganda team was Richard Musota and Robert Bogere; Maud from Nelen and Schuurmans and Lillian from Zephyr Consulting.

## Action list

- P1.8 Joost to confirm whether we can close the action
- P2.1 Maud suggested we come up with detailed questions for the field visit. Lillian suggested to split the questions into two sets; i) Questions regarding flood issues and SLAMDAM location. ii) Questions that would be relayed to the locals on the ground. It was suggested and agreed that Maud would come up with the first set of questions (i) and send to the team to add any other that might be left out while Richard together with Robert would come up with the second set of questions (ii) and send to the team as well to add any other that might have been left out. The team also were ok with the proposed itinerary draft for the field visit.
- P2.2 Maud took us through the progress so far achieved on the hydrodynamic model using the data that was provided by Richard and Robert. She mentioned that more data was needed to get a better model to which there was uncertainty on the availability of any additional data by Richard so it was agreed that the data deficit would be filled by the details that would be collected during the field visit to help improve the model. In the meantime it was agreed that Robert would provide Maud with typical rain events data for the 5 locations that the team would visit during the field visit to enable her create flood simulations for the same and post them on the portal. Maud will also do a presentation of these simulations during the next meeting.
- Lillian to add Robert to the mailing list
- Richard to request James to draft an invitation letter to the Netherlands team for assistance in getting them their travel visas.

# 1/1. Minutes previous meeting

## Opening

- In attendance for today's meeting from Uganda team was James Kaweesi, Richard Musota and Robert Bogere; Maud and Joost from Nelen and Schuurmans and Lillian and Omar from Zephyr Consulting.

## Action list

- P1.4 Robert said that he had reached a snarl in getting data as he was told he needed an official letter requesting for the same; he had drafted one but it was yet to be signed. James raised a concern on the data that was required on whether it would be used for the project during its implementation or later. Omar confirmed indeed the data is very important and would be used during the project to achieve the two objectives of the project i.e. deployment of the mobile barrier and implementation of the Flood Intelligence Software; he further added that better data would lead to better analyses. Richard added that the data could also be used for project scale up. James asked Robert to print a hardcopy of the letter and send it to him to assist with the approval of the same.
- P1.7 Lillian asked if the 1<sup>st</sup> steering committee meeting could be held during the field visit since we had already agreed on its membership. Omar added that even prior to this we could agree with the committee on future meetings day and timings for ease of planning and he meetings taking of. Richard said it might be a challenge as one member of the committee i.e. the local government representative might not be identified as yet as we are yet to settle on the project site location. James reiterated to the team to have in mind the project was specifically approved for the Obongi district and the team should try as much as possible to stay within the area unless a justifiable reason comes up and such the local government representative will be from the Obongi district but he further said the committee members will have to be officially communicated to by the PS MoWE through official letters to enable the set up of an initial meeting where they will be communicated to their mandate and set up further the steering committee meetings.
- P2.1 Lillian requested Richard and Robert to assist with coming up with a detailed itinerary for the field visit based on the main one drafted earlier and presented to the team. Details to include timings, exact people to visit etc. She further asked if they could plan also the transport during the stay. Omar added that the team would also need help especially with accommodation hotels in the areas to be visited. Richard said that they would be in a position to do that together with Robert and asked James to book the time slot for a presentation with the PS on time as he usually has senior management meetings on Mondays. James said he will book the PS meeting early on and if possible have presentations done to the senior management by the project team. James added that it will be of importance as well if the Uganda team visited the proposed field site locations to alert the local authorities of the visit and the purpose prior to the whole team arriving on the 15<sup>th</sup> January. Omar asked whether the Netherlands team needed to apply for visa early on which James said its normally visa on arrival but he will confirm if it changed in the meantime he was going to do an invitation letter for the Netherlands team. He also said the visiting team needed to come with yellow fever vaccination card as well as Covid-19 vaccination card.



## 2/2. Minutes previous meeting

- P2.2 Maud requested from Richard and Robert to send the different rain events with intensities for a 24hr period broken down in different time series for better simulations as well as the discharge of the Nile. Joost confirmed this would allow them to do different models for different intensity rainfall. Robert confirmed he would send this.
- P2.7 James said he will get details of the tax exempted items by the Uganda Government to check whether we meet the threshold then advise the team from there.
- Maud took the team through the hydrodynamic model of the proposed location 3 i.e. Obongi area. Richard asked Robert if he could share with Maud the administrative boundaries of Obongi area so that she can lay the same on the model to map out Obongi area specifically and possibly pick out possible locations that the Uganda team might visit during their preliminary field visit next week. Maud said it was possible but she needed the discharge data of the Albert Nile during a typical rain event. Richard said the influence of rain is insignificant to the Albert Nile but they can share the Nile river discharges.
- Maud, Richard and Robert will draft the field questions for the team to add value before the field visit.

## 1. Minutes previous meeting

### Opening

- In attendance for today's meeting from Uganda team was James Kaweesi and Richard; Maud from Nelen and Schuurmans and Lillian and Omar from Zephyr Consulting.

### Action list

- P1.4 The letter requesting for data was processed and approved. Data is being processed and will be sent shortly.
- P2.1 James has already prepared the team's invitation letter to assist in case they get any issues with visa on entry to Uganda. The letter is awaiting signage by the PS MoWE then James will email the soft copy to all. Omar has already booked the flights to Uganda and hotel in Kampala. Robert has already embarked on the preliminary field visit and will give a preliminary report including names of hotels for booking in the field. James and Richard are finalizing on securing transport for the teams during the field trip and James added that Zephyr Consultants Limited will need to pay for some costs including fuel for the vehicle(s) as well as per diem for the staff that will be involved in the field work. Lillian requested Richard to draw a budget for these costs to enable early preparation for the same. James will have a meeting with the PS to confirm the meeting with him and other senior management when the team arrives in Uganda. There will be a debrief report meeting after the field work where the team will meet the rest of the Uganda officials and teams.
- P2.7 James asked if a summary of the mobile barrier and accessories with their use could be sent to him to enable easier explanation of the same when seeking tax exemption to which Omar sent him a brochure of the SLAMDAM to assist him in this. James then invited the Head of Procurement to advise on this action and he said that it is possible to get a tax exemption. He said that we will need to engage the Revenue Authority officially requesting for this but before that he said he would visit the Revenue Authority offices and inquire exactly how to go about this request and update James on the outcome of the meeting.
- Omar asked if it would be possible to explore other sources of data for FIS analyses during our visit in Uganda; to discuss with other people to collect data at other high priority locations where programmes are ongoing or planned. James said that this was a good idea as there are some areas like River Nyamwamba in Kasere that might benefit from this assessment for their current flood management strategies. Richard added that the tool could be very useful to assist management in making decisions and that this can be discussed in the MoWE headquarters during the field visit.
- Maud asked if the element of drought could be added in the action list as there is an element of this in the project as well as when we expect to deploy the SLAMDAM and the actions required for the deployment.

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## Project Uganda Progress Meeting with Project Team Members

Held remotely via Zoom

<b>Date: Thursday, February 2, 2023</b>	<b>Time: 12:00 – 13:00hrs (Uganda time)</b>
<b>Purpose</b>	
<b>Project Weekly Update Meeting</b>	
<b>Project Uganda:</b> Implementation of a low-cost, climate resilient, re-usable, easy replicable, scalable and mobile flood barrier as an effective solution to adapt to enhance resilience and reduce vulnerabilities caused by floods (climate change-induced seasonal melt water from glaciers) in Obongi District, Uganda.	
<b>Attendance</b>	
Omar Saleh (Zephyr); Lillian Kalela (Zephyr); Maud Van Delden (Nelen & Schuurmans); Richard Musota (MoWE).	
<b>Absent with Apologies</b>	
James Kaweesi; Robert Bogere.	
<b>Notes, Decisions, Issues</b>	
<b>Minute 01/02.02.2023: Flood Risk Assessment Report: General Content</b>	
The meeting began with Lillian taking the team through the Risk Assessment Report document on google drive. She explained that the document begins with the project's mission general context then dives deeper into the technicalities.	
<b>Minute 02/02.02.2023: Flood Risk Assessment Report: Technical Content</b>	
Maud took the team through the technical aspects in the document. She informed the team that she	

was yet to post in the document the hydrodynamic model as she was yet to get the rainfall data needed to improve on the model. Maud suggested to merge the general context with the technical bit for the document to flow. Lillian said she would do this.

**Minute 03/02.02.2023: Flood Risk Assessment Report Status Update**

Richard promised to send to Maud by Monday 6<sup>th</sup> February a flood assessment report that was done earlier to help her refine the hydrodynamic model and post the same in the document. Richard was also tasked together with Lillian to follow up with James on the meteorological data.

**Minute 04/02.02.2023: Flood Risk Assessment Report: Decision Matrix**

The team also went through the decision matrix and it was agreed that Omar would fill in the suitability section and Maud fill the expected benefits section.

**Minute 05/02.02.2023: Reports clarification**

Richard suggested that we should have two separate reports; one specific mission report and two a flood risk assessment report. Omar clarified while the flood risk assessment will be a full document the mission specific document that will be presented to the steering committee will be a power point presentation.

**Minute 06/02.02.2023: Flood Risk assessment Report structure**

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Richard suggested that the technical aspect in the risk assessment report we were going through should begin with the technical aspects and have the mission's general content at the end. It was agreed that he would go through the document, make his input and make the necessary adjustments to the document's structure.

**Minute 07/02.02.2023: Other required data**

Maud informed the team that she was still awaiting the population density map; Robert was yet to share the same. Richard was asked to follow up with him on this.

**Minute 08/02.02.2023: Flood Risk Assessment Report Recommendations and Conclusion**

It was agreed that Lillian would draft the recommendations and conclusion's part and pass it by Omar for review before posting the same in the document.

**Minute 09/02.02.2023: Flood Risk Assessment Report Status Update**

It was agreed that the team should put effort and ensure that the first draft report is ready by Wednesday 9<sup>th</sup> February 2023 to enable team continue with other project actions.

**Minute 10/02.02.2023 AOB**

There being no other business the meeting was adjourned at 13:00hrs (Uganda time)

**Action Items**

Next meeting will be held on February 08, 2023

**Additional Notes:** None



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## Project Uganda Progress Meeting with Project Team Members

Held remotely via Zoom

<b>Date: Wednesday, February 8, 2023</b>	<b>Time: 15:00 – 14:30hrs (Uganda time)</b>
<b>Purpose</b>	
<b>Project Weekly Update Meeting</b>	
<b>Project Uganda:</b> Implementation of a low-cost, climate resilient, re-usable, easy replicable, scalable and mobile flood barrier as an effective solution to adapt to enhance resilience and reduce vulnerabilities caused by floods (climate change-induced seasonal melt water from glaciers) in Obongi District, Uganda.	
<b>Attendance</b>	
Omar Saleh (Zephyr); Lillian Kalela (Zephyr); James Kaweesi; Maud Van Delden (Nelen & Schuurmans); Richard Musota (MoWE); Robert Bogere (MoWE).	
<b>Notes, Decisions, Issues</b>	
<b>Minute 01/08.02.2023: Flood Risk Assessment Report Update</b>	
The meeting began with Maud taking the team through the Risk Assessment Report document on google drive. Explained she still awaits the rainfall intensities data to enable her finalize on the hydrodynamic model.	
<b>Minute 02/08.02.2023: Flood Risk Assessment Report: Comments</b>	
James suggested we edit the document to have a specific chapter on Flood Risk Assessment as compared to current where it was part of the field mission chapter. He further recommended a flow	

of the chapters in the document to which Lillian confirmed it was currently as his suggestion.

**Minute 03/08.02.2023: Flood Risk Assessment Report: Finalization**

It was agreed that the final deadline for submission of any missing information required was Friday 10<sup>th</sup> February 2023. James confirmed he would submit additional content to the introduction. Robert confirmed he would provide rainfall intensity data by CoB Thursday 9<sup>th</sup> February 2023 to enable Maud finalize on the hydrodynamic model for the risk assessment report. Robert together with Maud were also tasked to finalize on the risk assessment chapter. It was also agreed that if the rainfall data was not submitted by the agreed deadline, then Maud would use 50mm as the baseline and finalize on the hydrodynamic model. It was also agreed that if no new data was provided for the decision matrix then the team would use the current estimates already factored in. It was also agreed that Lillian would draft the executive summary together with Omar. Further it was agreed that on Monday 13<sup>th</sup> February 2023 Lillian would do the final compilation/editing of the document and send James for onward submission to the ministry's Permanent secretary among other stakeholders by Tuesday 14<sup>th</sup> February 2023.

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**Minute 04/08.02.2023: AOB**

There being no other business the meeting was adjourned at 16:30hrs (Uganda time)

**Action Items**

Next meeting will be held on February 15, 2023

**Additional Notes:** None

# 1. Minutes previous meeting

## Opening

- In attendance for today's meeting from Uganda team was James Kaweesi and Robert Bogere; Lillian and Omar from Zephyr Consulting. Maud from Nelen and Schuurmans and Richard Musota were absent with apologies.

## Action list

- P1.5 Lillian to draft a list of proposed stakeholders for confirmation.
- P1.6 Lillian to start drafting the M&E Plan now that the SLAMDAM deployment location area has been recommended.
- P1.7 Once the flood risk assessment report is finalized, James will write a letter to the PS MoWE on the need to oversee the project's implementation and offer of technical guidance by formation of a steering committee. In the letter, James will also propose the members to participate in this committee. The official member nominees to be recommended include: The PS MoWE, Dr. Zaake, Dr. Callist, The Director Water Resources Management, The Commissioner Water Regulation, The commissioner Water Production, The CAO Obongi District, Obongi District water production officer while the ex-officio member nominees to be recommended include: James Kaweesi, Richard Musota, Robert Bogere, Omar Saleh, Lillian Kalela, Maud van Delden, Obongi district water officer, community development officer and community representative. Omar requested James to send an email with a list of all the names of all the recommended steering committee members with their contact details for purposes of meetings planning logistics.
- P2.9 Robert said they had identified at least one project and will confirm the same during next meeting when richard will be in attendance.
- P3.1 James will add some content on the introductory part of the flood risk assessment report. Robert noted some data that needed to be added in the said report and he would be adding the same to the document. Lillian to add as annex to the report all the meeting minutes from the inception of the project to date as well as the list of all the people the team met during the first field mission. Members were advised to add any other content they felt was missing to the document to enable one final review of the same before presenting the same to the PS MoWE among other stakeholders.
- Omar noted that at this moment the length of the barrier as well as where the dam will be positioned should be of importance.

# **Intelligent Flood Resilience**

**Project initiation document**

**Version 3.0**

**28/08/2022**



## Document Control

### Document Information

	Information
Document Id	
Document Owner	
Issue Date	
Last Saved Date	
File Name	

### Document History

Version	Issue Date	Changes
[1.0]	[Date]	[Section, Page(s) and Text Revised]

### Document Approvals

Role	Name	Signature	Date
Project Sponsor	Adaptation Fund		
Project Review Group			
Project Manager	Lillian Kalela		
Senior Consultant-Project Management	Omar Saleh		
Monitoring and Evaluation Officer			
Communications Officer			

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## Project summary

The Obongi District is located in the West Nile Sub-Region of Northern Uganda. The complete district has 50,000+ inhabitants divided over 3 sub counties, 14 Parishes and 60 villages. Overflowing of the River Nile and heavy rainfall cause serious damage to the communities leading to displacements and loss of livelihoods.

The vulnerability became apparent in November 2020 when flooding of the river Nile caused displacements of more than 23.000 residents of the Obongi District. The whole of Obongi District is flood prone; however, there are hotspots that are least prepared for and most affected by the floods.

This project will focus on one of those hot spots being Namsambya in Obongi Town Council with an estimated population of about 800 people of which 408 male and 392 are female of whom 320 are children and about 50 persons are living with disability. There are also self-settled refugees from South Sudan who are vulnerable to floods.

The area has a level ground surface and lacks structures to prevent flooding of the river Nile. Even though the district experiences floods on a regular basis, there are also times when there is a shortage of water. Water isn't stored anywhere after flooding; subsequently, the water is lost even though it could be repurposed elsewhere or at a different time when there is a shortage. The people in the area therefore lack clean and safe water at times.

Adequate flood and drought risk analyses are missing at Obongi District and perhaps across the whole of Uganda. Reliable flood and drought risk analyses are needed to determine what resilient measures the district should implement to enhance its resilience effectively and cost-efficiently. These analyses require enriched flood and drought data to which the district currently doesn't have access to.

The project aims to increase the resilience of communities to the risk of floods and droughts at the Obongi district through the deployment of a scalable water-filled barrier technology known as SLAMDAM to prevent flooding and simultaneously store and harvest water. The project aims to increase the adaptation capacity of the pilot local population and the resilience of the ecosystems, while improving water availability for times when there is drought. This will be achieved through four main components:

1. Assessment of flood and drought risk profile and anticipated benefits from flood resilient solutions using innovative intelligence software
2. The development and implementation of the SLAMDAM-technology to manage the identified flood and drought risks effectively
3. Developing and strengthening climate change adaptive capacities of institutions and communities
4. Promoting the flood intelligence software and the SLAMDAM-technology as effective measures to enhance resilience to floods and drought

## Purpose

The main purpose of this project is to demonstrate the impact of FIS in combination with SLAMDAM. This can be categorized as follows:

1. Improved understanding of how to enhance resilience to flooding effectively yet cost-efficiently using flood intelligence software.
2. Improved resilience to floods strengthening –SLAMDAM will be used to effectively prevent damages caused by flooding
3. Enhanced capabilities to manage risk of floods enhanced – Local people and institutions are able to enhance resilience independently using flood resilient measures

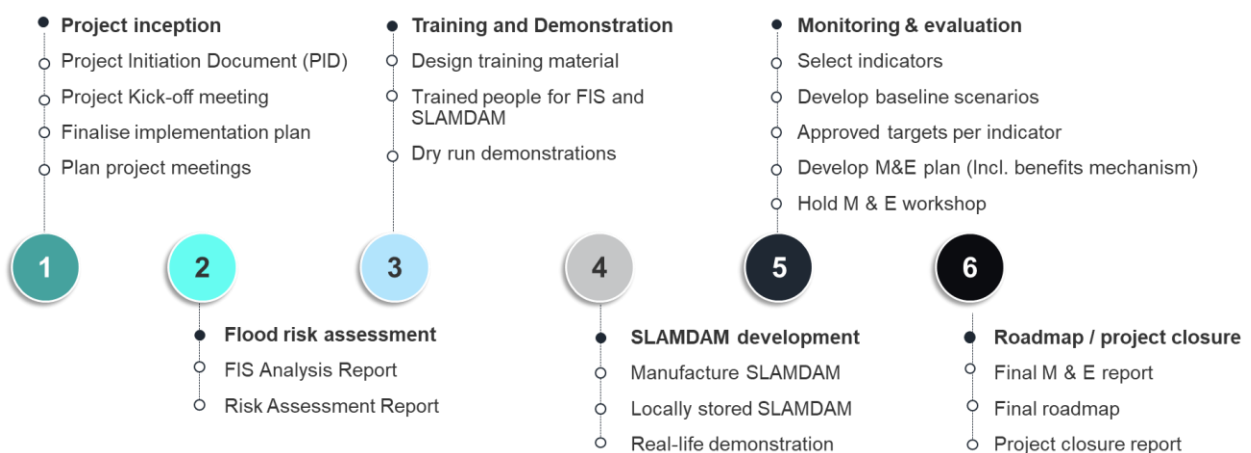
## Project objectives

The overall goal of the project is to strengthen resilience and reduce vulnerability of communities to the risk of climate change-induced floods and droughts within the Obongi District through data-driven risk analyses and the deployment of a scalable water-filled barrier to prevent flooding and optionally store and harvest water that will be repurposed for a drought event.

The specific objectives of the project are to:

1. Demonstrate the effectiveness of FIS to enhance resilience to floods
2. Demonstrate the effectiveness of SLAMDAM to enhance resilience to floods
3. Generate awareness and capacity building

## Scope and Exclusions



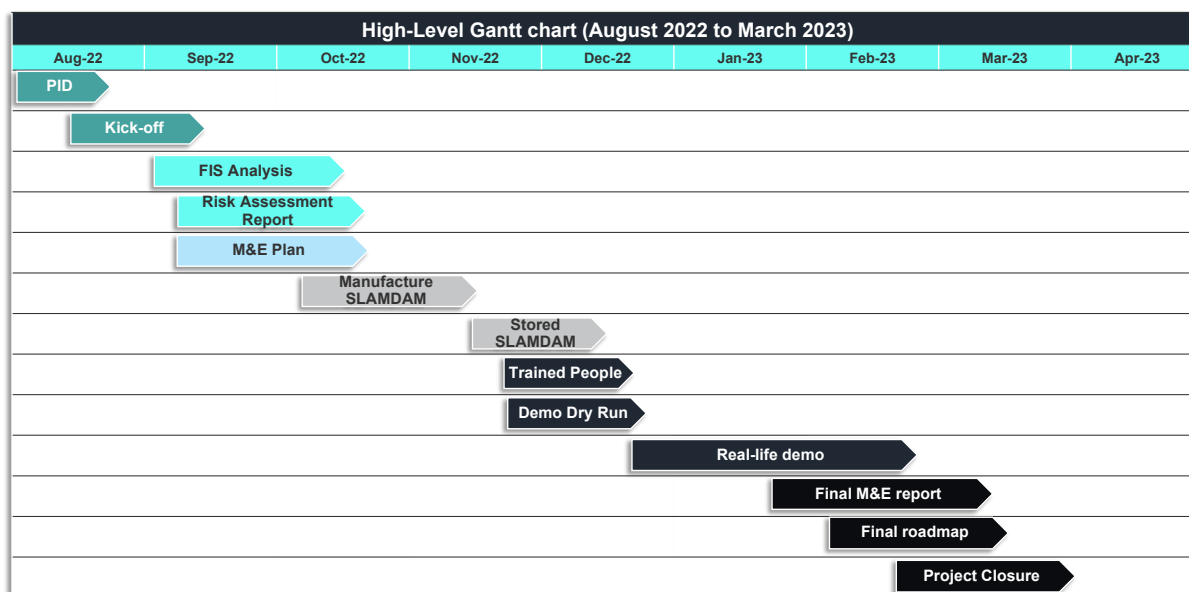


## Project deliverables

<b>Task</b>	<b>Deliverable</b>	<b>Timeline</b>
<b>PHASE 1</b>		
Prepare Project Initiation Document	Project Initiation Document	Week 4
Kick-off meeting	Kick-off presentation	Week 4
Prepare project implementation Plan	Project Implementation Plan	Week 5
<b>Task</b>	<b>Deliverable</b>	<b>Timeline</b>
<b>PHASE 2</b>		
Data exploration	Collected data & recommendations	Week 6
Store and publish data	Enriched data stored in a portal	Week 8
Develop flood scenarios	Flood scenarios and flood risk maps	Week 10
Flood risk assessment	Workshop and final risk assessment	Week 12
Flood barrier design	Assessment barrier design and location	Week 14
Prepare an FIS analysis report	FIS analysis report	Week 16
Prepare a risk assessment report	Risk assessment report	Week 16
<b>Task</b>	<b>Deliverable</b>	<b>Timeline</b>
<b>PHASE 3</b>		
Stakeholder mapping	A complete stakeholder list (Incl. Flood response team)	Week 17
Stakeholder consultation	Stakeholder workshop and report	Week 18
Design training material	Training material (manual / procedures)	Week 19
Train stakeholders on FIS and SLAMDAM	Trained people for FIS and SLAMDAM	Week 21
Training flood response team	Dry run demonstrations	Week 22
<b>Task</b>	<b>Deliverable</b>	<b>Timeline</b>
<b>PHASE 4</b>		
Flood barrier design	Manufacture SLAMDAM	Week 26
Ship SLAMDAM to Uganda	Locally stored SLAMDAM	Week 30
Real-life demonstration	Recording / report of demonstration	Week 31

Task	Deliverable	Timeline
	<b>PHASE 5</b>	
Select indicators	Indicators selected	Week 31
Develop baseline scenarios	Baseline scenarios selected	Week 31
Select targets per indicators	Approved targets per indicator	Week 31
Develop M&E plan (Inc. Benefits mechanism)	Approved M&E plan (Inc. Benefits mechanism)	Week 32
Hold M&E workshop	Collect M & E results	Week 32
Task	Deliverable	Timeline
	<b>PHASE 6</b>	
Make draft M&E report	Draft M&E report	Week 33
Finalize M&E report	Workshop and final M&E report	Week 34
Prepare roadmap	Draft roadmap to scale-up in Uganda	Week 35
Finalize roadmap	Workshop and final roadmap	Week 35
Project completion	Closure report and lessons learned	Week 36

## Project planning



## Monitoring and Evaluation

The M&E system encompasses all key building blocks required for the effective monitoring and evaluation. The term 'monitoring' refers to the continuous process of periodical performance reporting to stakeholders such as the MOWE. 'Evaluation' refers to the periodic formative and final assessments (evaluations after activities and/or funding have ended) of MOWE supported actions.

The M&E system will enable MOWE to monitor and evaluate the effectiveness of the piloted technology as well as the capabilities of the responsible people to execute M&E activities.

The M&E system comprises of (1) a theory of change and (2) a logical framework. The logical framework contains objectives, outcomes and outputs. Each output has indicators defined that have to be monitored as part of the M&E framework. The logical framework. With each indicator it is explained what the metrics are (source and how to measure). This logical framework has to be completed each time a flood event has occurred.

There will be a process in place describing the roles and responsibilities and the dissemination of the outcome of the M&E activities. Weekly meetings will be done online using Zoom or MS Teams. Our local partner will coordinate activities executed in Uganda. Because we have frequent project team meetings, we ensure progress, risks, issues and budget exceptions are monitored openly and closely. Training will be done online and onsite.

The project will be monitored in accordance with a detailed M&E plan. The monitoring activities will be carried out by the dedicated coordinator. M&E activities enable a learning curve that ensures that the SLAMDAM-technology is deployed more effectively with each flood or drought event. As part of the M&E-activities, local stakeholders will explore why they weren't able to realise certain flood or drought targets or how they can set more ambitious targets. This requires close collaboration between different stakeholder groups.

Below reports and evaluations will be developed throughout the project:

- **Monitoring and Evaluation Plan (M&E Plan)** – the Steering Committee approves
- **Quarterly Status Reports (QSR)** – submissions will be delivered every three months after the start of the project. There reports will monitor progress made.
- **Project Completion Report (PCR)** – this report will be made after the real-life demonstration to assess whether the targets of component 3 have been realized.
- **Monthly Steering Committee Report and Weekly Project Delivery Report**
- **External Audit Report (EAR)** – an external audit report will be prepared in accordance with regulations by the Ministry of Water and Environment (Uganda).

The project team will undertake baseline surveys and use the flood intelligence software to prepare a detailed M&E plan that streamlines project objectives, indicators and methodologies of data collection.

## Risk Log

#	Risk Description	Chance	Impact	Mitigation
R1	Risk that we choose the wrong locations to implement SLAMDAM due to improper analysis caused by inadequate tooling, expertise or data	M	H	<ul style="list-style-type: none"> <li>Use state-of-the-art software tooling to analyse flood and drought risks</li> <li>Collect the best possible data to analyse flood and drought risks</li> <li>Involve experts who can analyse flood and drought events using hydrodynamic modelling software</li> <li>Involve experts who know the project location well</li> </ul>
R2	Risk that SLAMDAM doesn't prevent a significant number of damages due to reality not being in line with the theoretical models	M	H	<ul style="list-style-type: none"> <li>See mitigation with R1</li> <li>Develop monitoring and evaluation plan</li> <li>Appoint monitoring and evaluation expert team</li> <li>Train flood response team to anticipate in case changes must be made to the initial setup</li> </ul>
R3	Risk that SLAMDAM isn't deployed in a timely manner due to the flood response team not being informed caused by a lacking flood early warning system	M	H	<ul style="list-style-type: none"> <li>Ensure an adequate flood and drought early warning system is in place</li> <li>Create a comprehensive flood and drought warning process including the appointment of roles and responsibilities</li> <li>Ensure that the storage facility is not too far from the location of deployment</li> <li>Deploy SLAMDAM for a longer period as opposed to when a flood or drought event is detected</li> </ul>
R4	Risk that SLAMDAM is not deployed well due to lack in capabilities of local people caused by inadequate training on	M	H	<ul style="list-style-type: none"> <li>Appoint flood response organisation</li> <li>Have a training program for authorities that need to act in case of floods and train staff accordingly</li> <li>Create processes / manuals / procedure / working instructions and visual aids</li> </ul>



	how to operate and maintain SLAMDAM			
R5	Risk that SLAMDAM doesn't work effectively due to leakage or overtopping water caused by improper design or defects	M	H	<ul style="list-style-type: none"> <li>Design SLAMDAM in line with the outcome of the hydrodynamic analyses</li> <li>Inspect the material before shipping the material in accordance with the pre-inspection template</li> <li>Inspect the material upon arrival</li> <li>Provide repair kits and train local people on how to make reparations is needed</li> </ul>
R6	Risk the project cannot be completed due to lack of funding caused by improper budgeting	M	H	<ul style="list-style-type: none"> <li>Budget the costs well using the input from different suppliers and discuss what happens in case of exceptions</li> <li>Establish contracts with the different suppliers</li> <li>Discuss budget deviations with the steering committee</li> </ul>
R7	Risk that SLAMDAM cannot be deployed due to lack in availability of water caused by drought or poor planning	M	H	<ul style="list-style-type: none"> <li>Carefully plan where to store and deploy SLAMDAM see also mitigation measures with R1</li> <li>Plan what to do in case there is insufficient water available to deploy SLAMDAM</li> </ul>
R8	Risk that SLAMDAM cannot be deployed due to lack of appropriate infrastructure and transportation equipment caused by improper planning	M	H	<ul style="list-style-type: none"> <li>Carefully plan where to store and deploy SLAMDAM see also mitigation measures with R1</li> <li>Purchase transportation equipment to move the flood barrier from the storage facility to the location of deployment</li> <li>Ensure the road to the location of deployment is accessible</li> </ul>
R9	Risk that SLAMDAM will rupture due to overfilling caused by lack in clarity when the flood barrier is full	M	M	<ul style="list-style-type: none"> <li>Have some markings on the units to indicate when unit has reached its maximum capacity to take in water</li> <li>Get a pressure valve that indicates when the flood barrier is full</li> </ul>

R10	Risk that SLAMDAM is ineffective due to the ground surface not being suitable for the mobile flood barrier caused by improper planning	<b>M</b>	<b>H</b>	<ul style="list-style-type: none"> <li>Need for project team, including the manufacturer of SLAMDAM, to visit proposed site(s) at the start of the project</li> <li>Use the decision tree and matrix to determine whether the location is suitable</li> </ul>
R11	Risk that the project runs out of funding to import the dams due to excessive import duties caused by missing tax exemption by the government	<b>H</b>	<b>C</b>	<ul style="list-style-type: none"> <li>Explore how to get a tax exemption</li> <li>Start the tax exemption process at the start of the project</li> <li>Escalate to the highest authorities in case import duties exceed project budget</li> </ul>
R12	Risk that the project is not implemented within the timeframe due to SLAMDAM and materials taking too long to be transported caused by bureaucracy and obstructions	<b>M</b>	<b>H</b>	<ul style="list-style-type: none"> <li>Get correct information from the local import company on how long it will take for a shipment from the Netherlands to arrive</li> <li>Plan carefully when to ship SLAMDAM and other materials</li> </ul>
R13	Risk that the SLAMDAM is not used properly due to insufficient buy in from local stakeholders caused by lack of involvement in the project	<b>M</b>	<b>H</b>	<ul style="list-style-type: none"> <li>Conduct workshops for the local community on the project and its benefits to them</li> <li>Include somebody in the project team who knows and is respected by the local community and local stakeholders</li> </ul>
R14	Risk that SLAMDAM or other materials gets damages or stolen due to mishandling or vandalism caused by improper security measures	<b>M</b>	<b>H</b>	<ul style="list-style-type: none"> <li>Ensure adequate security measures are in place to protect SLAMDAM and materials from vandalism or theft</li> </ul>

## Project Organisation

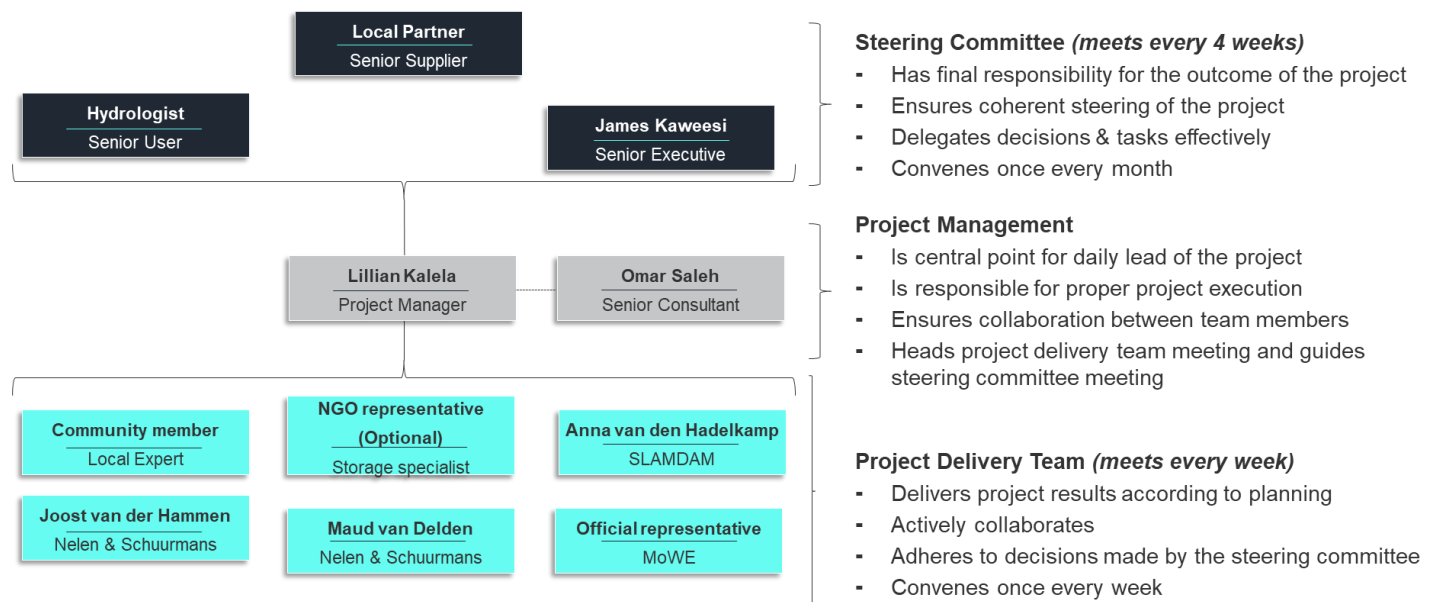


Table 1 below: Roles and Responsibilities:

Project Team's Roles and responsibilities		
Name	Role	Responsibilities
Local Partner	Senior Supplier	Responsible for clear and timely communication with local authorities and companies and the coordination of locally performed activities.
Hydrologist	Senior User	Responsible for specifying requirements of the outcome of the project to determine whether the project is successful or not.

James Kaweesi	Senior Executive	Responsible for a successful outcome of the project and they have significant decision power – supported by the senior supplier and senior user.
Lillian Kalela	Project Manager	Central point for daily lead of the project and is authorised to execute the project on behalf of the steering committee.
Omar Saleh	Senior Consultant	Supports Project Manager
Community Member	Project Team	Responsible collecting local data including project site(s) identification and for deploying the flood barrier
NGO Representative (Optional)	Project Team	Responsible for storage of the flood barrier
Anna van den Hadelkamp	Project Team	Responsible for designing and manufacturing the SLAMDAM-technology
Joost van der Hammen	Project Team	Responsible for overseeing data-driven flood risk assessment using the Flood Intelligence Software (FIS)
Maud van Delden	Project Team	Responsible for hydrological data gathering and supporting software analyses
Local Partner	Project Team	Responsible for liaising with local people and support in data collection for the Flood Intelligence Software (FIS)



## Communication Plan

Zephyr Consulting will develop a communication plan that stipulates when, how and to whom to communicate information gained from the pilot project. It is paramount to keep open and transparent communication lines with different stakeholders. We will inform stakeholder groups of any progress made or deliverables realized. It is important to communicate using pictures, StoryMaps, videos or with hard data.

A StoryMap is an effective way of communicating the project to a wider audience. This can be amplified by distributing it via other channels such as social media.

The M&E framework will provide evidence on the actual impact of FIS and the SLAMDAM-technology. These hard data are important to communicate, especially when scaling up across Uganda; this allows them to analyze what the impact of FIS and SLAMDAM would be for them.

## Financial / budget requirements

Table 1: Summary of Costs

TOTAL PROJECT COST (US Dollar Currency)	
COST COMPONENT	COST
Remuneration	171.000
Reimbursable Expenses	29.500
FIS installation and fees	55.000
Materials	125.000
TOTAL*	380.500

\* The amount exceeding the budget of USD 250.000 will be donated outside of the funding provided by the Adaptation Fund.

Table 2: Remuneration

Names	Position	Number of days	Daily Fees	Total
Lillian Kalela	Project Manager	50	800	40.000
Omar Saleh	Project manager	50	800	40.000
James Kaweesi	Local partner	25	600	15.000

<i>Maud van Delden</i>	Lead hydrologist	20	800	16.000
<i>Anna van den Hadelkamp</i>	SLAMDAM expert	20	700	14.000
<i>Jan Boes</i>	Senior consultant	40	800	32.000
<i>Local Community</i>	Community rep.	10	400	4.000
<i>Local Hydrologist</i>	Local hydrologist	15	400	6.000
<i>Gender Expert</i>	Gender expert	10	400	4.000
TOTAL				171.000

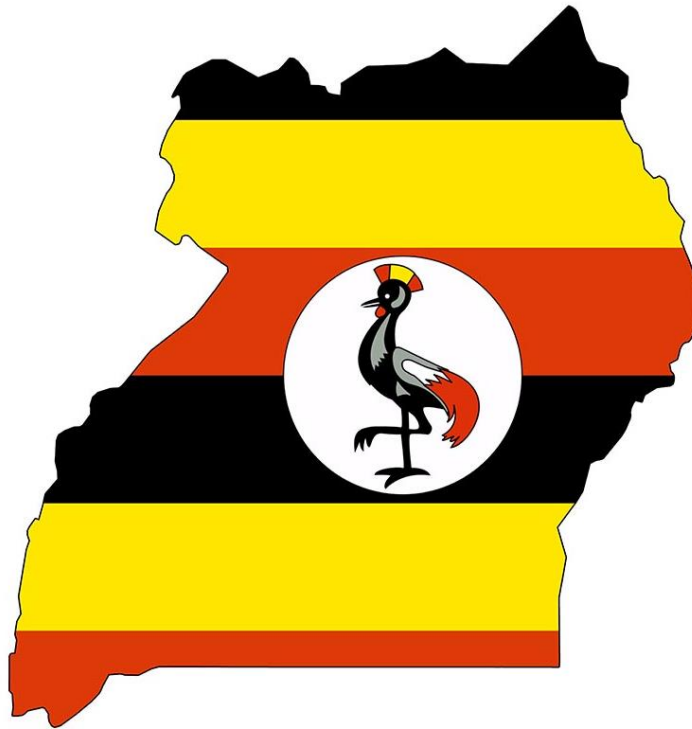
Table 3: Breakdown of Reimbursable Costs

Item No.	Description	Quantity	Unit Price	Total Amount
	<b>Travel:</b>			
	Airfare	8	1.000	8.000
	Hotel	40	150	6.000
	Meals and Incidentals	80	75	6.000
	<b>Local Travel:</b>			
	Ground transportation	40	50	2.000
	Other local travel cost	30	50	1.500
	Communication Expenses	30	200	6.000
	Other Direct Expenses (activity based)			
	TOTAL			29.500

\*Reimbursable Expenses shall be limited to reasonable, allowable and necessary costs to undertake the services defined In the Technical Proposal.

# Technology Transfer Plan SLAMDAM Uganda

*Building resilience against flooding using a mobile flood barrier*



<b>Project name:</b>	Project SLAMDAM UGANDA
<b>Date:</b>	20 / 06 / 2023
<b>Author:</b>	Lillian Kalela
<b>Owner</b>	Steering Committee Project SLAMDAM UGANDA
<b>Document code:</b>	PID012023
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**Version control**

Date	Revision	Notes
20 / 06 / 2023	Original document	Technology Transfer Plan (TTP) first created

## **1. Goals and objectives of the Technology Transfer Plan (TTP)**

The TTP outlines the goals and objectives of transferring the SLAMDAM-technology from the supplier in the Netherlands to the end-users in Uganda. In the context of the pilot project in Uganda, the technology transfer plan for SLAMDAM aims to achieve the following goals and objectives:

### **Introduce and Adapt Technology**

The primary goal of the TTP is to introduce the SLAMDAM flood barrier technology to Uganda and adapt it to local conditions. This involves ensuring that the technology is suitable for the Ugandan context and can effectively address the challenges posed by floods in the region.

### **Build Local Capacity**

The plan builds local capacity by transferring knowledge, skills, and expertise related to the deployment, operation, and maintenance of SLAMDAM. This involves training local flood response team, and community members on how to install, use, and manage SLAMDAM effectively.

### **Collaborate with Local Stakeholders**

The TTP emphasizes collaboration with and between local stakeholders, including government agencies, non-governmental organizations, community leaders, and relevant institutions. Engaging these stakeholders helps to ensure their active participation and support in the technology transfer process, fostering ownership and long-term sustainability.

### **Conduct Pilot Projects and Demonstrations**

The TTP includes conducting pilot projects and demonstrations in selected flood-prone areas of Uganda. These initiatives will showcase the effectiveness of SLAMDAM in flood mitigation, gather feedback from local communities, and provide real-world data to inform decision-making and further improvements.

### **Develop Monitoring and Evaluation (M&E) Mechanisms**

A crucial objective is to develop an M&E mechanism to assess the impact and effectiveness of the TTP. This involves setting up performance indicators, data collection processes, and evaluation frameworks to measure the success of SLAMDAM in enhancing resilience to floods and improving the well-being of the affected communities.

### **Promote Knowledge Exchange and Documentation**

The TTP facilitates knowledge exchange between the technology provider and the local stakeholders. This involves organizing workshops, seminars, and conferences to share experiences, lessons learned, and best practices in flood management. In addition, documenting the technology transfer process and outcomes will ensure that valuable knowledge is preserved and can be shared with others facing similar challenges.

By incorporating these goals and objectives into the TTP, we can create a comprehensive roadmap for successfully introducing and implementing SLAMDAM in Uganda to enhance resilience to floods.

## **2. Target audience**

The target audience of the TTP for SLAMDAM in Obongi, Uganda, primarily includes the following stakeholders:

### **Local Community Members**

The TTP caters to the needs and interests of the local community residing in Obongi. This includes individuals, families, and community groups directly affected by floods. The plan addresses their concerns, provide information about SLAMDAM's benefits, and engage them in the process of deployment, maintenance, and usage.

### **Local Flood Response Team**

The locally appointed flood response team responsible for the deployment and maintenance of SLAMDAM is a key target audience. The plan focuses on training and capacity building for these team members to ensure they possess the necessary skills and knowledge to effectively handle the flood barrier. It also establishes clear lines of communication and protocols for their involvement in the technology transfer process.

### **Ministry of Environment and Water**

As the supervising body, the Ministry of Environment and Water plays a crucial role in overseeing the project's implementation and success. The TTP should provides relevant information to the ministry, demonstrating the benefits of SLAMDAM and its potential impact on flood resilience in Obongi. This audience will be interested in the technical specifications, project timelines, M&E mechanisms, and overall project coordination.

### **Local Government Officials**

Local government officials, including district authorities and administrative personnel, are considered as an important audience. They are responsible for policymaking and resource allocation in the region. The TTP outlines the objectives, benefits, and potential for long-term sustainability, aiming to secure their support and collaboration. It addresses any regulatory or administrative requirements necessary for the deployment and maintenance of SLAMDAM.

### **Non-Governmental Organizations (NGOs) and Development Partners:**

NGOs and development partners involved in flood management and community resilience initiatives in the region can be engaged as part of the TTP. These organizations can provide valuable insights, resources, and technical expertise. The plan highlights opportunities for collaboration, knowledge sharing, and potential funding or partnership arrangements.

### **Community Leaders and Opinion Influencers:**

Engaging community leaders, religious leaders, and influential individuals within the Obongi community is essential for successful technology transfer. They can play a vital role in mobilizing community support, disseminating information about SLAMDAM, and encouraging community participation. The TTP outlines strategies for engaging and involving these key stakeholders in the project.

By identifying and targeting these specific audiences, the technology transfer plan can ensure effective communication, engagement, and collaboration with the relevant stakeholders involved in the deployment of SLAMDAM in Obongi, Uganda.

### **3. Regional scope**

#### **3.1 Uganda climate and hydrology**

Uganda is a landlocked country located in East Africa, bordered by South Sudan to the north, Kenya to the east, Tanzania to the south, Rwanda to the southwest, and the Democratic Republic of the Congo to the west. The climate and hydrology of Uganda are strongly influenced by its location near the equator and its varied topography.

##### **Climate**

Uganda has a tropical climate with two distinct seasons. The dry season, from December to February and from June to August, is characterized by low humidity, clear skies, and warm temperatures. The wet season, from March to May and from September to November, is characterized by heavy rainfall, high humidity, and cooler temperatures. The amount of rainfall varies depending on location and altitude, with the highest rainfall occurring in the western and central parts of the country. The average temperature in Uganda is around 26 degrees Celsius, with some regional variation due to altitude.

##### **Hydrology**

Uganda is a water-rich country with numerous lakes, rivers, and wetlands. The country is home to the largest lake in Africa, Lake Victoria, which is shared with Kenya and Tanzania. Lake Victoria is a major source of water for the country, supplying the majority of the water used for domestic and agricultural purposes. The Nile River also flows through Uganda, providing additional water resources. Other significant rivers include the Kagera, the Murchison, and the Semliki.

In summary, Uganda has a tropical climate with two distinct seasons and a varied topography that influences local weather patterns. The country is water-rich, with numerous lakes, rivers, and wetlands, and has a high potential for hydropower generation. However, access to clean water remains a challenge for many Ugandans.

#### **3.2 Impact of climate change**

Climate change has also greatly impacted the country's rainfall intensities over the years. The country has been experiencing increased frequency and severity of extreme weather events. Some of these events include erratic heavy rainfalls. Increased intensity of heavy rainfall has led to greater impact of floods and are causing more damage due to expanded infrastructure, human settlement and general development of the country. Uganda experiences both flash floods and slow-onset floods, which are common in urban areas, low-lying areas, areas along river banks and swamplands.

According to a World Bank report published in 2020; each year floods impact nearly 50,000 Ugandan people and cost over \$62 million in damages. Areas most prone to floods are the capital city, Kampala, as well as the northern and eastern areas of the country. Obongi District is also one of the areas in the northern area of Uganda that has been experiencing devastating floods. The complete district has 50,000+ inhabitants divided over 3 sub counties, 14 Parishes and 60 villages. In 2020 more than 23,000

residents of Obongi District in West Nile were displaced from their homes as the sub-region experienced severe flooding caused by rising River Nile waters. This left Obongi Landing Site and the Liri Trading Centre, Namisambya Town East and Kilamin village neighboring Obongi Landing Site as well as parts of Palorinya refugee settlement camp were among the affected parts by the floods.



Figure 1: Map of Uganda

### 3.3 Target area “Waka”

The most important river flowing through Waka is the Kochi river as part of the Kochi sub-catchment. In total, the sub-catchment covers an area of about 1600 km<sup>2</sup>. The majority of the tributaries of the Kochi river originate from the East side, all the way up to the border of DRC. On the west side of the catchment, the elevation reaches up to 1200 m AMSL, while 70 km to the East, at the outflow of the Kochi into the Nile, elevations of around 600 m AMSL are found. Hence, on average, over 117 meters the elevation drops 1 meter. The area of the Waka community is part of a depression in the landscape. It is bounded by the Kochi river on both the Western side and the Southern side. Besides, the elevation decreases by around 70 meters from Ombechi in the North to Waka in the Southern part of the sub-catchment.

The river course of the Kochi is a meandering river from North to South until it flows in the Eastern direction and discharges into the Nile. As a result of high discharges in the Kochi, the outer bends of the river are impacted by the high flow velocities perpendicular to the banks and experience soil erosion. This soil erosion is even worsened by animals and pastoralists crossing the banks and eroding the banks even more, see Figure 2.



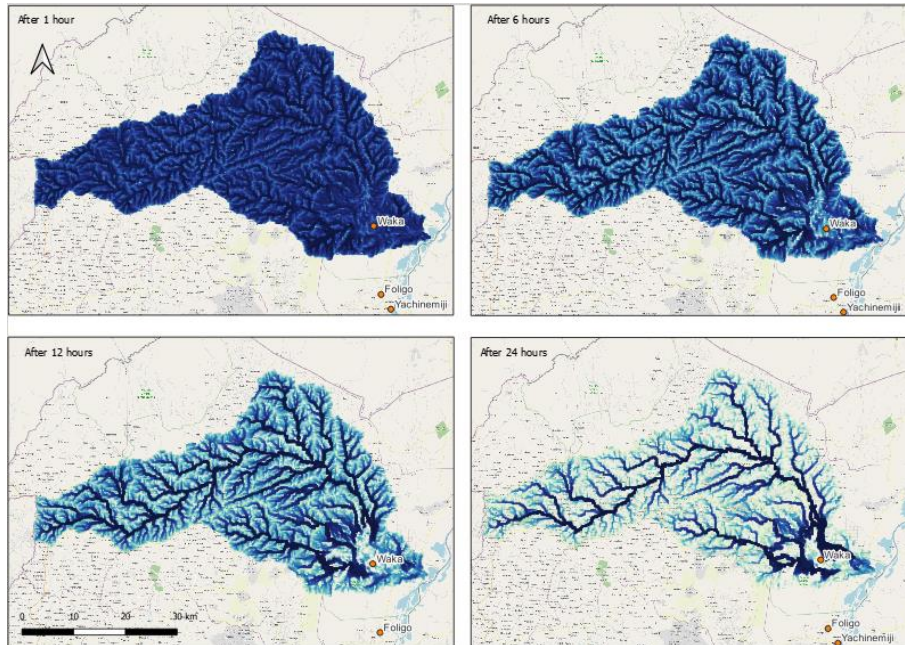


**Figure 2: Erosion of the Kochi River banks**

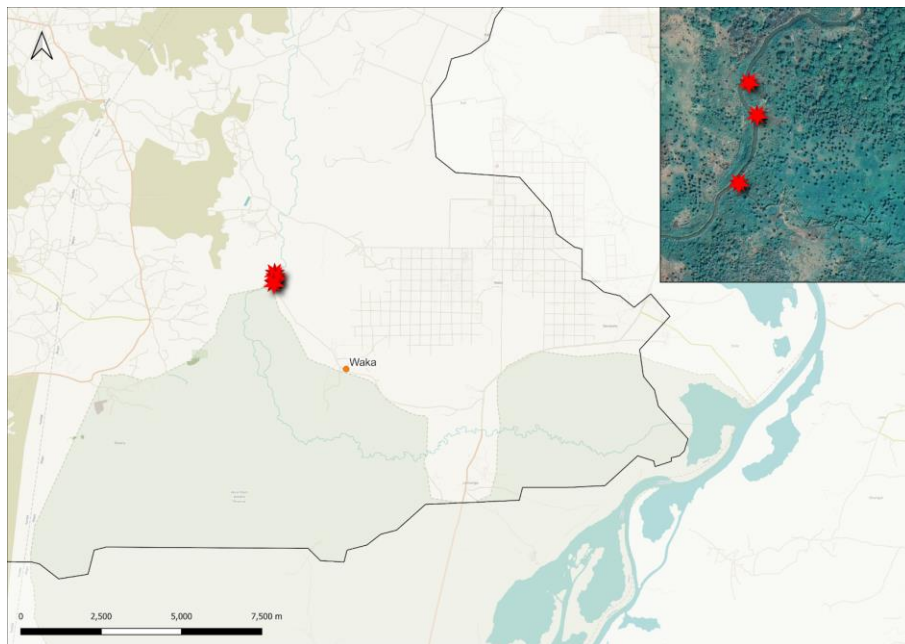
In case of a rainfall event in the sub-catchment, the Kochi river receives the water through surface runoff. Only a small share of the sub-catchment is not directly draining into the Kochi, but flows directly to the Nile, or joins the Kochi at the last 5 kilometers. The bottom right simulation in Figure 3 shows the dominant flow pattern of the Kochi river in case of a rainfall event.

As a result of the rather steep gradient in the sub-catchment, the response time of the catchment is fast. Hence, water levels in the Kochi rivers rise normally within 3 hours. Figure 3 shows the response time of the catchment based on modeling results of simulation with a forcing of 50 mm/h for two hours. One hour after the rainfall event, the catchment starts to drain into the larger streams. The Figure still shows a diffuse pattern becoming more distinct over time. After 12 hours, the majority of the rainfall has drained to the channels and rivers, and it is expected that the highest discharges occur, as indicated by the deep blue flowlines. The modeled response time of 12 hours deviates from the indicated response time of the community. Therefore, one of the recommendations is to monitor the catchment by rainfall and water level/discharge measurements.

The drainage of the catchment leads to rising water levels in the Kochi river. When water levels in the river rise, riverbanks overflow the lowest and most deteriorated locations. This happens at three locations along the Kochi (see Figure 4) resulting in inundation of the entire area from the breaches up to Waka



**Figure 3: Simulated response time of the Waka catchment of a rainfall event of 50 mm/h**



**Figure 4: Breach locations along the Kochi River**

When exiting the breaches, the water follows an incised stream for approximately 150 meters. Thereafter the stream continues its course by draining into an excavated channel, constructed by the Danish Refugee Council (DRC), see Figure 5. The purpose of this channel is to divert the water from flowing to Waka to flow to the South and join the Kochi river. However, due to the limited capacity of the stream, the stream does not discharge entirely into the constructed channel, but spills water into the direction of gravity, which is towards Waka in the (South)east. The water flows through the ditches parallel to the road, where they increase in size from 30 cm depth close to the Kochi to 50-100 cm depth closer to the



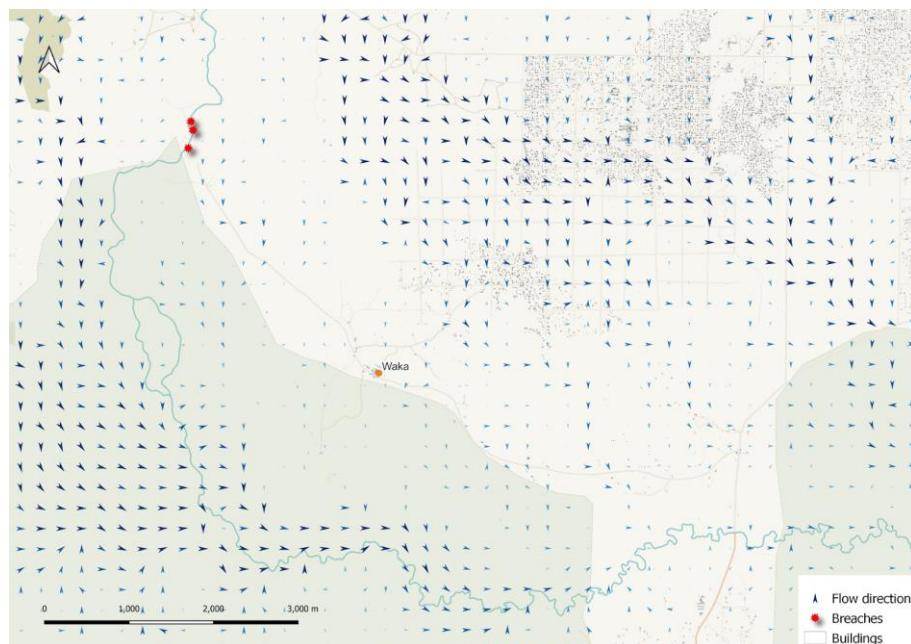
Nile. Both sides of the road are connected with large culverts of around 1.5 m and the water continues its flow over land. As a result, the entire area from the breaches up to Waka gets inundated, including the main road from Kochi-Waka-Moyo.



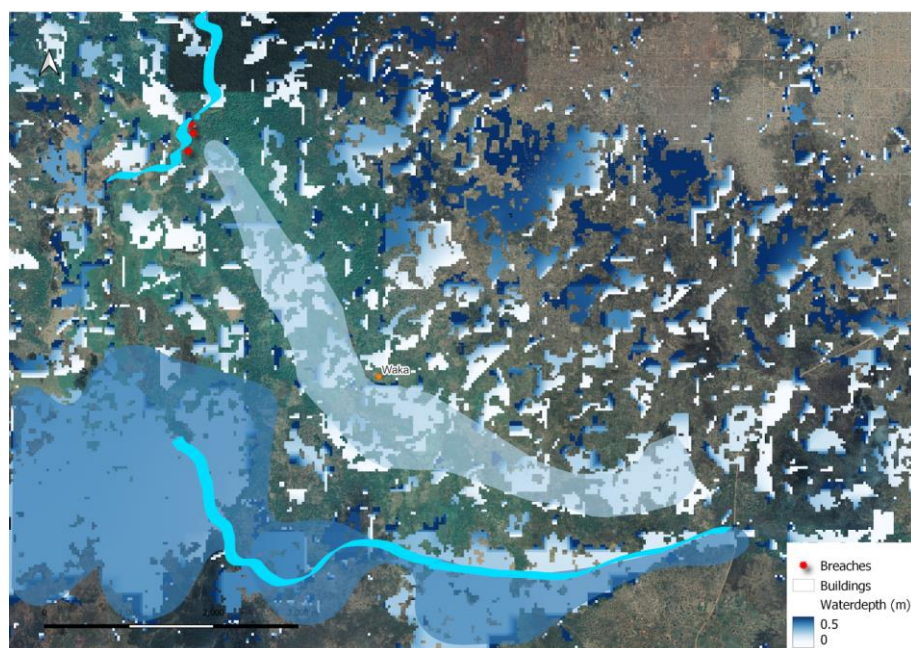
**Figure 5: A channel constructed by the Danish Refugee Council (DRC)**

The flow directions are shown in Figure 6. At the locations of the breaches, water can drain outside the river course towards Waka. Currently, the coarse model does not capture the breaches very well as a consequence of data lacking and poor data quality. However, the model already shows the tendency of draining towards Waka. Furthermore, the Kochi becomes indistinct when it drains into the wetland area to the south. A few kilometers to the East, the river picks up its course again and flows to the Nile. It should be noted water also flows around the community on both the Northern and the Southern side. It is important that these two drainage directions do not lead to any additional nuisance.

The flood observations of the community are confirmed by model simulations with the hydrodynamic modeling software 3Di as well. Figure 7 shows a large flood extent around Waka, as a result of the flows from the Kochi side as depicted in Figure 6. Besides the river flooding, Waka experiences local flooding due to poor drainage. The inundations in Waka range from the breaches to the road on the Eastern side and cause hindrance to the community.



**Figure 6: Flow directions around Waka**



**Figure 7: Flood extents and water depths around Waka**

Especially in Waka, 4 km downstream of the breaches, the consequences are high. Each year, this area experiences flooding. However, during the floods of 2020, 10 buildings experienced inundations of +/- 50 cm for almost six months according to the community. As a result of the flooding, water entered some of the buildings, including school buildings. Furthermore, sanitary was malfunctioning, crops were destroyed, and trees from the reforestation project were destroyed. One of the mitigation measures taken by the community was the construction of a ditch on the northern side of the sanitary. The purpose of this ditch is to convey the water, coming from the North and West, around the community and drain it into the

Kochi on the south eastern side of the community. However, inspections on the ditch showed that this channel was no longer operable and entirely covered with vegetation.

## 4. The SLAMDAM-technology

### 4.1 Description of SLAMDAM

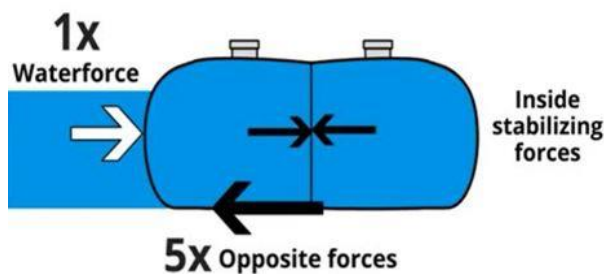
The SLAMDAM-technology is a flood prevention measure that can effectively control the flow of flood water and protect communities from devastating flood events. In addition, SLAMDAM can be used as a water storage facility to harness flood-/rainwater. SLAMDAM has a unique and patented material/design combination.

#### Material

The SLAMDAM is composed of the synthetic rubber Ethylene Propylene Diene Monomer (EPDM). This material yields high heat, ozone and weather resistance. This is important as these properties benefit the long-life expectancy of the dam and gives it good storage properties. For the dam a two-ply EPDM waterproofing membrane of 1.3 mm made of giscolene 130 MAX is used. This is internally reinforced with a high strength polyester scrim. An important feature of the EPDM is that it does not pollute the water when used as it behaves neutral. The material can be produced in unique shapes due to its hot-bonding process with created seal as strong as original raw material.

#### Design

Each SLAMDAM-unit comprises of two compartments that have to be filled with water. This design enables the flood barrier to withstand high outer pressure. The surface contact area is maximized, resulting in maximum friction force with the ground surface. The concave shape and the maximum friction force ensure that the SLAMDAM will 'stay' on its place and is therefore robust and reliable.



**Figure 8: Cross-section of SLAMDAM**

#### Highlights of the SLAMDAM-technology

- The technology can easily be deployed and dismantled, which makes it an effective intervention in unexpected situations.
- The material from which the SLAMDAM is composed has a lifetime of at least 40 years, when properly used. This makes the dam a sustainable solution. The SLAMDAM is 100 % recyclable.
- Because the dam is inflatable, it can be easily stored at any location.



- The dam can be employed with a few people and filled with a waterpump. This reduces the man-power needed compared to for example using conventional sand-bags.
- The flood barrier is a modular system with each standard model unit having a length of 5 m, which can be positioned alongside each other.
- Because of its concave shape, the force of the flood is acting under an angle on the SLAMDAM, which 'pushes' the dam towards the ground. This secures the dam in 'place'.

#### **4.2 Benefits of SLAMDAM**

Because of the mobility of the SLAMDAM, it can form a useful measure in unexpected situations. In this section other benefits and challenges of the dam will be discussed.

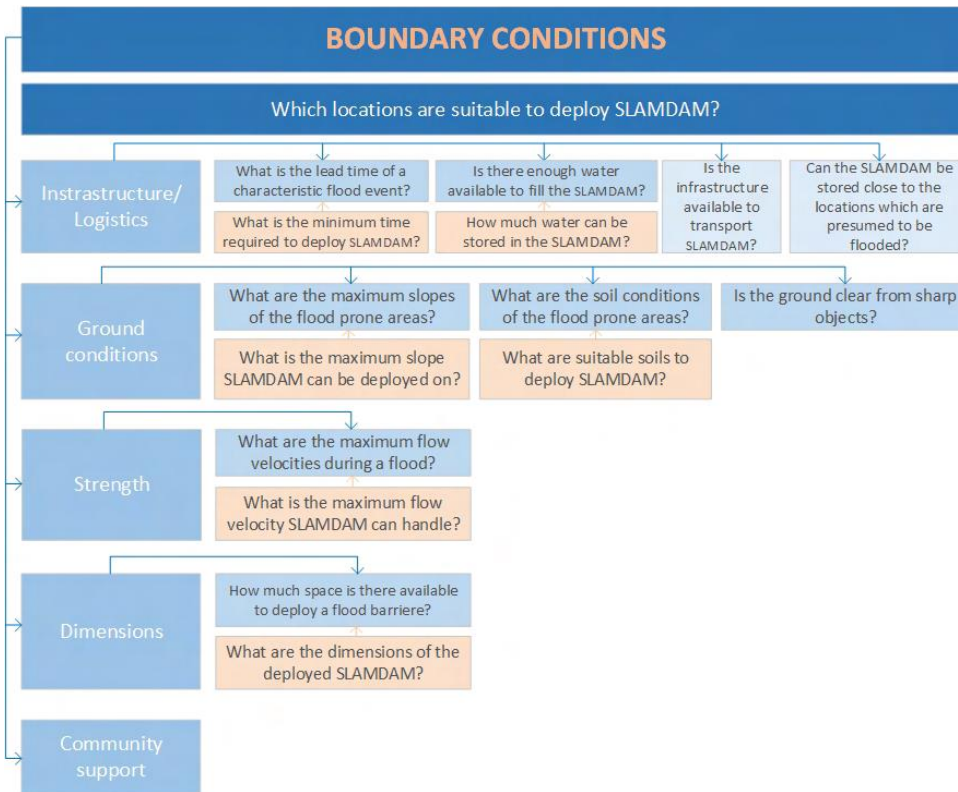
The SLAMDAM-technology has significant benefits for people and the environment:

1. Environmental: SLAMDAM can conserve water resources and reduce the risk of water-related environmental problems such as soil erosion and groundwater depletion.
2. Social: SLAMDAM will help improve the livelihoods of communities and farmers by enhancing food and water security. This will contribute to poverty reduction and improved health and well-being.
3. Economic: Improved food and water security will help to boost agricultural productivity and food production, which will contribute to economic growth and job creation.

To realise the most benefits with this technology, it is important to set targets and monitor and evaluate the realised benefits. Differences between target and realised benefits provide insight in possible improvements when deploying SLAMDAM. The benefit indicators are included in Annex A of this TTP.

#### **4.3 Boundary conditions of SLAMDAM**

Besides the examination of the benefits of the deployment of SLAMDAM, the anticipated effectiveness of the mobile flood barrier needs to be investigated. For this, the boundary conditions for the implementation of the SLAMDAM are defined.



### Infrastructure/ Logistics

The minimum time to deploy SLAMDAM depends on the span from the storage place to the deployment place. Therefore, the right infrastructure to transport the dam from place to place needs to be assured. Furthermore, the deployment time is dependent on the time required to get the SLAMDAM in place and fill it with water. This on its turn depends on the length needed to be protected and the amount of people that are available to fill the dam. It is recommended to use a water pump with at least capacity of 1200 L/min.

### Ground conditions

Not all sites are suitable for the deployment of SLAMDAM. The suitability depends on the soil type and on the topographic gradient. If the slope is too steep, the SLAMDAM might loose its friction with the ground due to gravitational forces and gain momentum. To avoid this, it is recommended to deploy the SLAMDAM on fairly flat terrains. In addition, the SLAMDAM is not highly suitable to be deployed on sandy soils, in particular loose sand. With sandy soils there is the risk that water seeps through the soil and carries with it particles. Eventually, this can cause the the dam to move and form an hazardous situation.

### Strength

During a flood event, both hydrostatic and hydrodynamic forces act on the SLAMDAM. The hydrodynamic forces will have influence on the robustness of the positioning of the SLAMDAM. The SLAMDAM will 'stay' on its place if the resultant force of the SLAMDAM is greater than the force of the flood water. This resultant force is determined by the friction coefficient with the ground together with the normal force of

the SLAMDAM. The water level of the flood event must be lower than the water level in the SLAMDAM. This is the case when the SLAMDAM is not overtopped

### **Dimensions**

SLAMDAM now available on the market has a maximum height of 1.35 m and can retain up to 100 cm. Depending on the height of the flood and the space that is available in the flood area, it can be chosen whether a SLAMDAM is a suitable mitigation measure.

### **Community support**

Another important aspect for the deployment of the SLAMDAM is community support. As the floods affect the agricultural or residential area of the local people, they will be the people benefiting from the dam. Therefore, it is important that the local community is informed about the technology so that they can deploy it in case of flooding. They would also know best where and when then deploy the dam as it is their land. If the community is aware the benefits of the dam, it is also less likely that they will vandalise it.

### **4.4 Operations and maintenance of SLAMDAM and the deployment area**

Proper operations and maintenance of SLAMDAM ensures the reliable and long-lasting performance of the flood barrier.

#### **SLAMDAM Operations**

To ensure that SLAMDAM is in optimal condition and ready for deployment when needed, operation activities involve:

- **Periodic inspections:** At least once per year conduct an inventory check. Keep records of the inventory check to ensure checks are conducted.
- **Readiness checks:** At least once per year check the availability of the flood response team and ensure communication lines are working. This check includes assessment of the flood monitoring activities including the flood early warning system. In addition, the availability and working of the transportation means from the storage facility to the location of deployment have to be verified.
- **Deployment exercises:** In case no flood event has occurred during which SLAMDAM had to be deployed, conduct a deployment exercise at least once per year. Make sure everyone understands their role and responsibilities and performs accordingly.

#### **SLAMDAM Maintenance**

Regular maintenance activities include:

- **Cleaning:** Ensure SLAMDAM is cleaned after each usage. There's no need to use chemicals to clean the flood barrier, cleaning off the dirt with water will suffice. Make SLAMDAM as dry as possible before storing it again.
- **Repairing any damages or leaks:** In case of a puncture, repair it using the repair kit. In case there is damage to the seams of the flood barrier, contact [info@slamdams.com](mailto:info@slamdams.com) for advise or support in repairing the flood barrier.
- **Replacing worn-out components:** Worn out components / accessories have to be replaced to ensure the flood barrier can be deployed effectively when needed. Many of the components such as pumps can be sources locally.

In addition, routine assessments can be conducted to monitor the structural integrity and stability of SLAMDAM. These proactive measures help maintain the effectiveness of the barrier and extend its lifespan, ensuring that it remains a dependable solution for flood prevention and protection.

### **Site Maintenance**

In the case of Waka, there is a significant amount of vegetation at the locations where SLAMDAM must be deployed. To ensure that the mobile flood barrier can be deployed in case of flooding, it is imperative that the vegetation is removed at the locations where SLAMDAM will be deployed. Erosion may also result in the ground surface becoming uneven to deploy the mobile flood barrier. It is therefore imperative to ensure that the ground surface is level. Site maintenance activities include:

- **Removal vegetation:** Removal of vegetation is done by using a machine. Removal of vegetation at the different locations in Waka is estimated to take two (2) of days. The removal of vegetation has to be done prior to any deployment
- **Ground surface leveling:** The site has to be inspected once every quarter to confirm whether any leveling is required. In case leveling is required, the flood response team has to initiate the required works.

### **4.5 How to deploy and dismantle SLAMDAM**

Deploying and dismantling SLAMDAM is designed to be a straightforward process that can be carried out without the need for heavy equipment or specialized technical expertise. Here are the general steps involved in deploying and dismantling SLAMDAM:

#### **Deployment of SLAMDAM**

- **Site preparation:** Identify the desired location for SLAMDAM deployment. Ensure the area is free from obstacles, debris, and sharp objects that could puncture the barrier.
- **Transport:** Transport SLAMDAM from the storage facility to the site of deployment.
- **Unrolling:** Remove SLAMDAM from the crate and unroll the SLAMDAM barrier along the desired length, making sure it is aligned properly (1 cm overlap between the barriers).
- **Filling with water:** Begin filling the barrier with water using a hose or pump. As the water fills the barrier, it will start to self-inflate and form a sturdy structure. There should be 15% less water than the max capacity; overfull barriers might burst.
- **Removal accessories:** Once all units are filled, thus creating one lengthy barrier, the accessories (pumps and hoses) can be removed.

#### **Dismantling of SLAMDAM**

- **Water Drainage:** Drain the water from SLAMDAM by removing the plugs or valves and allowing the water to flow out. Put something heavy on the barrier to speed up the drainage process.
- **Deflation:** As the water drains out, SLAMDAM will gradually deflate. Assist the deflation process by gently pushing down on the barrier to release any trapped air.
- **Pump out water:** When there is some water left in the barrier, remove it using a membrane pump to take out as much water as possible.
- **Rolling:** Start rolling the deflated SLAMDAM from one end to the other, making sure it is tightly rolled to facilitate storage and transportation.
- **Clean & dry:** Remove any debris using water in case there is some dirt on it. If possible, dry the flood barrier to remove as much of the water before storing it.
- **Storage:** Store the rolled SLAMDAM in a dry and secure location, protected from theft and vandalism, until the next deployment.



Also consult the manual and any instruction videos that describe the detailed procedure step-by-step as demonstrated in the next paragraph.

#### 4.6 SLAMDAM deployment Procedure

The images below give a pictorial description of how the SLAMDAM is deployed:



Remove the SLAMDAM® from the transportbox.



This photo shows how the SLAMDAM® is rolled out.



The SLAMDAM® is still upside down.



Turn the SLAMDAM® over and place in position.



Fold the SLAMDAM® along its longitudinal axis after rolling it out.



Remove every fold on the bottom. Then fold it back.



Also remove every fold on the bottom on the other side of SLAMDAM®.





Place the next empty SLAMDAM® and follow the line of the first SLAMDAM®.



Place the one SLAMDAM® 2 cm over the other for good closure and watertightness.



Make sure the weld on the bottom of the first SLAMDAM® follows the line of the next SLAMDAM®.



The SLAMDAM® now lies empty in the longitudinal direction.



Place the filler caps.



Click the hoses on the plugs.



Place the water pump.



Connect the hoses with the joints.



The SLAMDAM® is now ready to be filled with water. Both SLAMDAM® compartments must be filled simultaneously.



Fill the SLAMDAM® to a height of about 67 cm.



While disconnecting the hose, let some air escape.



By repeating this steps, length is created by placing several SLAMDAMS in a row like a chain.

#### 4.7 SLAMDAM dismantling Procedure

The images below give a pictorial description of how the SLAMDAM is dismantled:



Place the plugs again.



First connect to the diaphragm pump.



Connect the hoses with the joints again.



Start pumping to remove the water.

### 5 Roles and responsibilities

An effective SLAMDAM deployment requires the coordination of various people. All team members need to be aware of the processes and procedures, their roles and responsibilities following and up to the deployment of the mobile flood barrier. The below section outlines applicable roles and responsibilities.

#### Monitor flood risks

Floods can be serious catastrophes if not handled with urgency and expertise. A flood monitoring team is in place to ensure flood risks are monitored and are the first to alert the rest of the team in the event a flood risk is detected. One of the factors this team will be on the lookout includes rainfall forecast from the meteorological department.

#### Risk of flooding detected

Once a flood risk is anticipated and reported as so by the flood monitoring team, the appointed local community member(s) role is to monitor rising water levels in the event of rainfall and inform the head of flood response team when the water levels reach the flood threat threshold.

#### Notify head of flood response team

The first person notified of a threat of flooding will alert all members of the flood response team of the detected flood threat; the first person notified acts as the head or a senior member of the flood response team until this role is taken over by one of the senior members or head of the team. Responsibilities for the first person on-scene may include:



- Taking appropriate personal protective measures.
- Notifying all members of the flood response team of the threat of flood.
- Advising people in the area of any potential threat and initiate evacuation procedure.

### **Gather flood response team members**

The head of the flood response team is responsible for the coordination of the planned activities to prevent damage from the anticipated floods. The head of the flood response must ensure that all actors in the flood preparedness and response process are notified and periodically informed of the threat level and the actions that have been taken or are yet to be taken.

### **Transport SLAMDAM to the location**

The mobile flood barrier will be transported from the storage area by the flood response team to the flood risk location.

### **Deploy SLAMDAM**

Once the flood response team is on the flood risk location, the team is expected to remove the SLAMDAM from the boxes and follow the deployment procedures/manual. This can be done by at least two people and does not require high level skills.

### **Store SLAMDAM**

Once the water levels subside, the mobile flood barrier is emptied and folded and put back in the storage boxes and transported back to the designated storage facility by the flood response team. Alternatively, the mobile flood barrier can be used for storage of the water as well in the case where storage units are not available.

### **Lessons learned workshop**

After the flood risk is averted, a workshop(s) will be conducted to evaluate the concluded exercise. A series of reflection meetings will be held with the flood response team, project organization, donors, the local community and the local government to assess the effectiveness of the SLAMDAM technology, discuss challenges and emerging opportunities, and agree on necessary adjustments in the intervention. The workshop(s) will concentrate in answering questions in two areas as shown below.

### **Monitoring & Evaluation (M&E)**

The role of Monitoring and Evaluation (M&E) is crucial in ensuring the successful deployment of SLAMDAM and maximizing its benefits. In this context, a dedicated individual or team is appointed to oversee the M&E process and fulfill the following responsibilities:

- **Tracking and assessing benefits:** The M&E personnel closely monitor the realized benefits of deploying SLAMDAM, comparing them against the anticipated or expected benefits. They gather data on various aspects, such as flood prevention effectiveness, reduction in damages, water resource management, and community resilience. This data helps in assessing the actual impact of SLAMDAM and identifying areas for improvement.
- **Performance reporting:** The M&E team prepares comprehensive reports that document the performance of SLAMDAM based on the collected data and evaluation findings. These reports provide insights into the effectiveness, efficiency, and overall success of SLAMDAM deployments.

The reports include quantitative and qualitative analyses, highlighting key metrics and case studies to support the evaluation.

- **Stakeholder dissemination:** To foster a learning curve in the deployment of SLAMDAM, the M&E team ensures that the evaluation reports are disseminated among relevant stakeholders. This includes government agencies, community organizations, partners, and other entities involved in flood prevention and disaster management. The dissemination of evaluation findings encourages knowledge sharing, best practices, and lessons learned, contributing to continuous improvement and informed decision-making.

Overall, the M&E function plays a vital role in assessing the benefits of SLAMDAM, preparing performance reports, and disseminating valuable insights. This process enables stakeholders to understand the real impact of SLAMDAM deployments, identify areas for enhancement, and promote a collective learning experience to optimize future deployment efforts.

The various responsibilities are included in the RASCI Matrix in Table 1.



Table 1: RASCI Matrix

Activity	Role									
	Donor	MoWE Uganda	Local Government	Head Flood Response Team	Local Hydrologist	Flood Response Team	Women's Representative	Community Leader / Rep.	M&E Team / Expert	
		Strategic			Tactical / operational					
1. Flood monitoring										
1.1 Maintain flood warning system		S	A		R					
1.2 Set severity boundaries flood events				A	R					
1.3 Monitor flood risks				A	R					
1.4 Communicate high risk flood events			A	R	R	I	I	I		
2. Operation and maintenance										
2.1 Assemble flood response team			A	R		R	I	I		
2.2 Assign tasks flood response team			A	R		I				
2.3 Arrange transportation means				A		R				
2.4 Inform local stakeholders / community				A		R		R		
2.5 Routine maintenance team assigned (cleaning, repairing etc.)			A	R		R	A	A		
3. SLAMDAM deployment and dismantling										
3.1 Transport SLAMDAM to the location			S	A		R		S		
3.2 Position SLAMDAM				A		R				
3.3 Fill SLAMDAM with water				A		R				
3.4 Monitor effectiveness during flood			S	A		R		S	I	
3.5 Determine when to dismantle			A	R						

Activity	Role								
	Donor	MoWE Uganda	Local Government	Head Flood Response Team	Local Hydrologist	Flood Response Team	Women's Representative	Community Leader / Rep.	M&E Team / Expert
3.6 Dismantle SLAMDAM			S	A		R		S	
3.7 Verify the condition of SLAMDAM			A	R					
3.8 Transport SLAMDAM to storage facility			S	A		R		S	
3.9 Maintenance of SLAMDAM			I	A		R			
<b>4. Monitoring and evaluation</b>									
4.1 Conduct M&E activities	I	I	A					I	R
4.2 Hold lessons learned session	C	C	A	C	C	C	C	C	R
4.3 Incorporate lessons in operational plan			A	R					C
4.4 Communicate outcome deployment		A	R						R

R	<b>Responsible</b>	Those who do the work to complete the task.
A	<b>Accountable</b>	The one ultimately answerable for the correct and thorough completion of the deliverable or task, the one who ensures the prerequisites of the task are met and who delegates the work to those responsible.
S	<b>Support</b>	Resources allocated to responsible. Unlike consulted, who may provide input to the task, support helps complete the task.
C	<b>Consulted</b>	Those whose opinions are sought, typically subject-matter experts; and with whom there is two-way communication.
I	<b>Informed</b>	Those who are kept up-to-date on progress, often only on completion of the task or deliverable; and with whom there is just one-way communication.

## 6 Intellectual property

The objective of addressing intellectual property (IP) within the technology transfer plan is to establish a clear framework that respects the IP rights of MWD B.V. while ensuring the successful implementation and sustainability of SLAMDAM in Obongi, Uganda. This section defines the terms of the technology transfer, including the rights and responsibilities of all parties involved regarding the intellectual property associated with SLAMDAM.

### Acknowledgment of IP Ownership

- **Recognition:** The intellectual property rights of SLAMDAM, including patents, trademarks, copyrights, and any other related IP, are solely owned by MWD B.V.
- **Compliance:** All parties involved in the TTP, including the local stakeholders and the implementing organization, understand and respect the IP rights of MWD B.V. in all aspects of the project.

### Confidentiality and Non-Disclosure

- **Non-Disclosure Agreement:** There is a non-disclosure agreement (NDA) between MWD B.V. and the Government of Uganda to protect any confidential information shared during the technology transfer process. This agreement will safeguard trade secrets, technical specifications, and other proprietary information related to SLAMDAM.

### Training and Knowledge Transfer

- **Training materials:** The terms of sharing training materials, documentation, and technical know-how related to SLAMDAM. Specify whether the implementing organization has permission to reproduce or adapt these materials for local training purposes while ensuring compliance with IP rights.
- **Technical Support:** There is a service agreement that describes the mechanism for ongoing technical support from MWD B.V. to the implementing organization, especially for complex maintenance or troubleshooting. The Service Agreement clarifies the extent and duration of this support to avoid any ambiguity or misunderstanding.

## 7 Sustainability

Sustainability considerations for the implementation of SLAMDAM will effectively protect vulnerable areas from flooding while minimizing its environmental impact and ensuring long-term viability. Sustainability considerations are categorised as follows: (1) Operations and maintenance, (2) Service agreement, (3) Financial arrangement and (4) Monitoring and evaluation.

### 7.1 Operations and maintenance

See Paragraph 4.4

### 7.2 Service agreement

A sustainability handing over service agreement outlines the responsibilities and commitments between the supplier/manufacturer and the party responsible for operating and maintaining the mobile barriers and its accessories. This agreement ensures the ongoing sustainability of the project by defining the terms of service, maintenance, and monitoring activities.

See Service Agreement “UG01”.

### **7.3 Financial arrangement**

This section refers to the financial aspects of transitioning the project from the implementation phase to the operational phase, ensuring its ongoing sustainability. This arrangement typically involves financial considerations related to maintenance, operation, and funding sources.

#### **Operation and maintenance budget**

- Site suitability – Vegetation removal
- Site suitability – Ground surface leveling
- Compensation flood response team staff
- Flood monitoring activities
- Annual maintenance SLAMDAM and accessories
- Replacement costs

#### **Funding sources**

The annual budgeted costs shall be funded by:

Ministry of Environment

If the mobile flood barrier project benefits multiple stakeholders, consider establishing cost-sharing agreements.

#### **Long-term financial planning**

Develop a long-term financial plan that extends beyond the initial implementation phase. Consider factors such as inflation, changing maintenance requirements, replacement cycles, and potential future upgrades or expansion of the barrier system. This planning ensures the availability of sufficient funds throughout the project's lifecycle.

#### **Reserve Funds**

Establish reserve funds or contingency budgets to cover unexpected expenses, emergencies, or major repairs.

#### **Financial Reporting and Accountability**

Determine the reporting requirements for financial activities related to the project. Establish mechanisms for financial reporting, including regular financial statements, audits, and reviews.

### **7.4 Monitoring and evaluation**

See Chapter 5



## Annex 1: List of indicators for Monitoring & Evaluation

Benefit Area	Indicators	Unit	Target	Actual
Physical and natural assets made more resilient to climate induced flooding	Total area directly benefiting from more resilient physical and natural assets	(Km <sup>2</sup> / USD)		
	Agricultural landscape protected from flood damage	(Km <sup>2</sup> / USD)		
	Urban landscape protected from flood damage	(Km <sup>2</sup> / USD)		
	Rural landscape protected from flood damage	(Km <sup>2</sup> / USD)		
	Residential houses protected from flood damage	(Number / USD)		
	Public buildings protected from flood damage	(Number / USD)		
	Industrial or commercial units protected from flood damage	(Number / USD)		
	Small businesses / shops protected from flood damage	(Number / USD)		
	Irrigation or water structures protected from flood damage	(Number / USD)		
	Ports or landing sites protected from flood damage	(Number / USD)		
		Indirect (USD)		
	Airports protected from flood damage	Damage (USD) prevented		
		Indirect (USD)		
	Roads protected from flood damage	(Km / USD)		
		Number individuals		
	km rail networks protected from flood damage	Repair costs (USD) avoided		
		Affected individuals prevented		
Livelihoods and sources of income of vulnerable	Total no. of direct beneficiaries with diversified and strengthened livelihoods and sources of income	Number		
	Male	Number		
	Female	Number		

Benefit Area	Indicators	Unit	Target	Actual
populations diversified and strengthened	Reduction in No. people displaced / migrated	Number (specified per group)		
	Reduction in No. injuries and deaths	Number (specified per group)		
	Reduction in No. jobs lost	Number (specified per group)		
	Other	(specified per group)		
The number of people who are warned in advance of climatic induced floods and drought grows and the warning consistency and reliability is increased	Total no. of direct beneficiaries from the new/improved climate information systems	Number (specified per group)		
	No. of Climate hazards addressed compared to before	Number		
	No. of people who are warned for climate risks in advance	Number (specified per group)		
	Increase in percentage of uptime of weather information system	Percentage uptime		
	No. of correct warnings issued	Percentage		
	No. of people who have become more aware of their climate risks	Number		
	Hours between warning issue and climate disaster (lead-time)	Hours		
	No. of platforms to disseminate climate warnings has increased	Number		
Vulnerable natural ecosystems strengthened in response to climate change impacts	Vulnerable ecosystem protected	Protected area (ha)		
Active, skilled and materialised local flood and	Total no. of direct beneficiaries from more resilient physical and natural assets	Number of people (specified per group)		
	Km mobile flood barrier	Km.		

Benefit Area	Indicators	Unit	Target	Actual
drought response team	Litre water that can be stored in the mobile barrier	Liter		
	People trained on how to operate and maintain the flood barrier	Number of people (specified per group)		
	Strategically located storage facilities	Number		
Number of people trained and informed regarding climate change impacts and appropriate adaptation responses	People are trained and informed regarding climate change impacts	Number of people (specified per group)		
	People at line ministries are trained and informed regarding climate change impacts	Number of people (specified per group)		
	Community / association members trained and informed regarding climate change impacts	Number of people (specified per group)		
	Extension service officers trained and informed regarding climate change impacts	Number of people (specified per group)		
	Hydromet and disaster risk management agency staff trained and informed regarding climate change impacts	Number of people (specified per group)		
	Small private business owners trained and informed regarding climate change impacts	Number of people (specified per group)		
	Schoolchildren, university students or teachers trained and informed regarding climate change impacts	Number of people (specified per group)		
	Other (specify)	Number of people (specified per group)		