Flood risk management workflow:
MITIGATING THE IMPACT OF FLOODS

Floods are among the most destructive climate risks, particularly in regions hosting displaced populations. Climate change intensifies natural disaster risks. The Flood Risk Management Workflow, developed by UNHCR, SDC, and the Swiss Institute of Technology (ETHZ) through the Geneva Technical Hub (GTH), aims to provide a methodology for long-term flood hazard mitigation.

Bétou, Republic of Congo © I.Diane, UNHCR

Background & context

Each rainy season, floods displace thousands of people, with climate change increasing risks, especially in regions ill-prepared for such disasters. Many of these areas host refugee or internally displaced settlements. Some camps have had to be relocated permanently due to severe flood risks. Flooding often cuts off life-saving assistance for weeks or months.

UNHCR and SDC, in collaboration with ETHZ, developed technical solutions to mitigate flood impacts in refugee settlements. The goal is to help field staff identify and map flood hazards, evaluate risks through remote and field-based analysis, and develop context-specific mitigation strategies.

Tools and methodology

A six-step systematic workflow involves context analysis, remote hazard mapping, data collection including community engagement, risk analysis, intervention prioritization, and cost-benefit comparisons of mitigation solutions. The methodology provides a structured approach and a range of technical solutions supported by practical tools to strenghening field staff's knowledge on flood disaster risk reduction.

Trainings and field testing with technicians in several UNHCR operations, including a pilot in Bétou, Republic of the Congo, has allowed to refine these tools. User guides and tutorials are available for further support using the proposed methodology.

STEP	1 Context analysis compile baseline data	2 Remote analysis understand hazard	3 Field assessment collect local information	4 Assets at risk identify and prioritize	5 Mitigation scenarios combine adapted measures	6 Strategy compare and decide
ACTIONS	Define area of interest Sort existing data on: - flood hazard - boundaries, roads,… - buildings - natural features Use global sources and locally available data (drone, topo, maps, …)	Analyze: - existing hazard maps - watershed and natural drainage - lowlands - ground water - past events Identify type of flood	Observe the terrain: - natural features - human footprint - silent witnesses Engage with community: - interviews - participatory mapping Verify / adapt remote data Compile information in consolidated hazard map	Identify and categorize assets at risk (vulnerability / criticity) Define acceptability and prioritize intervention needs Receive propositions of migitation measures	Analyse maps and measures generated at step 4, understand type and effect Add local measures if adequate Adapt risk maps to estimate the impact of each mitigation scenario	Compare scenari, estimate implementation cost, time, feasibility Compile information to allow for an informed decision on the strategy Prepare an action plan for implementation
OUTPUT	**BASE MAP**	**INDICATIVE HAZARD MAP** can be inserted in GPS or phone for site survey	**GELOCALIZED DATA** **FINAL HAZARD MAP** adapted with local info	**RISK MAP ASSETS AT RISK LIST OF PRIORITIES**	**SCENARIOS** combining adapted measures	**STRATEGY** **ACTION PLAN**
TOOLS GUIDES	Internet qGIS software Tutorials	Internet qGIS software Tutorials	Avenza, Timestamp Local data collection guide	qGIS Risk Strategy plugin Priorization Table	Compendium of Measures Decision tree	Cost-Benefit Analysis

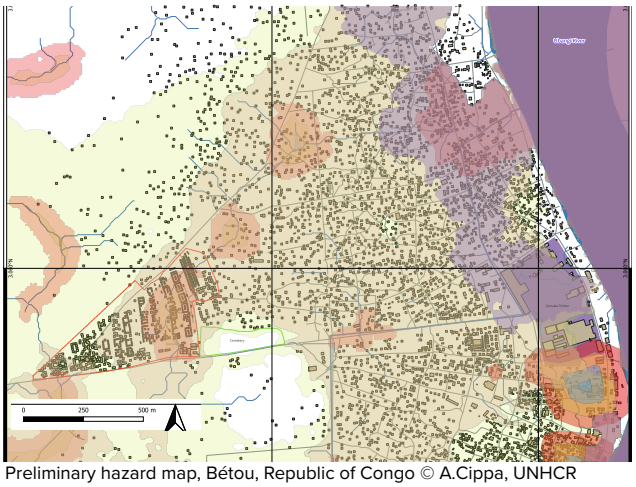
Flood risk management workflow © GTH

PRELIMINARY REMOTE ANALYSIS

Remote analysis with global data

Satellites capture invaluable data for most locations. The first steps of the workflow guides technicians to the production of a preliminary hazard map based on the geomorphological methodology. The map incorporates information about topography, landcover, watersheds, water bodies and other natural and human-made features, as well as past flood events to estimate hazard intensity and location.

The hazard map can be uploaded onto mobile devices, such as GPS units or smartphones, to support field assessments.



Preliminary hazard map, Bétou, Republic of Congo © A.Cippa, UNHCR

GIS tutorials for hazard mapping

Short video tutorials guide technical staff in using GIS for settlement mapping and remote flood hazard analysis, such as creating contour lines and watershed analysis, using open-source, globally available data. A step-by-step written tutorial for the basic use of GIS, complete with exercises, is also available to build qGIS expertise needed for applying this workflow.

Types of floods

The map's accuracy depends on the quality of available data and requires field verification. However, it offers an initial understanding of flood type, water behavior, and potential damage, aiding mitigation planning. Common flood types include riverine, coastal, urban, pluvial (surface water), and flash floods.

LOCAL DATA COLLECTION

Observing the terrain

While remote sensing supports analysis, on-site data collection is crucial for corroborationg and refining findings with local knowledge. Observing marks left by past events (sediment, vegetation, building damage) helps assess flood severity and location. Topographic, natural and man-made features also provide valuable insights. Several smartphone apps assist in geolocating and recording findings to update GIS hazard maps.

Participatory mapping workshop, Bétou © N.Antenen, ETHZ

Local Data Collection Guide

The guidance for local data collection assists field officers with field observations, conducting interviews with the community and local experts, and organizing participatory mapping workshops to capture local knowledge.

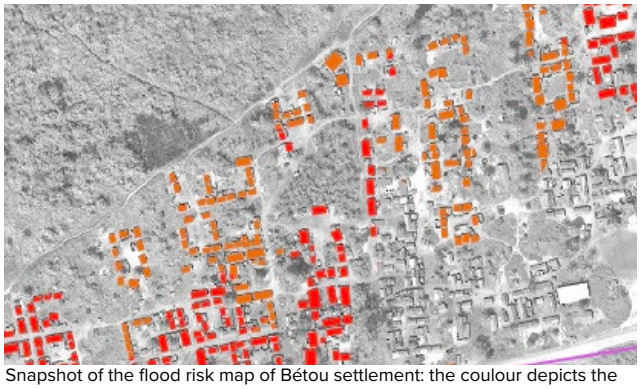
Engaging with the community

Local residents often know the most about past events, priorities for protection, and ad hoc mitigation measures. Engaging with the community through interviews and participatory mapping provides spatial insights based on their experience. It is also an opportunity to raise awareness and identify practical, sustainable and widely accepted mitigation measures.

RISK ANALYSIS AND PRIORIZATION OF INTERVENTIONS

The vulnerability increases the risk

Temporary shelters and infrastructures in refugee settlements will be more severely damaged in case of hazards than permanent constructions. Displaced people also live in precarious conditions, heightening their vulnerability if they are affected by floods. The risk level depends on hazard probability and intensity and asset fragility.



Snapshot of the flood risk map of Bétou settlement: the coulour depicts the risk level for each building (orange = medium, red = high) © N.Antenen, ETHZ

qGIS plugin for risk mapping

Risk mapping is crucial to understanding potential impacts. The qGIS Risk Strategy Plugin integrates global and local data to produce risk maps based on hazard levels and asset vulnerability. Additionally, it is linked with a range of potential mitigation measures adapted to the risk type. t also links to tailored mitigation measures. A user-friendly step-by-step guide is provided.

Prioritize assets to protect

To mitigate flood impact effectively, assets must be prioritized based on the criticity of their function and the consequences of damage in the short and long term. Defining acceptable risk levels and intervention timelines helps phase mitigation actions.

MITIGATION SOLUTIONS

Choosing the right combination

Mitigation measures fall into five categories:

- Manage water flow (divert or contain water)
- Manage surface water (improve soil permeability or drainage)
- Reduce asset vulnerability (protect or strengthen buildings)
- Restore the natural environment *(see right)*
- Limit casualties (raise awareness, build capacities, develop early warning systems, create land-use plans with safe zones)

A decision tree helps select appropriate measures based on the flood source and desired outcomes.

Home on barrels, Philippines © Pexels

Compendium of mitigation measures

The compendium outlines 22 mitigation measures, categorized by environmental impact, efficiency, timescale, and affordability. Examples of best practices and technical drawings illustrate each measure, with additional references for further details.

Nature-based solutions

Nature-based solutions can be a viable alternative to heavy engineered measures. These approaches are inspired by nature and integrate the water cycle into settlement planning. They mitigate hazards by restoring or conserving ecosystems, boosting biodiversity, and supporting climate change adaptation. Additionally, they can promote livelihoods through agriculture and forestry.

Nature-based solutions can be implemented at large scale (e.g., wetlands or mangrove restoration, reforestation), requiring collaboration with governmental entities. Smaller interventions, like rainwater harvesting, retention basins, and vegetation swales, offer local mitigation benefits.

Piloting the project: the Bétou Case Study

Bétou, a small town on the border of CAR and DRC in northern Republic of Congo, has hosted refugees for decades. Climate change has worsened recurring floods, impacting both refugees and host communities. After a severe flood in 2023 submerged most of the refugee site and half of the town, GTH was asked to analyze the situation and propose solutions. The flood risk workflow was applied both for remote and on-site analysis, allowing to test methodologies, and developing a strategy used as an advocacy tool for funding and awareness campaigns.
Ask for report and mapset for an insight of possible result

IMPLEMENTATION STRATEGY

Project priorization

Mitigation measures are most effective when combined. Comparing the feasibility, costs, and impacts of various scenarios helps select the best implementation strategy based on local priorities, time, and budget.
Tools like Cost-Benefit Analysis assist in evaluating the sustainability and efficiency of different scenarios. They are a useful advocacy tool and provide alternatives and support decision-makers.

SCENARIOS		COSTS		BENEFITS	
Scenario number	Combination of measures	Investment costs	Annual costs	Financial (10Y)	Human (10Y)
1	M1: EWS	200k $	50k $	200k $	20%
	M2: elevated shelters	600k $	150k $	3'000k $	60%
	total	**2'800k $ 10Y**		**3'200k $**	**80%**
2	M3: dyke	1'000k $	250k $	3'800k $	75%
	total	**3'500k $ 10Y**		**3'800k $**	**75%**
3	M1: EWS	200k $	50k $		20%
	M3: dyke	1'000k $	250k $		75%
	total	**4'200k $ 10Y**		**4'000k $**	**95%**

Risk analysis and mitigation matrix

GTH developed a matrix to help field planners identify and analyze risks, prioritize interventions, combine mitigation measures into scenarios, and evaluate their impact, costs, and benefits.

Multifocal strategy

A flood risk mitigation strategy typically combines quick-impact actions with long-term prevention and risk reduction. Various interventions can be applied at different scales, incorporating nature-based solutions, engineered measures, and behavior changes. Once the strategy is determined, an action plan with implementation phases, indicators, and partner engagement ensures continued long-term action.

Left: example of a CBA for 3 scenarios over 10 years. Here scenario 1 is more efficient than scenario 2. Scenario 3 has the highest human benefits © GTH

USEFUL LINKS:
- *Geneva Technical Hub Website*
- *Flood Risk Mitigation Toolbox*

For further information, please contact:
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