



INITIATIVE ON
Diversification in East
and Southern Africa

Co-Design and Implementation of Index Based Flood Insurance (IBFI) in Flood Proofing Communities of Mazabuka District, Southern Zambia

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Summary

The Magoye River, a vital resource for communities in Zambia's Southern Province, has a history of seasonal flooding with severe consequences. During the rainy season, the river often overflows, inundating surrounding areas and causing widespread crop and infrastructure damages. Factors such as deforestation and climate change exacerbate this natural phenomenon, leading to loss of lives, displacement, and destruction of infrastructure, farmlands, and livelihoods. An innovative insurance solution has been developed to address these challenges, compensating affected communities for losses incurred during flood events. The CGIAR Initiative on Diversification in East and Southern Africa, Ukama-Ustawi (UU), identified the bundling of climate insurance as an innovative climate risk management solution for smallholder farmers in Southern and Eastern Africa. This innovation involved mapping flood-prone agricultural areas near the river, ensuring tailored support for those most vulnerable. The innovation was aimed to mitigate the financial risks associated with recurrent flooding by providing timely insurance payouts to farmers while promoting climate resilience.

The International Water Management Institute (IWMI) in collaboration with Agriculture and Climate Risk Enterprise (ACRE Africa) and Professional Insurance Company piloted the [Index Based Flood Insurance \(IBFI\)](#) among smallholder farmers residing along the Magoye River, Mazabuka District, Southern Province, Zambia. IWMI has developed the IBFI concept in South Asia covering India and Bangladesh using an integrated approach of combining flood model and earth observation data to flood proofing among vulnerable populations (Amarnath et al. 2024). A similar concept was scaled out for IBFI product covering three villages at the lower Magoye Catchment and first of its kind in Zambia. To build trust and enhance resilience within affected communities, a robust flood index insurance product that is flexible, transparent, and closely aligned with ground-level realities was developed. It minimizes spatial, temporal as well as design-related basis risks, ensuring payouts accurately reflect actual losses. During the development of the IBFI product, the experts from the Water Resources Management Authority (WARMA), Ministry of Agriculture, Department of Community Development, Disaster Management and Mitigation Unit (DMMU) in co-designing and implementing with the pilot villages.

The IBFI pilot was conducted for the 2024-2025 rainy season in the Mogoye Catchment, Southern Province, Zambia. The product targets 250 households in the Magoye Catchment of Zambia's Southern Province. Coverage focuses on flood risk, measured via in-situ gauges and satellite-monitored flood depth along the Magoye River. Insurance applies to individual pixels along the river, with each participating farmer receiving about K 1786 equivalent to about USD 64 as the sum insured. The 150-day cover period (November 1, 2024 – March 30, 2025) uses a 10-day observation period for flood events. Payouts are tiered based on flood depth percentiles: minor flooding (80th percentile trigger, 25% coverage), moderate (85th percentile, 50% coverage), major (95th percentile, 75% coverage), and catastrophic (99th percentile, 100% coverage).

In summary, the IBFI pilot represents a vital step forward in addressing the twin challenges of climate change and poverty. Its success could herald a transformative approach to flood risk management, offering a lifeline to vulnerable farmers and contributing to sustainable development

in the region. Through innovation and collaboration, this initiative underscores the potential of insurance-based solutions in building climate resilience and securing livelihoods.

1. Introduction

In developing countries like Zambia, flood risk presents significant challenges that exacerbate food insecurity and threaten livelihoods, particularly for smallholder farmers (Reed et al., 2022). Flooding can lead to waterlogging due to long-duration inundation, resulting in crop failure and reduced crop yields as well as the destruction of vital infrastructure, making recovery arduous (Wang et al., 2022). Additionally, the socio-economic vulnerabilities of farmers, many of whom live below the poverty line, heighten their exposure to natural disasters; crop failures can push these communities further into poverty (De Silva and Kawasaki, 2018). The increasing frequency and severity of such impacts and socio-economic vulnerability of the community have highlighted the need for innovative risk management solutions. One such solution gaining traction is the bundling of climate index insurance. The bundling of index-based climate insurance solutions represents an innovative forward-looking approach to addressing the complex challenges under changing climate conditions. By combining innovative insurance products, advanced analytics, and collaborative efforts, this solution aims to build resilience and promote sustainable practices in the face of increasingly unpredictable climate extremes. The CGIAR Initiative on Diversification in East and Southern Africa, Ukama-Ustawi (UU), identified the bundling of climate insurance as an innovative climate risk management solution for smallholder farmers in South and Eastern Africa. The modelling efforts is also jointly supported by other initiatives namely the Digital Innovation for Water Secure Africa (DIWASA) and CGIAR initiatives on Climate Resilience towards development of flood forecasting and early warning systems and anticipatory action coordination through AWARE Platform developed by IWMI.

Index-based insurance is emerging as a vital tool to bolster the financial resilience of smallholder farmers against climate risks (Amarnath et al., 2021 and 2024). By linking payouts to measurable climate risks like droughts or floods, this approach ensures swift compensation without the need for lengthy damage assessments. This timely support helps farmers recover from economic shocks and encourages them to embrace sustainable farming practices with greater confidence.

While weather-based index insurance has become a widely recognized tool for managing agricultural risks among smallholder farmers, the use of flood-index insurance remains relatively underdeveloped in sub-Saharan Africa. This gap highlights a significant opportunity to expand tailored solutions addressing the unique challenges faced by farming communities in flood-prone areas, such as recurring financial instability, displacement, and vulnerability to extreme weather events.

Flood-index insurance offers a pathway to proactively address these challenges by providing a reliable safety net. Unlike conventional insurance, it minimizes administrative costs and delays through pre-determined triggers, such as rainfall thresholds or flood depths. The innovative pilot in Southern Zambia's Magoye Catchment represents a crucial step toward filling this gap. It not only integrates state-of-the-art technologies like satellite data and flood modeling but also aligns with the region's specific climatic and socio-economic context.

By leveraging lessons from ex-post surveys conducted in regions where index-based insurance has been implemented, the pilot incorporates best practices to refine its design and implementation. These include robust community engagement, transparent communication, and the creation of products that reflect ground realities. Collaboration among key stakeholders, including government bodies, local communities, private institutions, and international organizations, has been a cornerstone of this initiative, ensuring its sustainability and scalability.

This pioneering work breaks new ground by demonstrating the potential of index-based flood insurance to transform risk management for smallholder farmers in sub-Saharan Africa. It establishes

a foundation for future interventions, emphasizing the critical role of partnerships and innovation in building resilience against climate-induced challenges. With continued investment and scaling, index-based flood insurance could redefine agricultural risk management across the continent, equipping vulnerable communities with the tools needed to thrive in an uncertain climate future.

The main objective of this work was to develop an Index Based Flood Insurance (IBFI) product based on simulated flood depth along the Magoye River in the Southern Province of Zambia and pilot it in the target area. By leveraging physically-based modeling techniques and integrating Earth observation (EO) data, the index-based flood insurance product will be developed to provide risk cover against losses due to floods. The product is co-designed and co-developed with ACRE Africa and Professional Insurance Company. This approach not only strengthens farmers' resilience to climate risks but also supports long-term economic stability. Incorporating such index-based insurance into agricultural risk management strategies offers a transformative pathway to secure farmers' livelihoods and ensure agricultural sustainability in the face of a changing climate.

2. Pilot Area: Magoye Catchment

During the wet season, Zambia's Southern Province experiences significant challenges from river flooding and heavy rainfall, leading to waterlogging that threatens crop production, particularly during critical farming periods. The Mazabuka District, especially the areas surrounding the Magoye River illustrates the impact of these conditions on agricultural stability and food security. Smallholder farmers in this region, who depend primarily on rain-fed agriculture, are especially vulnerable to recurring floods, highlighting the urgent need for innovative solutions to mitigate financial risks.

Figure 1 shows the Magoye River Catchment, which is located within the Lower Kafue Catchment management area and spans an area of 2,186 square kilometers. It originates in the Sichili and Muzandu Villages, situated south of Pemba Town, and extends across portions of the Pemba, Gwembe, Monze, and Mazabuka Districts in Zambia's Southern Province. The Magoye River receives water from several perennial and intermittent tributaries, including the Ngwezi, Namaloba, Mayando, and Maluba rivers, before eventually discharging into the Kafue River northwest of Mazabuka Town, through the Kafue Flats in Chief Mwanachingwala's region.

The downstream region of the river (red rectangle, **Figure 1**) is part of the Kafue wetland and is frequently impacted by floods, which severely disrupt the livelihoods of local communities. Near the downstream of the gauging station are several agricultural fields and community settlements, namely, Kalama, Munenga, and Itebe frequently affected by floods. The picture in (Figure 1: right) indicates flooding in 2023. The primary cause of these floods is heavy rainfall at the river's headwaters, leading to river overflows. Additionally, the area's swampy, flat terrain and clay-rich soil contribute to flooding, as direct rainfall in this region exacerbates the problem. During the wet season, the floods affect the primary livelihoods in the Magoye area, mainly rain-fed agriculture and livestock farming. In 2023, WARMA reported that Villages such as Mwanampongo and surrounding settlements in Mazabuka District were affected by a 1-in-20-year flood event, which displaced the community, and damaged crop fields as well as livestock.



Figure 1. Left: Magoye River Catchment, red rectangle indicates Flood Zone in the downstream of the river. **Right:** location gauging station with flooding building up for flood event in 2023: Source Authors.

One of the challenges in flood modeling in developing countries is the lack of detailed information for flood model validation. In the current pilot study, the satellite flood maps for recent floods of 2023 were available for model validation, but past floods, for instance, floods in 2008/09 were not available. In such cases, the extent of flood damage can be compared with open sources and media reports. For instance, according to the Reuters report, at the end of February and beginning of March 2009, the southern province of Zambia experienced the worst floods, which destroyed crops and swamped whole villages (Figure 2). Similarly, Lusakatimes reports on 4th February 2023 indicated government support for communities affected by floods 2023 in the Mwanachingwala Ward, and indicated that 345 families were affected by floods.

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Zambia and Namibia face worst floods in 40 years

News and Press Release • Source: Reuters • Posted: 25 Mar 2009 • Originally published: 25 Mar 2009 • Origin: [View original](#)

By Frank Nyakairu

LUSAKA, March 25 (Reuters) - Zambia and Namibia face their worst floods in at least 40 years as rains swell the Zambezi River to record levels, destroying crops and swamping whole villages, disaster officials and aid workers said on Wednesday.

Primary country: [Zambia](#)

Other country: [Namibia](#)

The Southern Province of Zambia is the worst hit, with more than 20,000 households affected and 5,000 houses destroyed, the Swiss branch of relief group Action by Churches Together said.

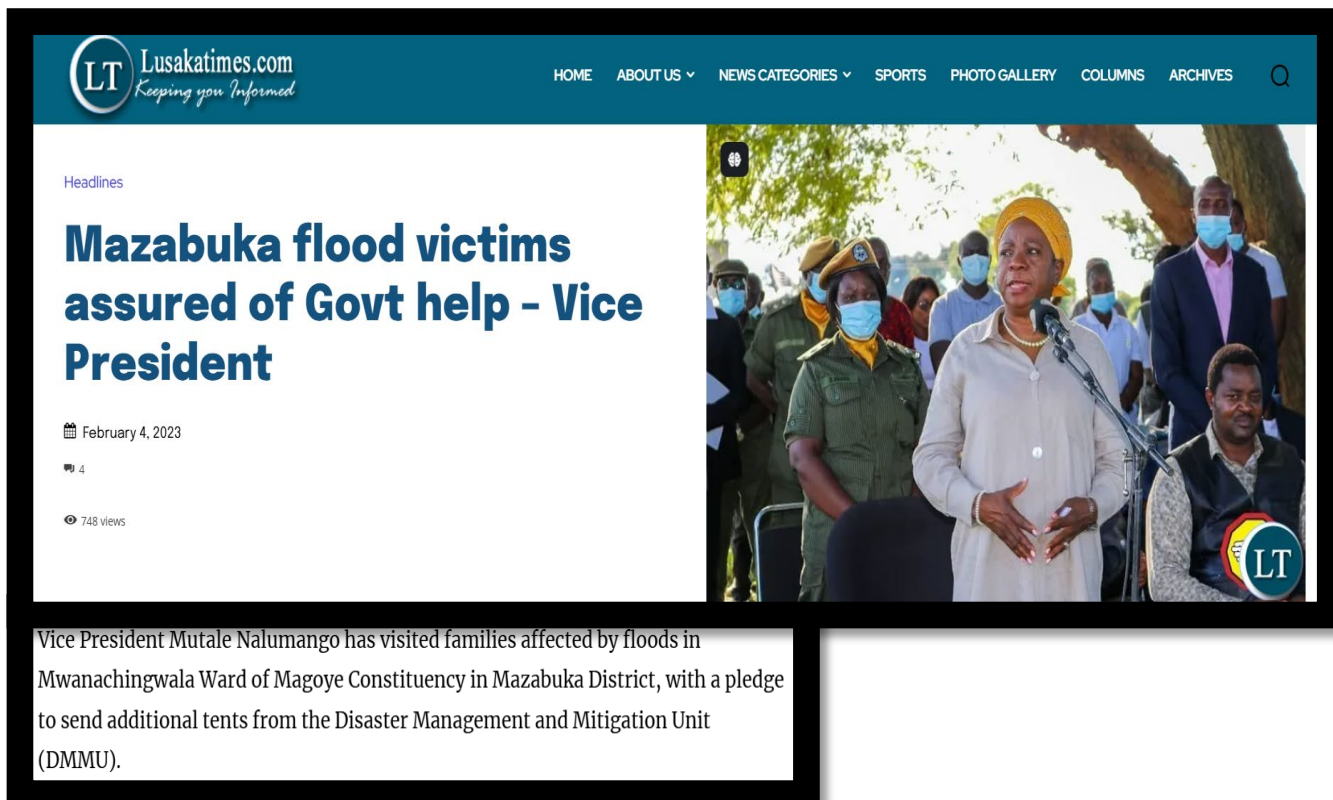


Figure 2. Screenshot of the published information on flood effect in 2009 and 2023 in Southern Province, Mazabuka: Top (Sources: <https://www.reuters.com/article/world/zambia-and-namibia-face-worst-floods-in-40-years-idUSJOE52P026/>). Bottom: (Source: <https://www.lusakatimes.com/2023/02/04/mazabuka-flood-victims-assured-of-govt-help-vice-president/>).

3. Methodology and Data

Figure 3 presents the overall framework followed to develop the IBFI. Flood parameter development is the starting part of the work, which includes data preparation, model development, and validating the model result to produce the flood parameter used for IBFI product development. The second part is stakeholder engagement at various levels to further support product development. The third part is product design and development in collaboration with partners. The fourth and fifth parts of the work are monitoring and triggering payout.

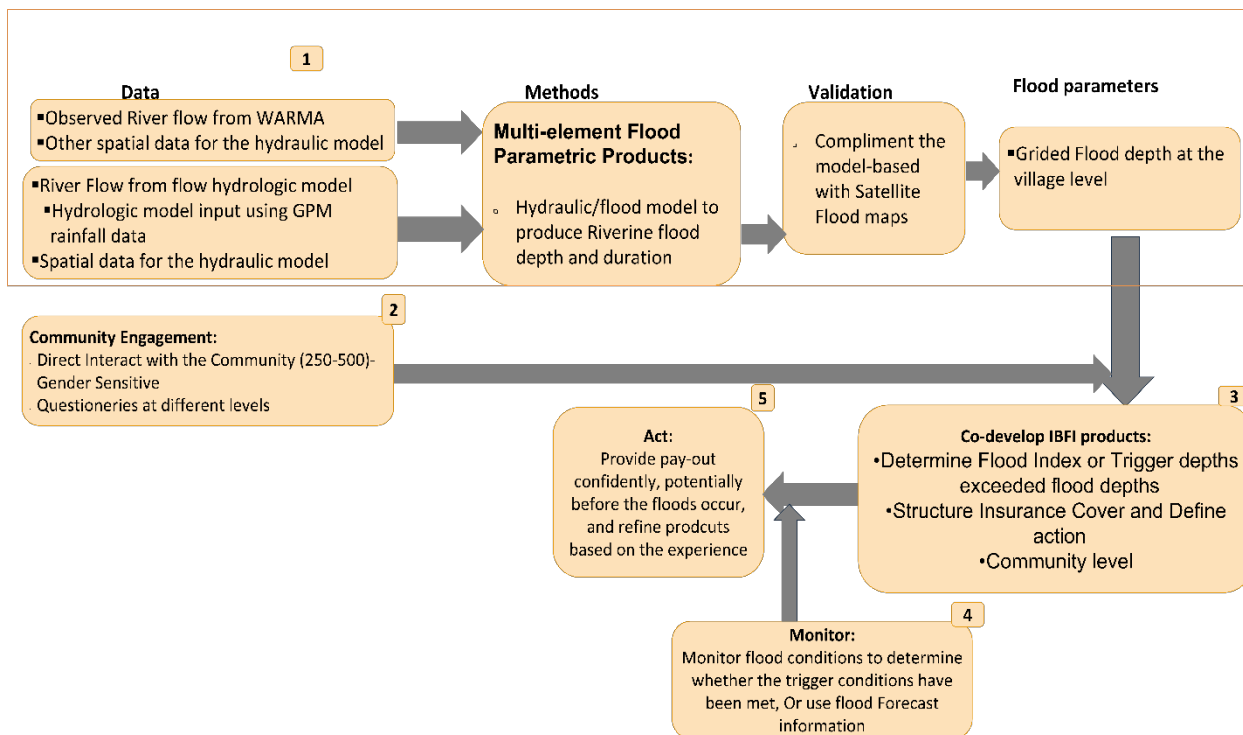


Figure 3: Study Framework and Methodology: (1) flood parameter development, (2) community engagement, (3) IBFI product development, (4) Monitoring the flood condition and triggers, and (5) Payout. Source: Authors

3.1. Data used – Observed Discharge

In this study, we used data from the Water Resources Management Authority (WARMA) of Zambia, which is the time series observed discharge data used for actual flood simulation and design flood estimation. Figure 4 shows the observed discharge data used for flood modeling. As shown in the figure, the discharge data is calculated based on the stage-discharge relationship based on the measured water level (stage) data at Magoye River, Chimbumbu'S Farm station, with the data available from 2001 to 2023. However, data is missing a lot, particularly during flooding events. Moreover, the river morphological changes at the stage location highly affected the stage-discharge relationship equation, which can lead to the accuracy of the calculated discharge data (Mafwabo et al., 2023).

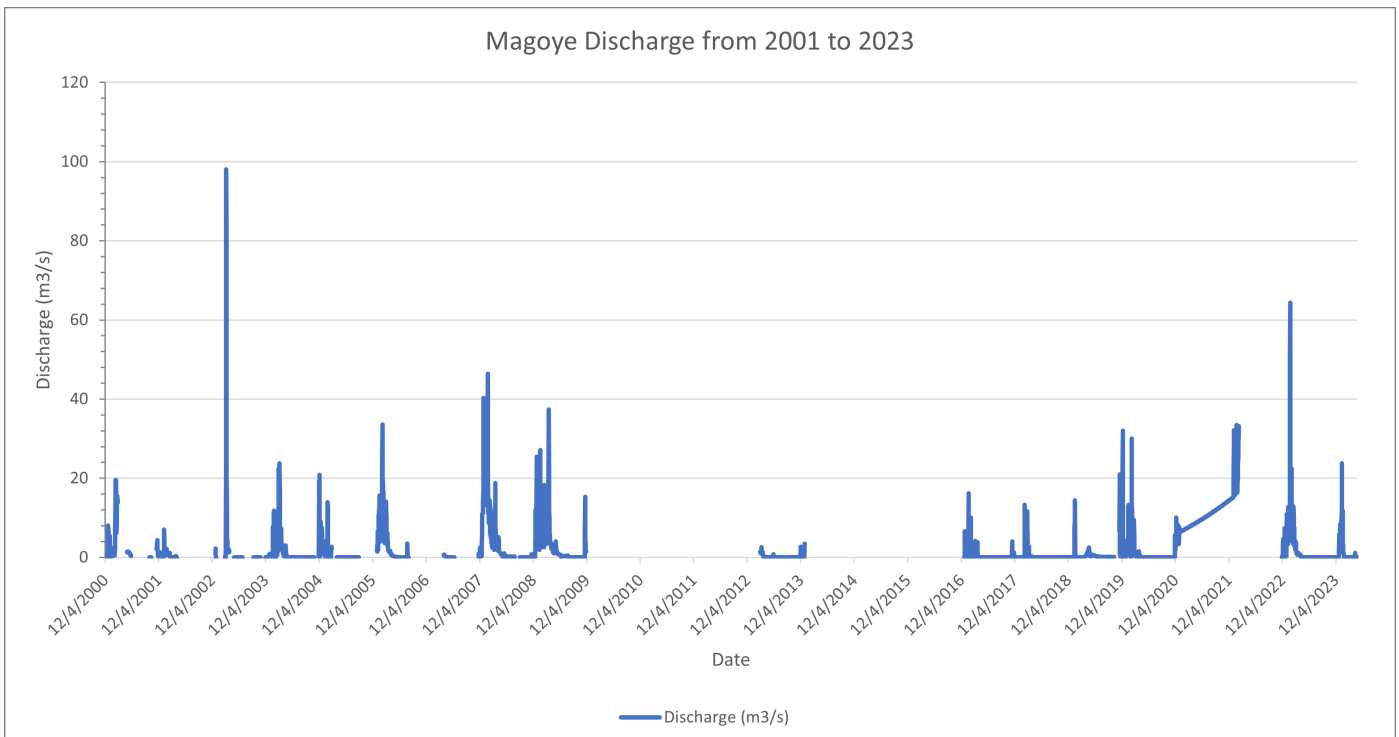
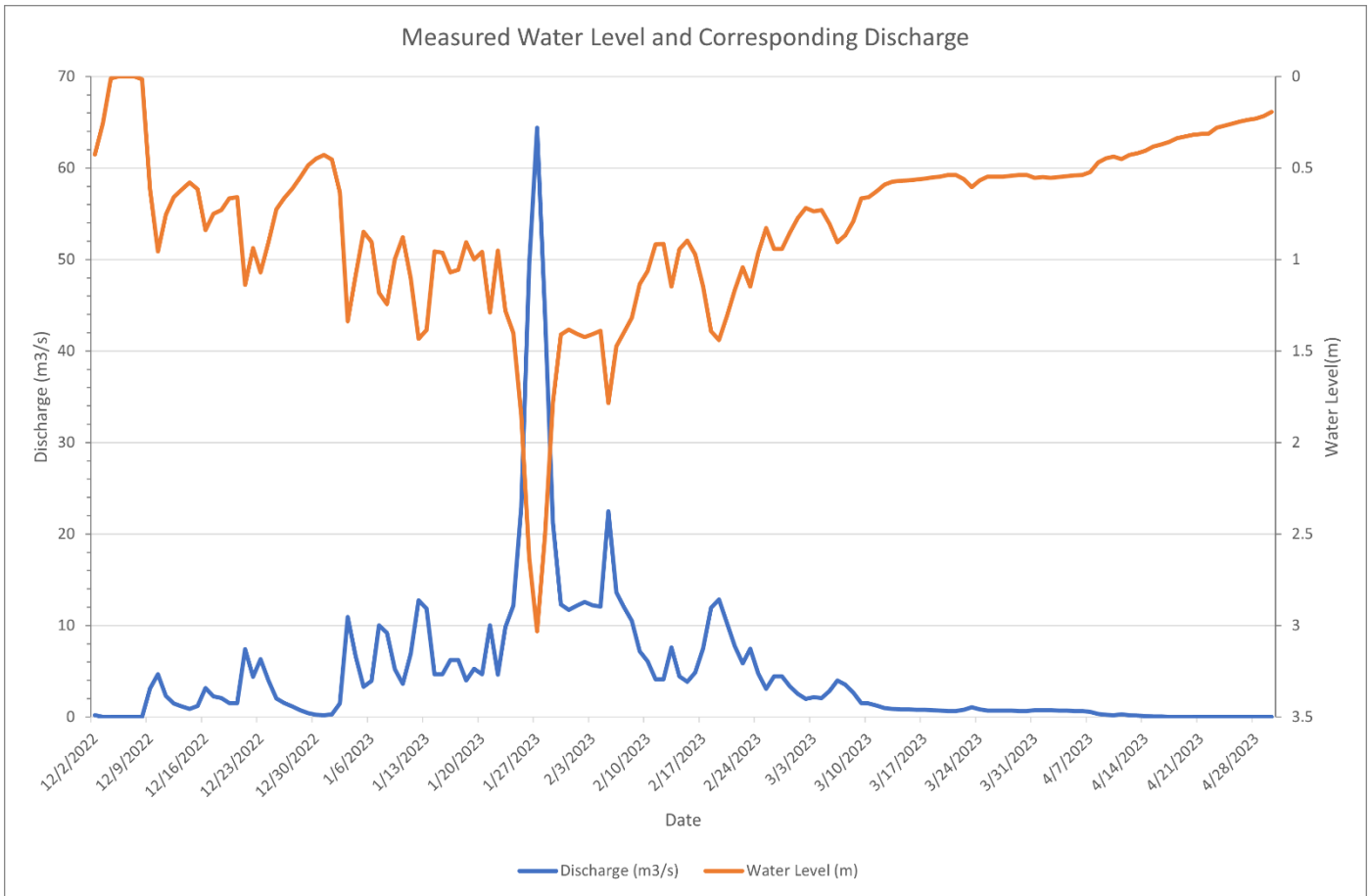


Figure 4. Magoye River Water level was measured at Chimbumbu'S Farm station, and the corresponding discharge was calculated based on the stage-discharge relationship. Top: Measured Water Level and the Corresponding Discharge for the 2023 flood event; Bottom: Available Discharge data from 2001 to 2023.

As illustrated in the figure, the hydrograph starts building up from mid-November onward and attains its peak from January to March. However, the peak event starts building up from December

onwards, with a flood threshold of 25 m³/s corresponding to a 2-year flood event. According to information from WARMA, the 2-year event is considered as the threshold for the flood danger level.

The flow is characterized by a single peak with high volume. These two flow characteristics together with the flat topography and clayish soil properties are the main contributors to the flooding in the downstream part of the catchment.

3.2. Flood Model

For flood inundation modeling, we employed the LISFLOOD-FP model, a raster-based approach that calculates water depth across each cell in the grid using hydraulic principles (Neal et al., 2012). For this study, a 2D configuration was used to accommodate the extensive floodplain areas, while a sub-grid setup was applied specifically to the Magoye floodplain, allowing for a comparative analysis with the 2D simulation.

Key inputs included the Digital Elevation Model (DEM) from FABDEM (Forest And Buildings removed Copernicus DEM) (Hawker et al., 2022) and river channel details from GRWL, which defined channel locations and characteristics (Allen and Pavelsky, 2018). Roughness coefficients for river and floodplain conditions were derived from literature sources. Two boundary conditions were set: upstream, where observed and modeled flow data influenced LISFLOOD-FP, and downstream, where DEM-derived normal depth was applied consistently. Historical flood simulations were conducted for model validation using flood extent maps from Earth Observation (EO) data, with the validated model then integrated with hydrological outputs to support a flood inundation early warning system.

The model was run from 2001 to 2023 when the observed discharge is available. The observed hydrograph is used as upstream boundary conditions to force the model to produce flood depth in the model domain.

3.3. Utilizing Satellite data for flood inundation mapping

While Zambia contends with several hazards, floods emerge as the most significant threat to people's livelihoods and agriculture. While Zambia contends with several hazards, floods emerge as the most significant threat to people's livelihoods and agricultural production. In February 2023, Zambia faced its most severe flooding in over half a century, as reported by the Zambia Disaster Management and Mitigation Unit (DMMU). Figure 5 shows the comprehensive flood assessment conducted by IWMI, the total flood-affected area was estimated to be approximately 4,662 square kilometers. This assessment utilized satellite data from MODIS, Sentinel-1, Sentinel-2, and RADARSAT CRD2.

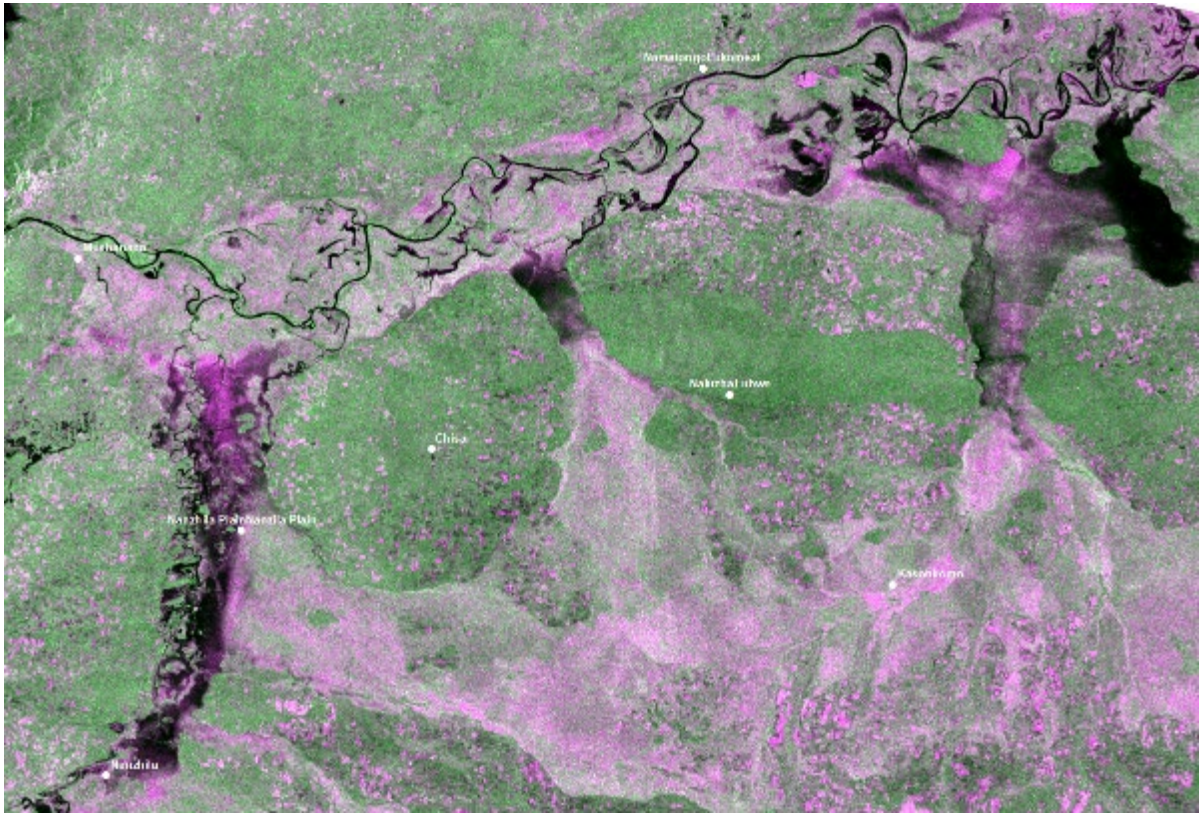
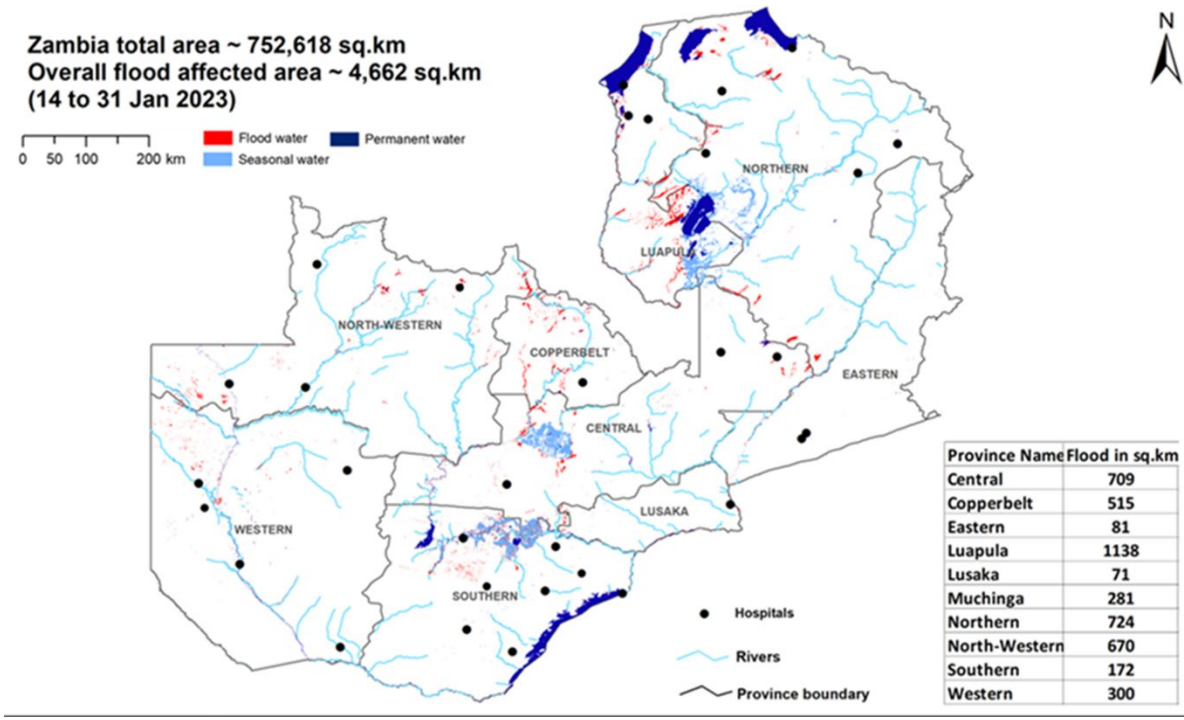


Figure 5: Satellite flood inundation map in Zambia. Top: Areas exposed to flooding. **The flood areas were calculated from the flood pixels which were extracted from MODIS and RADARSAT CRD2 satellite data and their spatial pattern is represented by the map.** The highest flooded area (approx. 307 sq. km) was recorded in Mansa district of Luapula province and the highest agriculture exposure (approx. 148 sq. km) was recorded in Chibombo district in Central province; Bottom: Satellite data from RADARSAT CRD2 with a spatial resolution of 10 m.

3.3.1 Flood Model Validation using Satellite-Derived Flood Maps

The performance of the model in simulating the flood inundation is evaluated by comparing model output with the satellite (observed) flood extent map extracted for the simulation period. Ideally,

the satellite overpass during the flood simulation period would be used for model comparison. However, in most developing countries, such information is not available. The available satellite products in these regions are either of low quality or available slightly outside the flood period after the actual flood peak resided. In the case of the Magoye catchment, we used the satellite data from the MODIS product available for 6 days (26 to 31 January 2023). Similarly, the flood model simulation is also for six days.

To evaluate how well the models are performing in terms of the fit between the observed and predicted inundation extent, we used the Fstat, F. The F stat calculates the fit, F, between the model and the observed flood extent calculated using the following formulae:

$$F = \frac{D}{B + C + D}$$

Where B, C, and D, are the pixel values defined according to the contingency table presented in Table 1.

Table 1: Contingence table used to compare the satellite flood inundation with simulated flood maps.

	Observed = Dry	Observed = Wet
Model = Dry	A = -Dry/dry	B = predicted dry but observed wet
Model = Wet	C = Predicted wet but observed dry	D = Wet/wet

This equation divides the number of pixels correctly predicted as wet by the total number of 'floodplain' pixels. It doesn't account for the pixels correctly predicted as dry as this might bias the measure according to domain size (e.g. it is easy to predict a small flood in a large domain as most pixels will be dry). The value of F goes from 0 for a model with no overlap between observed and modeled data, to 1 for a model with perfect overlap.

3.4. Stakeholder Engagement

Stakeholder engagement is carried out at three levels. First, consultation meetings with government institutions and private sectors such as insurance and product developers. Second, the District level meeting with Local Authorities and agricultural extensions to discuss past flood risk and provide support for data collection on past flood risks. Through questionnaires, the flood risk information at the community level was collected and the results of the analysis are presented in section 4.4. Moreover, the Local Authorities and Extensions' roles are to assist with mobilization and farmer engagement. Third, community engagement at the village level - farmers. We carried out community engagement at three Villages (Figure 6) and the key discussion with them is presented in section 4.4. Moreover, the farmers engaged in this initiative by participating in product onboarding and providing feedback.

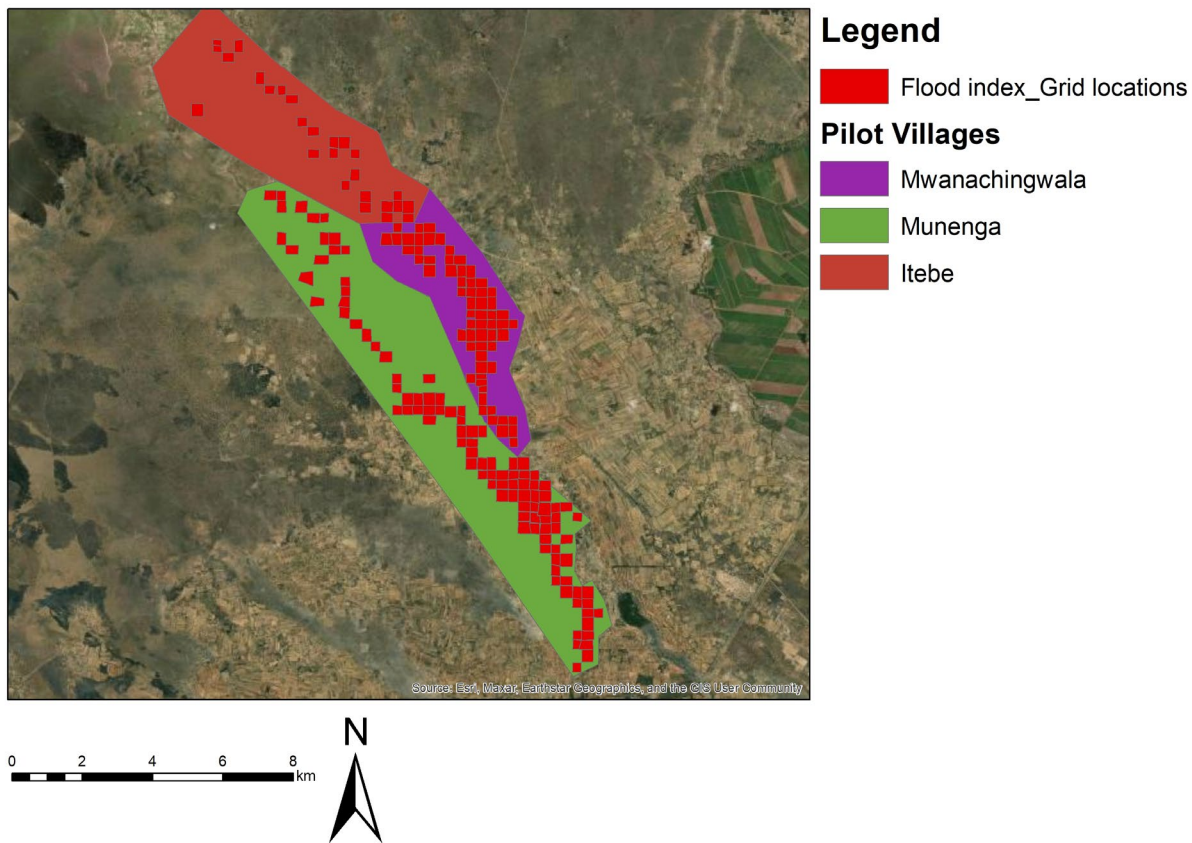


Figure 6: IBFI Pilot Villages and the flood depth grid locations that used for product development: Source authors.

3.5. Developing the IBFI product

The product is co-developed with ACRE Africa and Professional Insurance as an underwriter. The flood model was simulated from 2001 to 2023 for the days when the observed discharge data were available. The model was simulated at the spatial resolution of 180 m and later resampled to 300 m. Thus, the flood depth time series used for product development is extracted at 300 m—the grid locations from which the flood depths are collected are shown in Figure 6. In total, 130, 112, and 87 grids were collected from Munenga, and Mwanachingwala villages, However, for analysis we considered the grid locations that are more representative and located in crop field areas.

3.5.1. Burn Cost Analysis application

Calculation of premium using the parameters defined above uses the Burning Cost Analysis method. This method calculates the Risk Premium for a contingent claim. It is a simple and highly effective method and gives a good approximation of what the actual pure premium for each pixel would be. Based on past flood depth data, it assumes flood events in the future will be reminiscent of those experienced in the past. The steps taken are:

- The simulated flood depth data is cleaned and de-trended. This is the process of detecting and correcting (or removing) corrupt or inaccurate records from a database. It refers to identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the dirty or coarse data.
- Determine the historical average of the flood depth data for the coverage period across the historical years.

- Fit a distribution to the historical average data (Gumbel distribution) which is a type of extreme value distribution to model extreme flood events. This is used to estimate the probability of extreme flood events based on the historical data.
- The outputs from the distribution fitting are used to determine specific percentile thresholds that correspond to different flood severity levels. These percentiles—such as those for Minor, Moderate, Major, and Catastrophic events—reflect the severity of flooding and are used to set the trigger points for when payouts will be activated.
- Determine index value – hypothetical payoffs for each year. Based on the defined triggers, simulations of historical flood depth data are done to determine what the previous year's payouts would have been.
- Calculate payoff average which is a factor of the pure premium. This is done by taking the average of the potential historical payouts that have been generated by the model.
- Estimate the capital loading - one of the key components of the risk premium, which is a loading added on to cater for catastrophic losses. It is usually included because in the event that actual losses are significantly greater than the average, the insurer actually requires funding from other sources to cover claims (i.e. the premium collected from this particular group of farmers will not be sufficient).
- It is usually computed as $Capital\ Loading = Average\ cost\ of\ borrowing\ for\ insurer + (Average\ of\ losses\ exceeding\ a\ given\ threshold\ representing\ catastrophic\ losses,\ e.g.\ 95th\ percentile - Average\ losses)$. We work with 10% as the average cost of borrowing.
- A loading for expenses, Commission and Profit has to be added to obtain the final Premium

4. Results and Discussion

4.1. Flood model Simulation and comparison with Satellite flood maps

Figure 7a shows the river basins of Zambia with the study location indicated in the red rectangle. Figure 7b compares the model-simulated flood extent with satellite data for the Lower Magoye catchment during the flood event from January 26 to 31, 2023. The figure shows that the flood inundation pattern is well represented within the model domain, especially in the river's floodplain. Except for the upper section of the river, the model's flood extent aligns closely with the satellite observations. In the lower catchment, part of the expansive Kafue Flats, both the model and satellite exhibit similar flood extent characteristics as the floodplain fills easily. However, the pixel-to-pixel comparison indicates a 38.71% match, reflecting a relatively poor performance. This discrepancy is primarily due to the satellite's inability to detect flooding in the river's upper reaches, where the model shows greater inundation.

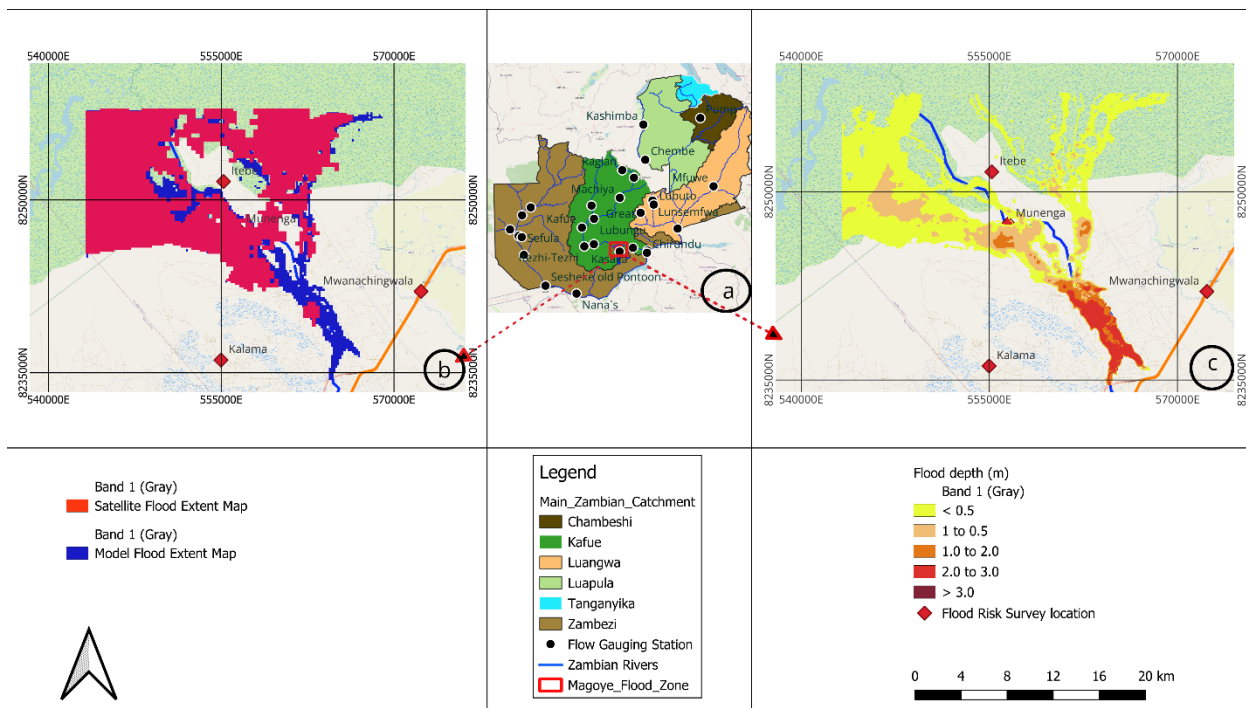


Figure 7: Flood inundation model result in the lower Magoye sub-catchment for flood event January 26 to 31, 2023; a) Main_Zambian_Catchments and Rivers; b) Flood inundation extent and comparisons with satellite flood extent map; and (c) flood depth distribution in the flood plain.

The results in Figure 7c show the simulated spatial distribution in flood depths using observed discharge data for flood events in 2023. As shown in the Figure, the simulated flood depth is greater than 1 m, particularly in the upstream and periphery of the middle sections of the river. In most downstream and a few middle sections of the river, the simulated flood depth varies between 1 m and less than 0.5 m. Deep flood depths above 1 m are simulated in the swamp and uninhabitable areas. Areas covered by crop fields experienced flood depths of less than 0.5, and few settlements experienced flood depths of 0.5 to 1 m.

4.2. Flood Depth at Grid locations

The flood depths were collected from grid locations along the Magoye River. Figure 8 shows the flood depths representing the three villages. As shown in the figure, each line represents the

simulated flood depth for a given grid cell. Due to missing values in the observed discharge, the simulated flood depth in the missing years is also zeros, and the irregularity in the plotted flood depth, as shown in the figure is, the result of interpolation, but kept zeros during product development.

The total number of grids considered for IBFI product development is 23, 21, and 24 for Munenga, Mwanachingwala, and Itebe, respectively. In terms of magnitude, the maximum flood depths are simulated in the Munenga then followed by Mwanachingwala and Itebe. Around the Itebe Village, which is the downstream location of the Magoye River, the river has disappeared and forms widespread deltas. The village is relatively at a higher topography than the surrounding locations which leads to lower flood depth. Munenga and Mwanachingwala villages are located upstream of the flood modeling domain where the flood depths are confined along the river stream which leads to higher flood depths compared to the Itebe villages. Moreover, the river burst out of the main river first around the Munenga and Mwanachingwala Villages, which leads to a higher flood depth. Particularly, the crop fields along the river in these villages are exposed to flood depths of around 1 meter to the river overflow.



Figure 8: Flood depths representing three Villages.

4.3. IBFI Product

The flood index product is designed to cover flooding events based on flood depth data from the flood modeling domain as the specific target area.

4.3.1. Setting the Trigger

The flooding triggers are designed to reflect different levels of severity and are established based on historical data, using a multi-tiered approach as shown in Table 2.

Table 2: Flood depth thresholds used to trigger the payout.

Level of Flooding	Percentile for Trigger Setting	Maximum Coverage
Minor	80%	25%
Moderate	85%	50%
Major	95%	75%
Catastrophic	99%	100%

The triggers for different levels of severity are explained as:

1. **Minor Flooding:** Represents less severe flood events. Triggered at the 80th percentile, it offers up to 25% coverage.
2. **Moderate Flooding:** Slightly more significant, these events are triggered at the 85th percentile, with a maximum coverage of 50%.
3. **Major Flooding:** Severe flood events, triggered at the 95th percentile, providing up to 75% coverage.
4. **Catastrophic Flooding:** Rare and highly destructive flood events, triggered at the 99th percentile, ensuring full (100%) coverage.

This tiered system provides flexibility and ensures appropriate compensation proportional to the severity of flood events while minimizing basis risk.

The payout function calculates the compensation based on the severity of the flood event. The payout is determined using a linear scale between different levels of flooding severity (Minor, Moderate, Major, Catastrophic). This payout model ensures that the compensation increases progressively as the flood severity increases but within specified trigger points.

4.3.2. Payout Formula

The payout percentage is determined by the severity of the flood (Minor, Moderate, Major, or Catastrophic) and is calculated linearly between trigger points. For instance:

- No Event (e.g., no flooding): If no flooding occurs (or if the flood depth is below the Minor Trigger), no payout is made.
- Minor Event: If the flood depth is above the Minor Trigger but below the Moderate Trigger, the payout triggered is up to a maximum of 25%.
- Moderate Event: If the flood depth is above the Moderate Trigger but below the Major Trigger, the payout triggered is up to a maximum of 50%.
- Major Event: If the flood depth is above the Major Trigger but below the Catastrophic Trigger, the payout triggered is up to a maximum of 75%.
- Catastrophic Event: If the flood depth is above the Catastrophic Trigger, the payout reaches the maximum (100% of the maximum coverage).

4.3.3. Loss Assessment

Flood events will be monitored in 10-day periods throughout the coverage period. Each block represents a predefined observation window during which river flow levels will be analysed to assess potential flood risks and impacts. This segmented monitoring approach ensures timely detection

and response to flood events while aligning with the crop growth stages and the insurance coverage structure. Table 3 shows the observation blocks to be applied.

Table 3: Observation blocks that will be implemented to monitor throughout the coverage period.

Block	Start	End
1	1 Nov	10 Nov
2	11 Nov	20 Nov
3	21 Nov	30 Nov
4	1 Dec	10 Dec
5	11 Dec	20 Dec
6	21 Dec	30 Dec
7	31 Dec	9 Jan
8	10 Jan	19 Jan
9	20 Jan	29 Jan
10	30 Jan	8 Feb
11	9 Feb	18 Feb
12	19 Feb	28 Feb
13	1 Mar	10 Mar
14	11 Mar	20 Mar
15	21 Mar	30 ar

4.3.4. Implementation Plan

The implementation of the product is co-implemented by ACRE Africa. As part of the implementation, capacity building on training local extension officers and community members to enhance understanding of the product is finalized. Enrolment of 250 household registrations is underway via local Ministry of Agriculture (MoA) offices. Besides, real-time flood monitoring and reporting have been well underway since the beginning of November 2024, as shown in Figure 9. The monitoring will continue until March 2025. The payout and final report will be out in May 2025. This includes calculating and facilitating payout post-season and conducting a post-project review.



Figure 9: Real-time monitoring of product implementation showing local extensions engagement with farmers at the farm level, and the current status of Magoye River (Photo taken during the first week of December, Credit: ACRE Africa).

4.4. Stakeholders Engagement

As part of IBFI product development and implementation, stakeholder engagement at different levels has been conducted. In the next two sections, two results are presented here (1) the flood risk information collected through support from Extensions and (2) Farmers' engagement at three Villages.

4.4.1. Collected Flood Risk Information

Past flood risk in Munenga, Mwanachingwala, and Itebe villages was assessed using questionnaires (Figure 10). Data collected for 2023 included the number of affected and displaced households and people, affected livestock, and crop damage (hectares). Displacement was consistently the most significant impact: 660 people in Itebe, 1320 in Munenga, and 1920 in Mwanachingwala. The second and third most significant impacts varied: in Munenga, it was crop damage (380 hectares), followed by the number of displaced households and households affected (both 220). In Mwanachingwala and Itebe, the number of displaced households and the number of households affected (both 320 and 110) ranked second and third, with crop damage at 93 and 60 hectares respectively.

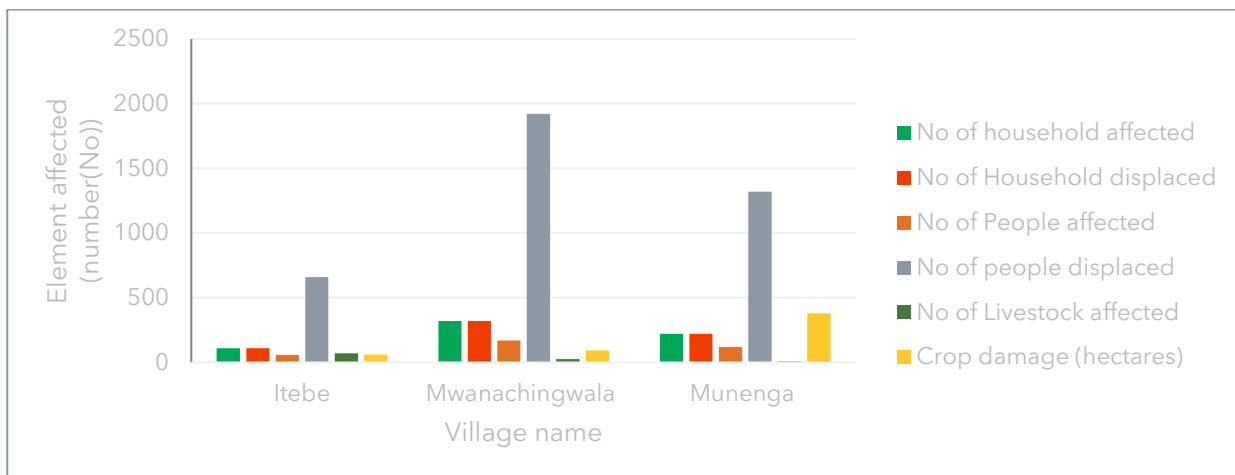


Figure 10: The 2023 flood risk information collected from three Villages: Munenga, Mwanachingwala, and Itebe.

4.4.2. Community Engagements

The IWMI researchers and ACRE Africa regional director, accompanied by a Ministry of Agriculture Block Officer (Mr. Giff Sikota), conducted community engagement in three Mazabuka villages (Itebe, Munenga, and Mwanachingwala) near the Magoye River. This engagement, part of a flood index research project investigating the river's impact on crop production, involved focus group discussions with approximately 65 farmers (gender-balanced) residing in agricultural camps. The purpose was to introduce IWMI and ACRE Africa's developing flood risk insurance solutions and gather feedback on their usefulness and applicability to local risks.

During the meetings, the following points were discussed and observed across all three camps:

- **Introduction of IWMI and ACRE Africa:**
Farmers were introduced to the International Water Management Institute (IWMI) and ACRE Africa. The discussions centered around the impact of floods, with an emphasis on the importance of protecting crops through flood insurance.
- **Farmer Testimonials on Flood Impacts:**
Many farmers shared their personal experiences of how flooding has severely affected their crop production in past years. Notably, farmers in **Munenga** recalled major floods occurring in **2005, 2007, and 2009**, which led to significant crop losses.

Farmers in Munenga also mentioned having faced challenges with waterlogging over past years.
- **Causes of Flooding:**
Farmers explained that flooding is exacerbated when the banks of the Magoye River break due to river sand mining activities. This human interference has increased the frequency and severity of flood events, heightening the risks for the surrounding agricultural lands.
- **Willingness to Pay for Insurance:**
Across all three camps, the farmers expressed strong interest in securing flood insurance coverage. The majority of farmers indicated that they would be willing to pay an insurance premium of **K 200 to K 400** about (USD 7 to USD 14) to protect their crops from flood risks.

Regarding Land Ownership and production data, the farmers told us on average, farmers owned between **2 to 5 hectares** of land. The average crop production across the three camps was consistent at approximately **1.5 tonnes per hectare**.





Figure 11: Community engagement as part of IBFI product development. Top: Focus group discussion with farmers at Itebe Primary School and flood mark 2023 indication; Middle: Focus group discussion with farmers at Munenga Health Center; Bottom: Focus group discussion with farmers at Chalimbana Camp and status of Magoyer River in October.

4.5. Conclusion

The Index-Based Flood Insurance (IBFI) pilot in Zambia's Magoye River Catchment demonstrates a groundbreaking approach to mitigating flood risks for smallholder farmers in flood-prone areas. Leveraging advanced flood modeling, satellite data, and a multi-tiered payout system, the IBFI product provides timely financial compensation, reduces economic shocks, and fosters climate resilience.

The pilot's results highlight both the strengths and challenges of implementing IBFI in the region. While the flood model effectively simulated inundation patterns and depths, discrepancies between model outputs and satellite observations, particularly in upper river reaches, indicate areas for further refinement. Additionally, community engagement efforts revealed high interest in flood insurance among farmers, confirming the need for scalable solutions tailored to local risks and socio-economic realities. The active involvement of stakeholders—government agencies, local communities, and private sector actors—ensures that the IBFI product aligns with on-the-ground conditions and builds trust within affected communities.

By setting clear flood severity triggers and offering flexible coverage tiers, the IBFI product minimizes basis risk and ensures payouts reflect actual losses. This approach is critical for building confidence in insurance solutions and promoting sustainable agricultural practices. The IBFI pilot establishes a solid foundation for scaling such initiatives across Zambia and other flood-prone regions in sub-Saharan Africa.

4.6. Recommendations

Scaling IBFI Recommendations

1. Refinement of Flood Modeling and Data Integration

- Improve the alignment between flood model simulations and satellite observations by incorporating additional calibration and validation steps, especially for upper river regions.

- Enhance the resolution of satellite data to better detect localized flooding and refine flood extent and depth predictions.

2. **Scaling IBFI Across Flood-Prone Regions**

- Expand the IBFI product to other vulnerable areas in Zambia and sub-Saharan Africa, prioritizing regions with frequent flood risks and high community demand for insurance.
- Develop region-specific triggers and payout structures to address local climatic and socio-economic variations.

3. **Strengthening Community Engagement and Capacity Building**

- Increase training for local extension officers and community members to improve understanding and adoption of the IBFI product.
- Continue engaging with farmers to gather feedback and refine the insurance design based on their needs and experiences.

4. **Policy Support and Stakeholder Collaboration**

- Advocate for policy frameworks that support the integration of index-based insurance into national disaster risk management and agricultural resilience strategies.
- Strengthen partnerships with government agencies, private insurers, and international organizations to ensure financial sustainability and scalability of the IBFI product.

5. **Technology and Innovation**

- Invest in advanced technologies, such as machine learning and IoT sensors, to improve real-time flood monitoring and risk assessment.
- Explore bundling flood insurance with other climate resilience solutions, such as drought insurance or input subsidies, to provide comprehensive risk coverage for farmers.

6. **Long-Term Monitoring and Evaluation**

- Implement a robust monitoring and evaluation framework to track the IBFI product's performance over multiple seasons and assess its socio-economic impact.
- Use insights from pilot results to continuously improve product design, reduce basis risk, and enhance its relevance to target communities.

The success of the IBFI pilot illustrates the potential of innovative insurance solutions to address climate risks, secure livelihoods, and promote sustainable growth. By scaling and refining such initiatives, Zambia can lead the way in building climate resilience for its most vulnerable populations.

5. **References**

Allen, G.H. and Pavelsky, T.M., 2018. Global extent of rivers and streams. *Science*, 361 (6402), pp.585-588.

Amarnath, G., Ghosh, S., Alahacoon, N., Sikka, A. and Brahmanand, P.S., 2024. Protecting vulnerable communities: a case study of index-based flood insurance in India, powered by flood

modeling and remotely sensed rainfall. In Adams, T. E.; Gangodagamage, C.; Pagano, T. C. (Eds.). *Flood forecasting: a global perspective*. 2nd ed. London, UK: Academic Press <https://hdl.handle.net/10568/152519>

Amarnath, G., Malik, R.P.S. and Taron, A., 2021. *Scaling up Index-based Flood Insurance (IBFI) for agricultural resilience and flood-proofing livelihoods in developing countries* (Vol. 180). International Water Management Institute (IWMI).

De Silva, M.M.G.T. and Kawasaki, A., 2018. Socioeconomic vulnerability to disaster risk: a case study of flood and drought impact in a rural Sri Lankan community. *Ecological Economics*, 152, pp.131-140.

Hawker, L., Uhe, P., Paulo, L., Sosa, J., Savage, J., Sampson, C. and Neal, J., 2022. A 30 m global map of elevation with forests and buildings removed. *Environmental Research Letters*, 17(2), p.024016.

Mafwabo, D., Muchanga, M., Wankie, R., Singubi, N. and Zulu, I., 2023. Anthropogenic Geomorphology of the Magoye Riverine Landscape, Zambia. *Asian Journal of Geographical Research*, 6(4), pp.1-16.

Neal, J., Schumann, G. and Bates, P., 2012. A subgrid channel model for simulating river hydraulics and floodplain inundation over large and data sparse areas. *Water Resources Research*, 48(11).

Reed, C., Anderson, W., Kruczkiewicz, A., Nakamura, J., Gallo, D., Seager, R. and McDermid, S.S., 2022. The impact of flooding on food security across Africa. *Proceedings of the National Academy of Sciences*, 119(43), p.e2119399119.

Wang, X., Liu, Z. and Chen, H., 2022. *Investigating flood impact on crop production under a comprehensive and spatially explicit risk evaluation framework*. *Agric 12* (4): 1–23 [online].

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