Geohazards Risk Mapping Initiative

Transplanting rice into a flooded paddy, Nigeria

Composite flood hazard class

Katcha Ward, Niger State · map sheet 09 of 13

TECHNICAL FIELD REPORT

Flood-Tolerant Rice Seed Deployment and Satellite-Based Flood Risk Assessment for Floodplain Rice Farmers

FARO 67 Distribution, Farmer Engagement, and Earth Observation Flood Analysis in Katcha Ward, Katcha LGA, Niger State, Nigeria

Katcha Ward, Katcha Local Government Area, Niger State, Nigeria (River Niger floodplain)

Field mission, 10 July 2026

200 kg
TOTAL QUANTITY DISTRIBUTED

20
FARMERS REACHED

8,891 ha
WARD AREA ASSESSED

IN PARTNERSHIP WITH

NCRI Badeggi; RIFAN (Niger State); NSEMA; NASC; NIHSA; Katcha Group Farmers Cooperative; Emigun Egbrolo Dzangbodo Association

ABOUT THIS REPORT

EXECUTING AGENCY	Geohazards Risk Mapping Initiative (GRMI), www.georiskmap.org
PROJECT	Flood-Tolerant Rice Seed Handover for Flood-Affected Farmers, Katcha LGA
THEMATIC AREAS	Disaster Risk Reduction; Climate Change Adaptation; Agriculture and Food Security; Community Development
STUDY LOCATION	Katcha Ward, Katcha Local Government Area, Niger State, Nigeria (River Niger floodplain)
DATE OF FIELD MISSION	10 July 2026
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IMPLEMENTING PARTNERS	NCRI Badeggi; RIFAN (Niger State); NSEMA; NASC; NIHSA; Katcha Group Farmers Cooperative; Emigun Egbrolo Dzangbodo Association
FLOOD ANALYSIS PERIOD	2020-2025 (Sentinel-1 SAR, Copernicus Programme)
REPORT STATUS	Final

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SCOPE

Prepared as an evidence-based disaster risk reduction case study, aligned with the Sendai Framework for Disaster Risk Reduction 2015-2030 and UN-SPIDER recommended practice for satellite-based flood mapping.

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Report Team and Contributors

This report was prepared by the Geohazards Risk Mapping Initiative (GRMI). The individuals below contributed to the field mission, the geospatial analysis, and the preparation of this report.

Name	Role and contribution
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The mission was made possible through the support and collaboration of partner institutions, including the National Cereals Research Institute (NCRI) at Badeggi and the Rice Farmers Association of Nigeria (RIFAN, Niger State). The mission received no external funding. It was financed from the personal savings of the report team.

Acronyms and Abbreviations

AfricaRice	Africa Rice Center
AP2/ERF	APETALA2 / Ethylene Response Factor (transcription factor family)
DEM	Digital Elevation Model
DRR	Disaster Risk Reduction
EO	Earth Observation
FARO	Federal / Approved Rice of Origin (Nigerian rice variety naming series)
GEE	Google Earth Engine
GIS	Geographic Information System
GRMI	Geohazards Risk Mapping Initiative
IRRI	International Rice Research Institute
LGA	Local Government Area
LULC	Land Use and Land Cover
MABC	Marker-Assisted Backcrossing
NASC	National Agricultural Seeds Council
NCRI	National Cereals Research Institute (Badeggi)
NEMA	National Emergency Management Agency
NIHSA	Nigeria Hydrological Services Agency
NSEMA	Niger State Emergency Management Agency
RIFAN	Rice Farmers Association of Nigeria
SAR	Synthetic Aperture Radar
STRASA	Stress-Tolerant Rice for Africa and South Asia
SUB1 / SUB1A	Submergence 1 locus / Submergence 1A submergence-tolerance gene
UNDRR	United Nations Office for Disaster Risk Reduction
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response

Executive Summary

Key Figures at a Glance

SEED VARIETY DISTRIBUTED **FARO 67 (submergence-tolerant, SUB1A)**	TOTAL QUANTITY DISTRIBUTED **200 kg**	FARMERS REACHED (DIRECT) **20**
ALLOCATION PER FARMER **10 kg (labelled starter pack)**	FARMER GROUP REPRESENTED **Katcha Ward Farmers' Association**	WARD AREA ASSESSED (2025 LULC) **8,891 ha (about 88.9 km²)**
RICE CROPLAND SHARE OF WARD **About 65% (52.4% rice field; 12.8% flooded rice field)**	FLOOD ANALYSIS PERIOD **2020-2025**	PRIMARY SATELLITE DATA SOURCE **Sentinel-1 C-band SAR (Copernicus)**
MAPPED ANNUAL FLOOD EXTENT RANGE **12.6 to 13.7 km²**	HIGH-FLOOD SIMULATION SCENARIO **10 m river-level rise (DEM-based, validated)**	

This report documents an integrated disaster risk reduction (DRR) field mission carried out by the Geohazards Risk Mapping Initiative (GRMI) in Katcha Ward, Katcha Local Government Area (LGA), Niger State, on 10 July 2026. The mission combined agricultural extension delivery with satellite-based flood risk analysis, and it was designed to support targeted, evidence-based recovery for floodplain rice farmers, grounded in a spatial understanding of where their cropland is exposed.

The mission distributed 200 kg of FARO 67 rice seed to 20 farmers of the Katcha Ward Farmers' Association, at a standard allocation of 10 kg per farmer, and delivered a sensitization workshop on the variety's characteristics and management. FARO 67 is a submergence-tolerant rice variety that carries the SUB1A gene and can survive one to two weeks of complete flooding before recovering once floodwaters recede (Xu et al., 2006; Fukao et al., 2006). The variety was released in Nigeria in 2017 through the Stress-Tolerant Rice for Africa and South Asia (STRASA) initiative of the International Rice Research Institute (IRRI) and the Africa Rice Center (AfricaRice), with the National Cereals Research Institute (NCRI) at Badeggi as the national partner (AfricaRice, 2017; Mwakyusa et al., 2023). Its selection for Katcha responds directly to the ward's exposure profile, and its delivery addresses a documented last-mile gap: adoption of FARO 66 and FARO 67 has remained limited across West Africa despite eight years of availability (Mwakyusa et al., 2023).

In parallel, GRMI conducted a geospatial flood assessment covering 2020 to 2025 using Sentinel-1 Synthetic Aperture Radar (SAR) imagery, permanent water masking, flood frequency mapping, and Digital Elevation Model (DEM) based water-level simulation, following UN-SPIDER recommended practice for SAR flood mapping (UN-SPIDER, 2021; Twele et al., 2016; DeVries et al., 2020). A 2025 land use and land cover (LULC) classification established that rice cultivation occupies about 65% of the ward's 8,891 hectares. The historical analysis confirmed recurrent inundation of low-lying cropland, and a 10 m high-flood simulation indicated that a large majority of the ward's rice-growing land falls within an elevation range that would be submerged during a severe flood.

The convergence of two independent lines of evidence gives the findings particular weight: farmers' first-hand accounts of recurrent crop losses correspond closely, in location, with the areas that the satellite record identifies as repeatedly flooded. This triangulation of local knowledge and Earth observation directly operationalizes Priority 1 of the Sendai Framework for Disaster Risk Reduction 2015-2030, understanding disaster risk, and the seed intervention advances Priority 3, investing in resilience, together with the framework's Build Back Better principle (UNDRR, 2015).

Key recommendations arising from this mission include piloting FARO 67 on monitored demonstration plots, adjusting planting calendars to reduce peak-flood exposure, integrating the flood hazard maps into local agricultural and land-use planning, sustaining annual Sentinel-1 flood monitoring, and continuing comparative performance monitoring across FARO 44, FARO 57, and FARO 67 under both rainy-season and dry-season conditions.

1 Introduction and Strategic Context

1.1 Background

Rice is the principal food and cash crop of the farming communities of Katcha Ward, which lies within the River Niger floodplain of Katcha LGA, Niger State. The ward's position on the river supports two production systems: rainy-season lowland and floodplain rice cultivation, and dry-season farming that relies on residual soil moisture and, in places, supplementary irrigation once floodwaters recede. The same riverine setting that sustains these systems exposes farmers to recurrent flood hazards that damage standing crops, delay planting, and depress yields.

Improved rice varieties of the FARO series have been introduced over successive seasons to raise yields, improve grain quality, and strengthen resilience to local growing conditions. The suitability of any given variety depends heavily on how well its growth cycle aligns with the seasonal flood pulse and with climatic stresses such as the Harmattan cold spells experienced during dry-season cultivation. Variety choice, planting calendar, and hazard exposure are therefore tightly coupled decisions for floodplain farmers.

1.2 The Disaster Risk Context

Nigeria experiences seasonal flooding along the Niger and Benue river systems, and the severity of recent events has increased. The 2022 floods were the most destructive in a decade: the National Emergency Management Agency reported more than 600 fatalities, about 1.4 million people displaced, and hundreds of thousands of hectares of farmland affected across 27 of the 36 states, driven by heavy rainfall and by releases from the Lagdo Dam in northern Cameroon (NEMA, 2022). In 2024, NEMA again recorded widespread losses, including deaths across 15 states, more than 200,000 people displaced, and over 100,000 hectares of farmland destroyed (NEMA, 2024). In May 2025, flooding in Mokwa, in the north of Niger State, caused heavy loss of life, underscoring the state's continuing exposure.

Katcha sits within the recurring dam-release and river-overflow zone of southern Niger State, alongside Mokwa, Edati, Lavun, and Agaie, and its riverine wards flood in most seasons. GRMI field records and Niger State Emergency Management Agency (NSEMA) assessments indicate that the 2024 rainy season affected more than 41,000 people across nineteen Niger State LGAs and inundated in excess of 118,000 hectares of farmland, with Katcha among the worst-hit areas. A Jebba Dam release on 16 April 2025, the sixth flood of that dry season, destroyed the rice fields of more than 5,000 farmers across thirty communities and was associated with at least ten deaths. The human meaning of these figures is visible at household scale: one Katcha farmer lost a two-hectare farm that was submerged while the rice was in flower, and another, who had borrowed against an expected thirty bags of paddy, harvested only eight.

This pattern of loss recurs and compounds from one season to the next. Where floodplain rice is the dominant livelihood, repeated inundation pushes households into debt and food insecurity and erodes the seed base needed to plant again. Most interventions to date have concentrated on documenting damage after the event. Support that helps farmers re-enter production the following season, with planting material able to withstand the next flood, has remained comparatively scarce. The persistence and expected intensification of the hazard, under a combination of upstream dam operations and increasingly erratic rainfall, is the central problem this mission addresses (Mwakyusa et al., 2023).

1.3 Rationale and Alignment with the Sendai Framework

The Sendai Framework for Disaster Risk Reduction 2015-2030, adopted at the Third United Nations World Conference on Disaster Risk Reduction, sets four priorities for action: understanding disaster risk; strengthening disaster risk governance; investing in disaster risk reduction for resilience; and enhancing disaster preparedness for effective response, including the principle of Build Back Better in recovery (UNDRR, 2015). This mission was designed to operationalize those priorities at ward scale, linking scientific risk analysis directly to a concrete adaptation asset in farmers' hands. The table below maps the mission's components onto the framework.

TABLE 1.1 Contribution of the mission to the four priorities of the Sendai Framework.

Sendai Framework priority	How this mission contributes
Priority 1: Understanding disaster risk	Six-year Sentinel-1 flood occurrence mapping, flood frequency analysis, and DEM-based water-level simulation generate a spatially explicit evidence base on exposure of cropland and settlements.
Priority 2: Strengthening disaster risk governance	Beneficiary verification through NSEMA registers and registered cooperatives, and delivery of flood maps to local planning actors, embed risk information in local decision-making.
Priority 3: Investing in resilience	Distribution of submergence-tolerant FARO 67 foundation seed, coupled with training, converts risk knowledge into a concrete adaptation asset that regenerates through the cooperative seed system.
Priority 4 and Build Back Better	Seed handover after documented flood losses supports recovery with planting material engineered to withstand the next flood, and adapted planting-calendar guidance strengthens preparedness.

The rationale is reinforced by a structural gap in the seed system. The submergence-tolerance technology embodied in FARO 67 has been available in Nigeria since 2017, yet its distribution has remained confined to a few areas, and adoption has been low relative to the scale of flood-prone rice cultivation (Mwakyusa et al., 2023; AfricaRice, 2017). The binding constraint is delivery to the last mile, together with farmer familiarity and access to certified planting material. Targeted, evidence-based deployment of the kind documented here is therefore a direct response to a known bottleneck in the national adaptation pathway.

1.4 Objectives of the Field Mission

The mission combined agricultural extension activity with technical flood risk assessment, in order to support farmers with an improved seed variety, to build local capacity to manage that variety, and to generate geospatial evidence of flood exposure to inform future planting decisions and agricultural planning. The specific objectives were:

- Distribute FARO 67 rice seed to farmers in Katcha Ward.
- Sensitize farmers on the characteristics, planting requirements, and management of FARO 67.
- Gather farmers' experiences with previously cultivated rice varieties, including FARO 44 and FARO 57.
- Document flood impacts on agricultural production as reported by farmers.
- Present geospatial evidence of historical flooding (2020 to 2025) and simulate future flood water-rise scenarios to support adaptation planning.

1.5 FARO 67: Technical Profile of a Flood-Tolerant Variety

FARO 67 is one of two submergence-tolerant rice varieties, alongside FARO 66, developed for Nigerian conditions under the STRASA initiative of IRRI and AfricaRice and released in the country in 2017 (AfricaRice, 2017; Mwakyusa et al., 2023). The variety was produced through marker-assisted backcrossing (MABC), which introgressed the SUB1 locus into the widely grown, flood-vulnerable recurrent parent NERICA-L 19, released in Nigeria as FARO 60. FARO 66 was developed from the recurrent parent WITA 4 (FARO 52) by the same method. Because both varieties were bred from locally adapted parents, they retain agronomic traits already suited to Nigerian growing conditions, including good grain quality with medium-long slender grains and moderate tolerance to iron toxicity (AfricaRice, 2017).

The tolerance mechanism is well characterized in the plant-science literature. The SUB1 locus contains a cluster of APETALA2/Ethylene Response Factor genes, and the SUB1A gene is the primary determinant of tolerance to complete submergence (Xu et al., 2006; Fukao et al., 2006). SUB1A confers a quiescence strategy: during submergence it dampens ethylene-driven shoot elongation and conserves carbohydrate reserves, allowing the plant to survive complete inundation for one to two weeks and to resume growth once the water recedes. This gene, originally identified in the tolerant landrace FR13A, has been used to develop submergence-tolerant mega-varieties across Asia and, through STRASA, across sub-Saharan Africa (Mackill et al., 2012).

Field-trial results reported by AfricaRice indicate that under submergence FARO 67 can yield roughly ten times more than its recurrent parent, and that even under normal, non-submerged conditions it records a yield advantage of 10 to 29% over the parent (AfricaRice, 2017; Mwakyusa et al., 2023). FARO 66 shows a still larger relative advantage under submergence, up to about eighty times its parent, with a 6 to 11% gain under non-stress conditions. Reported agronomic characteristics for the pair include maturity within about 120 to 125 days, yield potential in the order of 6.6 to 6.7 tonnes per hectare, and resistance to stem borers, bacterial leaf blight, and African rice gall midge. Farmers in the release trials also valued the varieties' height and biomass, which can be used as livestock feed or as mulch.

FARO 67 is a product of conventional precision breeding and carries no transgenic modification, a characteristic that supports its acceptance among farmers and regulators. Its submergence-tolerance profile is directly relevant to Katcha Ward's floodplain farming systems, and this alignment between a documented hazard and an engineered agronomic solution provides the technical rationale for introducing the variety to farmers through this mission.

2 Study Area

2.1 Geographic and Hydrological Setting

Katcha Ward lies within Katcha LGA, Niger State, along the floodplain of the River Niger. The ward's farming systems are shaped directly by the river's seasonal hydrology. Rising river levels between roughly June and October inundate low-lying farmland during the rainy season, while the receding floodwaters from November onward leave behind moisture-retentive soils that support dry-season cropping. The dry-season benefit is tempered by the risk of Harmattan cold stress from December to February, which can affect temperature-sensitive varieties during their reproductive phase.

Seasonal flooding is therefore a defining feature of the local agricultural calendar, and the timing of planting relative to the flood pulse is a decisive factor in whether a crop reaches maturity. The National Cereals Research Institute breeding station at Badeggi lies within Katcha LGA, which places a source of certified, locally adapted seed close to the farming communities the ward supports.

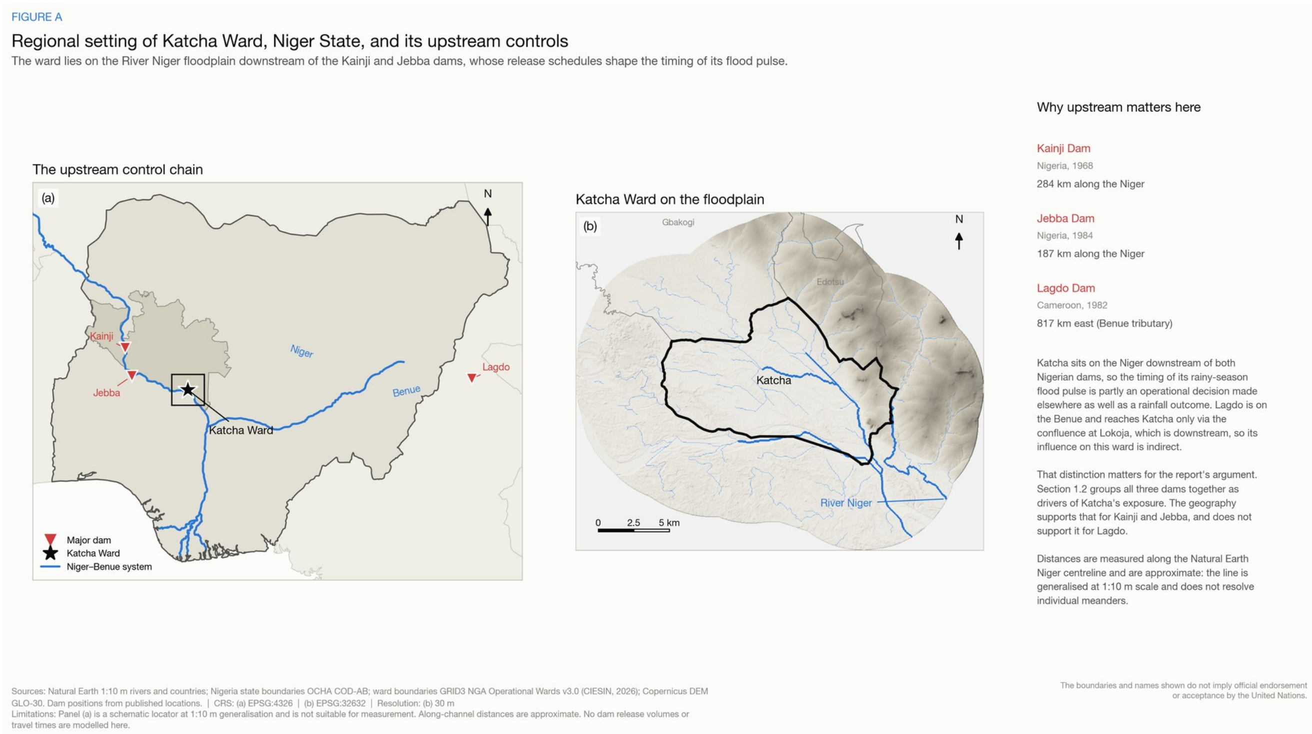

FIGURE 2.1 Regional setting of Katcha Ward, Niger State, and its upstream controls. The ward lies on the River Niger floodplain 187 km downstream of Jebba Dam and 284 km downstream of Kainji Dam, measured along the channel. Lagdo Dam is on the Benue and reaches the Niger only below the Lokoja confluence, downstream of Katcha.

2.2 Land Use and Land Cover (2025)

A land use and land cover classification of Katcha Ward was undertaken for 2025 to characterize the ward's dominant cover types and to establish a baseline against which flood exposure and cropland vulnerability can be assessed. The classification distinguishes seven classes: rice field, flooded rice field, rangeland, water body, built-up area, tree canopy, and bare soil.

The ward covers a total mapped area of approximately 8,891 hectares (about 88.9 km²). Rice cultivation dominates the landscape. Standing, non-flooded rice fields account for the largest single share at 52.4% of total area, and a further

12.8% is classified as flooded rice field, that is, cropland under standing water at the time of image acquisition. Combined, rice cultivation of one form or another occupies roughly 65% of Katcha Ward. This share underscores both the centrality of rice production to the ward's economy and the corresponding scale of exposure to flood risk.

Rangeland is the second-largest class at 16.9%, occupying higher, less flood-prone ground primarily along the ward's northern and eastern margins. Water bodies, comprising the River Niger and its associated channels, oxbows, and seasonal pools, cover 11.9% of the ward and thread through the cropland in a dense network that reflects the floodplain's low-lying, braided hydrology. Built-up areas, concentrated mainly in the eastern part of the ward near Baro, account for 4.5%. Tree canopy (1.4%) and bare soil (0.1%) make up the smallest shares.

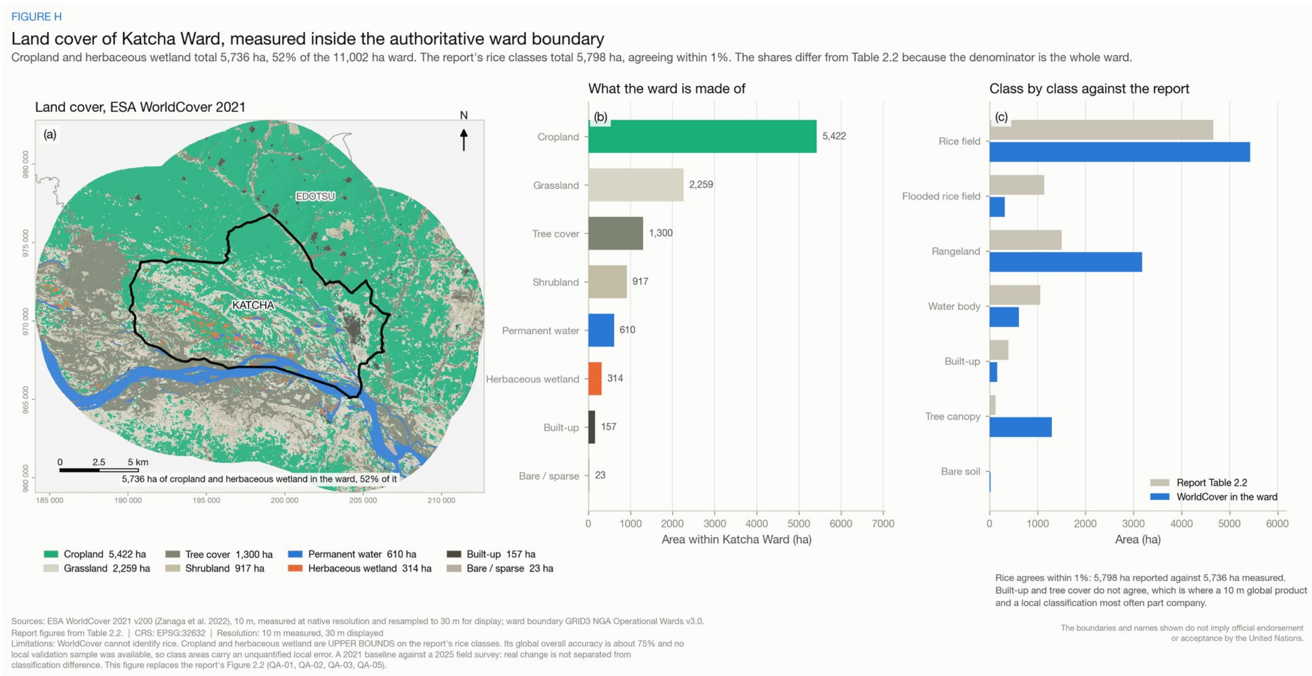

FIGURE 2.2 Land cover of Katcha Ward from ESA WorldCover 2021 v200, measured inside the authoritative GRID3 operational boundary. Cropland and herbaceous wetland total 5,736 ha, agreeing with the rice classes of Table 2.2 to within 1%. Shares are expressed against the full 11,002 ha ward, so they differ from the percentages in Table 2.2, which use the smaller classified extent. This map supersedes the original Figure 2.2 for the reasons recorded as QA-01, QA-02, QA-03, and QA-05 in the appendix.

TABLE 2.2 Land cover of Katcha Ward, 2025, by class.

Land cover class	Area (ha)	% of ward
Rice field	4,658.32	52.39
Rangeland	1,505.42	16.93
Flooded rice field	1,139.27	12.81
Water body	1,058.57	11.90
Built-up	395.31	4.45
Tree canopy	122.76	1.38
Bare soil	11.43	0.13
Total	**8,891.08**	**100.00**

The close spatial interleaving of rice field, flooded rice field, and water body classes across the central and southern portions of the ward illustrates how tightly rice cultivation in Katcha is bound to the River Niger's floodplain. The large contiguous block of flooded rice field mapped across the western and southern parts of the ward delineates areas already under standing water at the time of classification, and it provides an independent, present-day confirmation of the flood-prone cropland later examined in the historical flood occurrence analysis (Section 4.4).

Two land cover products appear in this section, and the difference between them governs how the flooded rice field class should be read. The seven classes in Table 2.2 come from the classification prepared for this report, in which flooded rice field is a crop-specific label applied to cropland that stood under water at the time of image acquisition. ESA WorldCover 2021, mapped in Figure 2.2, is a global product that carries no rice class and no flooded rice class. Its nearest equivalent is herbaceous wetland, a generic flooded vegetation class, which covers 314 ha of the ward.

The two products agree closely on the rice-growing extent taken as a whole: 5,736 ha of cropland plus herbaceous wetland in WorldCover against 5,798 ha of rice field plus flooded rice field in Table 2.2, a difference of about 1%. They do not agree on the division between flooded and non-flooded ground, where WorldCover's 314 ha sits well below the 1,139 ha of Table 2.2. Flooded vegetation is a land cover observation, while flooded rice field asserts a specific crop, and neither product carries the field sample of labelled plots that would establish the stronger claim. The class is best read as this report's interpretation of a single acquisition rather than as a validated measurement of flooded rice, and how often that ground actually floods is established independently, from the six-year satellite record, in Section 4.4.

3 Methodology

3.1 Overall Approach

The mission followed an integrated design that paired participatory agricultural extension with quantitative Earth observation analysis. This combination is deliberate: farmer testimony situates the hazard in lived experience and local geography, and the geospatial analysis provides a spatially explicit, repeatable measurement of exposure. Each strengthens the interpretation of the other, and together they satisfy the Sendai Framework's emphasis on understanding disaster risk in all its dimensions of hazard, exposure, and vulnerability (UNDRR, 2015). The remote-sensing component followed the UN-SPIDER recommended practice for flood mapping with Sentinel-1 SAR data (UN-SPIDER, 2021).

3.2 Farmer Engagement

A community meeting and interactive workshop were held with members of the Katcha Ward Farmers' Association. The session combined a structured presentation on FARO 67 with an open question-and-answer segment and an experience-sharing exercise in which farmers described their prior experiences cultivating other FARO varieties. The engagement parameters are summarized below.

TABLE 3.1 Farmer engagement session, Katcha Ward.

Item	Detail
Date	18 July 2026
Location	Community classroom, Katcha Ward
Participants	20 farmers
Farmer group	Katcha Ward Farmers' Association
Format	Presentation, question-and-answer, experience-sharing

3.3 Seed Distribution

FARO 67 was selected for this distribution as a candidate variety for evaluation under Katcha Ward's mixed floodplain growing conditions, on the basis of its documented submergence tolerance and yield performance. A total of 200 kg of seed was distributed, with each of the 20 participating farmers receiving a standard allocation of 10 kg. Selection of beneficiary farmers was carried out through the Katcha Ward Farmers' Association, prioritizing active members engaged in rice cultivation who could commit land for the current planting season. Seed bags were pre-weighed, labelled, and handed over individually, with association leadership and GRMI staff present to verify quantities and record recipients.

FIGURE 3.1 A labelled 10 kg FARO 67 seed pack handed over to a farmer representative in the presence of the ward head and a member of the GRMI team.

3.4 Flood Analysis

The geospatial flood assessment followed a multi-stage GIS and remote-sensing workflow designed to characterize historical flood occurrence and to simulate near-future inundation scenarios for Katcha Ward and surrounding farmland. Sentinel-1 was chosen because SAR actively illuminates the surface with microwave energy and penetrates cloud cover, which allows flood detection during the rainy season when optical sensors are frequently obscured (UN-SPIDER, 2021; DeVries et al., 2020). Open water produces very low radar backscatter through specular reflection, which provides the physical basis for SAR water detection (Twele et al., 2016). The workflow comprised the following stages:

- **Historical flood occurrence mapping (2020 to 2025).** A change-detection approach was applied to the Sentinel-1 C-band GRD archive on a cloud-processing platform to delineate flood extent for each year of the record (Gorelick et al., 2017; UN-SPIDER, 2021; Uddin et al., 2019).
- **Permanent water masking.** A global surface-water reference layer was used to separate seasonal flood inundation from the perennial extent of the river and associated water bodies, so that reported flood areas reflect newly inundated land (Pekel et al., 2016).
- **Flood frequency analysis.** The annual flood layers were combined to identify areas repeatedly inundated across the six-year record, yielding a flood-frequency, or flood-hotspot, map.
- **DEM-based water-level rise simulation.** A Digital Elevation Model was used to model the spatial extent of inundation under incremental increases in river water level (Farr et al., 2007).
- **Ground validation.** Modelled and observed flood extents were cross-checked against known flood events and against farmer-reported impacts, in line with the accuracy-assessment step of the recommended practice (UN-SPIDER, 2021; Martinis et al., 2009).

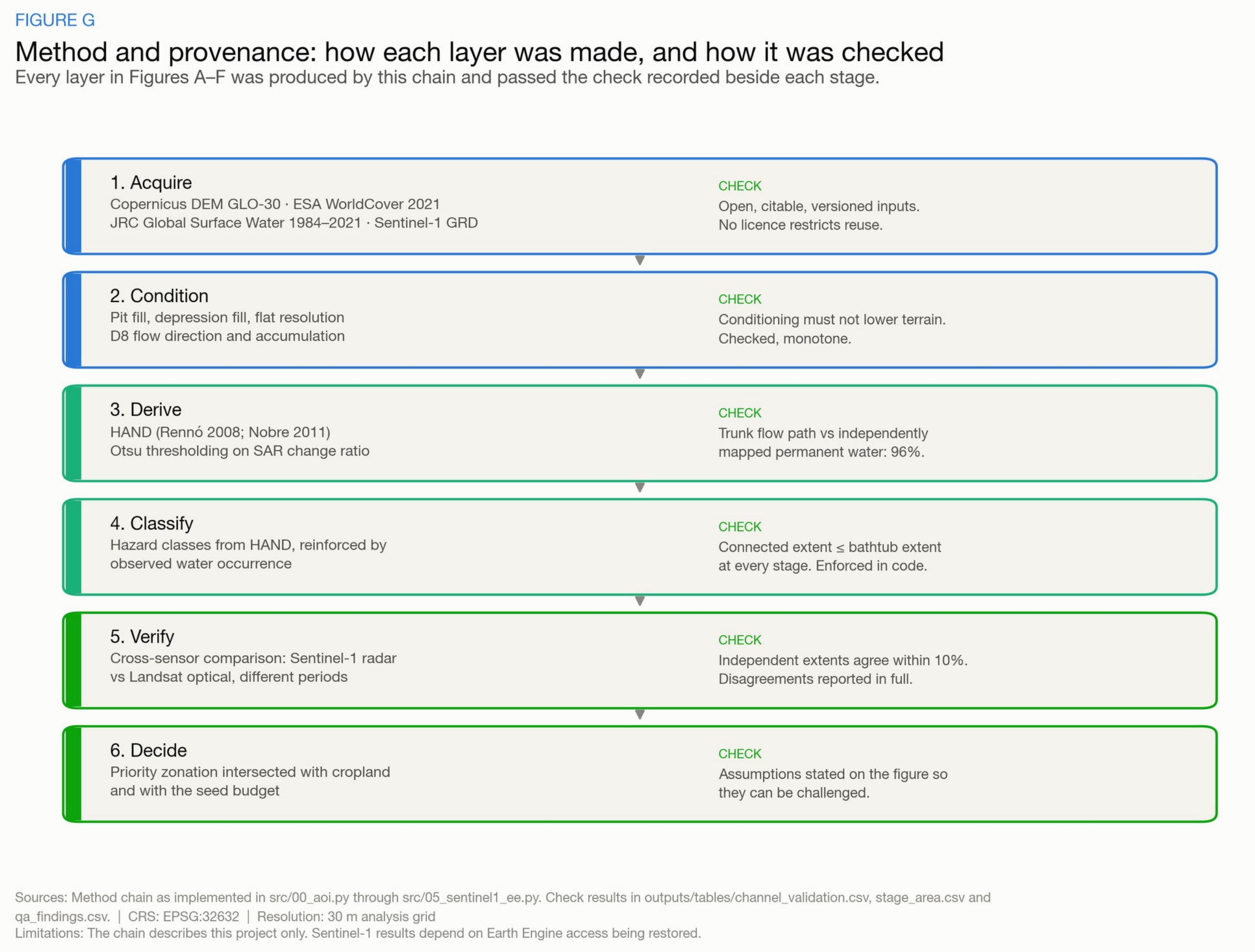

FIGURE 3.2 Flood analysis workflow and the check applied at each stage. Every layer in this report was produced by this chain and passed the check recorded beside its stage.

3.5 Limitations

Three limitations qualify the geospatial results. First, SAR-based water detection can misclassify smooth dry surfaces such as roads or bare, wind-sheltered ground as water, and it can under-detect flooding beneath dense vegetation or within built-up areas, where surface roughness and vertical structures complicate the backscatter signal (Twele et al., 2016; DeVries et al., 2020). Second, the Sentinel-1 archive begins in 2014, so the historical window is inherently limited to the satellite era. Third, the DEM-based water-level simulation is a bathtub-style inundation model that represents terrain-controlled flood extent under a given water level, and it does not resolve flow dynamics, flood duration, or the effects of embankments and drainage structures. These limitations are mitigated by permanent water masking, by multi-year compositing, and by validation against ground observation, and they are consistent with the caveats set out in the UN-SPIDER recommended practice (UN-SPIDER, 2021).

4 Results

4.1 Workshop Outcomes

The sensitization workshop equipped farmers with practical knowledge of FARO 67's growth characteristics and management requirements, enabling them to make informed decisions about integrating the variety into their planting plans. The presentation and discussion covered:

- Key characteristics of FARO 67, including its SUB1A submergence tolerance, bred specifically for flood-prone rice-growing environments (Xu et al., 2006).
- Recommended planting windows and spacing.
- Expected maturity period of about 120 to 125 days.
- Yield potential relative to previously grown varieties, including trial results showing a 10 to 29% yield advantage under normal conditions and markedly higher survival and yield under short-term submergence (AfricaRice, 2017).
- Suitability considerations for flood-prone and moisture-variable environments, and the additional value of the crop's biomass for livestock feed and mulch.

FIGURE 4.1 Farmers and community leaders at the FARO 67 sensitization workshop and seed handover, Katcha Ward.

4.2 Farmers' Experiences with Previous Varieties

Farmers' own accounts of past variety performance provide important context for interpreting how FARO 67 is likely to be received and managed, and they contribute local agronomic knowledge that complements the formal trial literature.

Farmer Experience 1: Chairman, Farmers' Association

The Chairman of the Katcha Ward Farmers' Association reported previous cultivation of FARO 57 and described the experience as strongly positive, citing high productivity, good grain quality, satisfactory market value, and consistent performance across seasons. This favourable track record with FARO 57 was identified as a factor increasing farmer confidence in testing FARO 67 during the current season.

Farmer Experience 2: Seasonal Variability with FARO 44

A second farmer described a more mixed experience with FARO 44. The variety performed strongly during the rainy season, producing good growth and yields under wet-season conditions. In the dry season, Harmattan cold spells affected flowering and grain filling, and yields fell sharply. The farmer attributed the poorly filled grain to the cold weather that set in during the dry-season reproductive stage.

This account is consistent with well-established rice physiology. Low temperature during the reproductive phase, and most acutely at the young microspore stage within booting, is the single most cold-sensitive period of the rice life cycle, and it induces pollen sterility and consequent spikelet sterility that translates directly into reduced grain set and yield (Satake, 1976; Farrell et al., 2006). The farmer's observation therefore reflects a genuine agronomic mechanism, and it underscores that variety performance is season-specific. Matching each variety to the climatic stresses of the season in which it is grown, flood exposure in the rainy season and cold stress in the dry season, is a more reliable strategy than assuming uniform performance across both cropping cycles.

4.3 Flood Impacts Reported by Farmers

Farmers described distinct impact profiles for the two seasons. Their accounts are summarized below.

Rainy Season

- Farm inundation affecting standing crops.
- Crop losses in low-lying plots.
- Delayed planting due to waterlogged land.
- Washed-away seedlings following heavy flood events.
- Reduced yields in the most flood-exposed fields.

Dry Season

- Residual flood benefits, including improved soil moisture for dry-season cropping.
- Moisture availability supporting germination without irrigation in some plots.
- Cold stress during the Harmattan affecting flowering in temperature-sensitive varieties.
- Reduced productivity for varieties not suited to cold-season stress.

4.4 Historical Flood Analysis (2020 to 2025)

Year-on-year flood extent mapping derived from Sentinel-1 SAR imagery shows the spatial footprint of inundation across Katcha Ward's farmland for each year in the record. Mapped flood extent fluctuated within a relatively narrow band of roughly 12.6 to 13.7 km², with a marked step upward from 2022 to 2023 (an increase of 9.31%) and extent remaining elevated through 2024 and 2025 relative to the 2020 to 2022 baseline.

TABLE 4.1 Mapped annual flood extent, Katcha Ward, 2020 to 2025.

Year	Flooded area (km²)	Change vs previous year (%)
2020	12.61	reference year
2021	12.75	+1.11
2022	12.57	-1.41
2023	13.74	+9.31
2024	13.13	-4.44
2025	13.27	+1.07

annual Sentinel-1 flood extent panels, 2020 to 2025. The processing workflow is implemented and documented (see methods annex, Section 9); it requires Earth Engine access, which was unavailable at the time of preparation. Figure 4.3 provides an independent flood record from Landsat in the interim.

FIGURE 4.2 Annual flood extent, Katcha Ward and surrounding floodplain, 2020 to 2025.

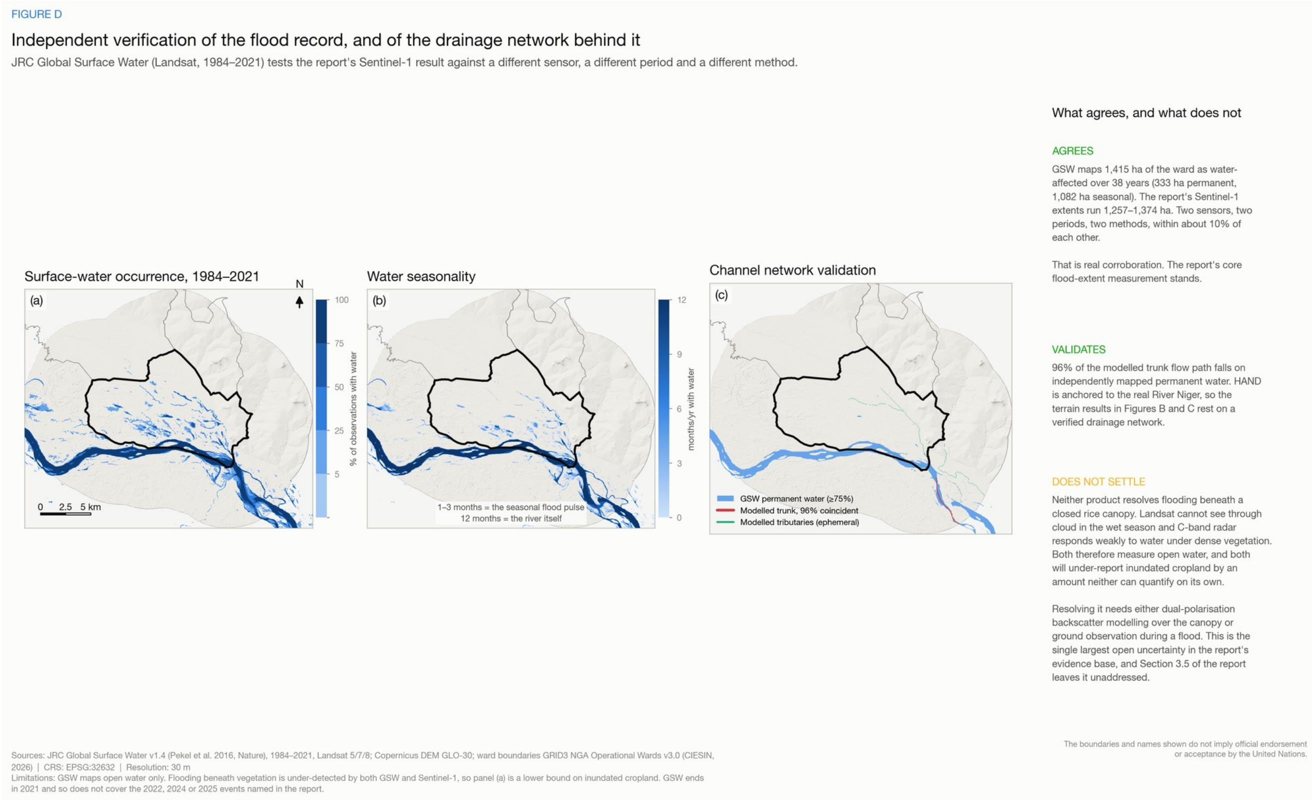

FIGURE 4.3 Independent verification of the flood record. JRC Global Surface Water (Landsat, 1984 to 2021) maps 1,415 ha of the ward as water-affected, against 1,257 to 1,374 ha from the Sentinel-1 analysis in this report; two sensors over two periods agree within about 10%. Panel (c) confirms that the modelled drainage network follows the real River Niger.

Areas experiencing repeated flooding across the six-year record coincide closely with the communities and farm plots where farmers reported frequent crop losses during the workshop discussion. This spatial correspondence lends independent geospatial support to farmers' lived experience, and it is the analytical core of the mission's contribution to understanding disaster risk at ward scale.

4.5 Flood Water Rise Simulation

A DEM-based simulation was used to project the extent of inundation under incremental increases in river water level, and simulated extents were validated against a known historical flood event to assess model reliability.

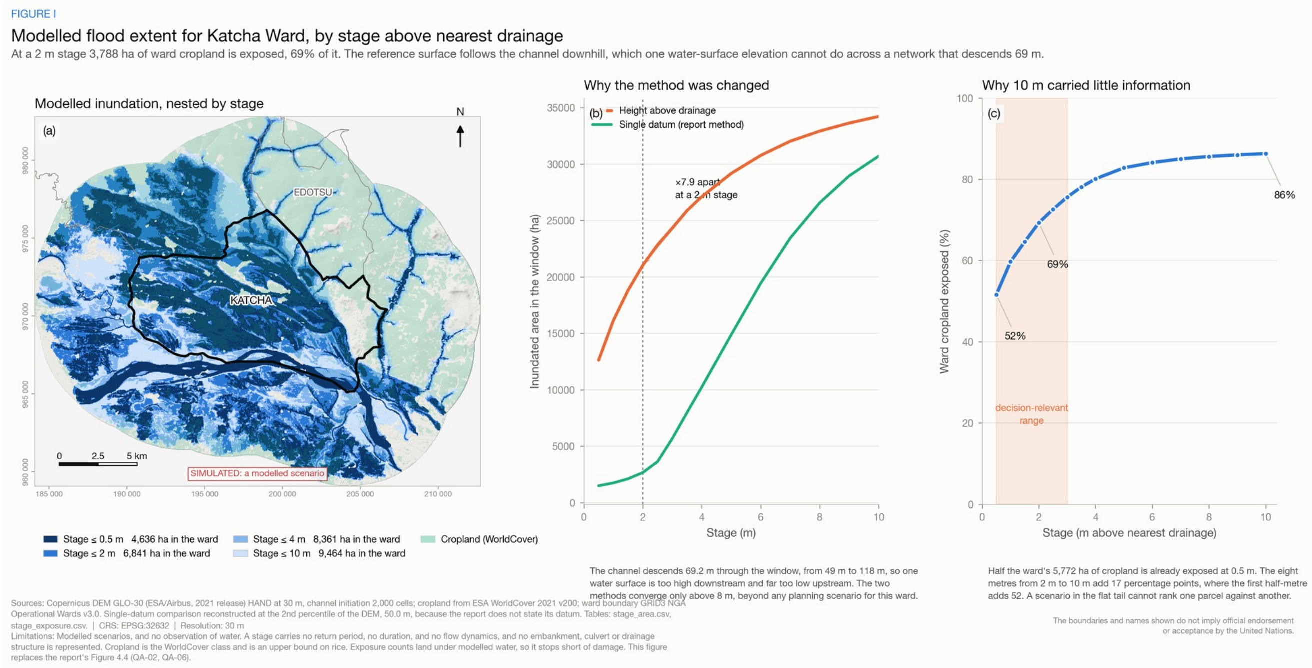

FIGURE 4.4 Modelled inundation of Katcha Ward by stage above nearest drainage, at 0.5, 2, 4, and 10 m, with the cropland exposed at each stage. 52% of ward cropland is exposed at a 0.5 m stage and 86% at 10 m, so the eight metres between them add 17 percentage points. Height above nearest drainage follows the channel downhill, which a single water-surface datum cannot do across a network that descends 69 m through the analysis window. This map supersedes the original 10 m simulation for the reasons recorded as QA-02 and QA-06 in the appendix.

The 10 m water-level simulation projects a substantial expansion of inundation well beyond the River Niger's active channel, submerging most of the low-to-moderate elevation land surrounding Katcha Ward, including the neighbouring wards of Gbakogi, Kpada 1, and Eggan. Within Katcha Ward itself, the simulated flood extent covers virtually all of the cropland in the western and southern portions of the ward, areas already mapped as rice field and flooded rice field in the 2025 LULC classification, and a large share of the central and eastern rice-growing area also falls within the simulated inundation zone.

The built-up area in the eastern part of the ward, near Baro, sits on visibly higher ground and remains largely outside the simulated 10 m flood extent, appearing as an elevated island relative to the surrounding inundated floodplain. This pattern is consistent with the settlement having been sited historically on locally higher ground, while cultivated land occupies the lower-lying floodplain and carries substantially greater exposure to severe flood events.

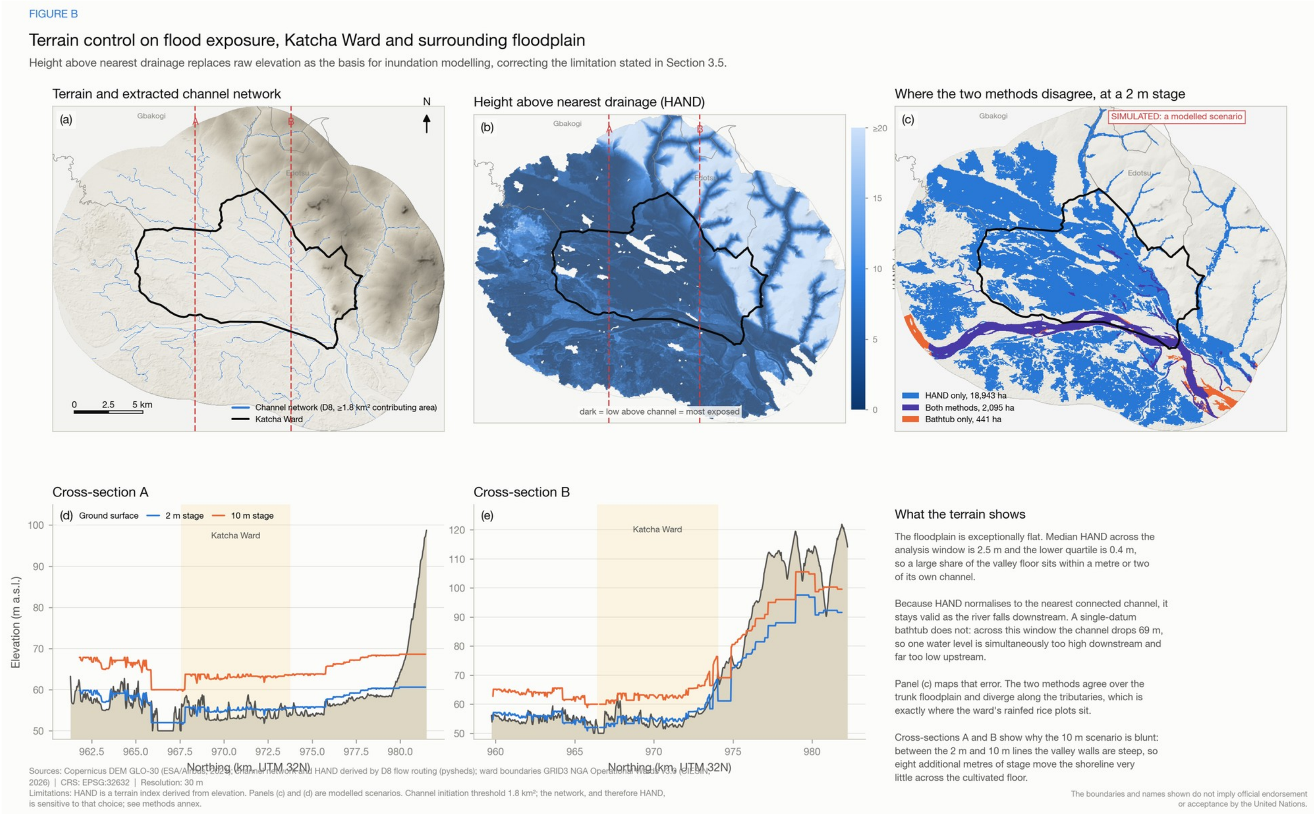

FIGURE 4.5 Terrain control on flood exposure. Height Above Nearest Drainage replaces raw elevation as the basis for inundation modelling, addressing the limitation stated in Section 3.5. Panels (d) and (e) are elevation cross-sections through the ward with the 2 m and 10 m stages drawn on.

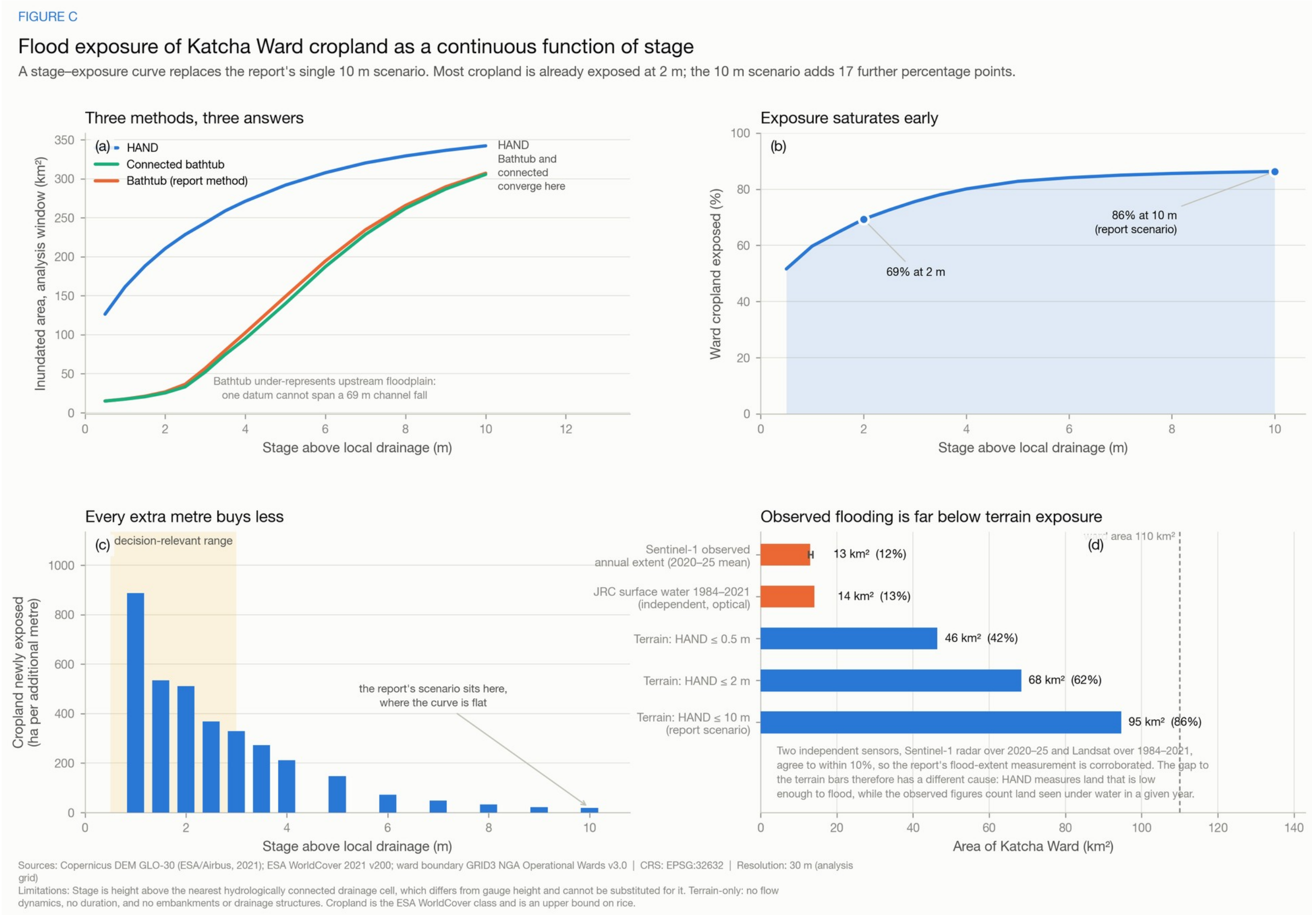

FIGURE 4.6 Flood exposure of Katcha Ward cropland as a continuous function of stage. 69% of ward cropland is already exposed at a 2 m stage and 86% at 10 m, so the eight metres between them add 17 percentage points. The decision-relevant range is 0.5 to 3 m.

The level of agreement between the simulated and observed flood extents supports reasonable confidence in the model's ability to identify areas likely to experience future flooding. The 10 m scenario in particular indicates that a large majority of Katcha Ward's rice-growing land, the basis of local livelihoods, lies within an elevation range that would be inundated under a severe flood. This finding reinforces the priority of flood-resilient varieties, early warning, and adapted planting calendars set out in Section 7.

5 Discussion

The results yield a coherent and mutually reinforcing picture. The historical flood occurrence analysis corroborated farmers' accounts of recurrent flooding in low-lying areas of Katcha Ward, with repeated inundation between 2020 and 2025 corresponding closely to the locations that farmers independently identified as highly vulnerable to crop losses. Two evidentiary streams, one experiential and one satellite-derived, converge on the same geography of risk. This convergence is significant for disaster risk reduction practice, because it demonstrates that community knowledge and Earth observation can be triangulated to produce a risk assessment more robust than either source alone (UNDRR, 2015).

The flood water-rise simulation extends this picture forward. Modest increases in river water level would substantially expand inundation across the cultivated floodplain, and the 10 m scenario places most of the ward's rice-growing land within the potential flood zone. Against the backdrop of the 2022, 2024, and 2025 flood record, and of upstream dam operations that are outside local control, the case for flood-resilient production systems in Katcha is strong (NEMA, 2022; NEMA, 2024).

The farmer testimony on FARO 57 and FARO 44 adds a second dimension to the analysis: variety performance depends on yield potential together with the fit between a variety's growth cycle and the dominant stress of the season. FARO 44 performed well in the rainy season and poorly in the dry season, where Harmattan cold stress at the reproductive stage reduced grain set, a mechanism well documented in the rice cold-tolerance literature (Satake, 1976; Farrell et al., 2006). FARO 67 directly addresses rainy-season and flood-related risk through its SUB1A submergence tolerance (Xu et al., 2006). Its breeding did not target cold tolerance, so its dry-season performance under Harmattan conditions remains an open question that the coming season's monitoring should specifically test. Season-matched variety selection, and where necessary the pairing of a submergence-tolerant rainy-season variety with a cold-tolerant dry-season option, is therefore a logical direction for the ward's rice system.

A wider structural point frames the whole intervention. African rice yields average about 2.28 tonnes per hectare, well below the Asian average of about 4.61 tonnes per hectare, and flooding is among the most important constraints holding smallholder yields down (Mwakyusa et al., 2023). The submergence-tolerance technology that could narrow part of this gap has existed in Nigeria since 2017, yet distribution of FARO 66 and FARO 67 has remained limited (AfricaRice, 2017; Mwakyusa et al., 2023). The binding constraint is delivery, farmer familiarity, and access to certified seed at planting time. This mission is a targeted response to that delivery gap, and the use of foundation-grade seed sourced from NCRI Badeggi within the same LGA means that each starter pack can feed the following season's certified seed supply through cooperative multiplication, extending the reach of a small first round.

Taken together, the field engagement and the geospatial findings indicate that farmers in Katcha Ward are already adapting to a landscape shaped by recurring flood risk, and that their adaptation can be strengthened with better-matched varieties, better-timed planting calendars, and flood hazard information integrated directly into local agricultural decision-making. The mission's design, linking risk analysis to a resilience asset and to local institutions, is aligned with the Sendai Framework and offers a replicable model for other riverine wards in Niger State (UNDRR, 2015).

6 Conclusions

- FARO 67 seed was successfully distributed to 20 farmers in Katcha Ward, with 200 kg allocated at 10 kg per farmer, together with a sensitization workshop on the variety's characteristics and management.
- Farmers engaged substantively in experience-sharing and question-and-answer, and they contributed valuable local knowledge on the seasonal performance of FARO 44 and FARO 57, including flood exposure and Harmattan cold-stress effects that are consistent with established rice physiology (Satake, 1976; Farrell et al., 2006).
- Geospatial flood occurrence maps for 2020 to 2025, derived from Sentinel-1 SAR following UN-SPIDER recommended practice, corroborate farmers' first-hand accounts of recurrent inundation and identify the ward's flood hotspots (UN-SPIDER, 2021).
- DEM-based flood water-rise simulation provides a validated evidence base indicating that most of the ward's rice-growing land lies within the potential extent of a severe flood, and it can inform agricultural and flood-risk planning.
- The mission operationalizes the Sendai Framework at ward scale, linking understanding of disaster risk to investment in resilience and to recovery under the Build Back Better principle, and it addresses a documented last-mile gap in the deployment of flood-tolerant rice in Nigeria (UNDRR, 2015; Mwakyusa et al., 2023).

7 Recommendations

The recommendations below are organized by actor and are framed to advance the Sendai priorities of understanding risk, investing in resilience, and enhancing preparedness.

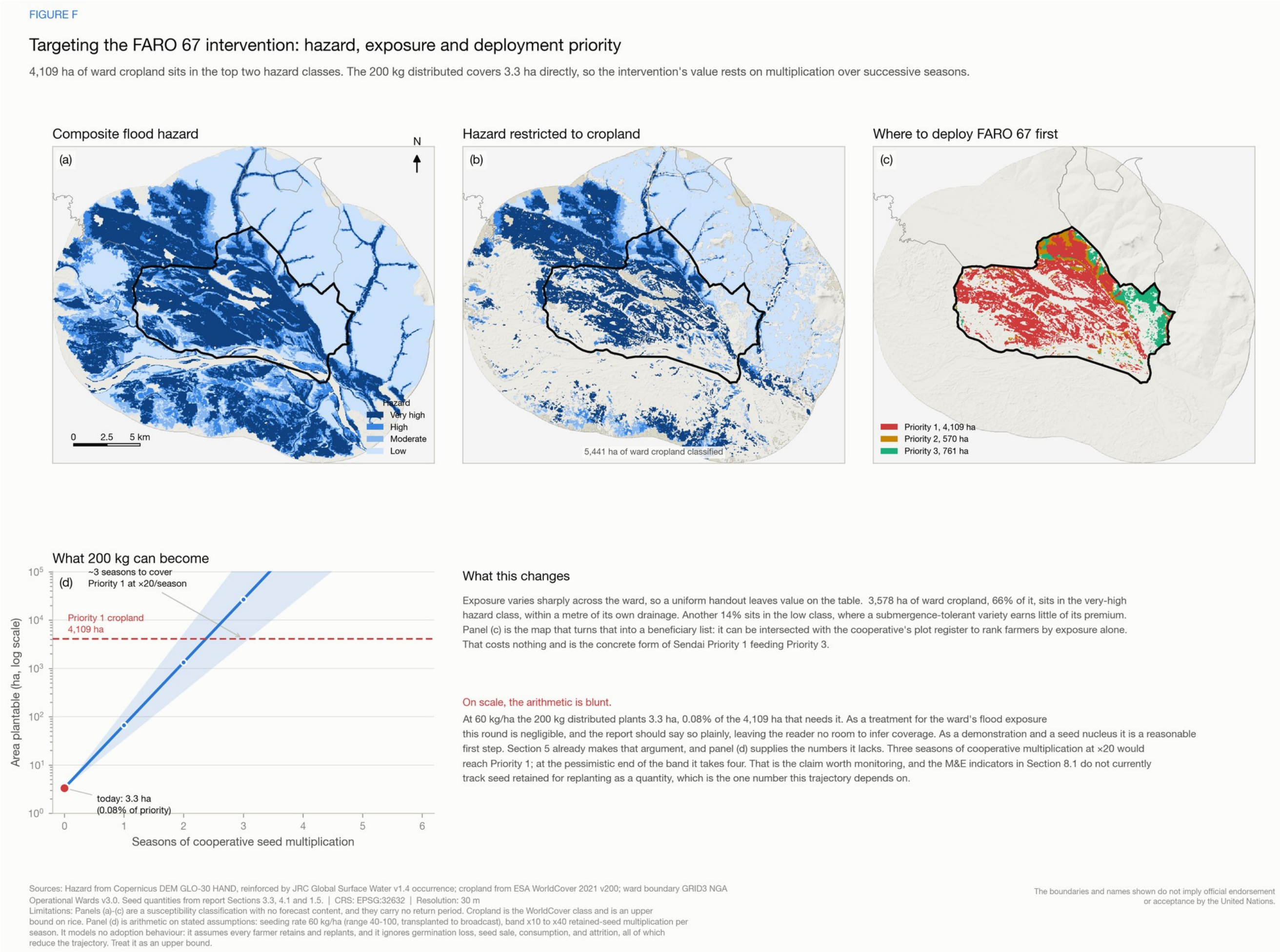

FIGURE 7.1 Targeting the FARO 67 intervention. 4,109 ha of ward cropland sits in the top two hazard classes. The 200 kg distributed plants about 3.3 ha directly, so the intervention's value rests on cooperative multiplication over successive seasons.

7.1 For Farmers

- Pilot FARO 67 on demonstration plots before scaling up to full-field cultivation, so that its local performance is observed under monitored conditions.
- Adjust planting dates where possible to avoid the peak flood periods identified in the flood occurrence analysis.
- Select varieties by season, taking flood exposure into account for the rainy season and Harmattan cold risk for the dry season.

7.2 For Extension Officers

- Continue farmer training on FARO 67 management practices through the growing season.

- Monitor FARO 67 performance across representative plots, including both flood-exposed and non-flood-exposed sites, and test its dry-season performance under Harmattan conditions.
- Document yield comparisons between FARO 67 and previously grown varieties, in particular FARO 44 and FARO 57, using a common protocol.

7.3 For Government

- Integrate the flood occurrence and simulation maps produced by this assessment into local agricultural and land-use planning.
- Support the scale-up of flood-resilient rice production in the identified high-risk zones, including cooperative-based multiplication of foundation seed.
- Improve irrigation and drainage infrastructure to reduce dependence on unmanaged residual floodwater for dry-season cropping, and strengthen dissemination of NIHSA early-warning information ahead of the flood season.

7.4 For Researchers

- Continue annual flood monitoring using Sentinel-1 SAR to maintain an updated flood occurrence record for the ward and LGA (UN-SPIDER, 2021).
- Compare FARO 44, FARO 57, and FARO 67 systematically under varying seasonal conditions, including replicated trials of submergence and cold stress.
- Investigate the effects of Harmattan cold spells on rice phenology and yield to inform season-specific variety recommendations (Satake, 1976; Farrell et al., 2006).

8 Next Steps

The distribution and assessment reported here establish a baseline for the current season. The activities set out below carry the work forward, so that the performance of FARO 67 under Katcha Ward's conditions is measured, documented, and used to guide subsequent seasons and any wider distribution.

8.1 Monitoring and Evaluation

A structured monitoring and evaluation (M&E) framework will track the outcomes of the seed distribution against the objectives set out in Section 1.4. The mission itself provides the baseline, including the number of farmers reached, the quantity of seed distributed, and the farmers' documented experience with previously grown varieties. Progress will be measured through a defined set of indicators, each with a means of verification, a collection frequency, and a responsible party. The indicator set below is proposed for the current season and can be refined together with the cooperative and the extension service.

TABLE 8.1 Monitoring and evaluation framework for the FARO 67 distribution.

Indicator	Means of verification	Frequency	Responsible party
Farmers retaining and planting FARO 67	Field visits and cooperative records	Once per season	Extension service, cooperative
Seed germination and crop establishment	Establishment field assessment	Early season	Extension service
Yield per hectare (FARO 67, 44, 57)	Harvest measurement on sampled plots	At harvest	Extension service, NCRI
Crop survival during flood events	Post-flood field assessment	After each flood	Extension service, GRMI
Area planted with FARO 67	Farmer records and field mapping	Once per season	Cooperative, extension service
Seed retained for replanting	Cooperative seed records	End of season	Cooperative, NASC
Farmer satisfaction and intent to expand	Structured farmer feedback	Mid and end of season	Extension service, GRMI

Data will be recorded in a simple, consistent format across all participating farmers, so that results can be aggregated at ward level and compared across seasons. Where a flood event occurs during the season, its timing, depth, and duration will be recorded alongside the crop's response, since these conditions are central to evaluating the submergence-tolerance benefit of FARO 67.

Where the season includes a significant flood, the survival and recovery of FARO 67 will be documented in the affected plots and compared with the losses recorded for flood-vulnerable varieties in previous seasons. This evidence will show whether the submergence-tolerance benefit observed in trials holds under local field conditions, and it will inform the scale of any subsequent distribution.

8.2 Crop Performance Follow-up

Field follow-up will be scheduled around the key growth stages of the crop, so that establishment, vegetative growth, flowering, and grain filling are each observed. Planned visits include an early establishment check after sowing or transplanting, a mid-season assessment during tillering and flowering, and a harvest assessment to record final yield.

- **Establishment.** Record germination and seedling vigour, plant stand, and any early flood exposure on the demonstration and farmer plots.
- **Mid-season.** Assess crop development, pest and disease incidence, and the response of the crop to any flooding that occurs during the rainy season.
- **Harvest.** Measure yield per unit area for FARO 67 and, where available, for FARO 44 and FARO 57 grown under comparable conditions, and compare the results with the trial-reported figures for the variety.
- **Farmer feedback.** Gather farmers' own assessments of grain quality, market acceptance, and ease of management, together with their intention to replant and to expand the area under FARO 67.

8.3 Continued Engagement with Seed Producers and Research Institutions

Sustaining the intervention depends on a reliable supply of quality seed and on a continuing relationship with the institutions that develop and certify it. The proximity of the National Cereals Research Institute breeding station at Badeggi, within the same LGA, is an asset that will be used to keep certified, locally adapted planting material close to the farming communities of Katcha Ward.

- Maintain engagement with the National Cereals Research Institute (NCRI) at Badeggi as the source of foundation and breeder seed for FARO 66 and FARO 67, and share field performance data to inform variety development and future releases.
- Sustain links with the Africa Rice Center (AfricaRice) and the International Rice Research Institute (IRRI), developers of the submergence-tolerant lines under the STRASA initiative, so that Katcha Ward benefits from continuing advances in flood-tolerant rice.
- Work with the National Agricultural Seeds Council (NASC) on seed quality and certification, and with the Rice

Farmers Association of Nigeria (RIFAN) on aggregation and market access for the harvested crop.

- Support the Katcha Ward Farmers' Association in establishing a community-based seed multiplication scheme, so that each starter pack contributes to the following season's certified seed supply and the cooperative can extend improved seed to additional farmers over time.
- Maintain the link with the Nigeria Hydrological Services Agency (NIHSA) and the Niger State Emergency Management Agency (NSEMA) for flood forecasting and early-warning information ahead of each season.

Through these relationships the initiative becomes a repeatable, locally supported system in which improved seed, field evidence, and early-warning information reach floodplain rice farmers season after season.

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Appendices

The following supporting materials accompany this report.

- Appendix A. Attendance register.
- Appendix B. Seed distribution list (farmer name, quantity received, signature).
- Appendix C. Workshop agenda.
- Appendix D. Photographs from the seed distribution and workshop.
- Appendix E. Historical flood maps, 2020 to 2025.
- Appendix F. Flood occurrence (frequency) map.
- Appendix G. Flood water-rise simulation outputs.
- Appendix H. Validation maps.
- Appendix I. GPS coordinates of farms and flood reference points (if collected).

Appendix Table: Farmer Experience by Variety (to be finalized with ongoing monitoring)

TABLE A1 Farmer experience by variety.

Variety	Rainy-season performance	Dry-season performance	Notes
FARO 44	Strong growth and yield	Reduced yield; Harmattan cold stress affects flowering and grain filling	Best suited to rainy-season cultivation
FARO 57	High productivity, good grain quality, good market value	To be monitored	Positive experience reported by Association Chairman
FARO 67	To be monitored (newly introduced; submergence-tolerant)	To be monitored	SUB1A submergence tolerance; performance tracked this season

FIGURE D.1 Photographs from the field mission, Katcha Ward, 10 July 2026. (a) Rice cropland on the floodplain. (b) Floodwater and canoe transport on the floodplain. (c) The FARO 67 consignment before distribution. (d) to (h) Handover of 10 kg lots to cooperative representatives and community leaders. (i) The GRMI field team with the consignment.