Operationalising Flood Risk Scenarios to Bridge the Gap Between Risk Assessment and Decision-Oriented Early Warning

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CNR - Istituto per la BioEconomia

Contents

Flood risk is increasing

- Intensifying rainfall
- Land-use & exposure changes

↓

Increasing impacts in Sahel

Decisions remain difficult

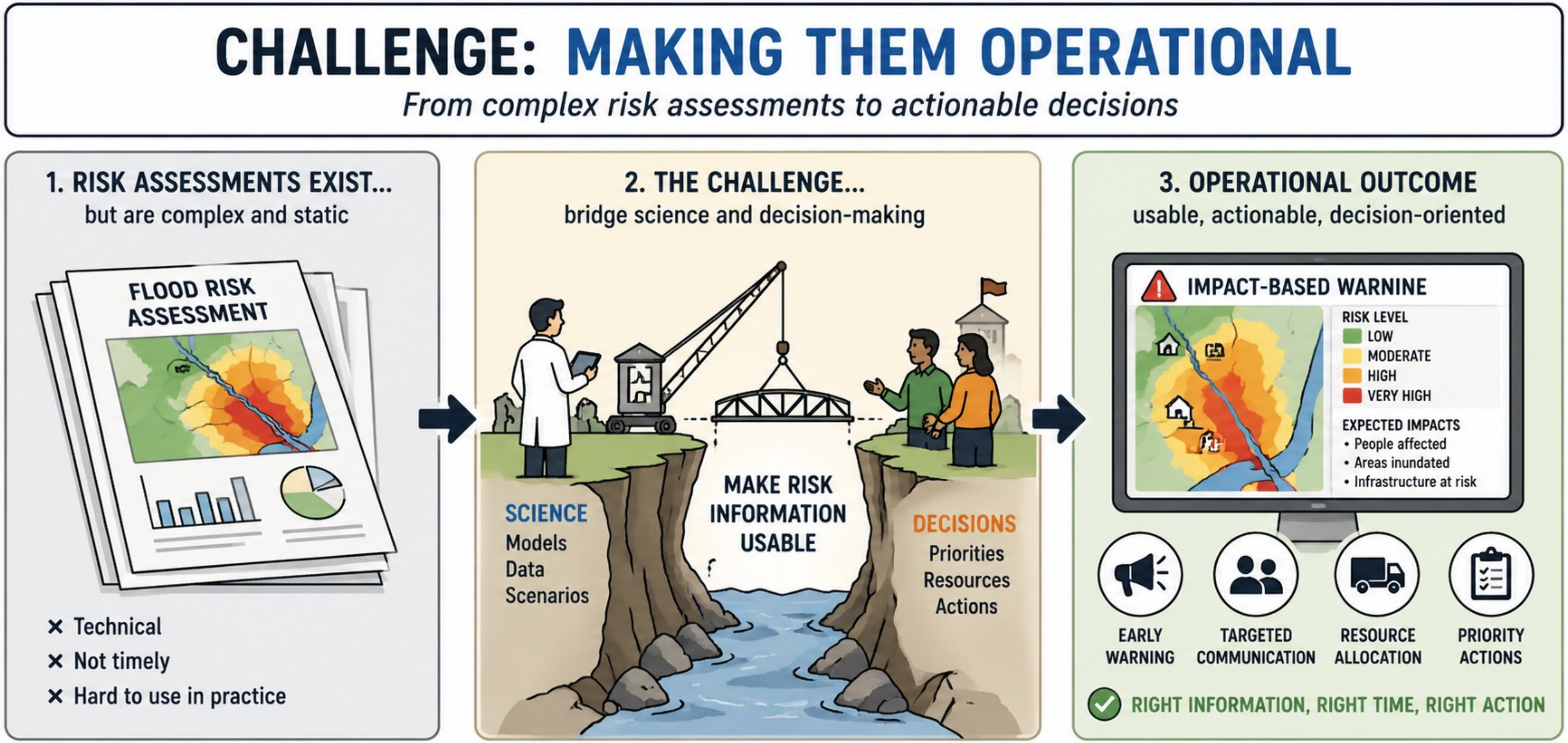
- Early warning systems mostly hazard-based
- Detecting floods ≠ appropriate decisions

The missing link: from risk assessment to decisions

- Risk assessments → complex, static, non-operational for EW
- Early warning → focused on hazard rather then impacts
- Limited usability in real decision contexts :
  - Context specificity
  - Comprehension
  - Uncertainty
  - Timing
  - Format

Where is the operational bridge?

Using risk scenarios as operational interface



From conceptual tools to operational triggers

Objective

– Bridge hazard assessment and early warning

– Support **impact-based** and **decision-oriented** warning systems

Context conditions:
- data scarcity
- high uncertainty
- operational constraints

Hydrological information

River discharge
Forecasts
Thresholds

Risk scenarios

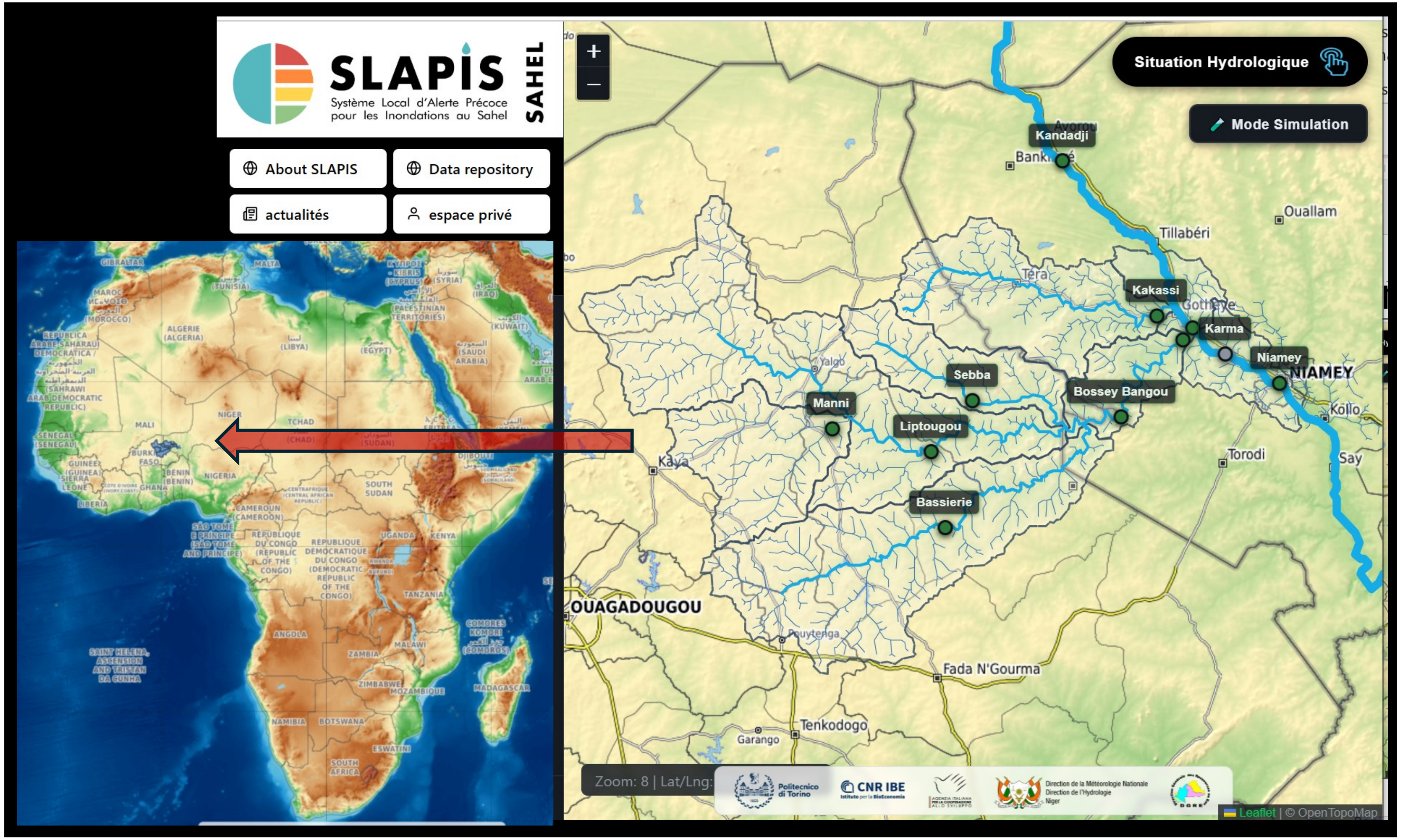
Spatialised impacts
Exposure + vulnerability
Return periods

Decision-making

Warning levels
Expected impacts
Priority actions

Case study: Sirba basin and Niger River (Sahel)

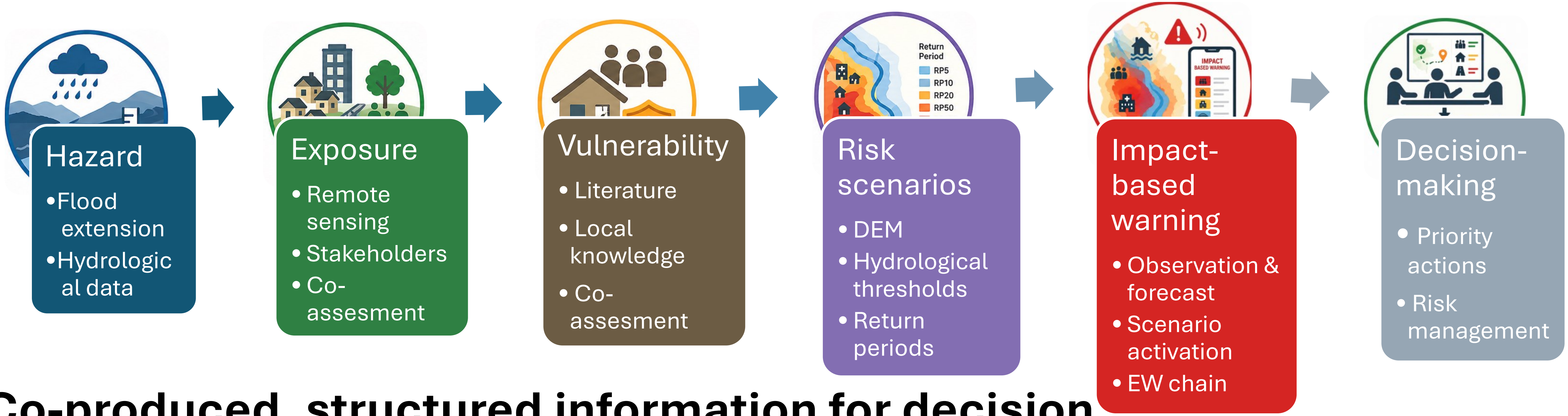
- Niger & Burkina Faso
- Outlet Niamey
- Constraints:
  - limited observations
  - restricted field access
  - security constraints
- Enablers:
  - Long term Project continuity (since 2012)



Methods and approach

Participatory risk assessment :

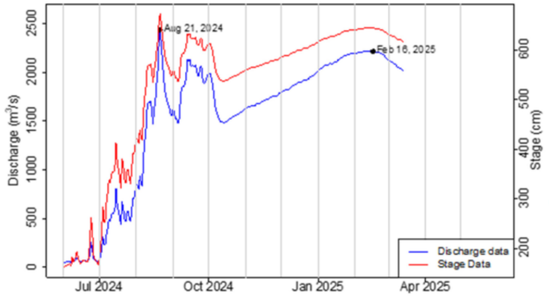
- Co-assesment with stakeholders:
  - hazard
  - exposure
  - vulnerability
- Hydraulic-hydrological analysis
- Remote Sensing
- Field validation
- Integration of local knowledge



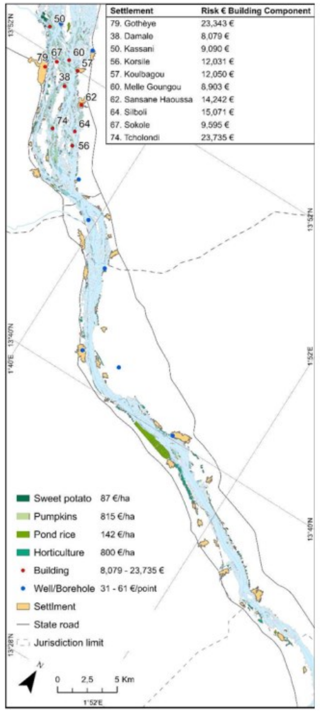
Co-produced, structured information for decision

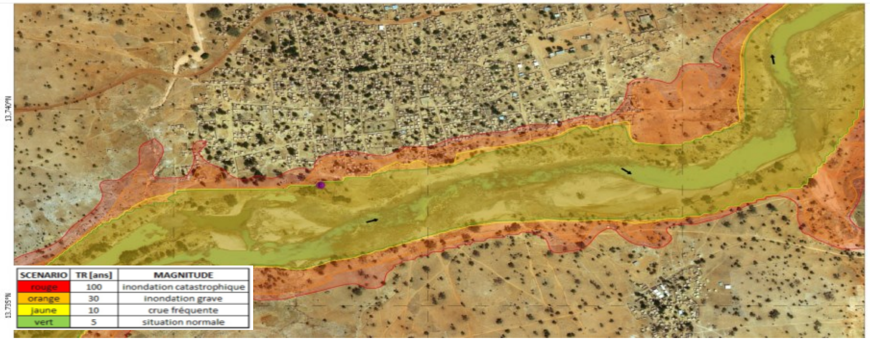
Potential damage (impact) assesment

- Hazard:
  - Multi-return periods
  - Water levels/discharge
  - Flood extent and depth
  - Field validation
- Exposure:
  - Geolocalisation of assets (buildings, infrastructures, crops)
  - Field validation
  - Estimation of assets value
- Vulnerability:
  - Crops and buildings
  - x water level and flood duration
  - Damage factor
- Spatially explicit risk scenarios
  - Critical assets
  - Exposed settlements
  - Risk expressed by cost per Municipality



Crop	Phenological Stage		Submersion Duration		
	Mid-February	Mid-August	Mid-February	Mid-August	Crop Failure After
			Days	Days	Days
Okra	Fructification		10–47		5
Cassava	Early fruiting		10–47		30
Sorghum	-		3	3	5
Cowpea	-		3	3	5
Onion	Bulb		10–47		3–7
Pumpkins	Fructification		10–47		7
AHA rice	-	Bolting, tillering			
Pond rice	Transplanting Leaf out		10–47	30	7–10–15
Sweet potato	Growth		10–47		10
Basilique	Transplanting, growth		10–47		15
Chilli	Fructification		10–47		7





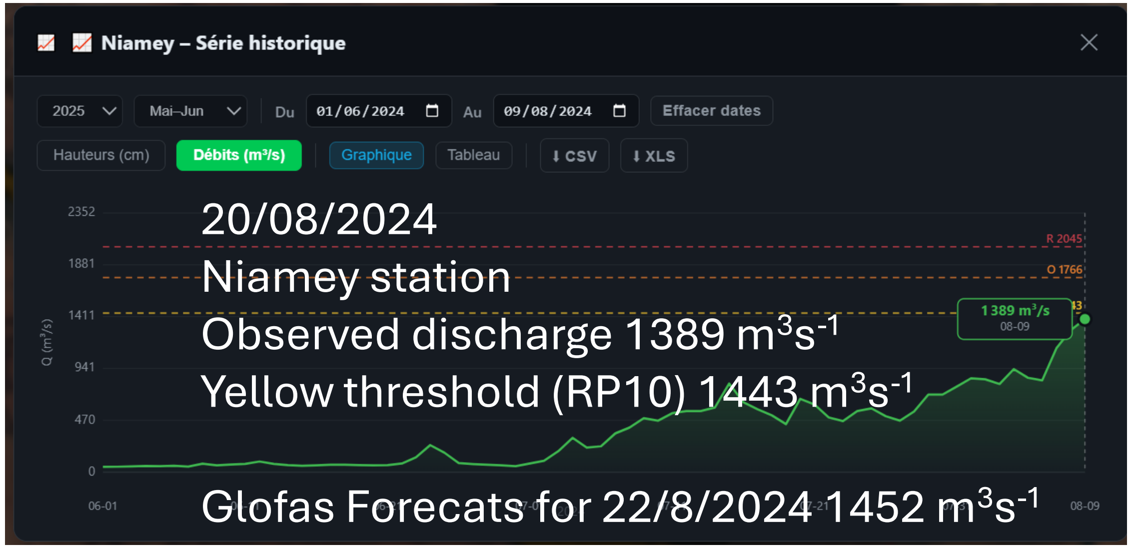
Scenarios as operational tools (not just outputs)

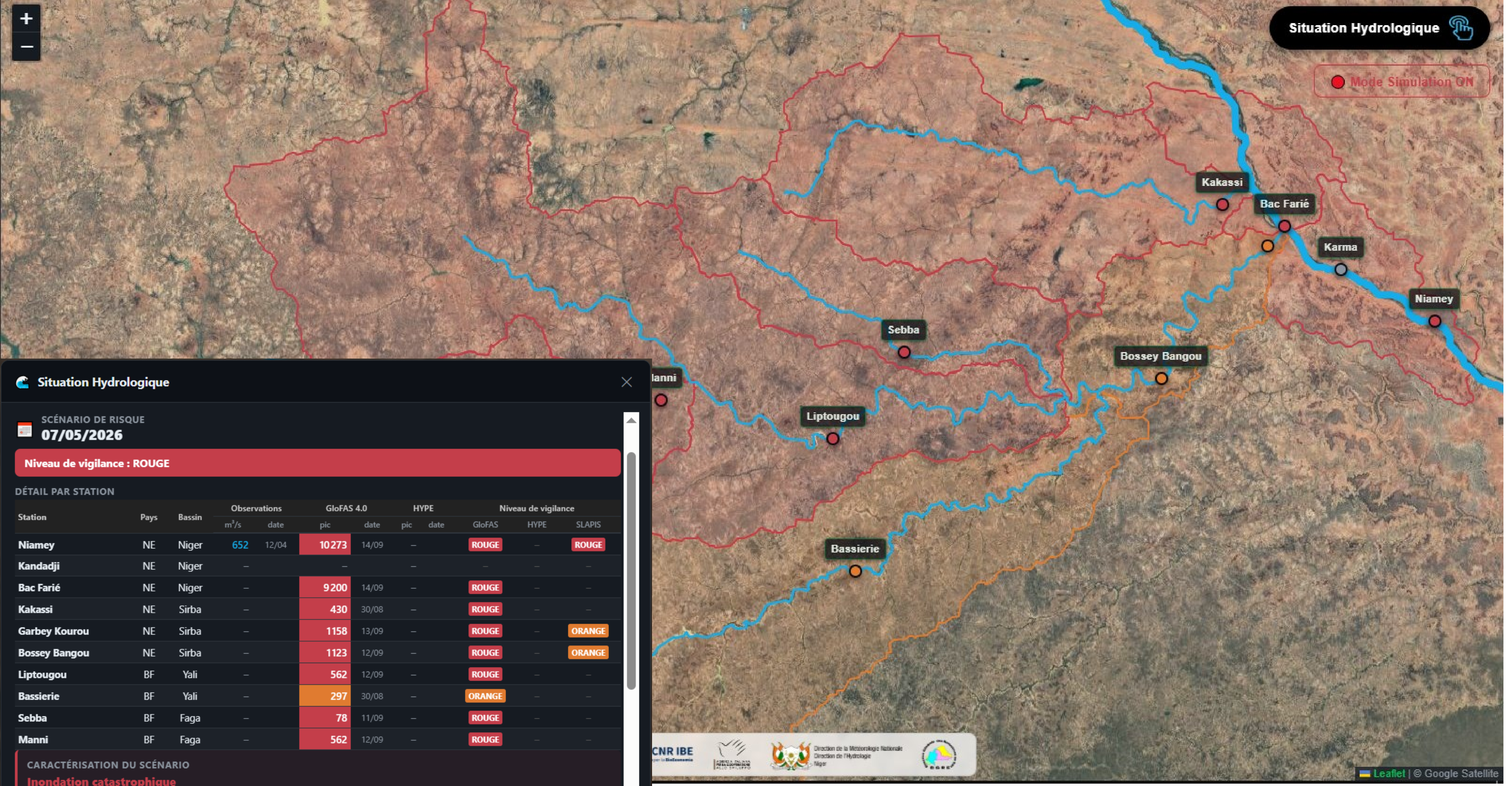
From hazard to risk thresholds

Linking discharge to risk levels

- Observations/Forecasts
- Hydrological thresholds
- Flood risk scenario activated
- Associated impact levels (Potential damage x RP)
- Scenario-based warning
- Communication (multiple chains)

Hydrology → impacts → warning





Situation Hydrologique

SCÉNARIO DE RISQUE
07/05/2026

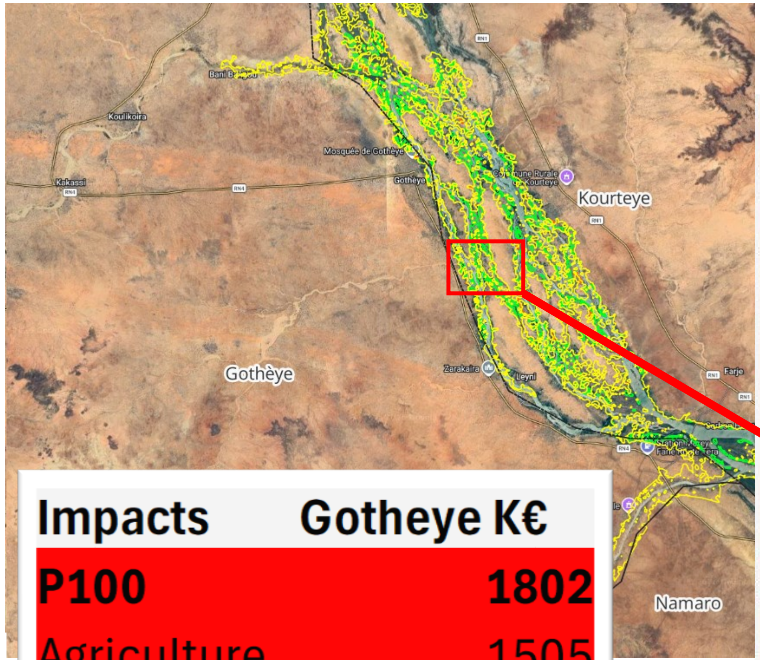
Niveau de vigilance : ROUGE

DÉTAIL PAR STATION

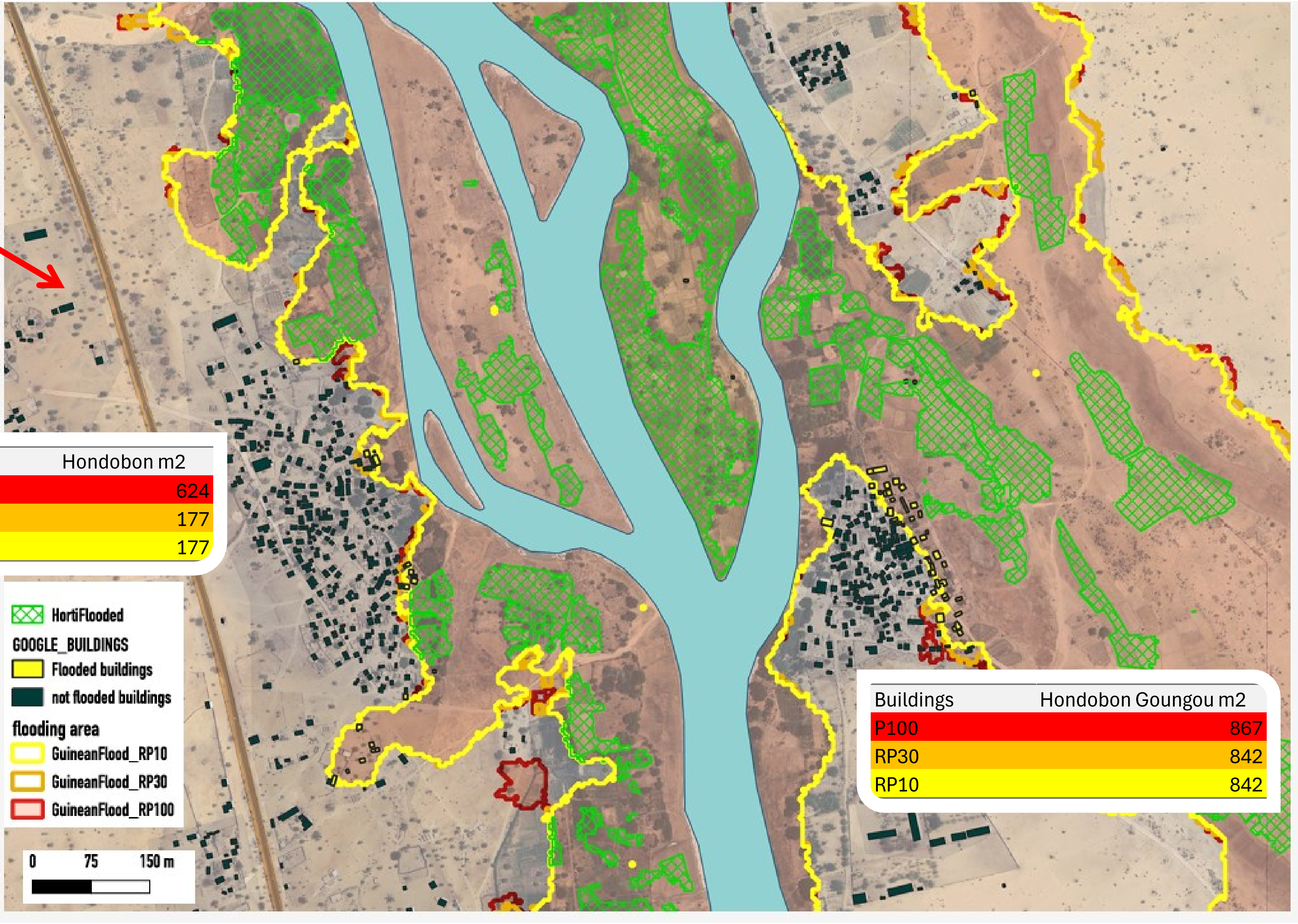
Station	Pays	Bassin	Observations		GloFAS 4.0		HYPE		Niveau de vigilance		
			m³/s	date	pic	date	pic	date	GloFAS	HYPE	SLAPIS
Niamey	NE	Niger	652	12/04	10 273	14/09	–		ROUGE	–	ROUGE
Kandadji	NE	Niger	–		–		–		–	–	–
Bac Farié	NE	Niger	–		9 200	14/09	–		ROUGE	–	–
Kakassi	NE	Sirba	–		430	30/08	–		ROUGE	–	–
Garbey Kourou	NE	Sirba	–		1158	13/09	–		ROUGE	–	ORANGE
Bossey Bangou	NE	Sirba	–		1123	12/09	–		ROUGE	–	ORANGE
Liptougou	BF	Yali	–		562	12/09	–		ROUGE	–	–
Bassierie	BF	Yali	–		297	30/08	–		ORANGE	–	–
Sebba	BF	Faga	–		78	11/09	–		ROUGE	–	–
Manni	BF	Faga	–		562	12/09	–		ROUGE	–	–

CARACTÉRISATION DU SCÉNARIO
Inondation catastrophique
Dommages potentiels : Grande portion moins élevée dans les villages riverains (maison, jardin et grenier).
Impact sur la vie humaine : Directe menace à la sauvegarde des personnes et des biens.

Managing uncertainty and lack of observed data



Impacts	Gotheye K€
P100	**1802**
Agriculture	1505
Buildings	297
RP30	**1201**
Agriculture	1003
Buildings	198
RP10	**460**
Agriculture	346
Buildings	114



Buildings	Hondobon m2
P100	624
RP30	177
RP10	177

Buildings	Hondobon Goungou m2
P100	867
RP30	842
RP10	842

OPERATIONAL EARLY WARNING CHAIN
From hydrological data to effective actions
1
MONITOR & FORECAST
drological monitoring
an forecasting
Real-time data collection (rainfall, river levels, discharge)
Hydrological and hydraulic modelling
Forecast of water levels and impacts
WE ANTICIPATE WHAT CAN HAPPEN
2
RISK SCENARIO
From water levels to potential impacts
RISK LEVEL
Low
Very High
Flood extent and depth estimation
Exposure of population and assets
Impact-based scenarios (damage, disruption)
WE UNDERSTAND THE POTENTIAL IMPACTS
3
WARNING & COMMUNICATION
Clear alerts to the right people at the right time
FLOOD WARNING
Impact warning levels
Orange, Red)
Multi-channel diss ination
(SMS, email, radio,
Targeted communication to authorities and communities
WE INFORM TO ENABLE ACTION
4
DECISION-MAKING & PRIORITY ACTIONS
Authorities act based on expected impacts
Assess the situation and expected impacts
Activate response plans and procedures
Define and implement priority actions
WE DECIDE WHAT TO DO
5
ACTION & RESPONSE
Timely actions to protect lives and reduce impacts
Evacuation of at-risk populations
Protection of critical infrastructure
Mobilization of resources and assistance
WE ACT
CONTINUOUS FEEDBACK & IMPROVEMENT
Post-event evaluation, lessons learned and system improvement
The perfect world

What works

- Early stakeholder engagement
- Integrated impact assessment (top-down/bottom-up)
- Field validation of risk maps (in secure areas)
- Capturing spatial heterogeneity
- Simplified operational workflows
- Adapted to local alert protocols

What doesn't work

- Social vulnerability/risk underrepresented
- Conflict and insecurity factors
- Real-time data limitations
- Risk scenarios static
- Difficult update by local stakeholders
- Non stationarity of return periods

Flood risk governance remains a challenge for many Sahelian regions

Key insight

Simplification improves usability

Participation improves legitimacy

Scenarios enable operationalisation

Impact-based scenarios enable decision-oriented warnings

Methods transferable to other data-scarce contexts

Bridging science and decision-making

Thank you

SLAPIS SAHEL
Système Local d'Alerte Précoce pour les Inondations au Sahel

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climateservices.it/slapis-sahel

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