PROTECT Project

Climate-resilient WASH infrastructure in the Lake Kivu Region

Case of Karongi & Nyamasheke Districts, Rwanda

23 - 27 February 2026

CROIX ROUGE RWANDAISE
RWANDA RED CROSS

Australian Red Cross

Objective

Enhance capacity of WASH stakeholders to plan, design and manage climate resilient WASH systems and services

Specific objectives

OBJECTIVE 1

Deepen understanding of climate change impacts on WASH infrastructure in Rwanda.

OBJECTIVE 2

Build skills in climate risk & vulnerability assessment for water and sanitation systems.

OBJECTIVE 3

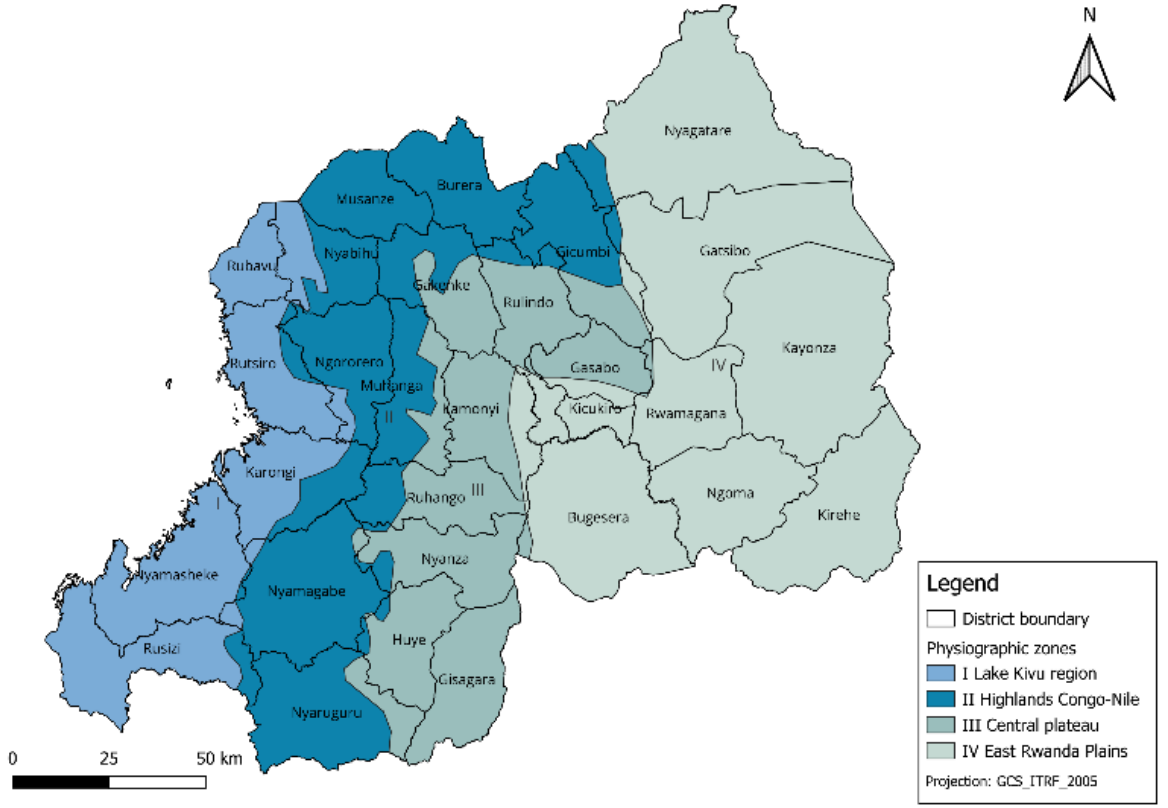
Strengthen capacity to design and operate climate-resilient WASH services, including applying nature-based/green infrastructure solutions.

OBJECTIVE 4

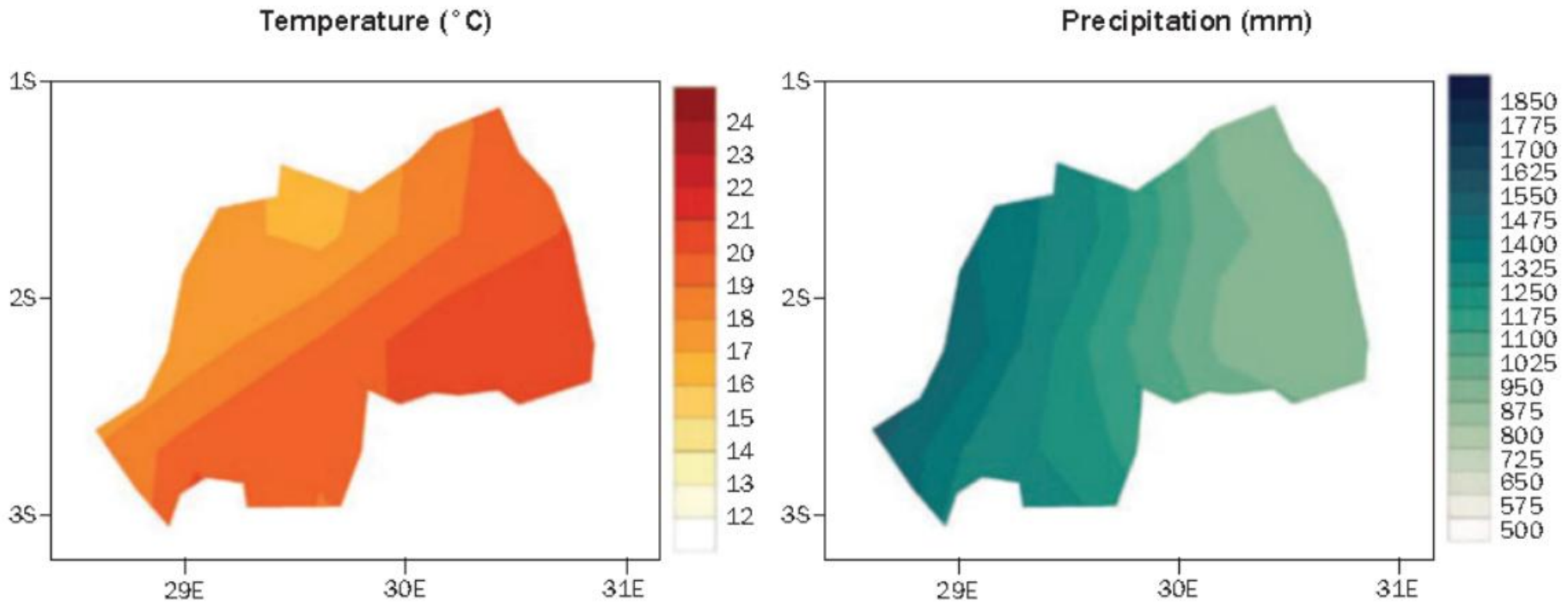
Mainstream climate considerations into WASH planning and investment decisions for adaptive, climate-smart development.

Biophysical background – physiographic zones

- **I - Lake Kivu Region:** medium to steep slopes, 1100 mm/y rainfall;
- **II - Highlands of the Congo-Nile Ridge:** metasedimentary rocks with granite intrusions and basalts in the North, steep slopes, deeply incised valleys, clayey soils, 1200 mm/y rainfall;
- **III - Central Plateau:** gneisses and granites, steep slopes, massive slope and valley colluvia, 900-1200 mm/y rainfall;
- **IV - East Rwanda Plains:** metasedimentary rocks and granites, alluvial sediments in the vicinity of water bodies, relatively shallow soils, 700-900 mm/y rainfall with prolonged dry spells.



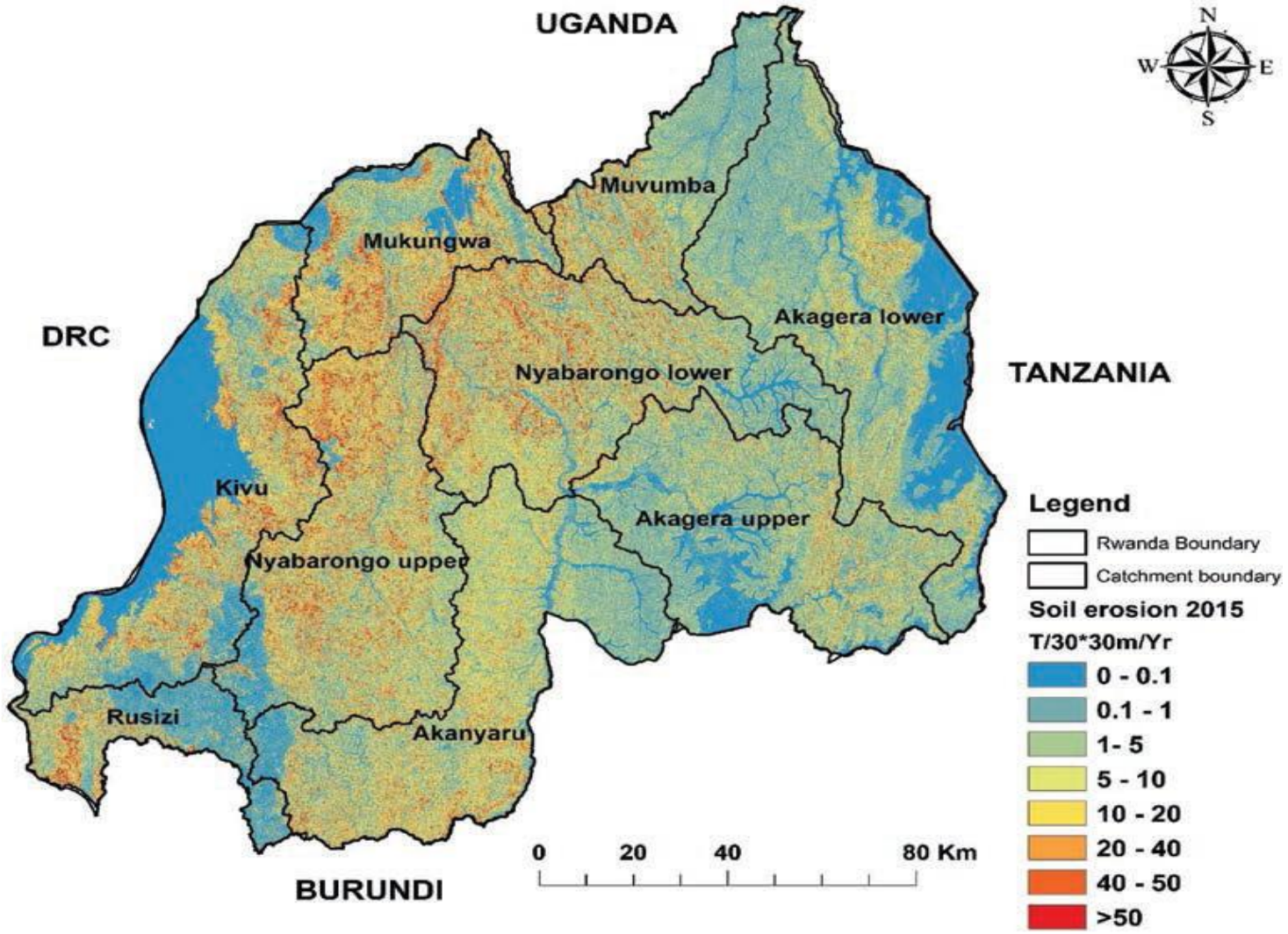
Impact of climate change in Rwanda



- **Average temperature has increased by roughly 1.4°C since 1970,** according to Rwanda's updated NDCs 3.0.
- **Rainfall has become increasingly intense,** and the variability is predicted to increase by 5% to 10%.

Impact of climate change in Rwanda

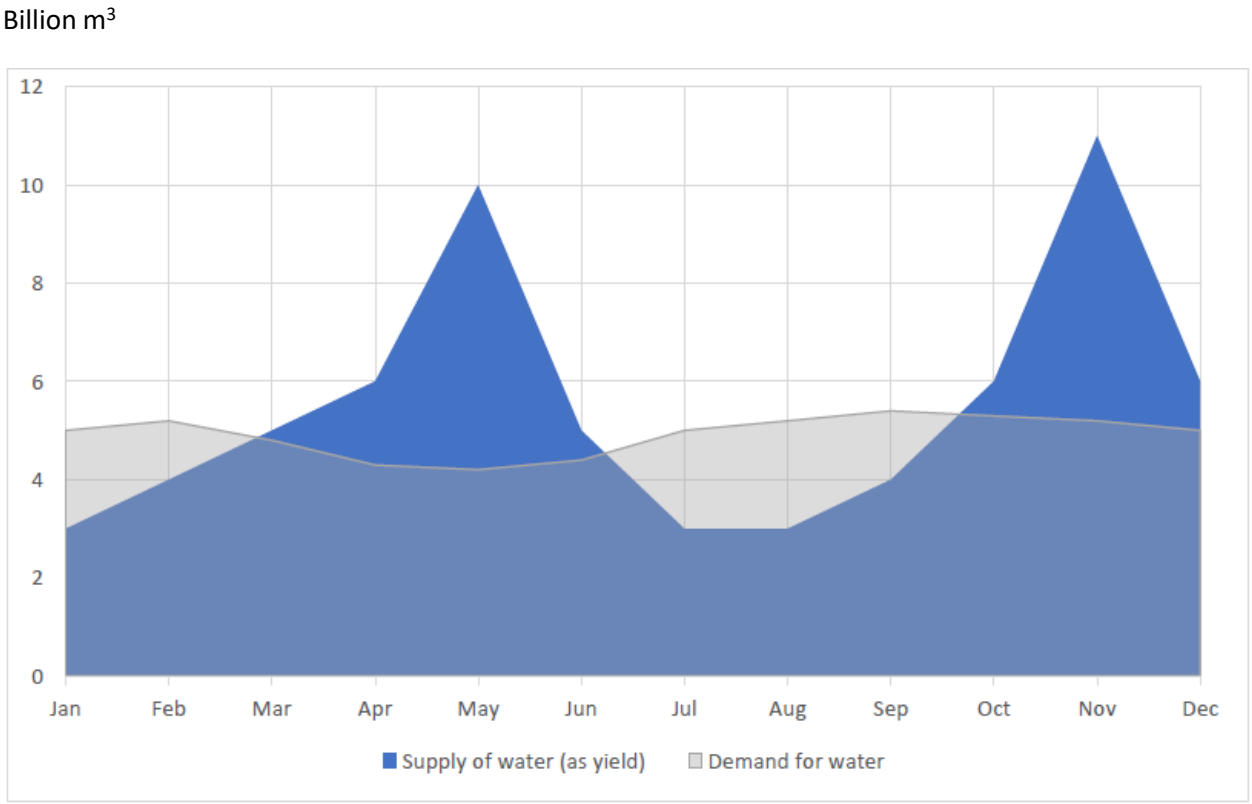
- Human activities exert a significant impact on soil erosion;
- Pressure on available land resources;
  - **Heavy rainfall** in particular result in increased **erosion** and lead to increased **flooding** and **landslides**



Source: WBG, 2021

Impact of climate change in Rwanda

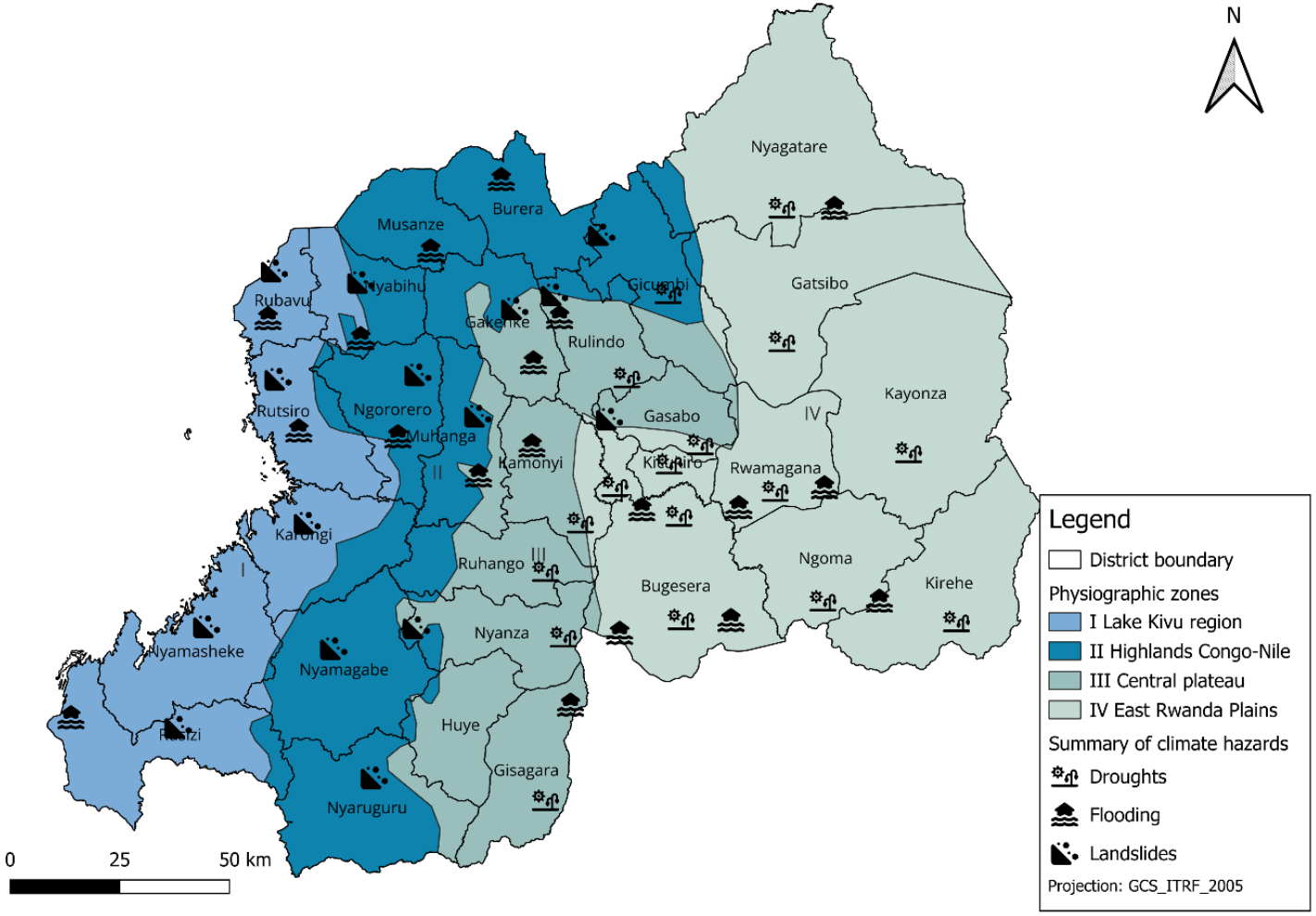
- **Changing characteristics of precipitation** is increasingly likely to disrupt river flow and lead to challenges in water supply;
- **Frequency and intensity of floods, erosion and landslides** are expected to increase affecting WASH infrastructures;
- **Increasing water demand** due to anticipated climate change, economic growth and demography.



Source: NISR, 2019. RNCA

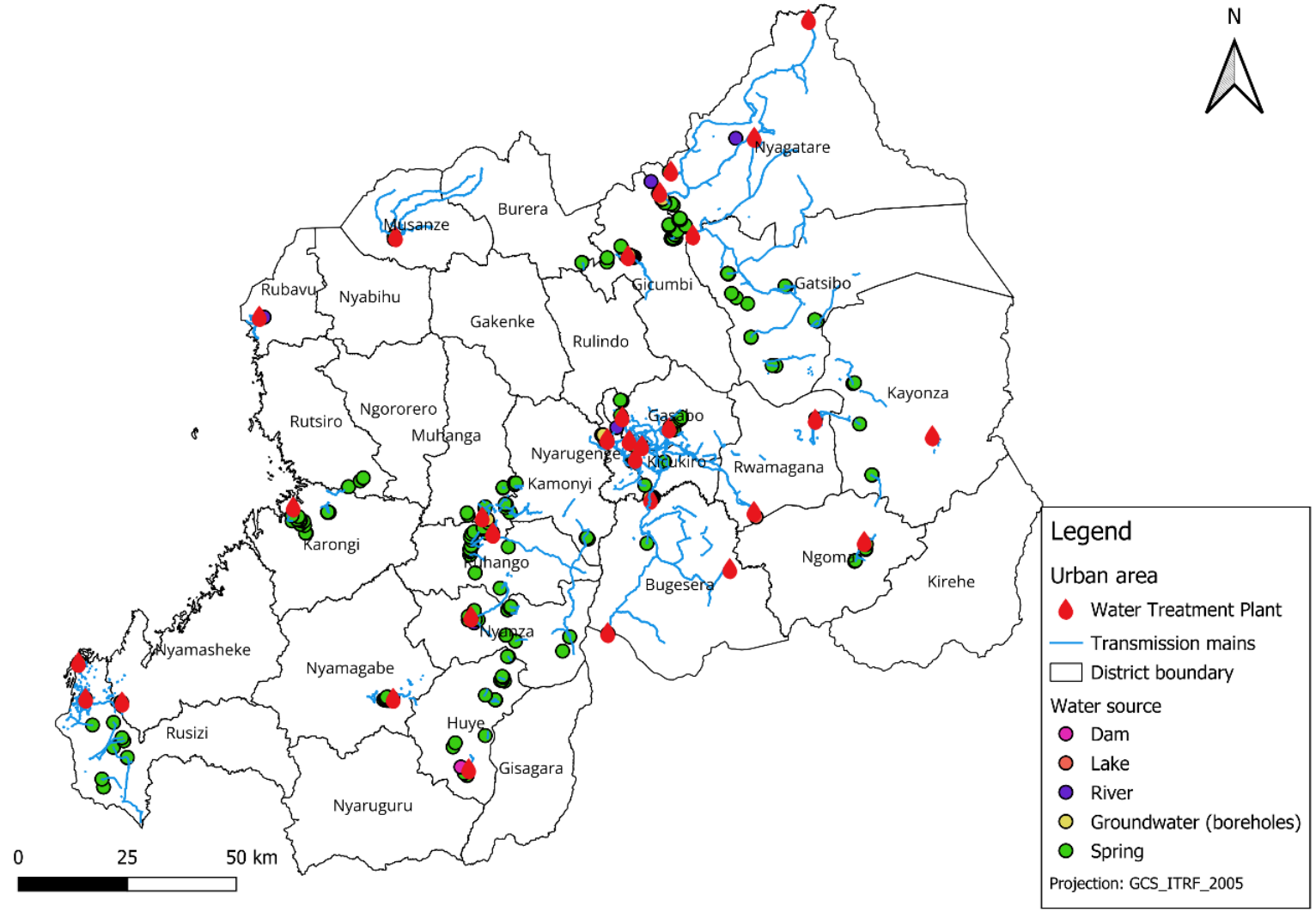
Examples - climate hazards risks in Rwanda

Summary climate hazards risks in Rwanda



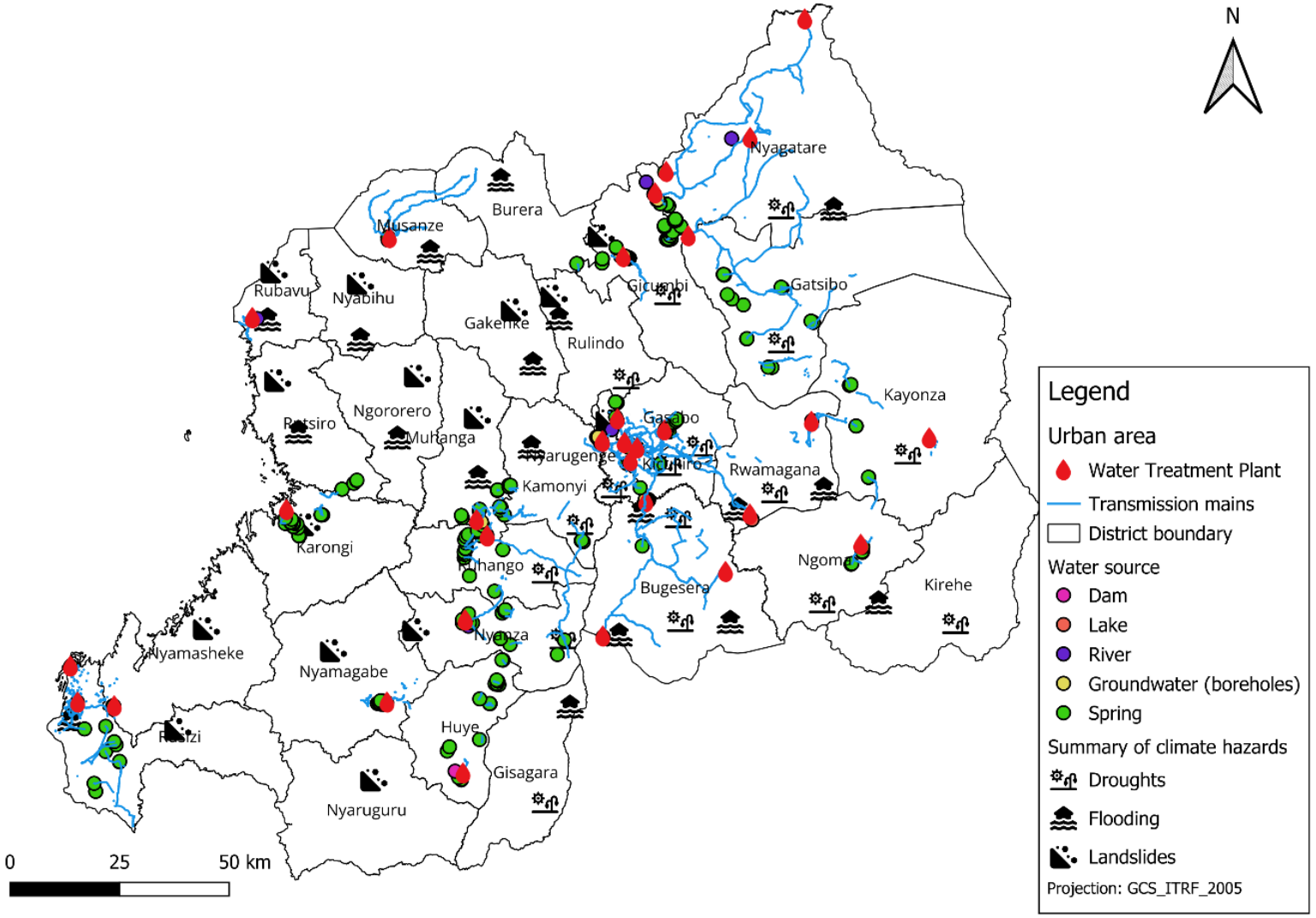
Source: WASAC Group, 2024; based on national risk assessment (MININFRA, 2022)

Urban water supply



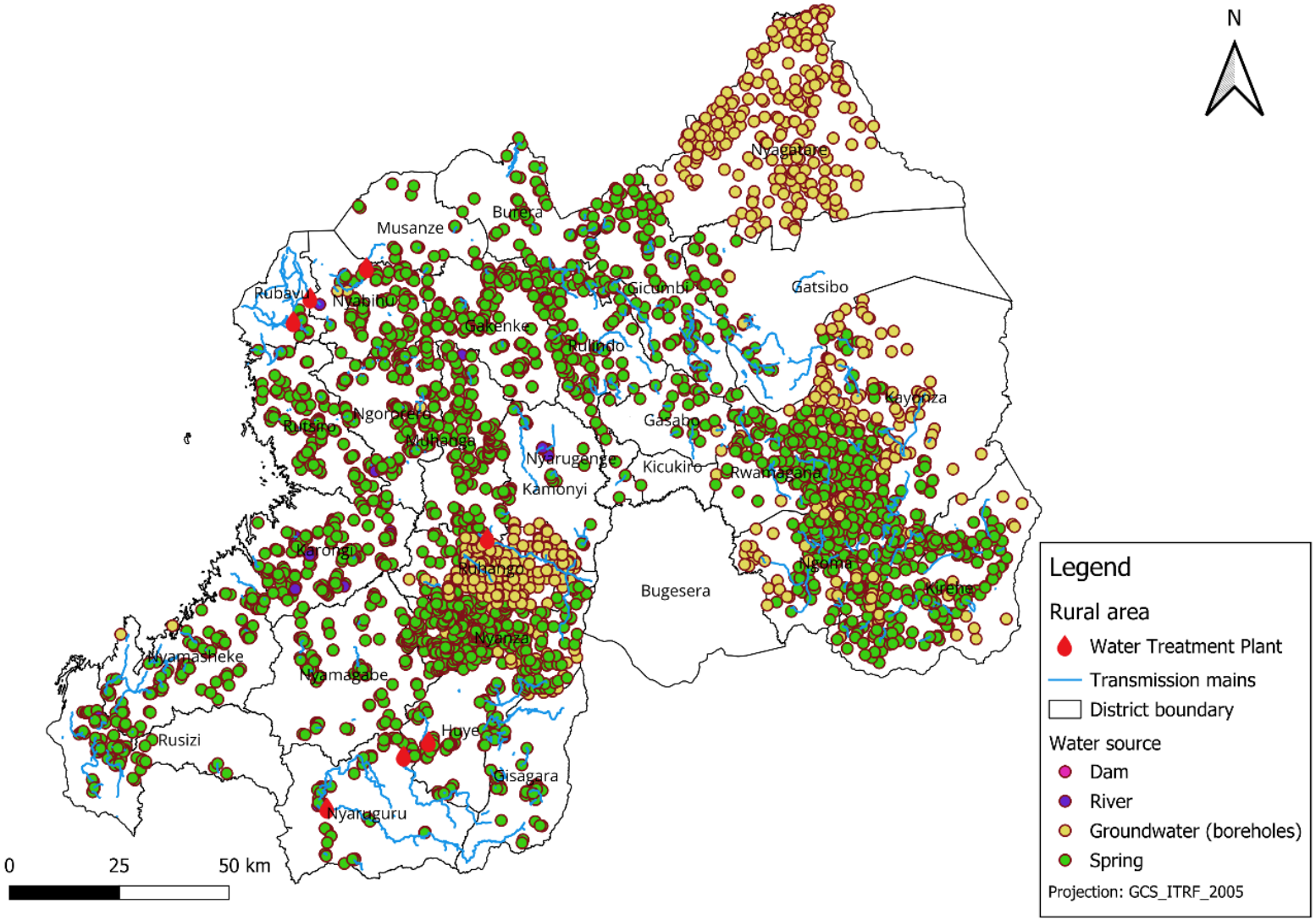
Source: WASAC Group, 2024

Urban water supply - Overlay climate hazards with assets



Source: WASAC Group, 2024

Rural water supply - Overlay climate hazards with assets

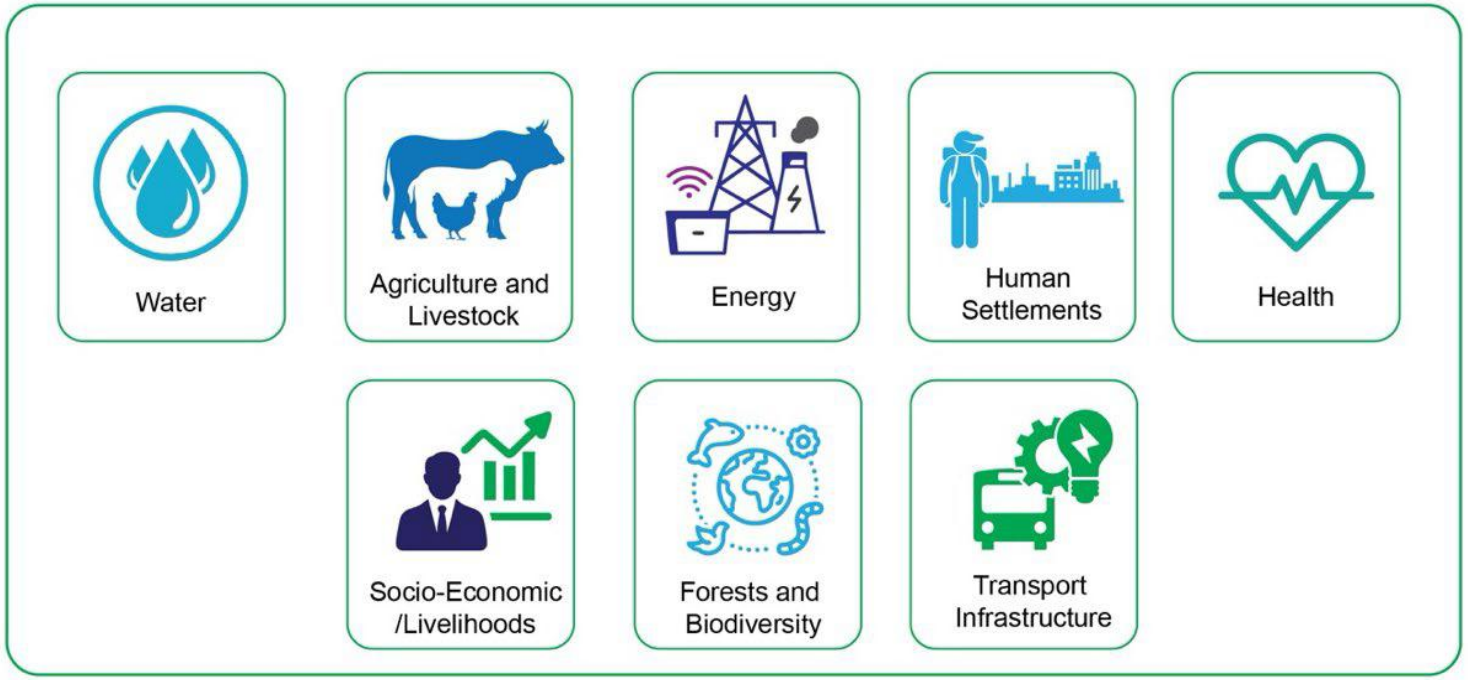


Source: WASAC Group, 2024

Climate vulnerability: Karongi & Nyamasheke in the national picture

Sector-based national CCVIA - Rwanda

CCVIA: Climate Change Vulnerability Index Assessment.



Source: REMA, 2025 (CCVIA- December 2025)

- **Index components:** Household vulnerability indicators were grouped into **Exposure (E), Sensitivity (S)**, and **Adaptive Capacity (AC)**; each indicator was scaled to an index between 0 and 1.
- **Impact index (CCV1):** CCV1 = (E + S) / 2 → captures climate impact based on exposure and sensitivity.
- **Adaptive capacity** handled as "inability to adapt": IAC = inverted adaptive capacity index (higher IAC = lower capacity).
- **Overall vulnerability** (CCV2): CCV2 = (CCV1 + IAC) / 2 → combines impact and (inverted) adaptive capacity.
- **Interpretation:** **Lower index values = better** (lower exposure, lower sensitivity, and lower IAC meaning higher adaptive capacity; therefore lower CCV2 = lower vulnerability).

Climate vulnerability: Karongi & Nyamasheke in the national picture

Total Vulnerability by District

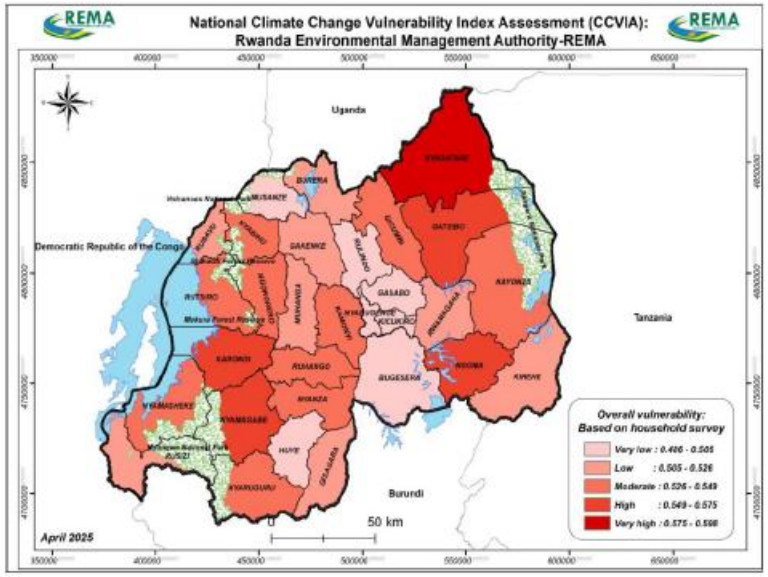


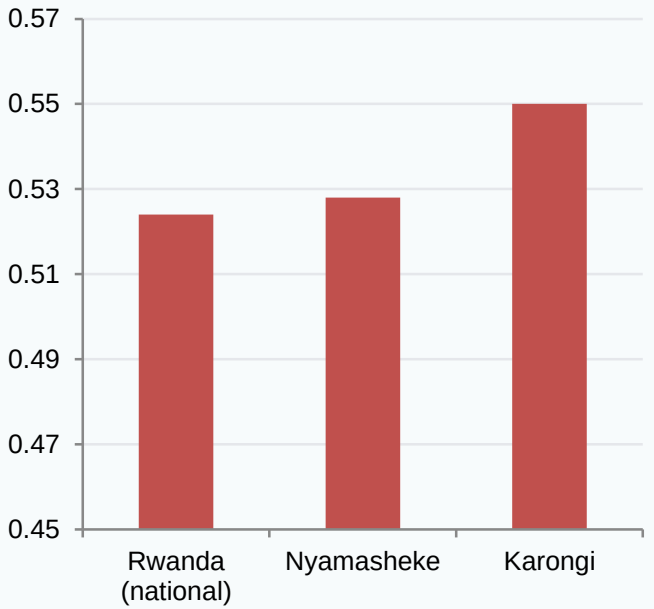
Figure 1 - Distribution of total Vulnerability by District

This map indicates the districts, and their total vulnerability to climate change based on the climate change vulnerability index assessment, which is derived from the household questionnaire, including quantitative and qualitative data. The districts with the darkest shade have the highest overall vulnerability.

District	Ranking
Nyarugenge	0.480
Gasabo	0.485
Kicukiro	0.487
Musanze	0.493
Huye	0.495
Bugesera	0.501
Rulindo	0.503
Rusizi	0.506
Rubavu	0.512
Rwamagana	0.513
Muhanga	0.514
Burera	0.515
Gakenke	0.520
Kirehe	0.522
Gisagara	0.525
Ruhango	0.527
Nyamasheke	0.528
Nyanza	0.531
Nyabihu	0.532
Nyaruguru	0.533
Ngororero	0.536
Rutsiro	0.537
Gicumbi	0.538
Kamonyi	0.538
Kayonza	0.541
Karongi	0.550
Ngoma	0.555
Gatsibo	0.565
Nyamagabe	0.567
Nyagatare	0.568

Table 7 – Ranking of Districts – total Vulnerability

Total Vulnerability Index (lower is better)



Interpretation

Both districts fall in the “moderate to high” range on the illustrative map; **Karongi is among the higher-vulnerability** districts.

Source: REMA, 2025 (CCVIA- December 2025)

Climate + WASH: Defining “climate-resilient”

Hazard

Climate-related events that can cause harm (e.g., extreme rainfall, floods, landslides, droughts).

Exposure

People, assets and services located where hazards occur (e.g., intake in floodplain, pipeline on steep slope).

Sensitivity

How easily the system is affected (e.g., single intake, low redundancy, high turbidity sensitivity).

Adaptive capacity

Ability to anticipate, cope and recover (e.g., O&M capacity, spare parts, monitoring, contingency plans).

Common language used throughout the CCVIA and WASAC vulnerability assessment

Climate-resilient WASH = services that continue to deliver safe, reliable water & sanitation despite climate variability and change.

Local example: Karongi WTP disruptions linked to turbidity

Production site (Districts)	Installed Capacity m³/day (average current production m³/d)	Sources	Turbidity in July2022-June2023 in NTU Average (Maximum)	Total duration of plant stops in days in Jul2022-Jun2023 (main reasons for stops)	Main issues
Karenge (Rwamagana, Kayonza)	15,000 (12,109)	Mugesera Lake (680 m³/h)	20 (700)	5 (power cuts)	High concentrations of algae and organic matter, old intake which becomes unstable during rainy season due to flooding, papyrus and strong winds, which are expected to worsen further in future. General old infrastructure that needs rehabilitation: sand filters, sedimentation tanks and pumping station
Muhazi (Rwamagana, Kayonza)	7,964 (5,498)	Muhazi Lake (500 m³/h), 3 springs (67 m³/h) and 1 well (2,16 m³/h)	8 (75)	8 (power cuts)	Turbidity, organic matter, effluent from households, farms and industries. Intake from the lake depends on one inlet pipeline, clogging of the well (clay)
Nyamabuye (Gicumbi)	2,328 (2,113)	Several spring sources (through dammed reservoirs 112 m³/h)	0.9 (3.5)	16 (mainly power cuts)	Water shortages during dry season due to lower discharge of springs
Mutobo (Musanze)	12,500 (8,214)	2 Springs (1000 m³/h)	0.2 (18)	ND	Water shortages during dry season due to lower discharge of springs, upgrade of (staff) facilities needed
Kanyabusage (Karongi)	1,250 (1,289)		1.6 (2.3)	0	
Nyabahanga CU (Karongi)	2,000 (523)	Nyakagezi River (? m³/h)	280 (3600)	215 (112 turbidity, 2 leakage, maintenance, rehabilitation and expansion works)	Turbidity, intake is threated during periods of heavy rain
Gihira (Rubavu)	23,000 (10,590)	Pfunda River (750 m³/h) and Sebeya River (450 m³/h) - College reservoir	1300 (5500)	137 (34 turbidity, 3 power cuts, 100 maintenance, rehabilitation and expansion works)	High turbidity, particularly during rainy season

Source: WASAC Group, 2024

What the data shows

- Very high turbidity at Nyabahanga CU (average 280 NTU; max 3600 NTU)
- Long duration of plant stops reported (215 days in Jul 2022–Jun 2023)
- Main issue noted: intake threatened during periods of heavy rain

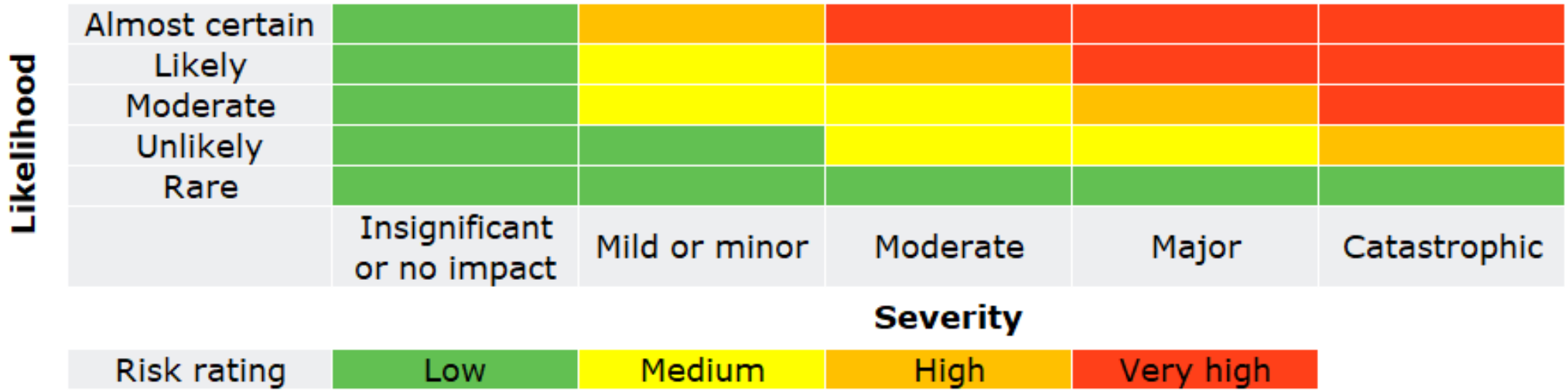
So what?

Resilience investments that reduce sediment loads and protect intakes often pay back quickly through fewer shutdowns and lower O&M costs.

Risk matrix – for improved planning

Risk matrix – for improved planning

- Risk = Likelihood x Severity



Source: IWA, Strategic Recommendations for Climate Smart Utilities (2019)

Integrating climate information (i/ii)

- Risk = Likelihood x Severity

Likelihood					
Almost certain 5	5	10	15	20	25
Likely 4	4	8	12	16	20
Moderate 3	3	6	9	12	15
Unlikely 2	2	4	6	8	10
Rare 1	1	2	3	4	5
	Insignificant or no impact 1	Mild or minor 2	Moderate 3	Major 4	Catastrophic 5

Severity

Risk score	<6	6-9	10-12	15-25
Risk rating	Low	Medium	High	Very high

Integrating climate information (ii/ii)

- Risk = Likelihood x Severity

Likelihood	Insignificant or no impact 1	Mild or minor 2	Moderate 3	Major 4	Catastrophic 5
Almost certain 5	5	10	15	20	25
Likely 4	4	8	12	16	20
Moderate 3	3	6	9	12	15
Unlikely 2	2	4	6	8	10
Rare 1	1	2	3	4	5

Severity

Risk score	<6	6-9	10-12	15-25
Risk rating	Low	Medium	High	Very high

Example – Landslide affecting sources (i/ii)

- **Rare: <0.01/yr (less frequent than once per 100 years)**
- **Unlikely: <0.1/yr (about once per 10 years)**
- **Moderate: <0.2/yr (about once per 5 years)**
- **Likely: <1/yr (up to about once per year)**
- **Almost certain: >1/yr (more than once per year)**

Likelihood					
Almost certain (>1/yr) 5	5	10	15	20	25
Likely (<1/yr) 4	4	8	12	16	20
Moderate (<0.2/yr) 3	3	6	9	12	15
Unlikely (<0.1/yr) 2	2	4	6	8	10
Rare (<0.01/yr) 1	1	2	3	4	5
	Insignificant or no impact 1	Mild or minor 2	Moderate 3	Major 4	Catastrophic 5
Number of customers without water	<100	<1000	<5000	<100,000	>100,000
			Severity		

	a	b	c	d	e
Assetgroup	Springs	Boreholes	Riverbank filtration	Lakes, wetlands, dams	Streams and rivers
Likelihood	4			2	
Number of customers affected	3			3	
Risk score	**12**			**6**	

Example – Landslide affecting sources (ii/ii)

	a	b	c	d	e
Assetgroup	Springs	Boreholes	Riverbank filtration	Lakes, wetlands, dams	Streams and rivers
Likelihood	4			2	
Number of customers affected	3			3	
Risk score	**12**			**6**	

Tools & data sources (Rwanda): what to use, and when

1

Meteo Rwanda

Seasonal forecasts, rainfall/temperature data, climate information services.

2

Rwanda Water Resources Board (RWB)

Hydrology and water resources data (rivers, groundwater, water quality monitoring).

3

MINEMA & district DRM

Disaster risk information, contingency plans, historical events and hotspots.

4

WASAC systems (GIS/Oracle/operations reports)

Asset condition, failures, outage logs, chemical and energy costs, production data.

5

Water Safety Plans (WSP)

Structured hazard identification, monitoring and improvement planning for water supply systems.

6

Community knowledge

Local early warnings, access constraints, vulnerable groups, informal water points.

Minimum dataset to start: hazard hotspot map + asset inventory + outage/repair history + turbidity/quality time series. Combine national datasets with local knowledge!

What has already been planned (national level)

What has already been planned (national level)

Vision: secure resilient water supply & sanitation under climate change while maintaining sustainable, quality services.
Built from the 2024 vulnerability assessment + field visits and stakeholder consultations.

Targets 3 main vulnerability pathways for WASH services:

- **Water quantity** (drought, dry springs, lower river flows)
- **Water quality** (turbidity/erosion, runoff, pollution)
- **Physical damage to assets** (floods, landslides, storms)

8 strategic objectives:

1. Risk-based asset management & water safety planning
2. Reduce vulnerability to flooding
3. Reduce vulnerability to erosion (catchment protection)
4. **Reduce vulnerability to landslides (Lake Kivu/Congo–Nile ridge)**
5. Reduce vulnerability to drought (sources, storage, monitoring)
6. Strengthen sanitation to cope with floods/landslides
7. **Reduce NRW + increase energy efficiency (win-win mitigation/ adaptation)**
8. Improve disaster risk management (early warning, protocols, contingency)

Source: WASAC Group, 2024

From strategy to action plan

- **Actions are grouped under 15 strategic areas** (e.g., flood protection, catchment protection, landslide protection, drought monitoring).
- **Each action is tagged by:** hazard (landslides/floods/drought), timeframe (short/medium/long), cost (low/medium/high) and feasibility.
- **For Lake Kivu Region**, the plan prioritizes: flooding + erosion/turbidity + landslides (plus emergency response readiness).

Flood protection

- System-level detailed plans (per intake/WTP/network)
- Protect/relocate vulnerable intakes & pump stations
- All-weather access to key assets (WTP, WWTP, landfills)

Erosion & turbidity

- Catchment protection programmes with RWB & districts
- Strengthen catchment committees / IWRM coordination
- Riverbed protection + erosion measures in high-turbidity areas

Landslide protection

- Drainage + retaining walls + slope stabilization
- Upgrade vulnerable pipes/materials where suitable
- Afforestation/reforestation + community engagement

How actions are organized (objectives → strategic areas → priority actions)

Lake Kivu Region: priority actions already in the plan

Asset planning & design

1.3.2 — Identify infrastructure most at risk and their needed adaptation
1.3.3 — Enhanced supervision in areas that are more disaster prone

Flood protection (systems & assets)

2.1.1 — Based on climate vulnerability assessment (2024) create a detailed plan for individual systems
2.1.2 — Implement detailed plan (e.g. shifting locations of intakes and pumping stations)

Catchment & erosion / turbidity

3.1.3 — Strengthen collaboration with the existing catchment management committees…
3.1.4 — Increase riverbed protection and erosion measurements in high turbidity areas…

Landslide protection (Lake Kivu slopes)

4.1.1 — Plan and strengthen existing infrastructure with appropriate engineering solutions
4.1.2 — Promote Afforestation and Reforestation in landslide prone areas
4.1.3 — Engage and Train Community about landslide risks and protective measures

Disaster preparedness & service continuity

8.1.1 — Create action protocol based on early weather warnings
8.1.2 — Establish monitoring mechanism for systems behavior during extreme weather events
8.2.1 — Define protocol on recording disaster events (via WASH Cluster)
8.2.4 — Create backup in water sources and systems

Climate risk assessment practicals (group)

Thank you!