Climate Resilience and Ecosystem Management



SADC TFCA NETWORK

Investing in People, Nature and Partnerships

ANNUAL MEETING 2026

9 - 13 NOVEMBER 2026

SKUKUZA KRUGER NATIONAL PARK

GREAT LIMPOPO TRANSFRONTIER CONSERVATION AREA





forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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IUCN ifaw

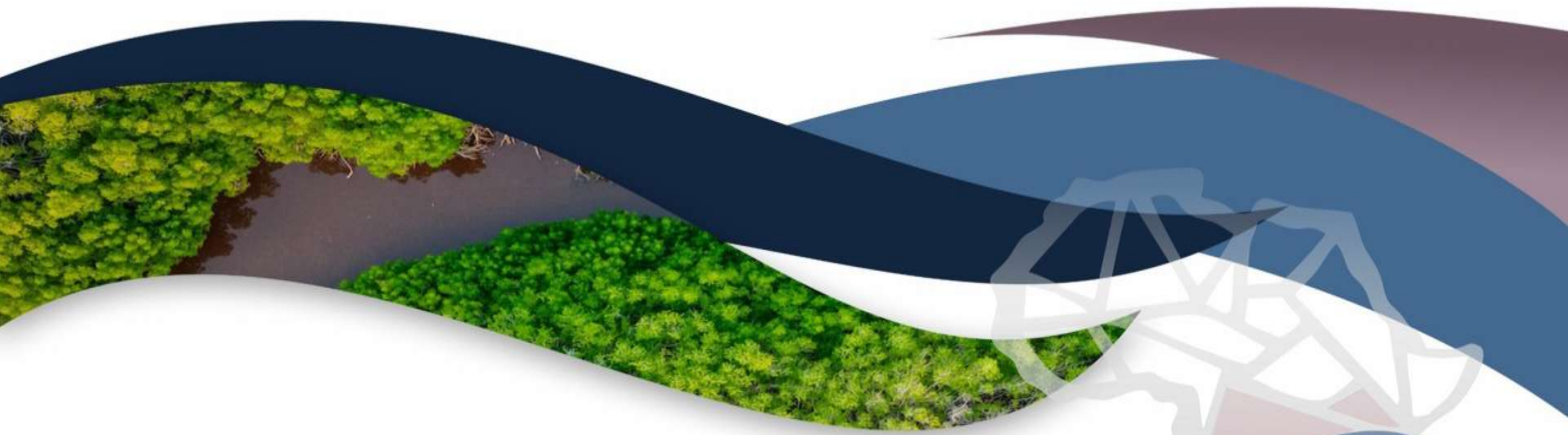
South African NATIONAL PARKS

Climate Resilience and Ecosystem Management

- Climate change adaptation and DRR in TFCA management plans.
- RBO Climate mitigation and ecosystems.
- 2027 El Nino drought implications and interventions

Lead: **Ninahoelisoa Ratrimoson**, Madagascar

Presenters:
Eddie Riddel – GWP/LIMCOM
Sanet Geldenhuys – ALSSON
Comfort Molosiwa – Orange Senque River Basin Commission
Lisa Zanerini – COSPE



Seasonal Outlook and ENSO / El Niño Implications for Southern Africa

SADC TFCA Network Annual Meeting 2026, Climate Resilience and Ecosystem Management

GIZ Transboundary Water Management in the SADC Region

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Executive messages

WHAT DECISION-MAKERS SHOULD RETAIN

ENSO is a risk signal, not a deterministic rainfall forecast.

1. El Niño was described as firmly established by mid-August 2026, with rapid intensification in the central-eastern equatorial Pacific.
2. For the South African region, seasonal systems indicated increasing likelihood of below-normal rainfall toward mid-summer, alongside very high probabilities of above-normal temperatures.
3. SARCOF 33 review material shows why the previous season and other ocean basins must remain part of the interpretation.
4. Priority: monitor updates, use local forecasts, and trigger staged preparedness across water, agriculture, health and disaster-risk systems.

Source: ENSO Reference Group Summit, 10 Sep 2026; SARCOF 33 review deck

2026/27 El Niño status

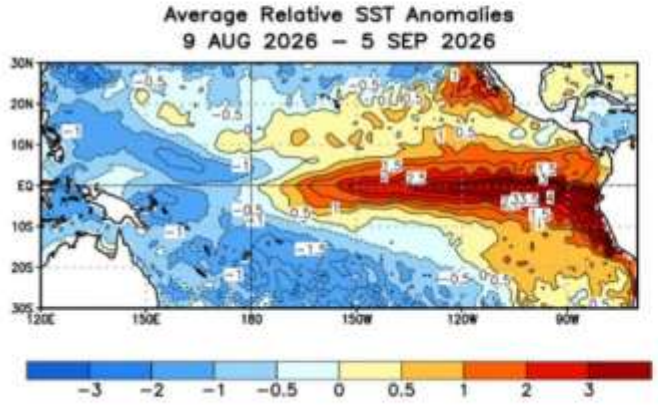
REFERENCE GROUP ASSESSMENT AS PRESENTED IN SEPTEMBER 2026

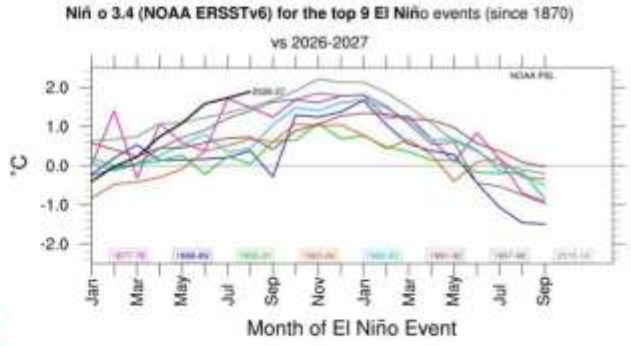
1. By mid-August 2026, positive SST anomalies were persistent and intensifying across the central-eastern equatorial Pacific.

2. The presentation characterised the event as a mature coupled ocean-atmosphere event, rapidly intensifying.

3. The event magnitude should not be read directly as the magnitude or spatial pattern of southern African impacts.

As of mid-August 2026, El Niño has become firmly established, marked by persistent and intensifying positive sea surface temperature anomalies across the central-eastern equatorial Pacific.





This is no longer a developing El Niño. It is a mature coupled ocean–atmosphere event that is rapidly intensifying.

Use the actual seasonal rainfall and temperature forecasts for impact planning.

Source: ENSO Reference Group Summit, pp. 43 and 46

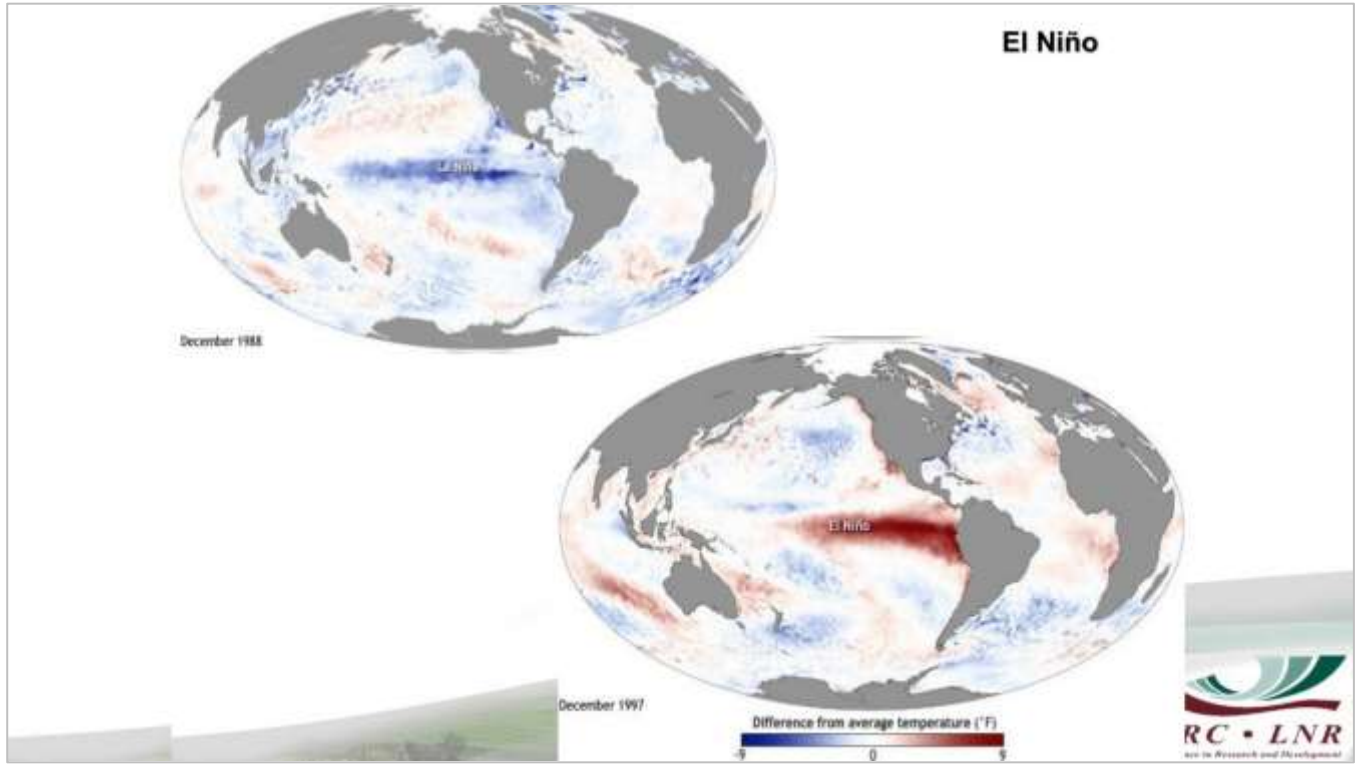
ENSO in one slide

COUPLED PACIFIC OCEAN-ATMOSPHERE VARIABILITY

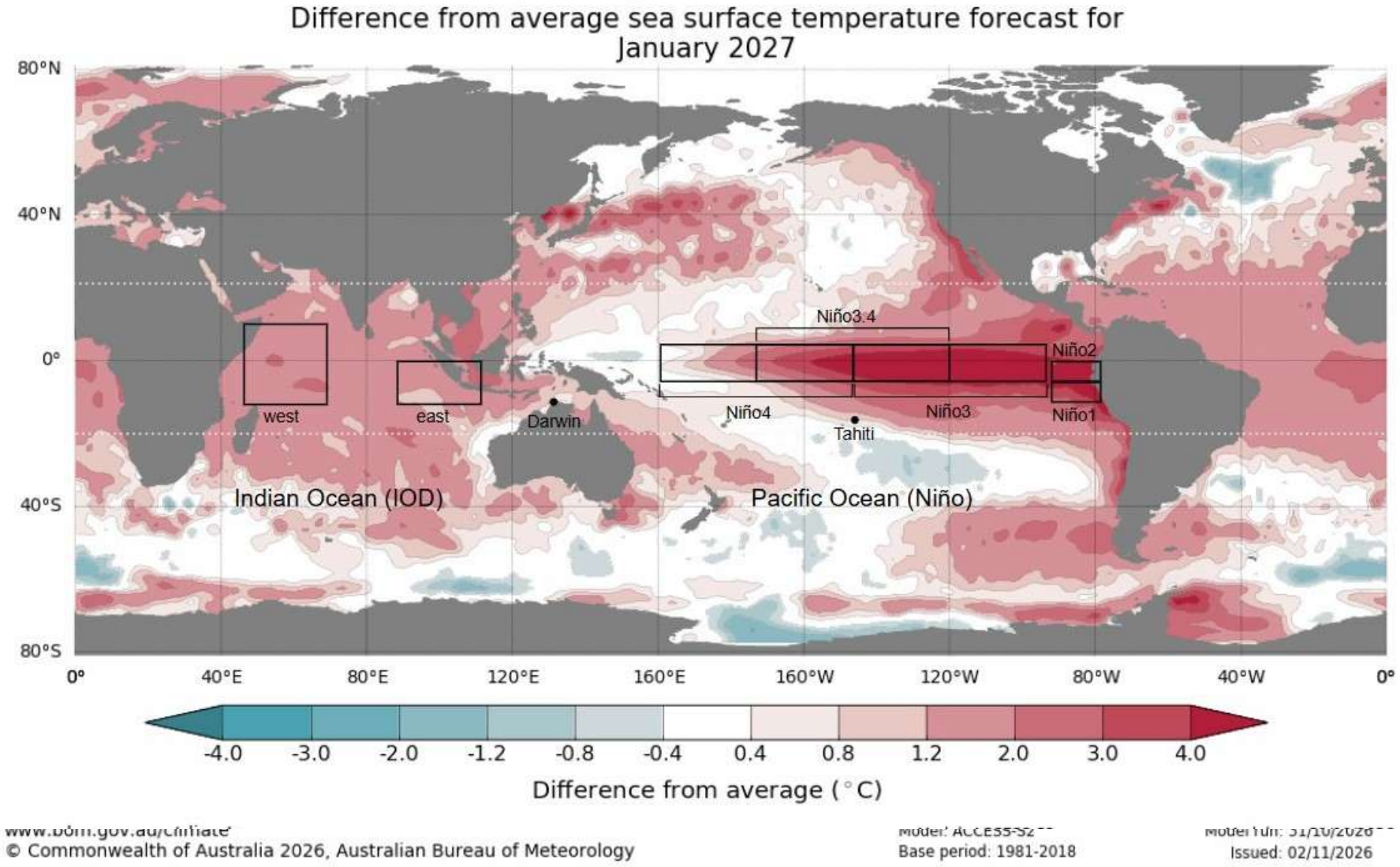
1. El Niño is the warm phase of the El Niño–Southern Oscillation.

2. The signal is tracked through Pacific sea-surface temperatures and atmospheric indicators such as the Southern Oscillation Index.

3. Teleconnections influence southern African circulation, but their strength and geography vary by event and season.



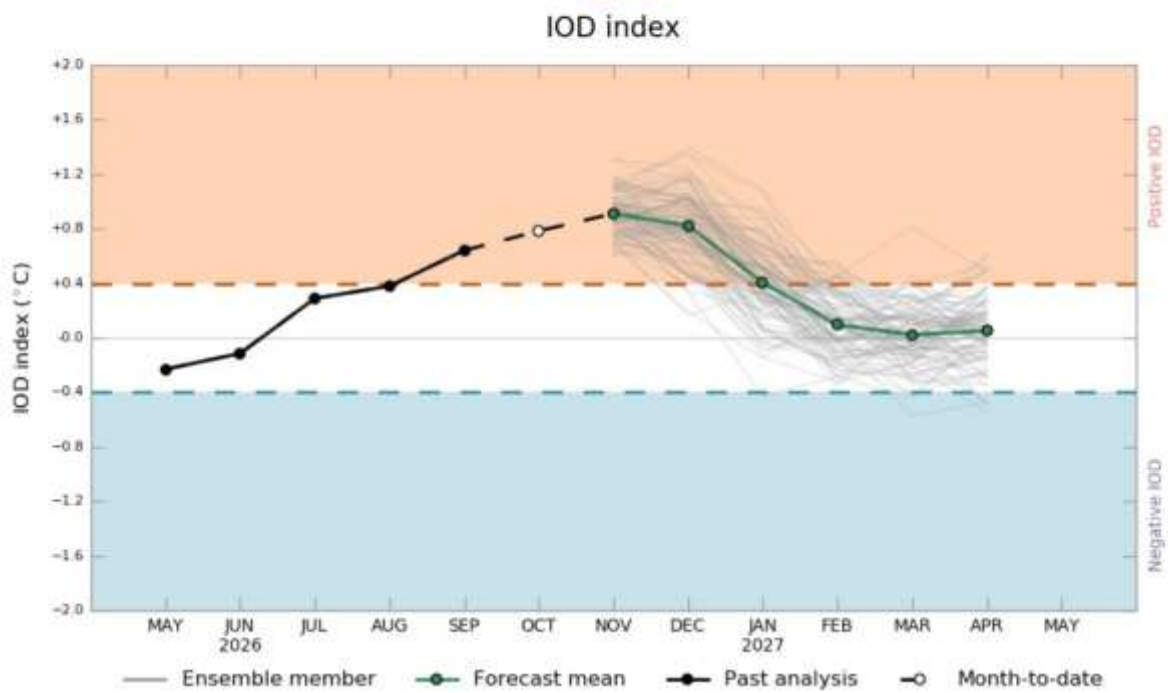
Source: ENSO Reference Group Summit, pp. 8–11



 https://www.bom.gov.au/climate/ocean/outlooks/?index=nino34

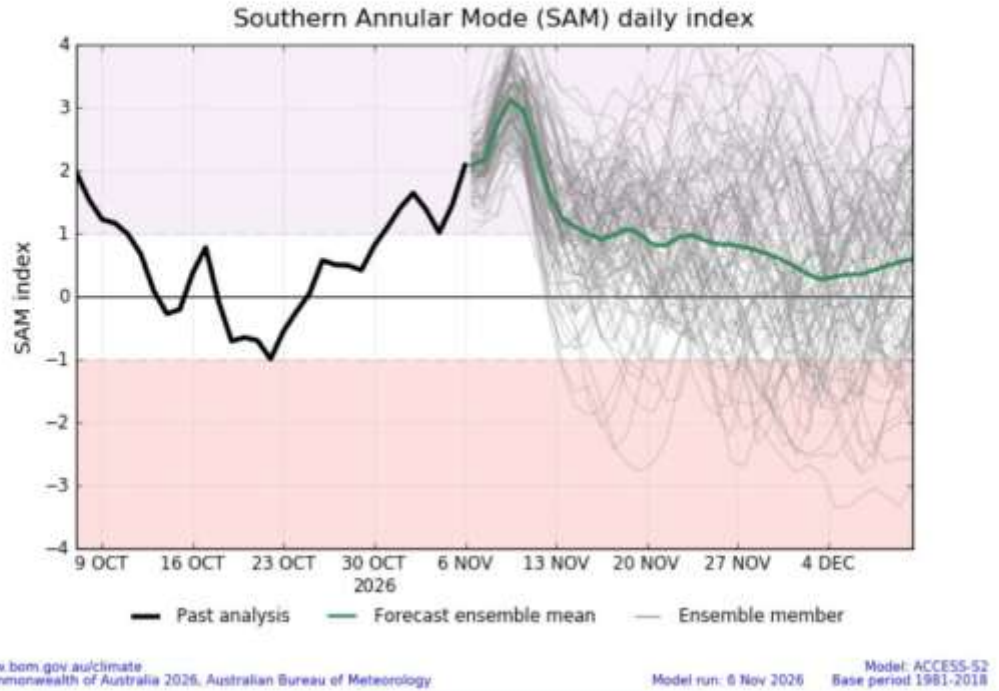
IOD, SAM and Relative Niño index graphs

R-Niño3.4 | R-Niño3 | R-Niño4 | IOD | SAM | Latest SAM



IOD, SAM and Relative Niño index graphs

R-Niño3.4 | R-Niño3 | R-Niño4 | IOD | SAM | Latest SAM



www.bom.gov.au/climate
Commonwealth of Australia 2026, Australian Bureau of Meteorology

Model: ACCESS-S2
Model run: 6 Nov 2026
Base period 1981-2018

Why caution is essential

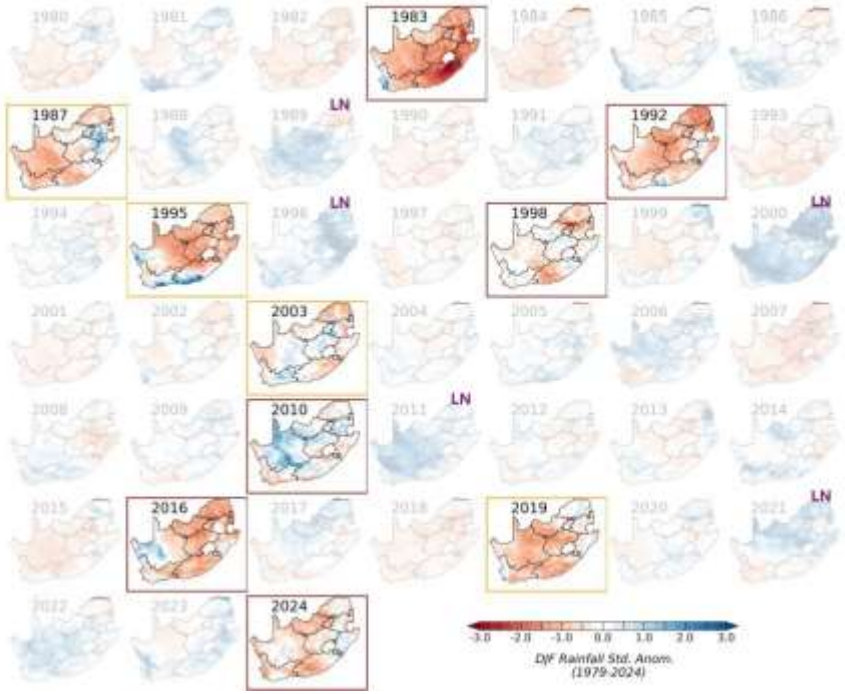
NO TWO EL NIÑO EVENTS PRODUCE IDENTICAL REGIONAL OUTCOMES

Summer rainfall anomalies since 1979/80

In most cases (not all!), **dry** years occur during EN and **wet** years during LN

The rainfall anomaly is not proportional to the intensity of ENSO

Red = less rain | **Blue** = more rain



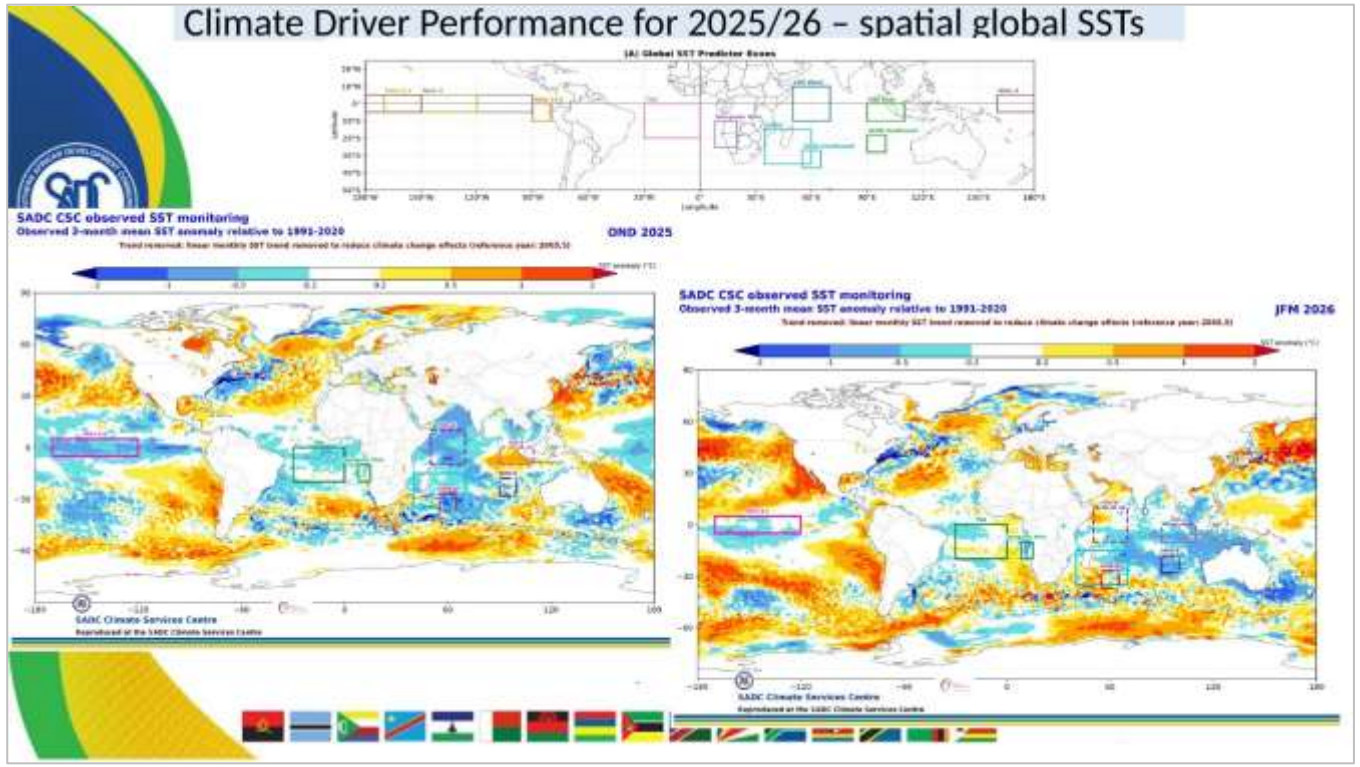
1. Most, but not all, dry summer rainfall years occur during El Niño.
2. Rainfall anomaly is not proportional to ENSO intensity.
3. Differences arise from ENSO “flavours”, other climate modes, regional circulation and background warming.
4. Intra-seasonal timing, dry spells and heat can matter as much as seasonal totals.

Source: ENSO Reference Group Summit, pp. 30, 34 and 38

ENSO Reference Group https://www.access.ac.za/

Regional Outlook SARCOF 33

2025/26 PERFORMANCE REVIEW AS THE REGIONAL BASELINE



1. The review examined Pacific, Indian and Atlantic Ocean drivers, plus atmospheric indicators.

2. This multi-basin framing is important because ENSO is only one source of seasonal predictability.

3. The 2025/26 review provides antecedent-condition context for interpreting 2026/27 risks.

Source: SADC Climate Services Centre, SARCOF 33, slides 3–8

SUMMARY

- **OND 2026 rainfall:** Below-normal over most of SADC. Normal to above-normal over most of the DRC, NW Angola, N Zambia, central Malawi and N Mozambique; above-normal over eastern DRC, most of Tanzania and Seychelles.
- **JFM 2027, centre and south:** Below-normal rainfall over most of the region, particularly Angola, Namibia, Botswana, Zimbabwe, Zambia and parts of South Africa.
- **JFM 2027, north:** Normal to above-normal over the DRC, N Zambia, N Malawi, N Mozambique, parts of Tanzania and Seychelles; above-normal favoured over eastern Tanzania and the Comoros.
- **Madagascar and islands:** Normal to below-normal in the north and west of Madagascar and normal to above-normal in the southeast; Mauritius normal to above-normal.
- **Temperature, Oct 2026 to Jan 2027:** Above-normal over most of SADC, except below-normal in central to northeastern parts.



JANUARY-FEBRUARY-MARCH 2027

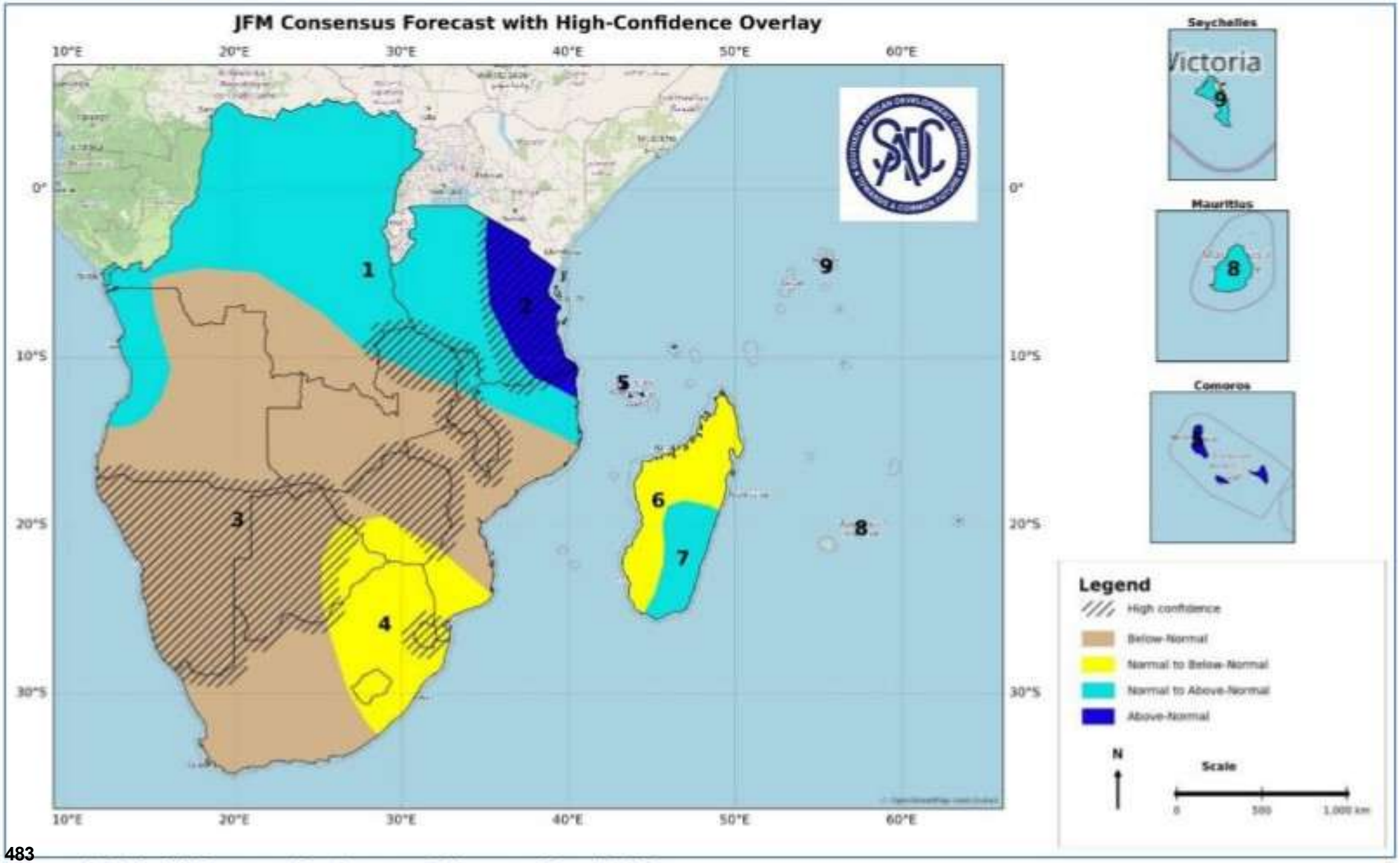
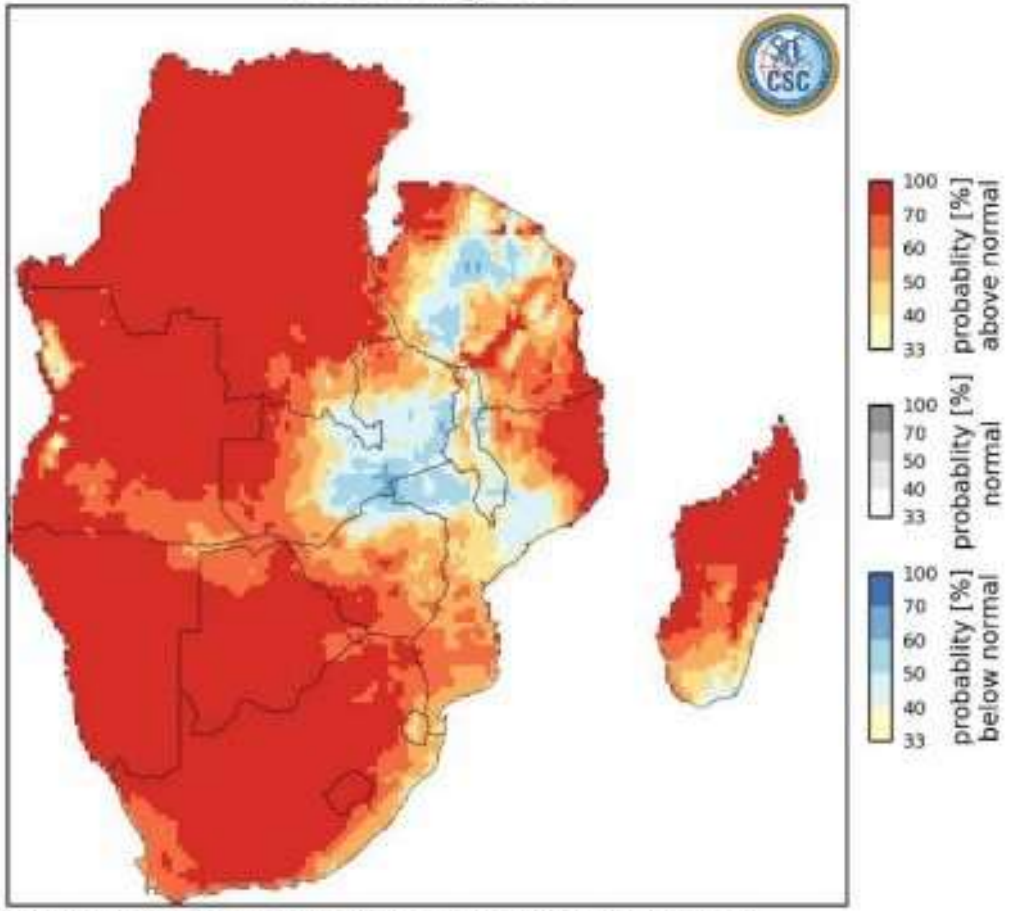


Figure 4: Rainfall forecast for January-February-March 2027

OCTOBER-NOVEMBER-DECEMBER 2026

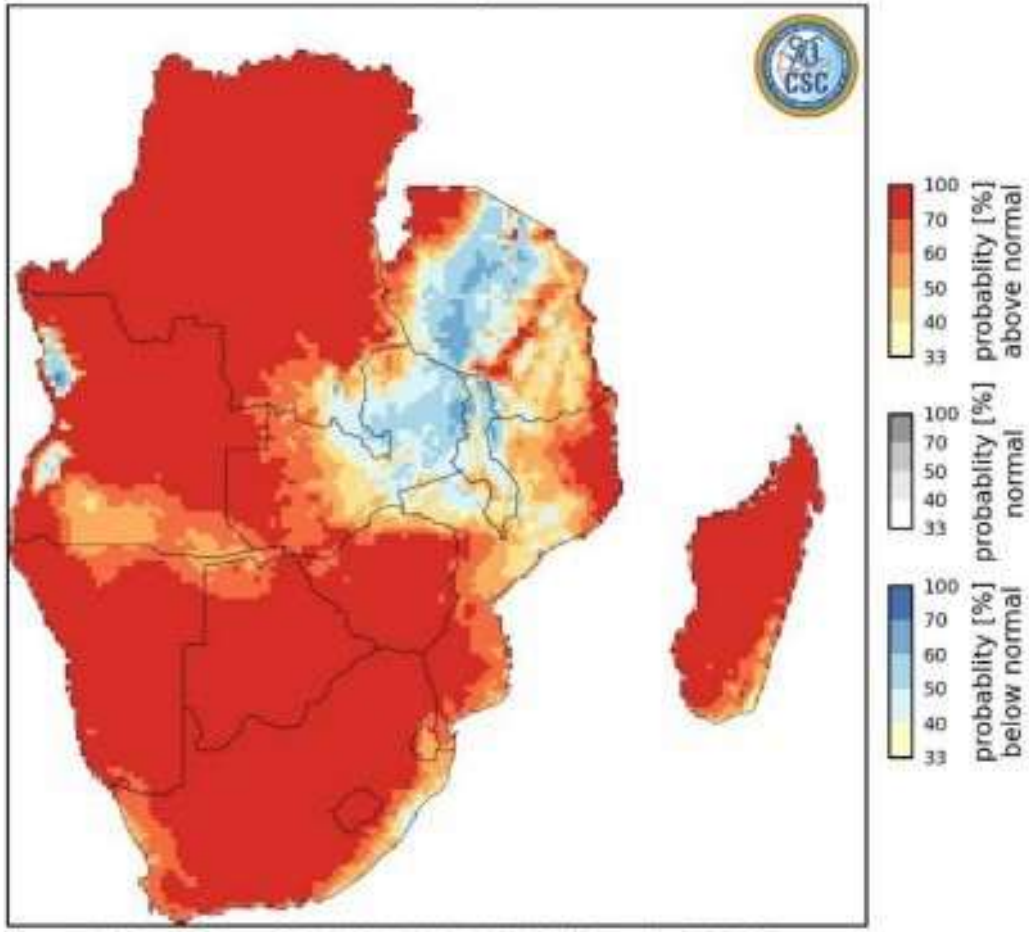
Probabilistic (tercile) forecast
of mean temperature for OND 2026
issued in Aug 2026



Source: Multi-model ensemble (SEAS51, CFSv2, CCSM4) calibrated at SADC CSC

NOVEMBER-DECEMBER 2026-JANUARY 2027

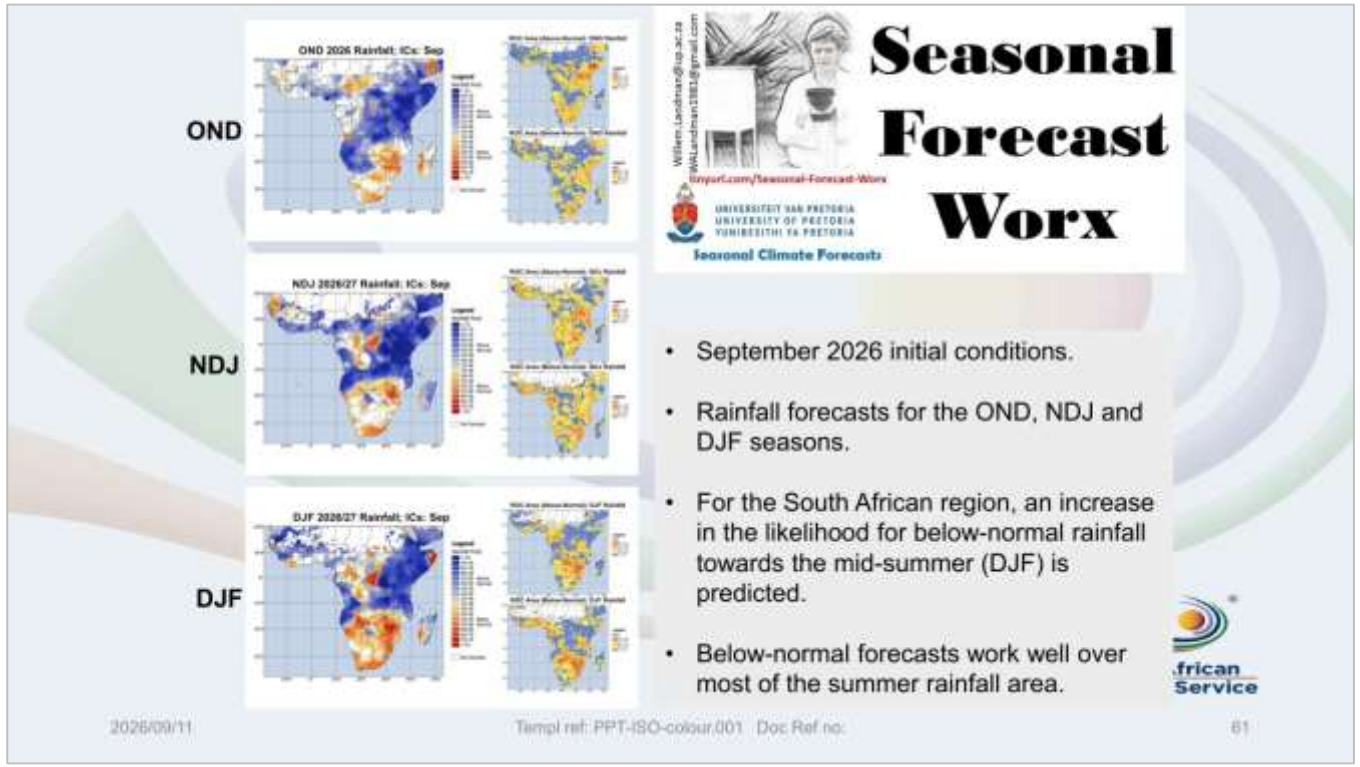
Probabilistic (tercile) forecast
of mean temperature for NDJ 2026
issued in Aug 2026



Source: Multi-model ensemble (SEAS51, CFSv2, CCSM4) calibrated at SADC CSC

Forecast evolution through the season

OND → NDJ → DJF



1. The risk signal strengthens toward mid-summer.

2. Spring rainfall can still be shaped by episodic systems such as cut-off lows.

3. Overlapping three-month outlooks should be updated monthly rather than treated as a single fixed forecast.

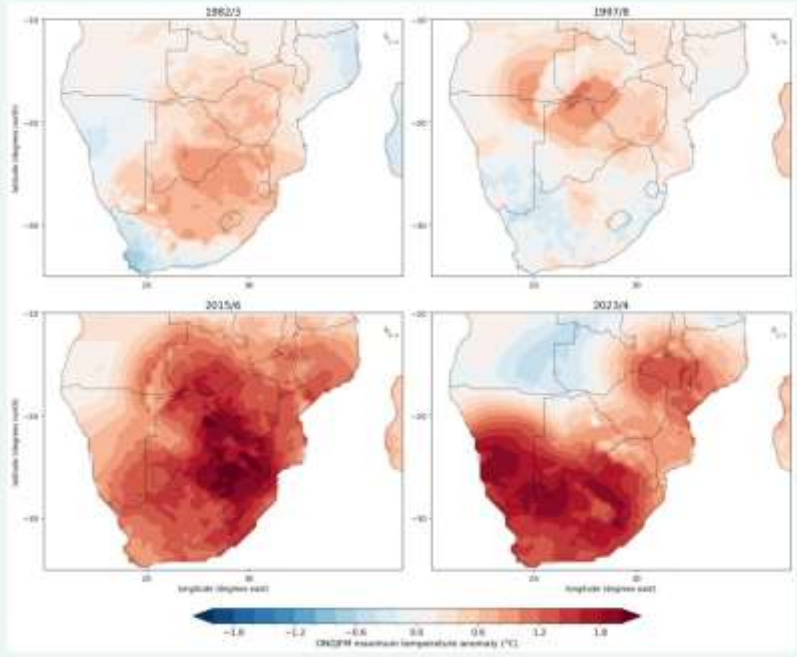
Source: ENSO Reference Group Summit, pp. 61–64

Temperature and heat outlook

A HIGH-CONFIDENCE OPERATIONAL CONCERN

1.5 degree warming threshold passed and next year likely to be 1.7 degree above pre-industrial levels!

El Niño summers in southern Africa have been getting warmer



- 2027 is likely to be the warmest year ever recorded, with the level of global warming reaching 1.7 ° C.
- Southern Africa is likely to experience below-normal rainfall and the drought may be severe.
- If the El Niño of 2026/27 is to bring below-normal rainfall to southern Africa, the summer is likely to be the warmest on record with unprecedented heat waves.
- Climate change fuelled heat-stress is a major risk this summer: in terms of human health, crops and water losses via enhanced evaporation.

Figure: Observed maximum temperature anomalies (°C) during the summer half-year in southern Africa for different El Niño events.

1. Very high probabilities of above-normal temperatures were indicated for all three-month periods in the forecast window.
2. Heat can amplify evaporation, crop stress, livestock stress, health impacts and fire weather.
3. Plan for compound hot-and-dry conditions even where rainfall outcomes remain uncertain.

Source: ENSO Reference Group Summit, pp. 54, 59 and 64

Water-security implications

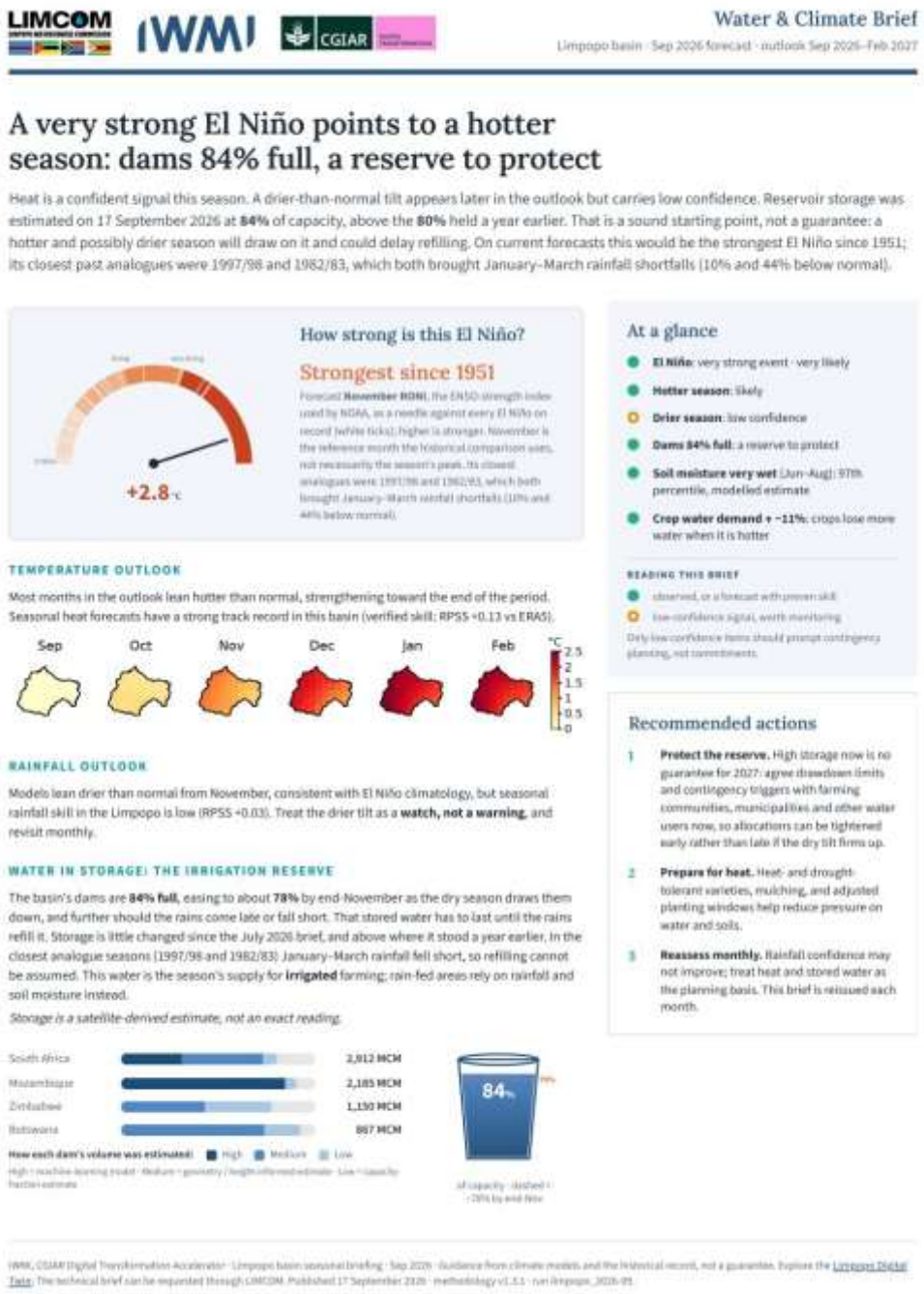
FROM CLIMATE SIGNAL TO BASIN OPERATIONS

1. Track dam and reservoir storage, river flows, groundwater trends and municipal demand together.

2. Elevated temperatures can increase open-water and soil-moisture losses.

3. Below-normal mid-summer rainfall would raise risks to recharge, environmental flows, irrigation reliability and hydropower operations.

4. Use basin-specific thresholds and operating rules rather than a region-wide ENSO assumption.


LIMCOM IWMI CGIAR

Water & Climate Brief

Limpopo basin · Sep 2026 forecast · outlook Sep 2026–Feb 2027

A very strong El Niño points to a hotter season: dams 84% full, a reserve to protect

Heat is a confident signal this season. A drier-than-normal tilt appears later in the outlook but carries low confidence. Reservoir storage was estimated on 17 September 2026 at **84%** of capacity, above the **80%** held a year earlier. That is a sound starting point, not a guarantee: a hotter and possibly drier season will draw on it and could delay refilling. On current forecasts this would be the strongest El Niño since 1951; its closest past analogues were 1997/98 and 1982/83, which both brought January–March rainfall shortfalls (10% and 44% below normal).

How strong is this El Niño?

+2.8 °C

Strongest since 1951

Forecast **November** ONI, the ENSO strength index used by NOAA, on a needle against every El Niño on record (white ticks); higher is stronger. November is the reference month the historical comparison uses, not necessarily the season's peak. Its closest analogues were 1997/98 and 1982/83, which both brought January–March rainfall shortfalls (10% and 44% below normal).

At a glance

- **El Niño**: very strong event · very likely
- **Hotter season**: likely
- **Drier season**: low confidence
- **Dams 84% full**: a reserve to protect
- **Soil moisture very wet** (Jun–Aug): 97th percentile, modelled estimate
- **Crop water demand + ~11%**: crops lose more water when it is hotter

READING THIS BRIEF

- observed, or a forecast with proven skill
- low-confidence signal, worth monitoring

Only low-confidence items should prompt contingency planning, not commitments.

TEMPERATURE OUTLOOK

Most months in the outlook lean hotter than normal, strengthening toward the end of the period. Seasonal heat forecasts have a strong track record in this basin (verified skill: RPSS +0.13 vs ERA5).

Sep Oct Nov Dec Jan Feb °C 2.5 2 1.5 1 0.5 0

RAINFALL OUTLOOK

Models lean drier than normal from November, consistent with El Niño climatology, but seasonal rainfall skill in the Limpopo is low (RPSS +0.03). Treat the drier tilt as a **watch, not a warning**, and revisit monthly.

WATER IN STORAGE: THE IRRIGATION RESERVE

The basin's dams are **84% full**, easing to about **78%** by end-November as the dry season draws them down, and further should the rains come late or fall short. That stored water has to last until the rains refill it. Storage is little changed since the July 2026 brief, and above where it stood a year earlier. In the closest analogue seasons (1997/98 and 1982/83) January–March rainfall fell short, so refilling cannot be assumed. This water is the season's supply for **irrigated** farming; rain-fed areas rely on rainfall and soil moisture instead.

Storage is a satellite-derived estimate, not an exact reading.

South Africa 2,012 MCM

Mozambique 2,185 MCM

Zimbabwe 1,150 MCM

Botswana 867 MCM

How each dam's volume was estimated: High Medium Low

84%

of capacity · dashed = 78% by end-Nov

Recommended actions

1. **Protect the reserve.** High storage now is no guarantee for 2027: agree drawdown limits and contingency triggers with farming communities, municipalities and other water users now, so allocations can be tightened early rather than late if the dry tilt firms up.
2. **Prepare for heat.** Heat- and drought-tolerant varieties, mulching, and adjusted planting windows help reduce pressure on water and soils.
3. **Reassess monthly.** Rainfall confidence may not improve; treat heat and stored water as the planning basis. This brief is reissued each month.

IWMI, CGIAR Digital Transformation Accelerator · Limpopo basin seasonal briefing · Sep 2026 · Guidance from climate models and the historical record, not a guarantee. Explore the Limpopo Digital Twin. The technical brief can be requested through LIMCOM. Published 17 September 2026 · methodology v1.0.1 · run limpopo_2026-09.

Source: Synthesis from ENSO Reference Group risk themes and SARCOF review categories

Agriculture and food security

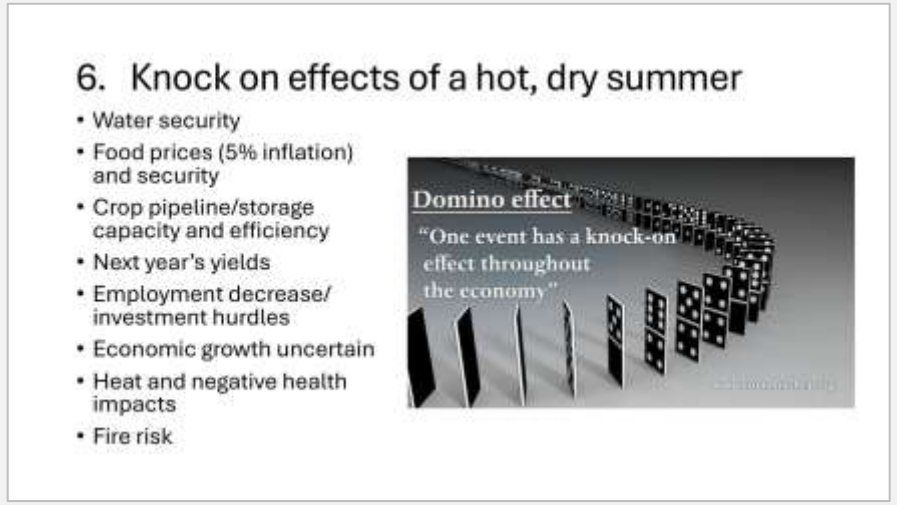
EXPOSURE DIFFERS BY CROP, LOCATION AND PRODUCTION SYSTEM

1. El Niño is associated with lower grazing and lower summer-grain yields, but impacts vary substantially between events.

2. The Reference Group noted favourable antecedent conditions relative to 2015/16, including high residual soil moisture and strong 2025/26 production.

3. Hot, dry conditions can affect planting decisions, input investment, yields, storage, feed and market prices.

4. Risk reduction options include conservation agriculture, cultivar and crop selection, water conservation, insurance and hedging.



Source: ENSO Reference Group Summit, pp. 30, 69 and 74–75

Connected impact pathways

PLAN FOR COMPOUNDING AND CASCADING RISKS



Livestock

Grazing pressure, heat stress, milk production and herd-management decisions.



Fire & ecosystems

Dry vegetation, high temperatures and wind can elevate veld-fire and degradation risks.



Health

Heat exposure, water quality and service interruptions can affect vulnerable communities.



Livelihoods

Production losses and higher food costs can interact with employment and household resilience.

Source: ENSO Reference Group Summit, pp. 65, 73–74

Economic considerations

RISK IS SHAPED BY STARTING CONDITIONS AND RESPONSE CHOICES

1. The summit material described a strong 2026 maize harvest and a production surplus as buffers at the start of the season.
2. Potential pressures include higher input costs, reduced investment, employment effects, food-price pressure and fire losses.
3. Commercial and small-scale producers have different access to finance, storage, inputs and risk-transfer instruments.
4. Avoid a single headline narrative: separate climate hazard, exposure, vulnerability and market response.

Decision lens

Protect the gains from 2025/26 while preparing for a hotter and potentially drier mid-summer.

Source: ENSO Reference Group Summit, pp. 69–75

ECOLOGICAL IMPACTS · KRUGER NATIONAL PARK, 2015/16 DROUGHT

A grazer drought: selective losses, then eruptions

~ 375 → 15

hippo in Nwanetsi streams, before and after the drought (dams excluded)

40% → 5% → 80%

rodent trapping success: before, during, and in the two winters after

8.6 → 37.4

fence and gate breakages per month in Skukuza staff village, as animals sought forage

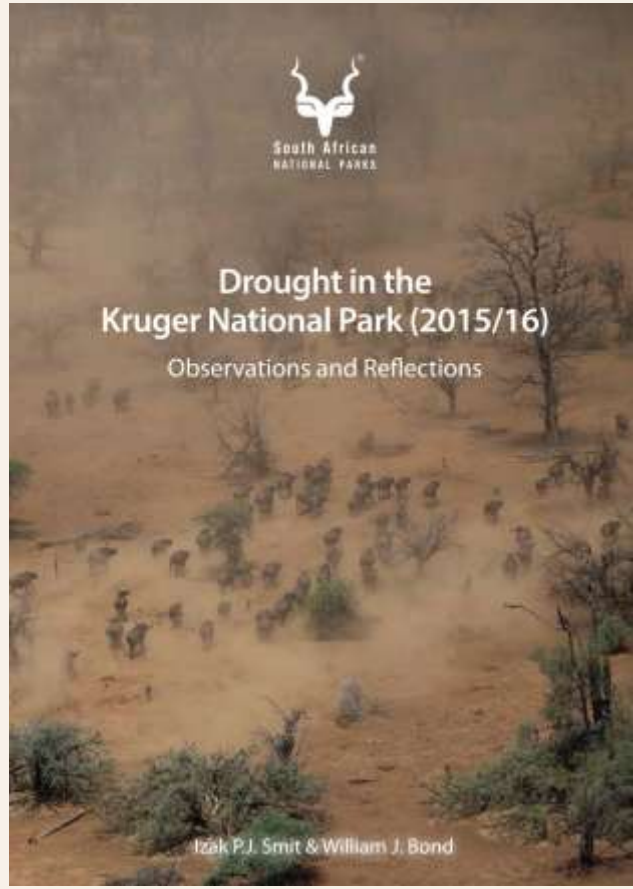
Selective mortality

- Hippo and buffalo died in large numbers
- Impala, kudu and warthog largely spared
- Sickle bush and tamboti die-offs

Boom and bust

- Insects and reptiles crashed, slow to recover
- Rodent and quelea eruptions after the rains
- Forbs and annuals replaced grass tussocks

Source: Smit & Bond (2020), SANParks Scientific Report 01/2020; AJRFS 37(1)



RESILIENCE · WHAT BUFFERED THE SYSTEM

Water, rainfall timing and past lessons built resilience

Groundwater

Springs and river pools held water. Deaths came from lack of food, not thirst.

Rainfall timing

March 2016 rain (106% of the long-term average) paused mortality in parts of the central park.

Fewer waterholes

About two thirds of borehole waterholes were closed after 1991/92, leaving reserve forage in water-remote areas.

River management

Upstream dam releases and irrigation cuts of up to 80% gave better flows than in 1991/92.

Refugia matter: in the better-watered far north, buffalo herds stayed intact and a few calves were born.

Source: Smit & Bond (2020), SANParks Scientific Report 01/2020; AJRFS 37(1)

Risks imposed by the Extreme drought 2015-16

Keeping the primary tributary of the Limpopo Flowing through stakeholder driven Eflows



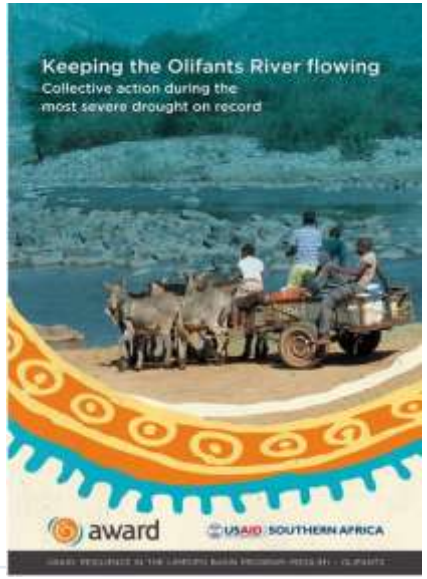


The Crisis

- Flows in the Olifants river drop to below 1 cumec mid-summer (peak rainfall season)
- Agric, industry and mining jobs at risk
- Multiplee sectors (Water utilities, conservation, agriculture and NGO) work together on interim operating rules to avoid repeat of 2005 river management failures

Key Finding — A Shared, Transboundary Crisis

- Adaptive coordinated action and decision support tools provided for effective river management, safeguarding agric jobs, biodiversity conservation and maintained cross border flows



Priority Recommendations

- Local actors can innovate and provide solutions for readiness and adaptation
- These solutions reduce developmental and environmental risk when well informed
- Maintain integrated systems for adaptive allocation and mitigation readiness

IMPLICATIONS · WILDLIFE ECONOMY AND TRANSFRONTIER AREAS

Drought risk reaches tourism, neighbours and borders

Observed in and around Kruger

- **Tourism:** the post-drought rodent eruption brought complaints, unit moves and refund demands
- **Neighbours:** cattle deaths, irrigation cuts and seasonal job losses
- **Borders:** Zimbabwean cattle grazed Pafuri in 2018/19, and snaring rose

What it suggests

- **Scale:** drought is patchy, so large linked areas and refugia buffer it, supporting transfrontier conservation
- **Foresight:** El Niño forecasts gave advance warning; droughts may become more frequent and intense
- **Lags:** tree deaths, falling groundwater and a buffalo calf gap persisted for years

Source: Smit & Bond (2020), SANParks Scientific Report 01/2020; AJRFS 37(1). Economic effects are qualitative.

Summary

- **Still strong signs this could be one of the strongest El Nino impacts on the region**
- **However, still a reasonable hydrological buffer in most systems (storages and soil moisture)**
- **Experience has shown that adaptive coordination can have positive impacts**
- **January SARCOF outlook will be critical to see duration and possibility that this may become a multiyear impact**

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Summary

- **GLTFCA example from 2015/16 - Effects differed in duration and scale: some were transient (post-drought eruptions), others long cycles (Dichrostachys cinerea and hippo mortality); some were highly localised, others shifted species distributions.**
- **Responses were species-specific and patchy, shaped by herbivory, fire history and geology; animals adapted by foraging longer, moving to refugia, fragmenting herds and travelling further to water.**
- **The first wet season was highly dynamic: eruptions across many taxa normalised within ~2 years, while invertebrates and their food web were hit hard and reptiles (chameleons, snakes) recover slowly.**
- **Management benefits: die-off of bush-encroaching Dichrostachys cinerea, palatable Urochloa replacing unpalatable Bothriochloa grass, and gains for blue wildebeest and black-backed jackal.**
- **Savanna systems showed resilience – coping, recovering and reorganising – and some species may be "drought specialists" exploiting during/post-drought conditions.**
- **Memory fades fast: document observations and archive photos in future droughts to preserve learning as the experienced generation of managers and scientists retires.**

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THANK YOU
Questions and discussion

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INTEGRATING DISASTER RISK REDUCTION INTO TRANSBOUNDARY INTEGRATED DEVELOPMENT PLANNING

… the ZIMOZA TFCA experience …

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH



SADC TFCA Network Meeting | Skukuza, South Africa | 12 November 2026

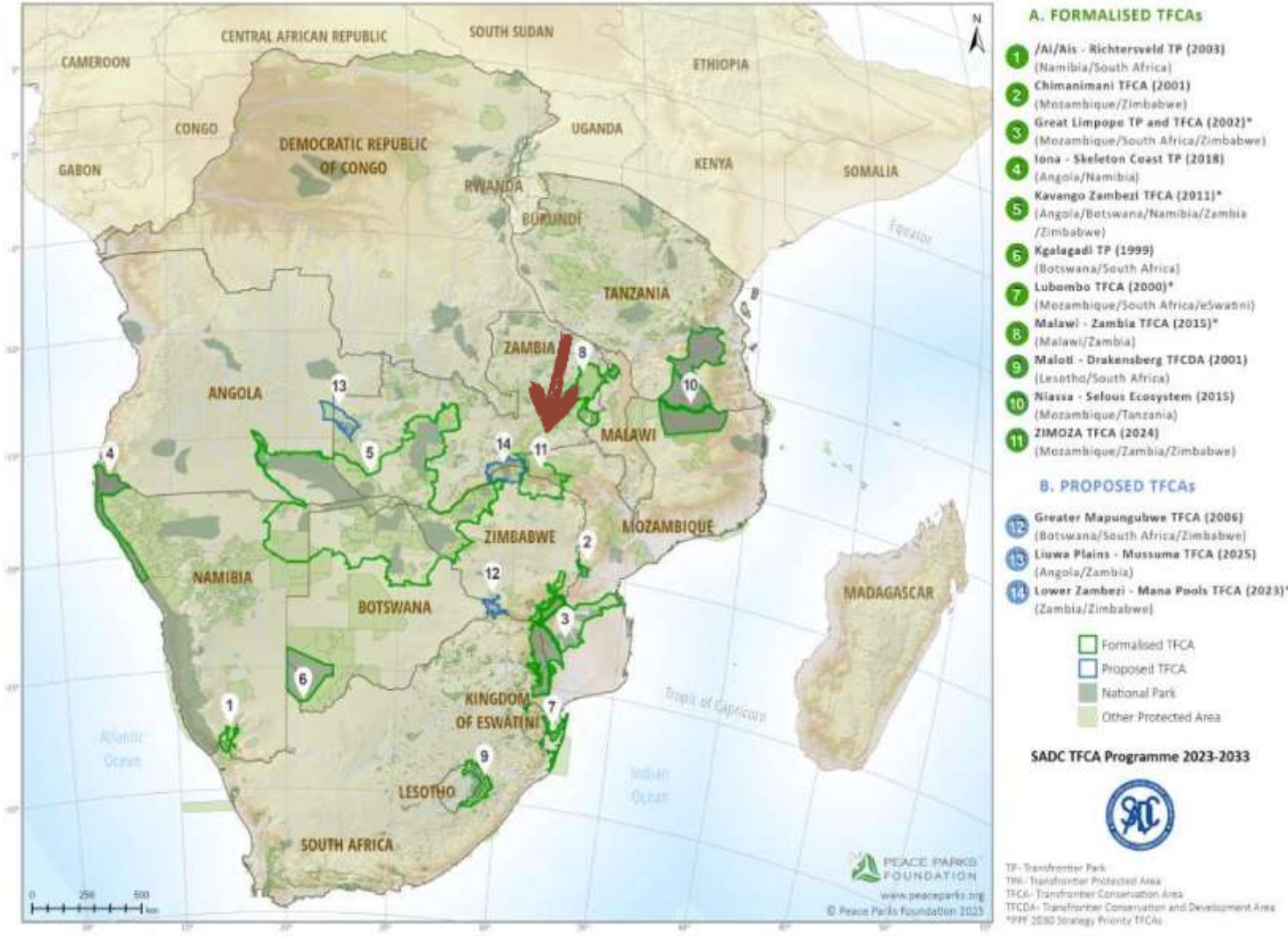
ABOUT THE ZIMOZA TFCA

39,165 km²

Three Partner States [Zimbabwe, Mozambique, Zambia] shared ecosystems, river systems and wildlife movement

Three connectivity zones are particularly significant:

1. **Rufunsa-Luangwa-Lower Zambezi Movement Zone:** Connects the Luangwa Valley and Lower Zambezi ecosystems, facilitating wildlife movement across protected and communal landscapes
2. **Mbire-Mágoè Connectivity Zone:** Links wildlife habitats across northern Zimbabwe and western Mozambique, including communal lands, safari areas and Mágoè National Park, supporting wide ranging species such as elephants and large carnivores
3. **Zambezi-Cahora Bassa Riparian Corridor:** Forms the principal aquatic and riparian axis of the TFCA, sustaining fisheries, riverine habitats, wildlife movement and hydrological processes essential to ecosystems and communities



THE LANDSCAPE INCLUDED IN THE MOA



Size of Zimbabwean Component: 19,358 km²

~49% of the TFCA

Districts Included:

- Mbire (~7,092 km²)
- Muzarabani (~5,226 km²)
- Mount Darwin (~3,535 km²)
- Guruve (~2,865 km²)
- Makonde (wards 1, 2 and 11: ~640 km²)



Size of the Mozambican Component: 17,507 km²

~44% of the TFCA

Districts Included:

- Mágoè National Park (~3,500 km²)
- Mágoè outside the park (~3,800 km²)
- Tchuma Tchato Community Managed Area (~4,200 km²)
- TFCA-designated portions of Zumbo (~3,200 km²)



Size of the Zambian Component: 2,304 km²

~7% of the TFCA

Districts / Areas Included:

- Luangwa Valley
- Rufunsa Game Management Area

RISK INFORMED PLANNING

Risk informed planning provides the **foundation** for determining the Integrated Development Plan's (IDP's) strategic focus areas, in setting priorities and directing investment to address identified risks



Disaster risk is therefore a strategic concern that directly influences the sustainability of the landscape. It shapes conservation outcomes, livelihoods of the communities inside and around the TFCA, as well as infrastructure resilience, making coordinated action across borders essential

Why the ZIMOZA context warranted a transboundary Disaster Risk Reduction (DRR) lens in the IDP

Shared river systems

Upstream-downstream dependencies, seasonal floodplain dynamics and water security pressures

Remote border communities

Dispersed settlements, limited accessibility and uneven access to timely risk information

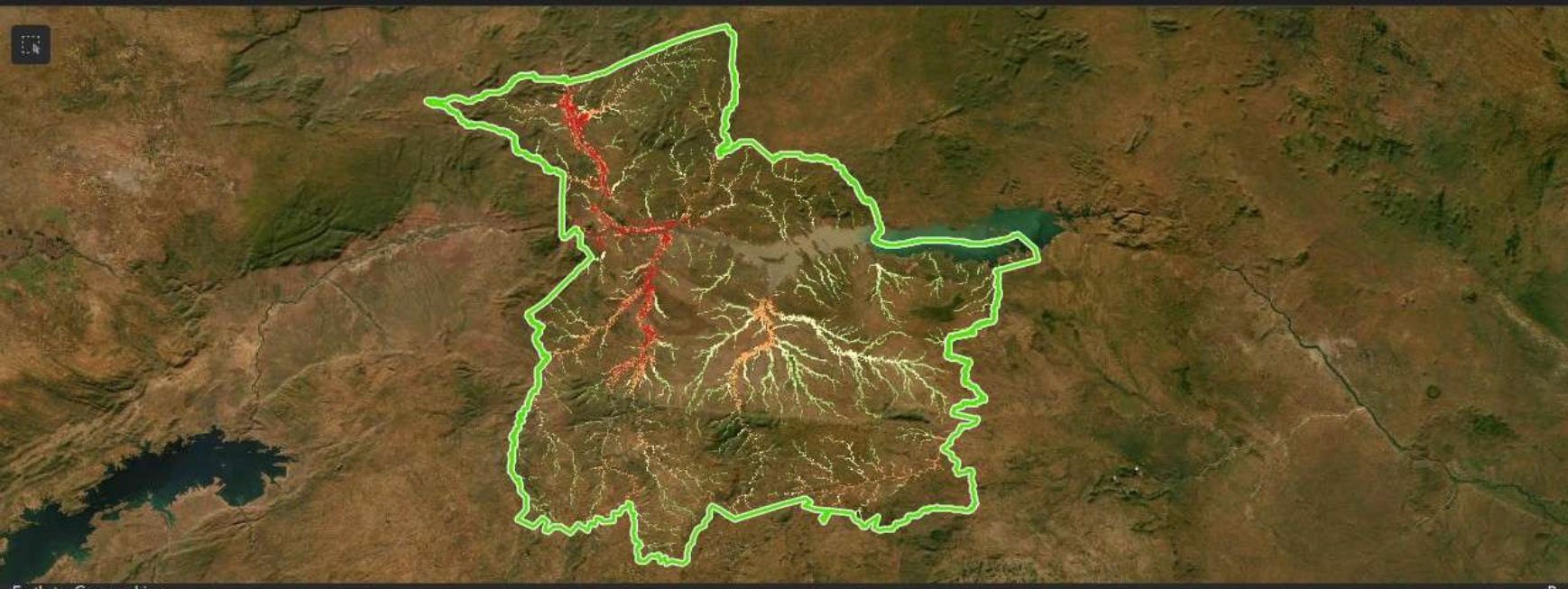
Linked ecosystems and livelihoods

Wildlife movements, fisheries, agriculture and natural resource dependence connect risks across borders

Focus on risks that cannot be adequately managed by one country alone

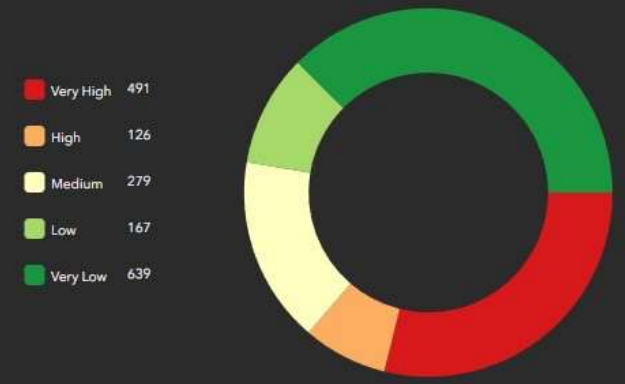
COPERNICUS | A VALUABLE MULTI HAZARD MAPPING KNOWLEDGE PRODUCT

Multi hazard mapping in ZIMOZA Transfrontier Conservation Area in Zimbabwe, Mozambique, Zambia



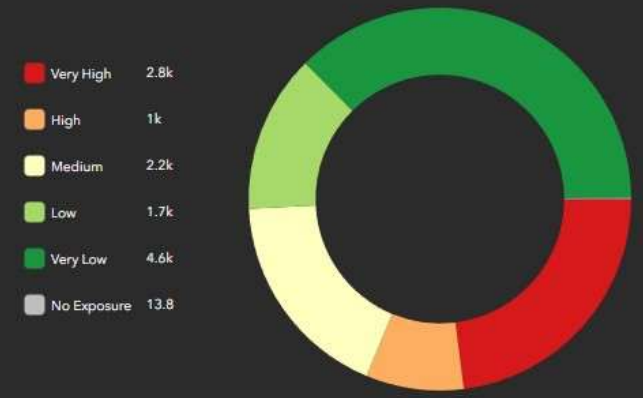
Map | The case | Dashboard Tips

Exposure of Critical Buildings to Soil Erosion hazard (Counts per ...

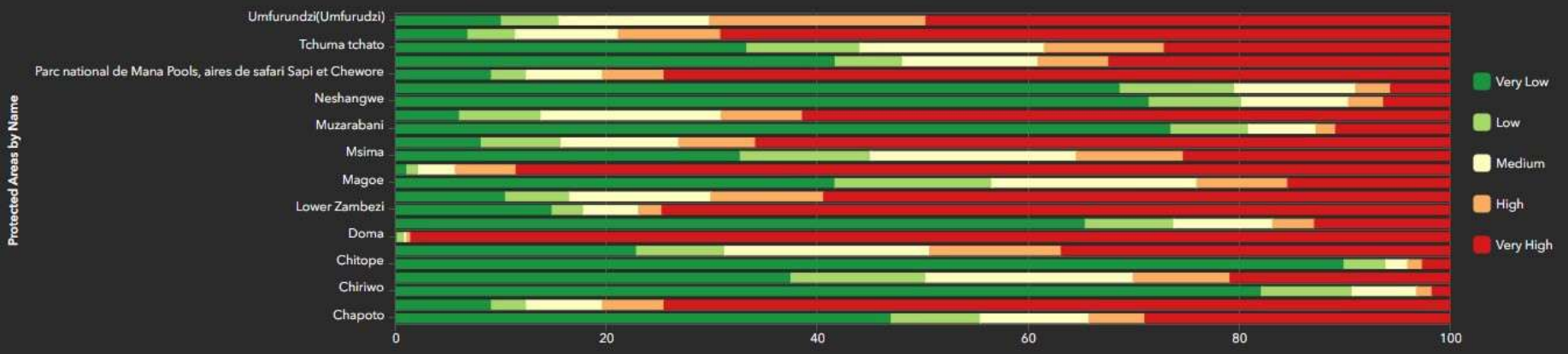


Flood | Fire | Drought | Soil Erosion

Exposure of Road Network to Soil Erosion hazard (Total length in ...



Exposure of Protected Areas to Soil Erosion Hazard



Flood | Fire | Drought | Soil Erosion

Flood | Fire | Drought | Soil Erosion

PROCESS FOLLOWED TO DEVELOP THE IDP

Situational Analysis Report

2.4.4 Climate-Related Threats

Climate variability is intensifying across the Zimbabwean districts of the ZIMOZA TFCA, with recurrent droughts, seasonal floods, and escalating fire hazards undermining ecological resilience and community livelihoods. The Copernicus EMSN227 (2026) multi-hazard assessment maps provide spatially explicit evidence of these dynamics, overlaying hazard exposure with biodiversity corridors, settlements, and agricultural mosaics. These maps highlight:

- Drought frequency and severity, particularly in Mt Darwin, Muzarabani, and Mbire, where prolonged dry spells erode pasture quality and water availability.
- Flood hazard zones along the Zambezi and Musengezi rivers, where inundation overlaps with settlement clusters and wildlife dispersal routes, intensifying human–wildlife conflict and agricultural losses.
- Fire hazard hotspots in Guruve and Makonde, where uncontrolled bushfires degrade miombo woodlands, fragment habitats, and reduce carbon sequestration potential.

Specific Climate-Related Threats

- Droughts: ENSO-driven rainfall variability exacerbates water scarcity, reducing forage availability and stressing both wildlife and livestock. Mbire and Muzarabani floodplains are most exposed, with fisheries and dry-season grazing collapsing during prolonged droughts as in **Figure 3**.

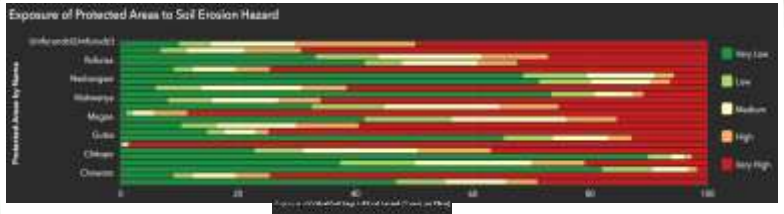


Figure 3: Drought Hazard Index for ZIMOZA TFCA[4]

[4] Drought hazard index classified in 5 classes (1 being very low, and 5 very high (Copernicus 2026)

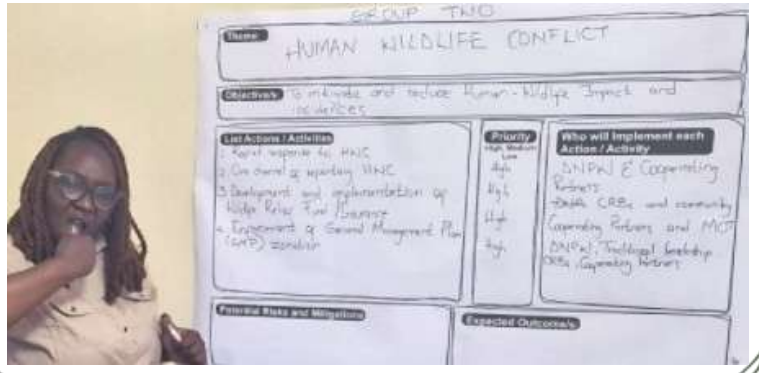
PROGRAMME OF THE EUROPEAN UNION

Copernicus





Stakeholder Engagement in Landscape



IDP Framework

STRATEGICALLY IF ZIMOZA:

1. GOVERNS TOGETHER
2. EMPOWERS COMMUNITIES
3. ENABLES COEXISTENCE
4. SAFEGUARDS THE NATURAL ASSET BASE
5. BUILDS RESILIENT LOCAL ECONOMIES
6. CONNECTS THE LANDSCAPE & UNLOCKS VALUE
7. MANAGES SHARED RISKS TOGETHER

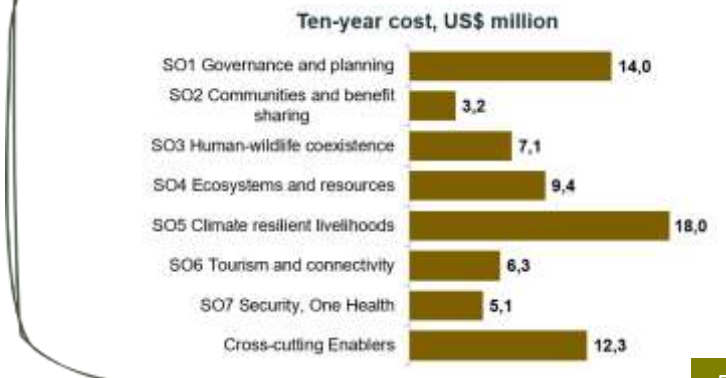
Comprehensive IDP

Description of Activities	Priority	Implementing Agency
Assess priority climate related production, livelihood vulnerabilities and promote locally adapted climate smart agriculture, agroforestry, resilient crops and livestock production systems	High	Agriculture / Livestock / Climate and Environment Authorities / Agricultural Research and Extension Services / Community Institutions
Improve sustainable water harvesting, conservation and productive water use, including appropriately scaled irrigation and multiple use water systems, where technically, environmentally and economically feasible	High	Water / Agriculture Authorities / District and Local Authorities / Community Institutions

Core Risk	Potential Effect
Increasing climate variability and extreme events, including droughts, floods, climate and associated livestock, crop and fisheries production risks	Reduces agricultural productivity, food availability and household incomes and may undermine investments in climate resilient livelihood systems

Performance Area	Suggested KPI
Adoption of climate resilient and sustainable production practices	1. Percentage of targeted producers or households applying agreed climate resilient and environmentally sustainable agriculture, livestock, water, fisheries or other production practices

Costed Action Plan



Multi-Hazard Risk Assessment (MHRA) evidence became actionable through the IDP

01



Map Hazards

Copernicus MHRA: floods, drought, fire, soil erosion

02



Interpret Risk

Overlay exposure with livelihoods, biodiversity, infrastructure and local knowledge

03



Translate

Use stakeholder validation to shape proposed IDP strategic priorities and interventions

04

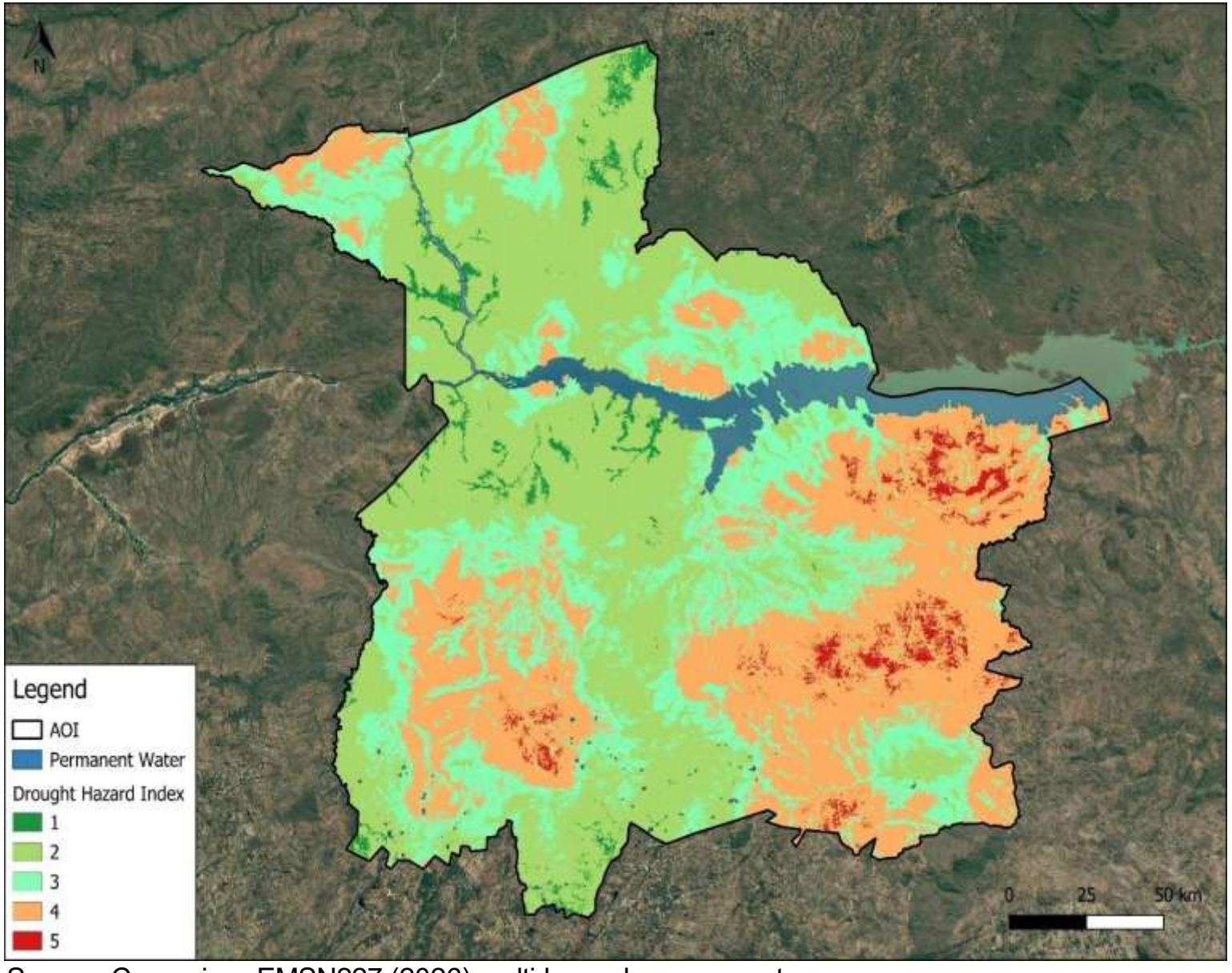


Institutionalise

Integrate risk sensitive indicators, joint reviews and adaptive management

MHRA identifies where underlying hazards are concentrated, while seasonal climate forecasts help determine when preparedness and investment should be accelerated

RISK INFORMED DEVELOPMENT PLANNING : DROUGHT



Hazard Class		Area extension (ha)
1	Very Low	74025.1
2	Low	1440719.5
3	Moderate	974156.2
4	High	1197462.7
5	Very High	67266.5

- This map indicates that over 1.26 million hectares are vulnerable with high or very high drought hazard
- Overlaying these areas with communities, livelihoods and ecosystems helps target the IDP's focus on water security, drought resilient livelihoods and ecosystem protection

Source: Copernicus EMSN227 (2026) multi-hazard assessment maps

Proposed implementation arrangements

1. Activate trigger: Official forecasts signal increased drought risk. Combine MHRA hotspots with local water monitoring to agree when to act

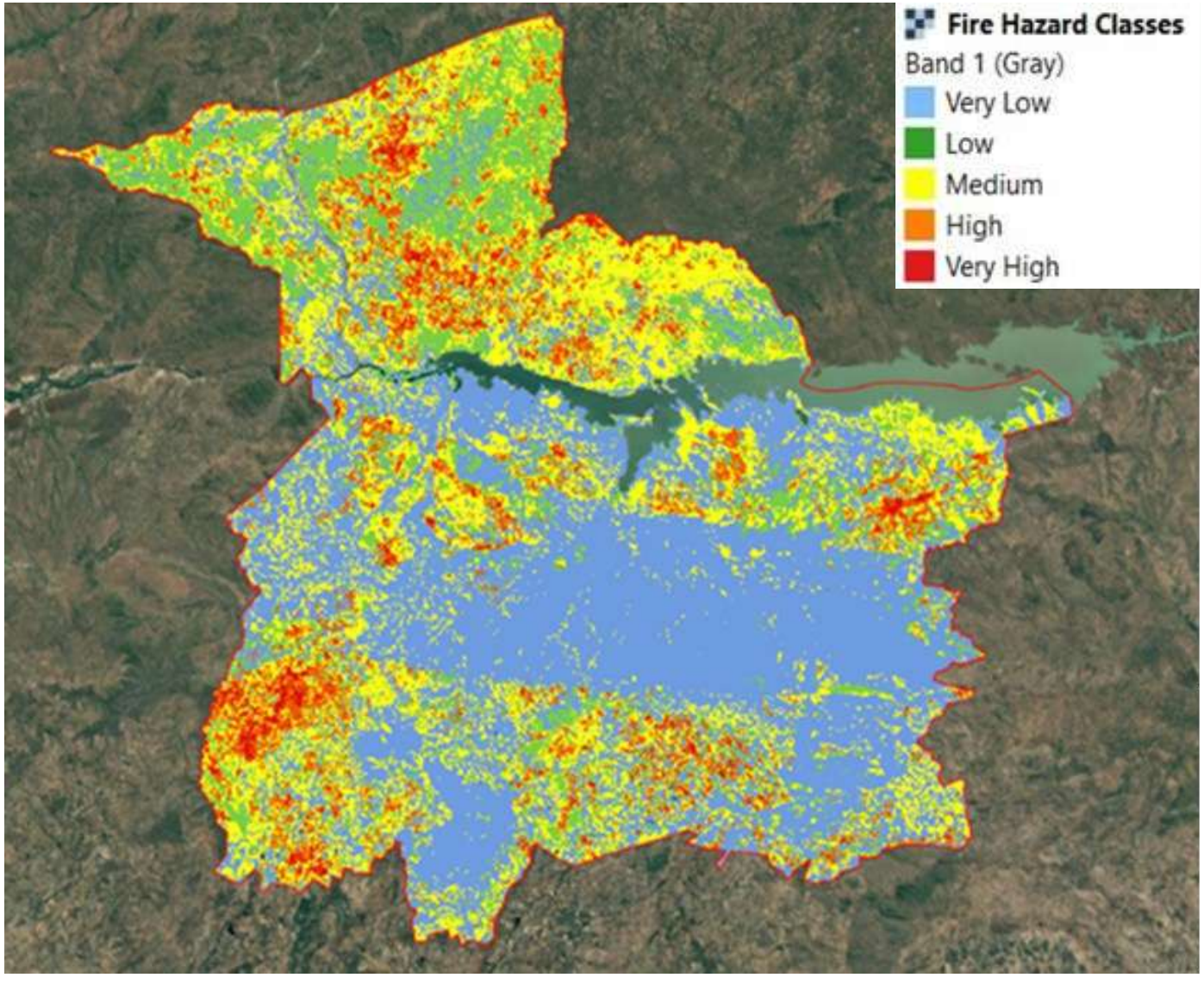
2. Early action: Repair priority water points, provide farmers with guidance on planting while securing water and fodder for livestock, also consider strengthening the preparedness for fires and HWC

3. Responsibilities: Meteorological services provide forecasts. District and sector agencies lead local action. TFCA coordination supports shared priorities and cross-border updates

4. Financing: Partner States agree funding sources and disbursement arrangements

El Niño provides a practical test of the IDP's implementation readiness:
… Partner States should use shared forecasts and mapped vulnerabilities
to activate coordinated, funded actions before impacts escalate …

RISK INFORMED DEVELOPMENT PLANNING : FIRE HAZARDS



Source: Copernicus EMSN227 (2026) multi-hazard assessment maps

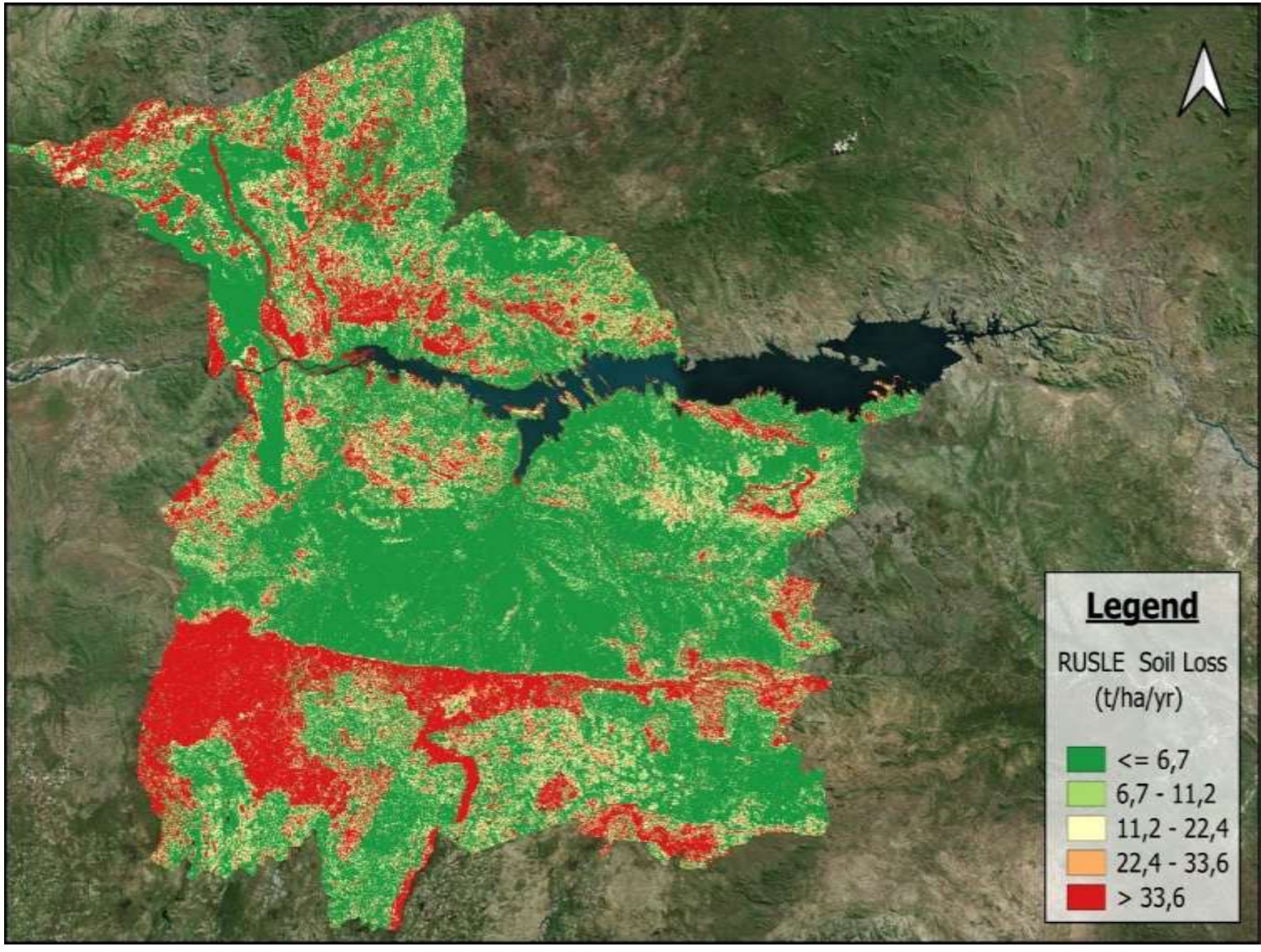
Fire Hazard Category	Percentage of Total Area (%)	Description
Very Low	43.6%	Dominant class in the study area
Low	16.5%	Contributes to the large low-risk portion
Medium	25.7%	Significant moderate fire hazard
High	8.8%	Limited areas with elevated hazard
Very High	1.5%	Very small fraction of the area
Unburnable	4.0%	Includes water bodies and non-burnable surfaces

- Hotter, drier conditions increases fire danger where vegetation and fuel conditions permit
- In the management plan, ensure early fire preparedness, community alerts and coordinated management systems across borders are in place

RISK INFORMED DEVELOPMENT PLANNING : SOIL LOSS

- Soil loss erodes the foundation of livelihoods and landscape resilience
- This assessment identified that about 26% of the landscape is in the high or severe potential soil loss classes
- For the IDP, these hotspots must guide targeted investment in catchment restoration, sustainable farming and erosion control, protecting productive land while reducing sedimentation downstream

Soil Erosion Class	Potential Soil Loss (t/ha/yr)	Area (km^2)	Area (%)
Very Low	<6.7	19628	52.23%
Low	6.7-11.2	3602	9.58%
Moderate	11.2-22.4	4534	12.07%
High	22.4-33.6	2260	6.01%
Severe	>33.6	7558	20.11%

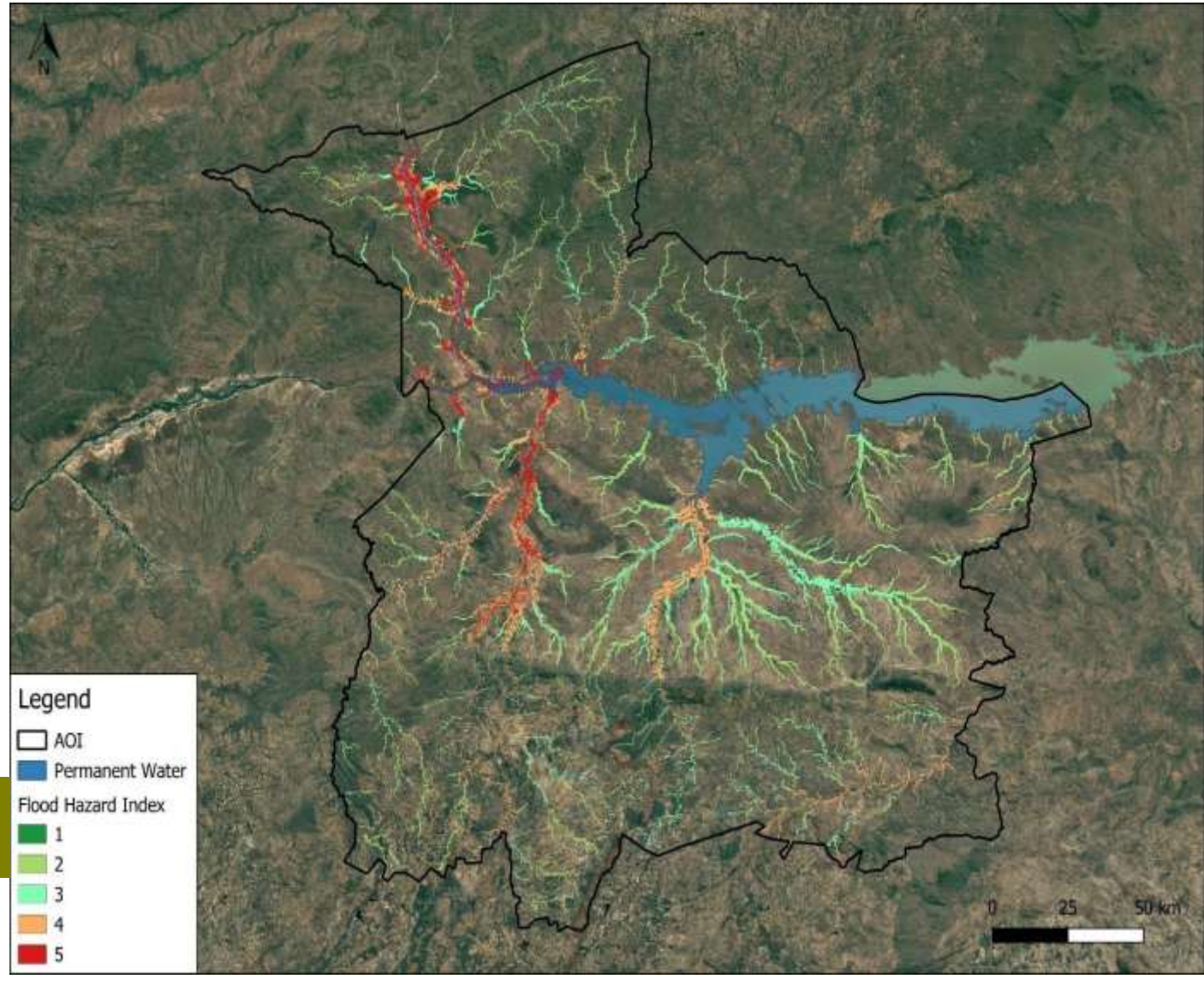


Source: Copernicus EMSN227 (2026) multi-hazard assessment maps

RISK INFORMED DEVELOPMENT PLANNING : FLOODS

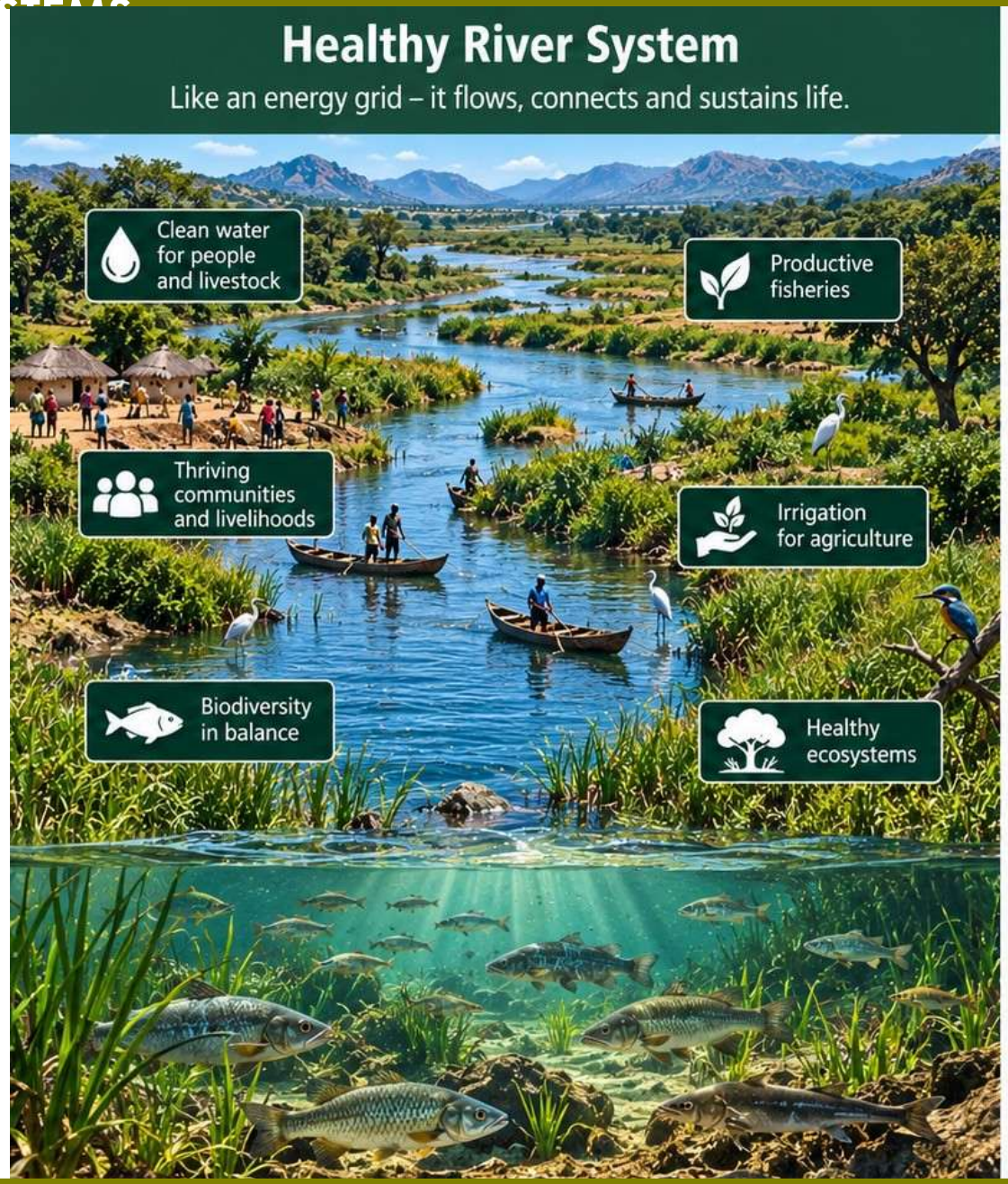
- This map shows where flood hazards concentrate along the river network
- For the IDP, this evidence guided where infrastructure is located to protect livelihoods, key corridors and prioritise early warning and evacuation planning systems
- The strategic imperative is to ensure that today's development investments do not create tomorrow's disaster losses

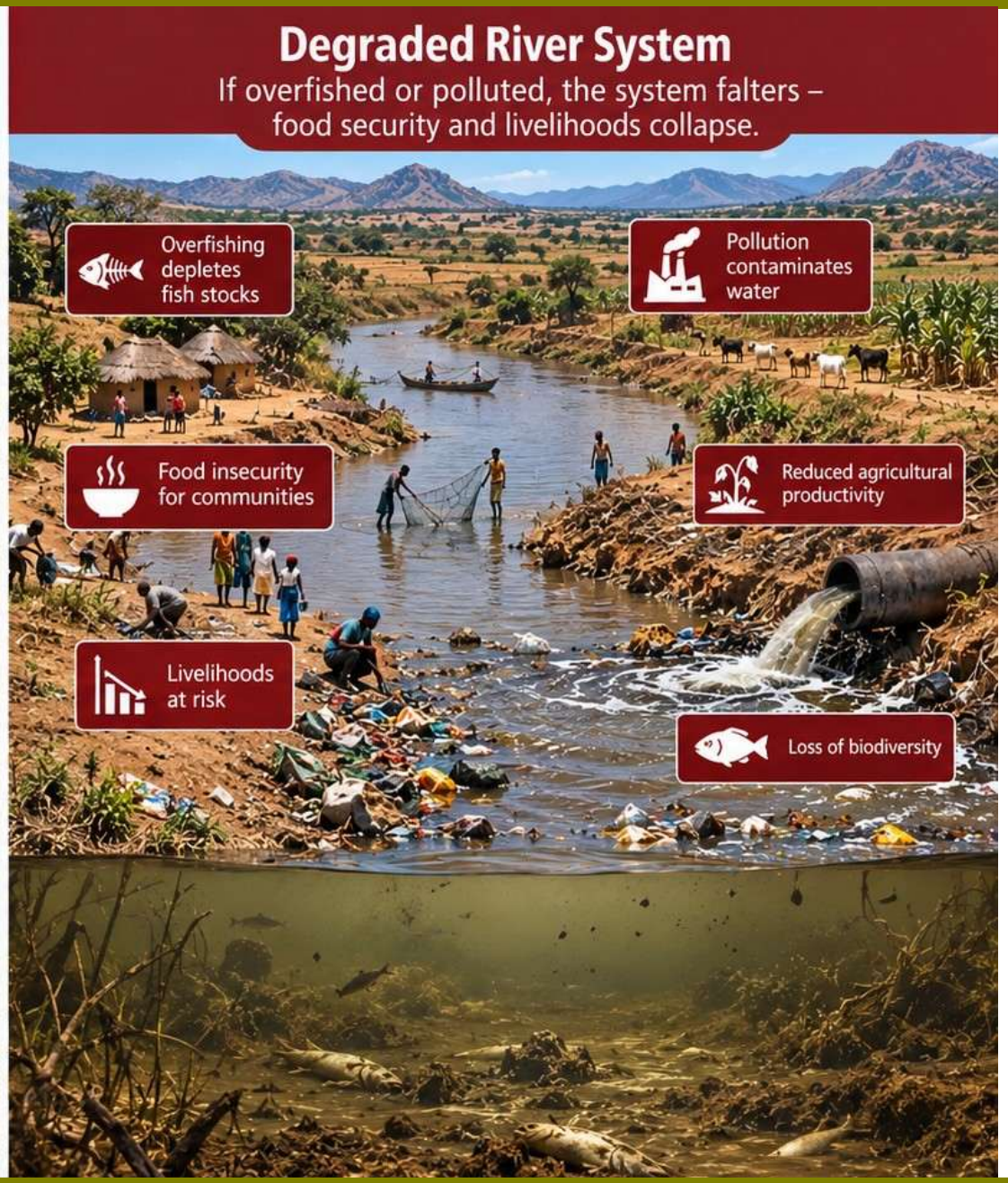
A drier seasonal outlook does not remove the need for flood preparedness



Source: Copernicus EMSN227 (2026) multi-hazard assessment maps

TREAT ECOLOGICAL CONNECTIVITY AS CRITICAL INFRASTRUCTURE … RIVER SYSTEMS





PRACTICAL SOLUTIONS … THE WATER-HUMAN-WILDLIFE RELATIONSHIP

‘Take the water to the people’ captures a practical approach to disaster risk reduction by reducing people’s exposure to danger (HWC), while meeting an essential daily need. Water security and ecological connectivity are linked priorities under drought stress!

Bringing safe, reliable water sources closer to communities can reduce these risks, ease the burden of water collection and strengthen resilience. However, installing a borehole or pump is only the starting point. Its location, water quality, sustainable yield and maintenance determine whether it provides a lasting solution. For the IDP, the implication is clear: prioritise water investments where they can close service gaps and reduce disaster risk together. **Safe water access is both an essential service and an investment in disaster risk reduction**

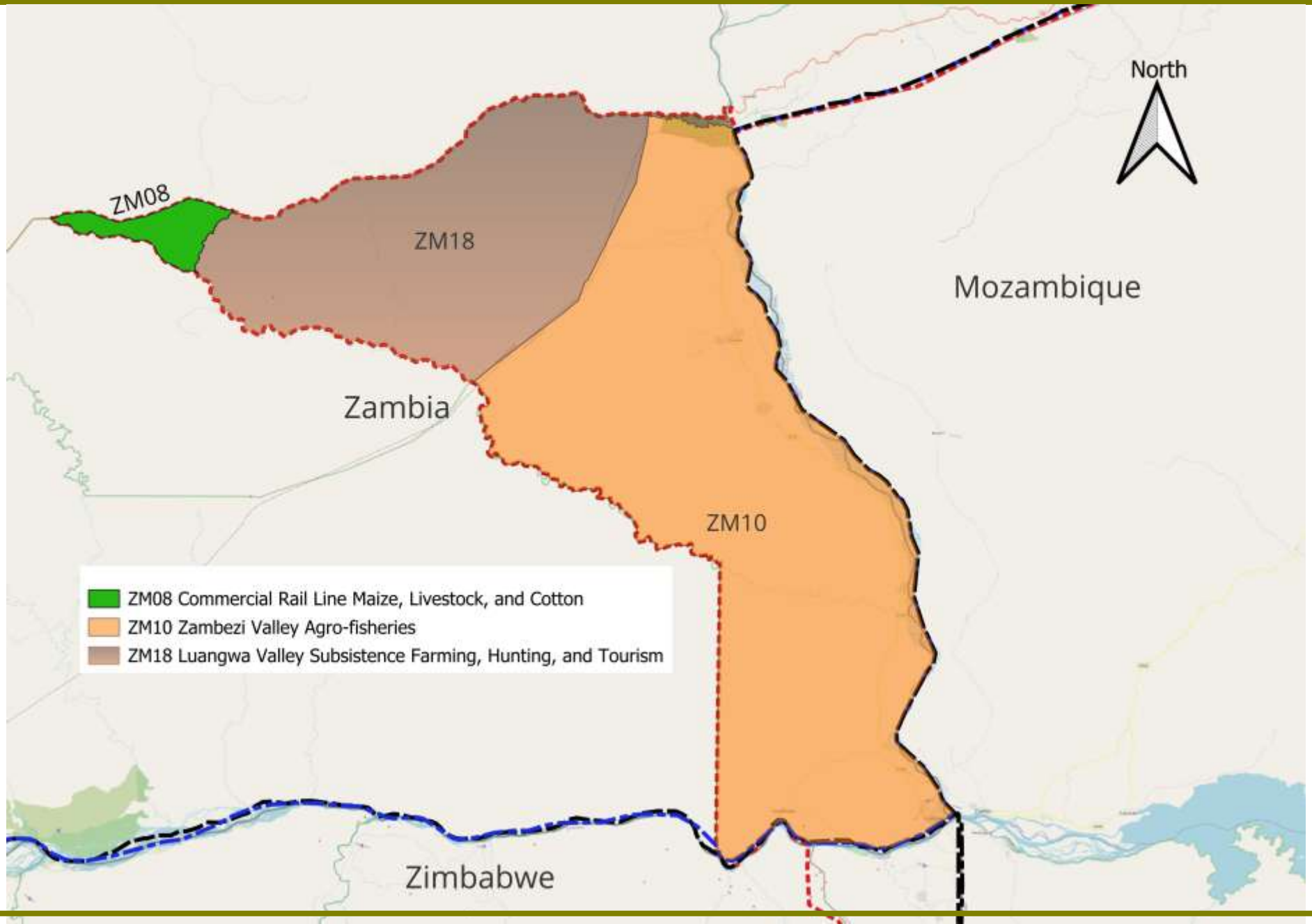


Photo credit: MSF, Zimbabwe, 2024

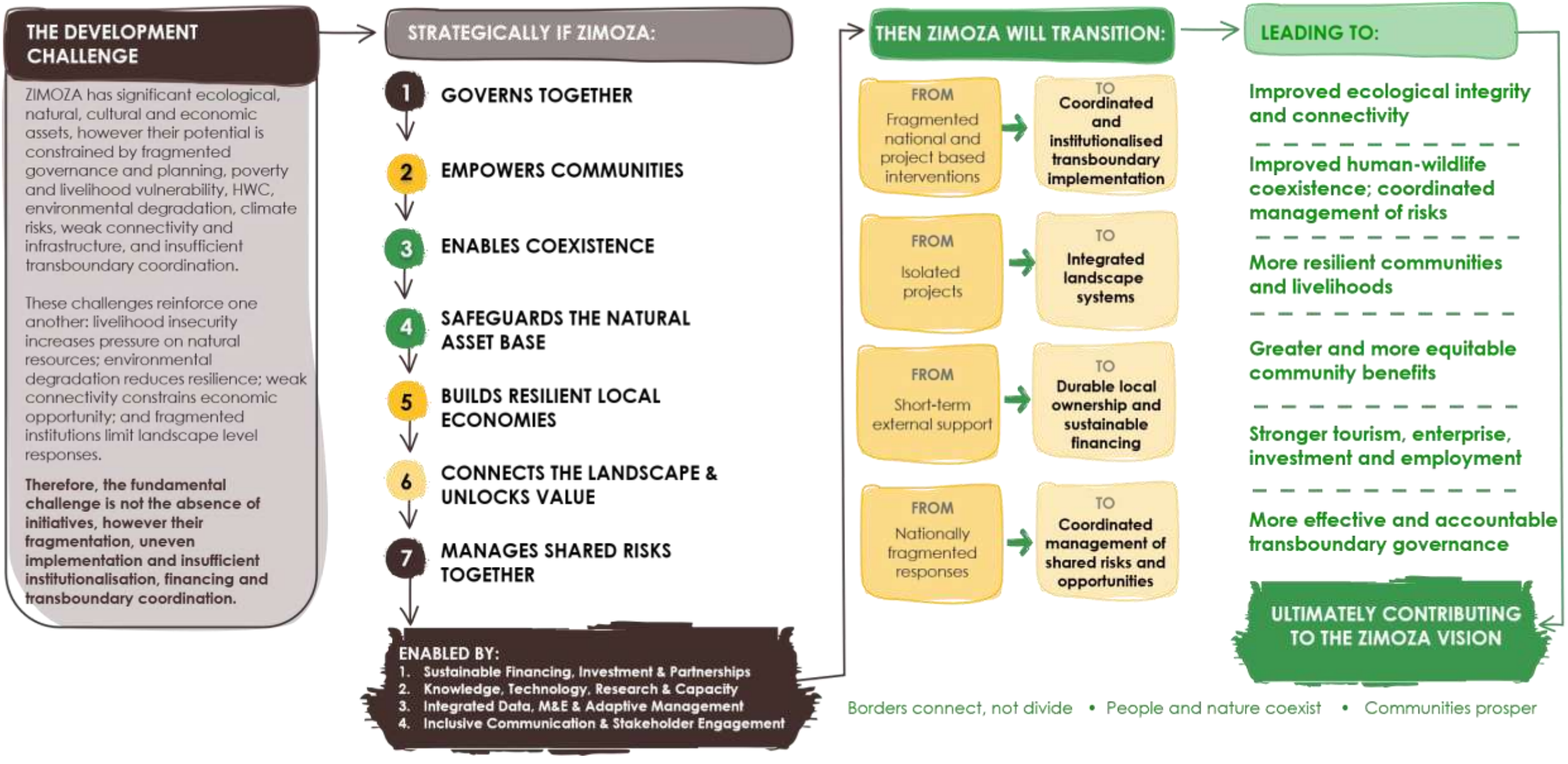


Photo credit: African Development Bank, Zambia, 2022

LAND USE | LIVELIHOOD ZONES [ZAMBIAN COMPONENT AS AN EXAMPLE]



HOW THE RISKS WERE INCORPORATED INTO THE IDP FROM A THEORY OF CHANGE PERSPECTIVE



Guided by the Theory of Change, the IDP process translated identified risks into the following strategic responses

Climate resilient production | Strategic Objective (SO) 5

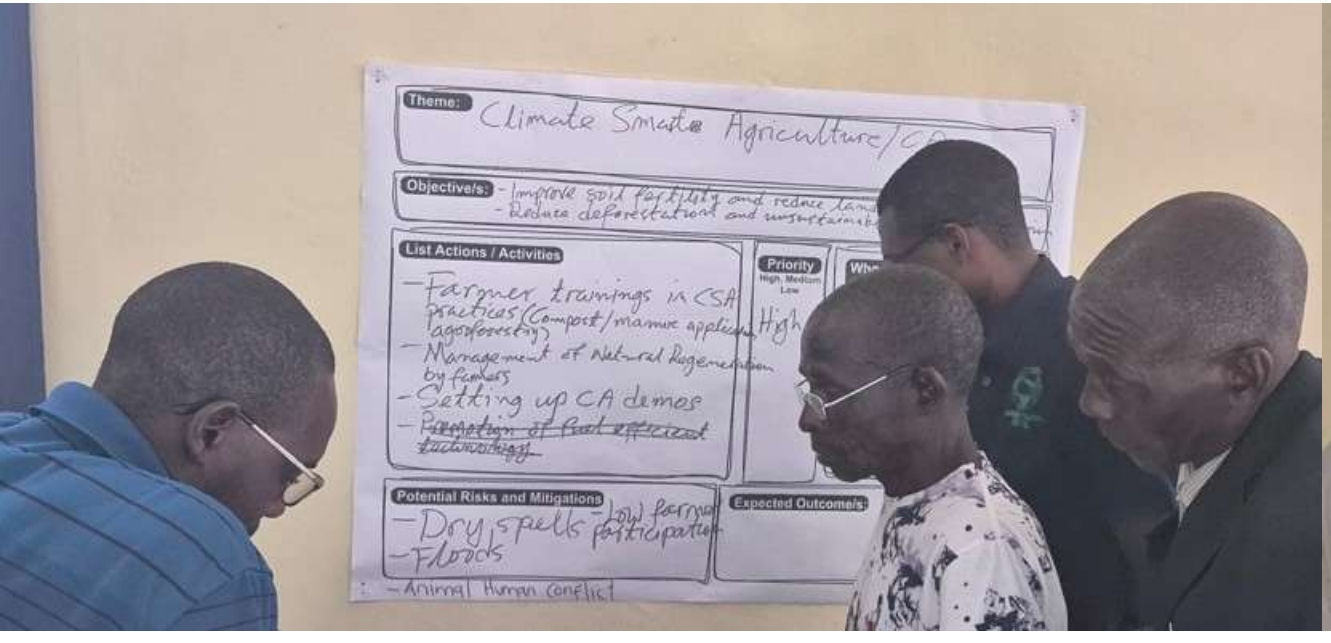
Strengthen climate resilient agriculture, livestock and productive water use

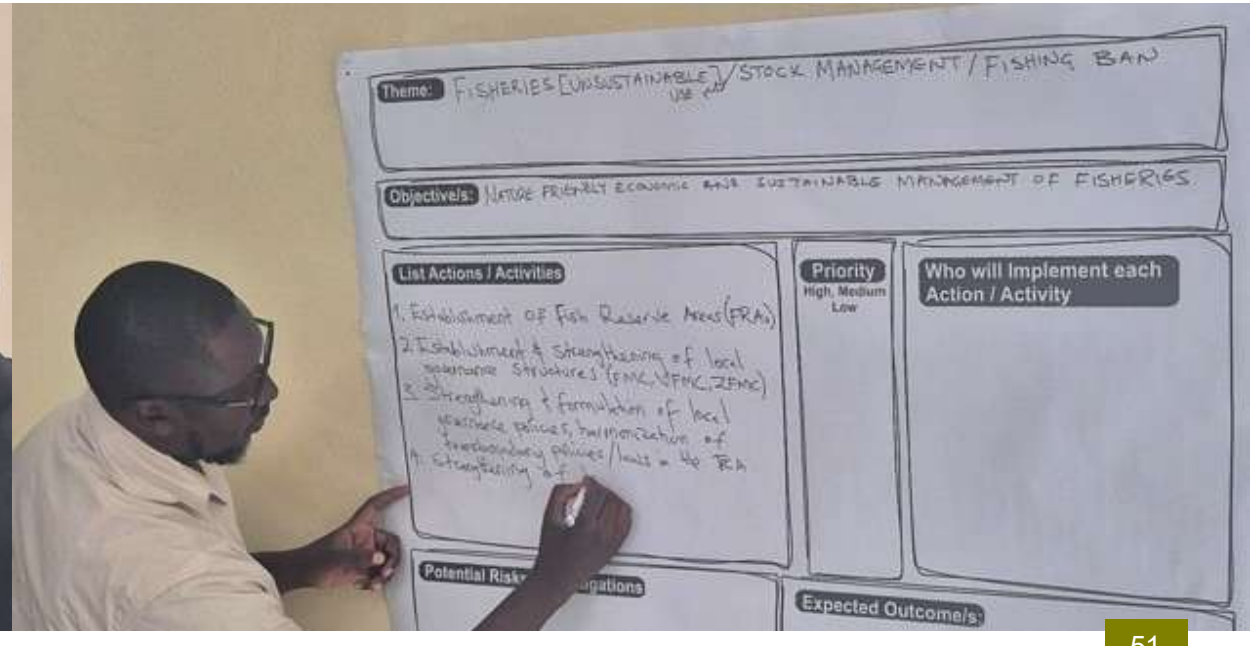
Diversified livelihoods | SO 5

Sustainable fisheries, aquaculture and nature based enterprises

Ecosystem resilience | SO 4

Restore priority ecosystems; reduce pressures and strengthen climate resilience





IDP RESPONSE II | PREVENTION, PREPAREDNESS AND ACCESS

Coexistence and early warning systems | SO

Integrated HWC prevention, early warning, reporting and response systems

Community preparedness | SO 3

Strengthen community preparedness and cross-border HWC coordination

Strategic connectivity | SO 6

Improve transport, aviation and digital links supporting access and response



Key operational link: shared warnings, agreed triggers, responsibilities assigned, and ensure there is financing available before impacts escalate

Integrated planning | SO 1

Align transboundary priorities with national and sub-national spatial planning inclusive of harmonisation of legal and policy frameworks

Coordinated preparedness | SO 7

Strengthen transboundary safety, LEAP, One Health preparedness and response

Knowledge and participation

Strengthen conservation technology, capacity and inclusive stakeholder engagement

Joint learning and finance

Use MEL, adaptive management and sustainable financing enablers

KEY LESSONS LEARNED

The ZIMOZA experience of integrating DRR into the SAR to shape the IDP's strategic direction yielded the following key lessons for risk informed transboundary planning:

1. **Make risk evidence a driver of development choices.** Use risk findings to guide spatial priorities, investment allocation and implementation measures within the IDP, measuring their value through decisions that reduce vulnerability and prevent new risks
2. **Assess risk through an integrated evidence base.** Interpret MHRA outputs alongside national datasets and livelihood information to understand the social, economic and environmental conditions that shape vulnerability across the landscape
3. **Establish shared priorities through stakeholder engagement.** Draw on local knowledge to validate findings and identify practical responses, while building agreement among Partner States on coordinated transboundary action
4. **Embed DRR in institutional planning and accountability.** Integrate risk management into existing TFCA systems, with clear responsibilities and measurable indicators to track progress, support adaptive management and sustain resilience over time
5. **Risk informed planning** must connect spatial evidence with evolving forecasts and adequately resourced



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a

Climate Resilience Investment Plan and Ecosystem Management of the Orange-Senqu River Basin

PRESENTATION TO THE SADC TRANSFRONTIER CONSERVATION AREA NETWORK MEETING AT KRUGER NATIONAL PARK , 12 NOV 2026

November
17, 2026

Comfort Molosiwa,
Executive Secretary
Orange-Senqu River Commission

PART ONE

Climate Resilience Investment Plan

November
17, 2026

Structure of the Presentation

1 **CLIMATE RESILIENCE INVESTMENT PLAN**

2 **ECOSYSTEM MANAGEMENT**

3 **CLIMATE RESILIENCE THROUGH ECOSYSTEM MANAGEMENT**

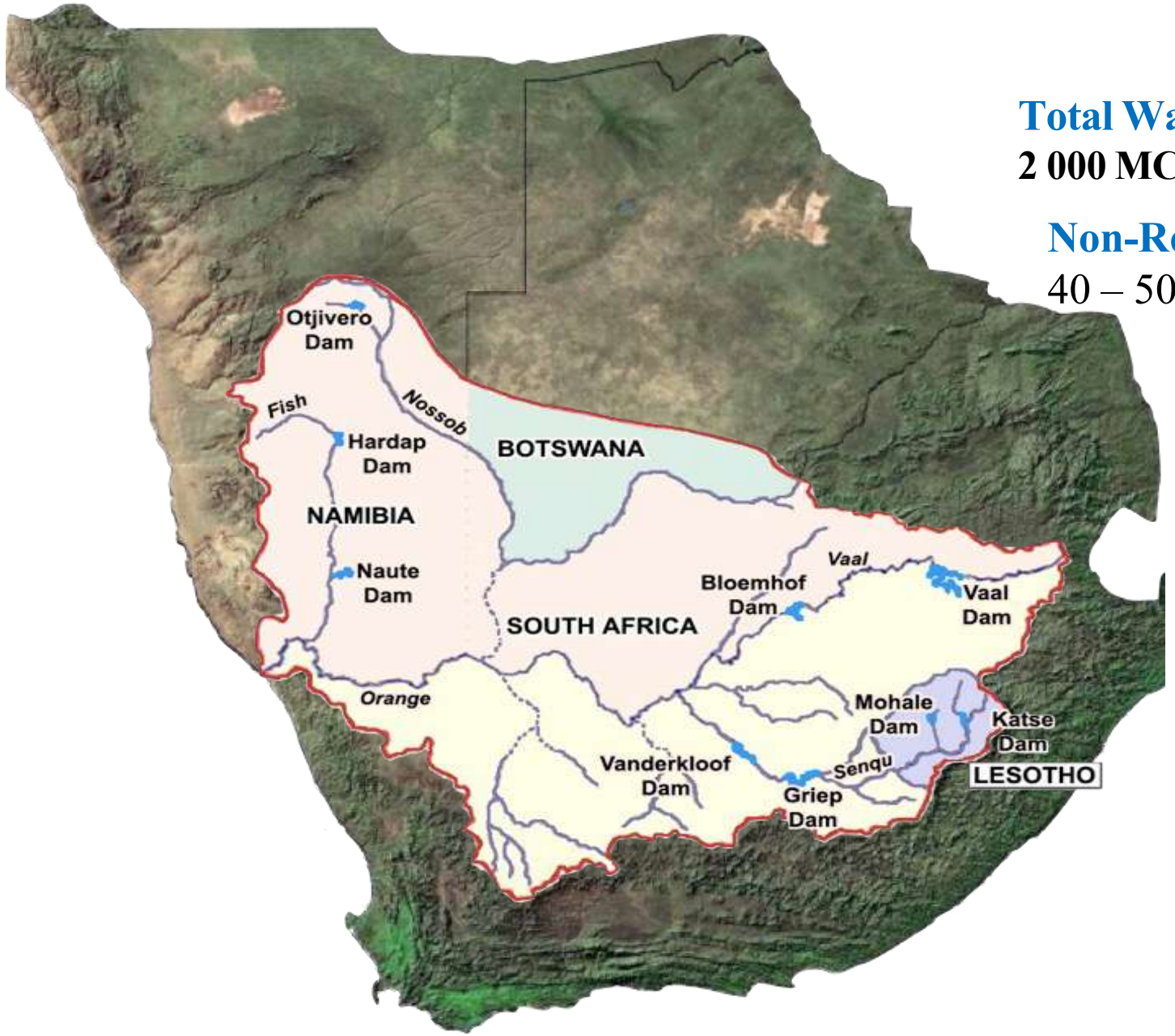
Location, Extent, Countries, Population and Water Supply

Basin Area : approx. 1 million sq km.

Basin States:
Botswana, Lesotho, Namibia and South Africa.

Population Depending on Basin Water: 21 million.

Population Living Within Basin: 15 million



Total Water Supply: 2 000 MCM

Non-Revenue Water: 40 – 50 %

Level of Infrastructure Development:

- 80 Major dams
- 270 Small dams
- <1200 demand centres
- 4000 System network links (pipelines, tunnels, river sections)

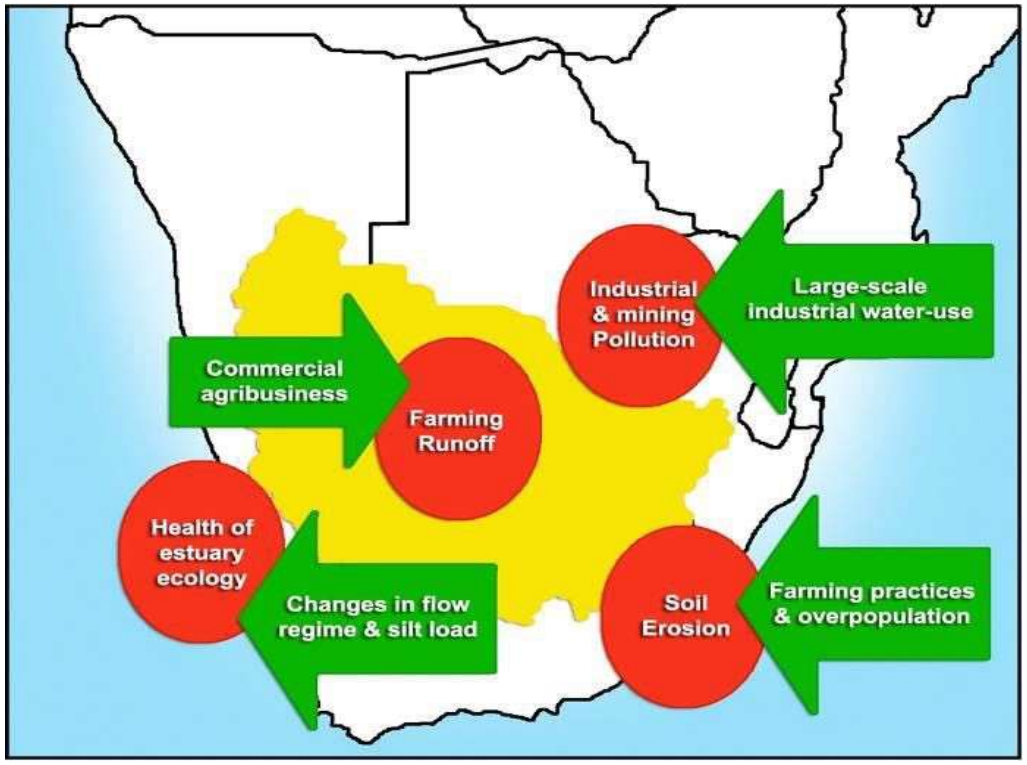
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CONFIDENTIAL | DRAFT

Why Action Is Needed Now

ORASECOM's basin-wide advisory role is critical now

ORASECOM's agenda responds to fully used water resources, rising demand, climate pressure, and cross-border development. Its basin-wide advisory role helps shape resilient, acceptable options.



1

System resources are fully utilized

- Water Resources of the Orange-Senqu System are now fully utilized

2

New development pressures are rising

- New developments needed to keep pace with growing demands
- New developments are needed to address the impacts of Climate Change

3

Impacts cross borders and states

- Upstream developments' impact on downstream users
- Have to ensure new developments are acceptable to all basin states

Strategic Objectives for Sustainable Basin Management

To provide a framework for sustainable development and management of the water resources of the Orange/Senqu River Basin

1

Central objectives

Advance sustainable water management to reduce poverty and manage floods and droughts.

- Sustainable water management
- Poverty reduction
- Catchment and disaster risk management

2

Enabling objectives

Strengthen systems, institutions, and support for coordinated basin implementation.

- Improve the knowledge base
- Build capacity and support
- Finance, monitor, evaluate

3

Cross-cutting priorities

Embed resilience and inclusion across basin actions.

- Address climate change
- Support resilience projects
- Support gender considerations

What the Climate Resilience Plan Contains

Orange-Senqu River Basin climate resilience investment strategy

1 Strategic Action Projects

9 Strategic Action Projects that enable and support delivery of the basin's climate resilience investment strategy.

2 Core Scenario Projects

36 Core Scenario Projects grouped into 9 clusters: 23 medium to large infrastructure projects and 13 integrated management options.

Combined roadmap

Combination of Strategic Actions and Core Scenario Projects

STRATEGIC ACTIONS (BUDGET ESTIMATE OF $23m)

	Description	Capital Cost ($m)	Running Costs ($m/annum)
1	Agreement and Implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management	$5m	$1m per annum
3	Development of Guidelines for sharing	$1m	
4	Synchronisation and Preparation of Future and Planned Developments	$1m	
5	Implementation and monitoring of WDM activities	$1m	
6	Assurance of Supply and Economic Value of Water	$1m	
7	Water Disaster Management – Climate Adaptation	$2m to $3m	
8	Capacity Building	$2m	$2m every 3 years
9	Hydrology Update and WQ Model Calibration	$3m	

CORESCENARIOPROJECTS(36INTOTALWITHABUDGETESTIMATEOFUS$7.9BILLION

Cluster Name	Capital cost $ million	Operational Cost ($ million)	Yield impact (million m³/a)
1. Orange River Project intervention options +NVD	2 096	6.9	724
2. Lesotho Botswana Water Transfer Scheme	2 856	45.3	308
3. Lesotho Lowland developments	73	0.3	65
4. Integrated Vaal River System intervention options	1 723	84.4	522
5. Caledon to Greater Bloemfontein transfers	15	0.6	11
6. Greater Bloemfontein internal resource improvements	82	8.8	31
7. Gariep to Greater Bloemfontein transfer	226	12.1	43
8. Neckartal Scheme in Namibia	26	0.7	90

Investment Roadmap and Portfolio Logic

Plan of possible actions showing time scales and budgets & chronological order

Project preparation

Priority projects move into design, packaging, and implementation planning.

Funding mobilization

Budgets are aligned with staged delivery across the basin portfolio.

Strategic actions

Low- to medium-budget actions prepare delivery and enable larger investments.

Core projects

Medium- to high-budget infrastructure and integrated management options are sequenced.

Basin-wide delivery

The roadmap combines strategic actions and core scenario projects into one way forward.

Environmental Protection Built In

Three priorities embed environmental protection in basin resilience.

Sustainable basin management

Protecting basin water resources supports resilience and sustainable development across the basin.

Catchment and disaster resilience

Reducing catchment degradation strengthens flood and drought resilience.

Climate-responsive options

Integrated management options address climate impacts and support resilience projects.



In the Orange-Senqu Basin, environmental protection is woven into the plan's implementation logic. Because upstream actions affect downstream users, new developments must remain acceptable across basin states.

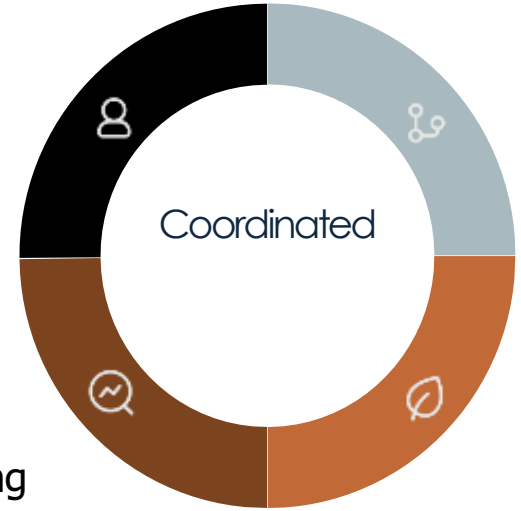
Governance, Implementation and Funding Roles

ORASECOM role

ORASECOM to have key facilitating role. Advisory on new developments and strategic actions.

Strategic actions funding

Most projects need modest budgets. They suit grant funding and can be managed through ORASECOM.



Basin States role

Basin States to manage and co-ordinate. They lead implementation across the larger portfolio.

Core projects funding

Major international funding is needed. Some resilience projects may get loans and grants.

Why it works

- ✓ Clear regional roles support delivery.
- ✓ Funding logic fits project scale.
- ✓ ORASECOM can enable strategic actions.
- ✓ States coordinate major portfolio delivery.

Delivery enablers

Improved knowledge, capacity building and institutional support.

Stakeholder engagement builds basin-wide acceptability.

Financing mechanisms help move projects into delivery.

Monitoring and evaluation keeps implementation aligned and accountable.



Proposed Way Forward and Next Steps

Proposed way forward

Align now, deliver basin-wide

The proposed way forward for the basin is a sequenced mix of Strategic Actions and Core Scenario Projects. ORASECOM should facilitate, Basin States should manage and co-ordinate, and delivery should remain acceptable to all basin states.

Three next steps

1

Endorsement of the roadmap

Confirm the combined delivery logic and sequence actions over time from a shared basin perspective.

2

Advance strategic actions

Move enabling actions first and pursue grant and donor funding through ORASECOM where appropriate.

3

Mobilize priority funding

Prepare priority core projects for international and climate resilience funding with state-led co-ordination.

PART TWO

Orange-Senqu River Basin Ecosystem Management

November 17, 2026



Basin Context and Why Ecosystem Management

Orange-Senqu context from source to sea

01

2,300 km

The Orange-Senqu runs from the Lesotho highlands to the Atlantic, linking headwaters, rivers, estuary, and coast in one connected system.

02

4 countries, 21M people

Shared by Botswana, Lesotho, Namibia, and South Africa, the basin supports agriculture, mining, industry, hydropower, transfers, and water supply.

03

Water security depends on ecosystem health

Management must be basin-wide because upstream runoff, dry-season regulation, pollution, over-abstraction, land degradation, invasive species, and weak demand management shape resilience across the whole basin.

Main Ecosystem and Water Pressures Across the Basin

Urban and Industrial Loads

Sewage, wastewater, and industrial pollution are concentrated in major hotspots, especially the Vaal, calling for coordinated compliance and treatment upgrades.

Mining and Toxic Contaminants

Mining adds heavy metals, salinity, uranium, and radionuclide risks in affected areas, requiring basin-wide monitoring and shared response priorities.

Agriculture and Abstractions

Irrigation, tributary runoff, and growing abstractions increase nutrient and salinity pressure, strengthening the case for joint demand management.

Dams Alter Flow Regimes

Impoundments and transfer schemes change flow volume and timing, so coordinated operations are needed to protect environmental flows.

Habitat and Sediment Stress

Erosion, sedimentation, and habitat loss remain significant outside the main hotspots, reinforcing the need for coordinated catchment restoration across the basin.

Emerging Basin-Wide Risks

Plastics, microplastics, POPs, and invasive species add newer cross-border risks that require shared surveillance and adaptive basin management.

A system under pressure

- Drivers & Pressures
  - Urbanization
  - Mining & Agriculture
  - Impoundments
  - Water quality/pollution
  - Flow alteration
  - Sediment flows
  - Barriers for movement
  - Habitat loss



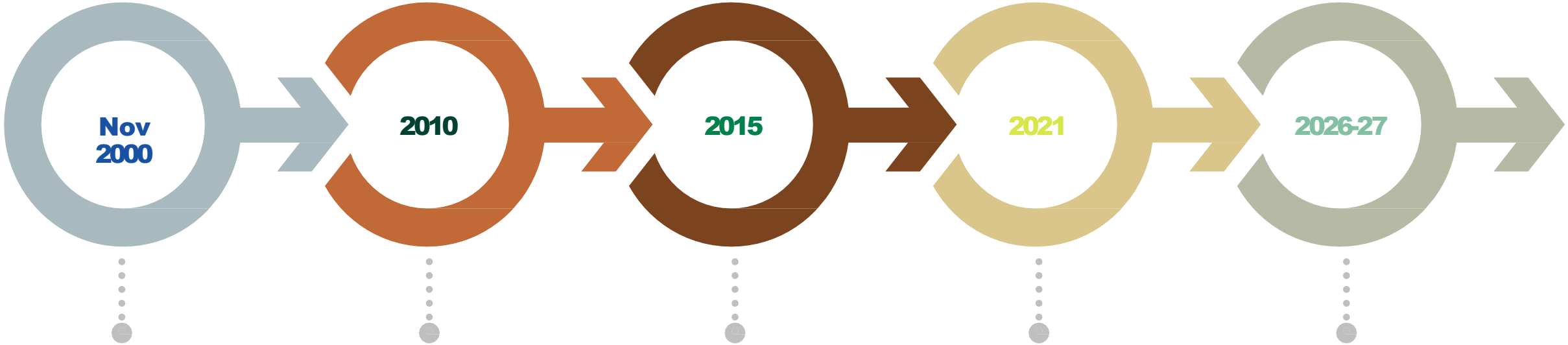






Joint Basin Surveys Guide Management

Five-yearly monitoring tracks hotspot decline and shows future cycles need stronger sampling, accredited labs, and analytics.



ORASECOM

Platform for basin coordination.

JBS1

Baseline aquatic health survey.

JBS2

Five-year trend update.

JBS3

Vaal decline; lower Mohokare severely degraded.

JBS4

The next cycle has stronger sampling, accredited labs, and analytics and is being undertaken through partnerships between GIZ, UNISA and TWP

❖ Basin-wide impacts

- **Vaal** – Sewage, coal, industry, domestic etc.
- **Upper Orange** – Unregulated agriculture (erosion and sediment).
- **Lower Orange** – Agriculture (pesticides) & mining (heavy metals).





❖ Bio-accumulation

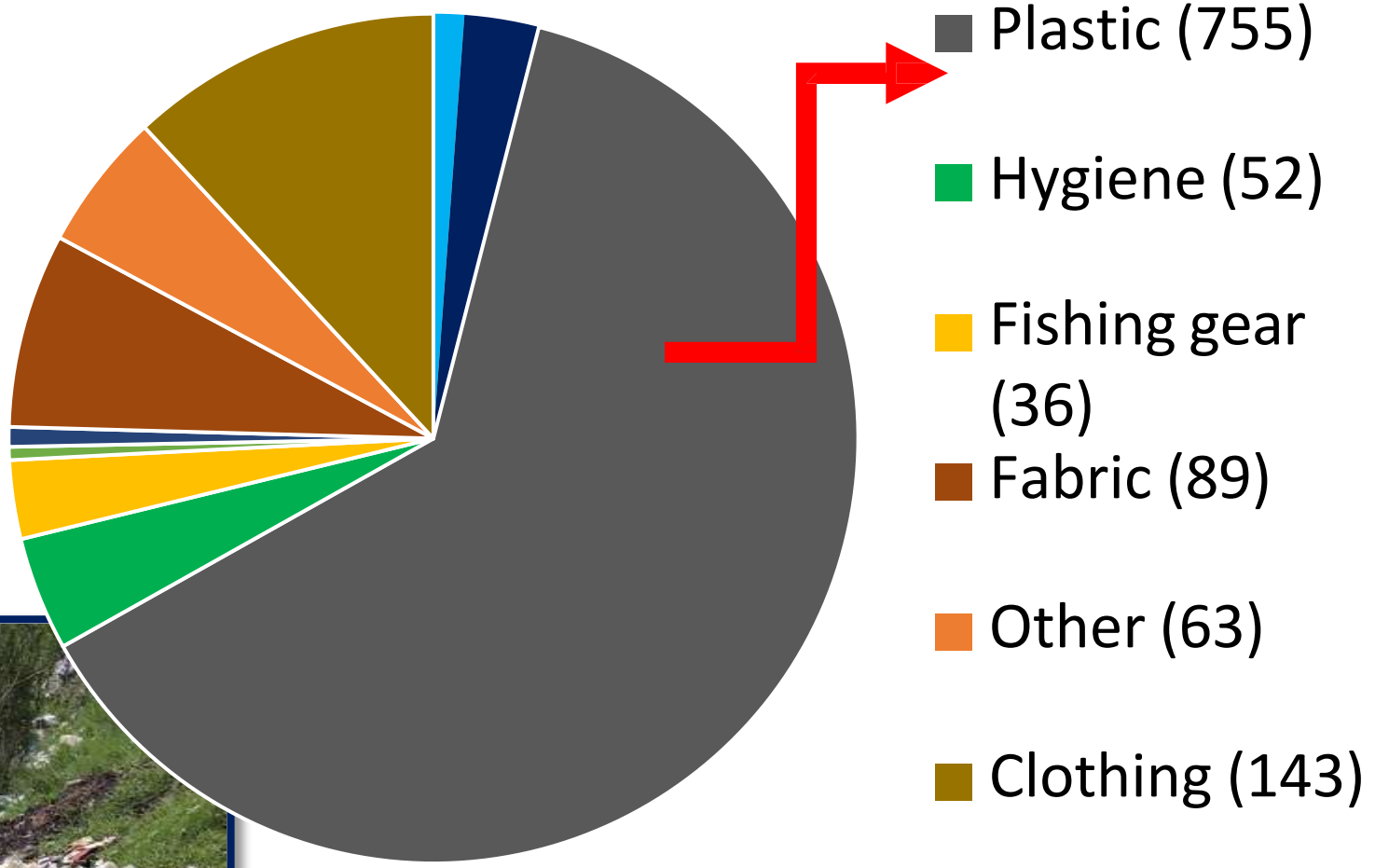
- Large fish have dangerous levels of heavy metals (e.g., mercury).



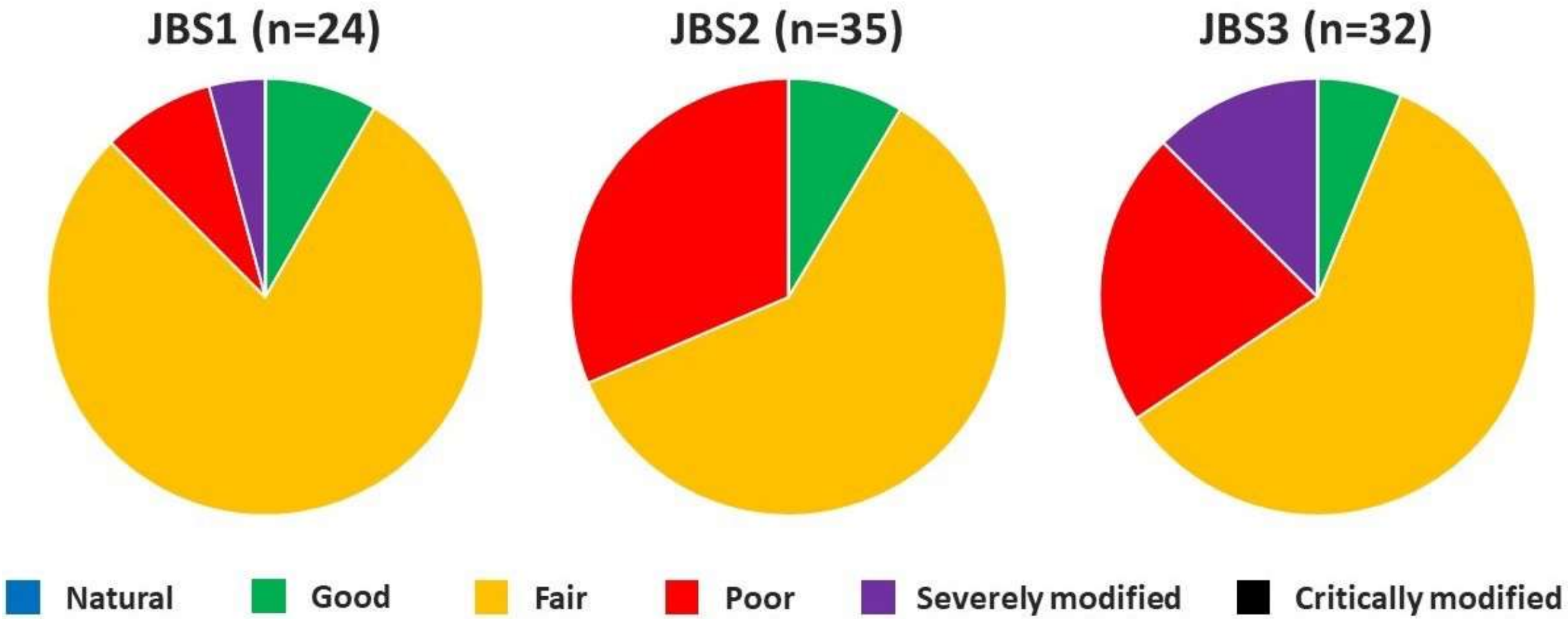
Large Solid Waste

- Plastic the major contributor to solid waste pollution.





JBS AEH Comparison



ORASECOM applies a basin-wide cycle so monitoring, standards, action, and adaptation work from source to sea.

Integrated basin management cycle



1. **Monitor basin conditions**

   Monitor water quality and flows.

1. **Set shared objectives**

   Agree resource quality, transboundary, and flow standards.

1. **Identify priority hotspots**

   Map critical habitats, pressures, and areas in need of action.

1. **Prioritise interventions**

   Drive restoration and demand control.

1. **Adapt and improve**

   Use shared learning to refine actions and basin priorities.

Governance instruments

- Water Resource Quality Committee
- Two experts from each state party
- Basin-wide monitoring programme
- Surface and groundwater sites
- Shared data standards

Standards and controls

- Resource quality objectives
- Transboundary quality objectives
- Environmental flow tools
- Environmental and social guidelines
- Aquatic health frameworks

Why basin-wide matters

- Upstream gains need downstream action
- Pollution crosses borders
- Over-abstraction weakens shared flows
- Adaptive management protects outcomes

From Monitoring to Investment and Practical Interventions

Three implementation pillars translate basin evidence into coordinated action, investment, and adaptive delivery.

1

Target key landscapes

Evidence guides hotspot mapping and restoration priorities where risk is greatest.

- Hotspot mapping
- Critical habitat focus
- Restoration prioritisation

2

Implement key measures

Priority actions include pollution control, conservation, demand management, and pilot investments.

- Pollution control
- Water demand management
- Pilot investments

3

Secure long-term finance

The Water Fund links strategy to bankable projects, coordinates investors, and sustains basin action.

- Water Fund concept
- Bankable project pipeline
- Coordinated long-term funding



Benefits and Next Steps

Effective ecosystem management strengthens water security, resilience, and stewardship

Basin-wide benefits

Effective ecosystem management improves water security, ecological integrity, and climate resilience across the basin. It also protects services that sustain people, livelihoods, and key sectors while supporting more coordinated and inclusive transboundary governance.

Priority next steps

1

Institutionalise JBS

Strengthen monitoring capacity and institutionalise future JBS cycles across the basin.

2

Sharpen analysis tools

Improve accredited laboratory capability, contaminant analysis, hotspot mapping, and decision-support tools.

3

Scale investment

Build bankable projects, expand pilots, mobilise resources, and embed adaptive learning basin-wide.

CLIMATE RESILIENCE THROUGH THE ECOSYSTEM MANAGEMENT

Healthy ecosystems underpin resilience

ONE CONNECTED BASIN

- Botswana, Lesotho, Namibia and South Africa share the Orange-Senqu system.
- Headwaters, rivers, estuary and coast connect people, livelihoods and economic activity.
- Upstream decisions shape downstream water quality and flows.

ONE COMBINED AGENDA

- Protect ecological integrity and water security.
- Reduce pollution, degradation and demand pressure.
- Pair restoration and integrated management with climate-resilient investment.

Shared pressures require joint action

WATER AND CLIMATE PRESSURE

- The resilience plan describes system water resources as fully utilised.
- Rising demand and climate impacts create new development needs.
- Dams and transfers change flow timing and volume.
- Upstream impacts require agreement across basin states.

ECOSYSTEM PRESSURE

- Vaal sewage and industrial loads threaten water quality.
- Mining adds heavy metals and salinity risks.
- Agriculture contributes nutrients, pesticides, erosion and sediment.
- Plastics and invasive species require shared surveillance.

Evidence must drive basin-wide action

MONITOR AND SET PRIORITIES

- Joint Basin Surveys track aquatic health and hotspots.
- Reported concerns include Vaal decline and lower Mohokare degradation.
- Strengthen sampling, laboratories and contaminant analysis.
- Map critical habitats and restoration priorities.

ACT AND ADAPT

- Agree shared water quality and environmental flow objectives.
- Coordinate pollution control, demand management and catchment restoration.
- Use environmental and social guidelines to guide investment.
- Monitor outcomes and refine interventions through shared learning.

Restoration and investment must work together

PROTECT BASIN FUNCTIONS

- Target critical habitats and degraded catchments.
- Improve wastewater treatment and pollution compliance.
- Coordinate dam operations to protect environmental flows.
- Expand pilots and reduce water demand pressure.

BUILD RESILIENT DELIVERY

- Reduce catchment degradation to support flood and drought resilience.
- Combine infrastructure with integrated water management.
- Strengthen knowledge, institutions and inclusive participation.
- Develop bankable projects and long-term finance, including the Water Fund concept.

Enabling actions unlock the core portfolio

9 STRATEGIC ACTION PROJECTS

- US$23 million estimated budget.
- Prepare delivery through knowledge, capacity and institutional support.
- Support stakeholder engagement, finance, monitoring and evaluation.
- Individual project names and budgets need confirmation from the full plan.

36 CORE SCENARIO PROJECTS

- US$7.9 billion stated budget estimate.
- Nine clusters combine 23 infrastructure projects and 13 integrated management options.
- Sequence project preparation and funding over time.
- Listed cluster capital costs total US$7.434 billion. Reconcile the difference.

Clear roles align finance with delivery

ORASECOM FACILITATES

- Advise on basin-wide developments and strategic actions.
- Coordinate shared monitoring, standards and learning.
- Support enabling actions suited to grants and donor funding.
- Build institutional capacity and basin-wide acceptability.

BASIN STATES LEAD

- Manage and coordinate major project implementation.
- Prepare priority projects for international funding.
- Pursue loans and grants where appropriate for resilience projects.
- Maintain stakeholder engagement, environmental protection and accountability.


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