Evaluating the Effectiveness of Weather Forecasting Service in SA

SJRP Deep Dives: 16 April 2026

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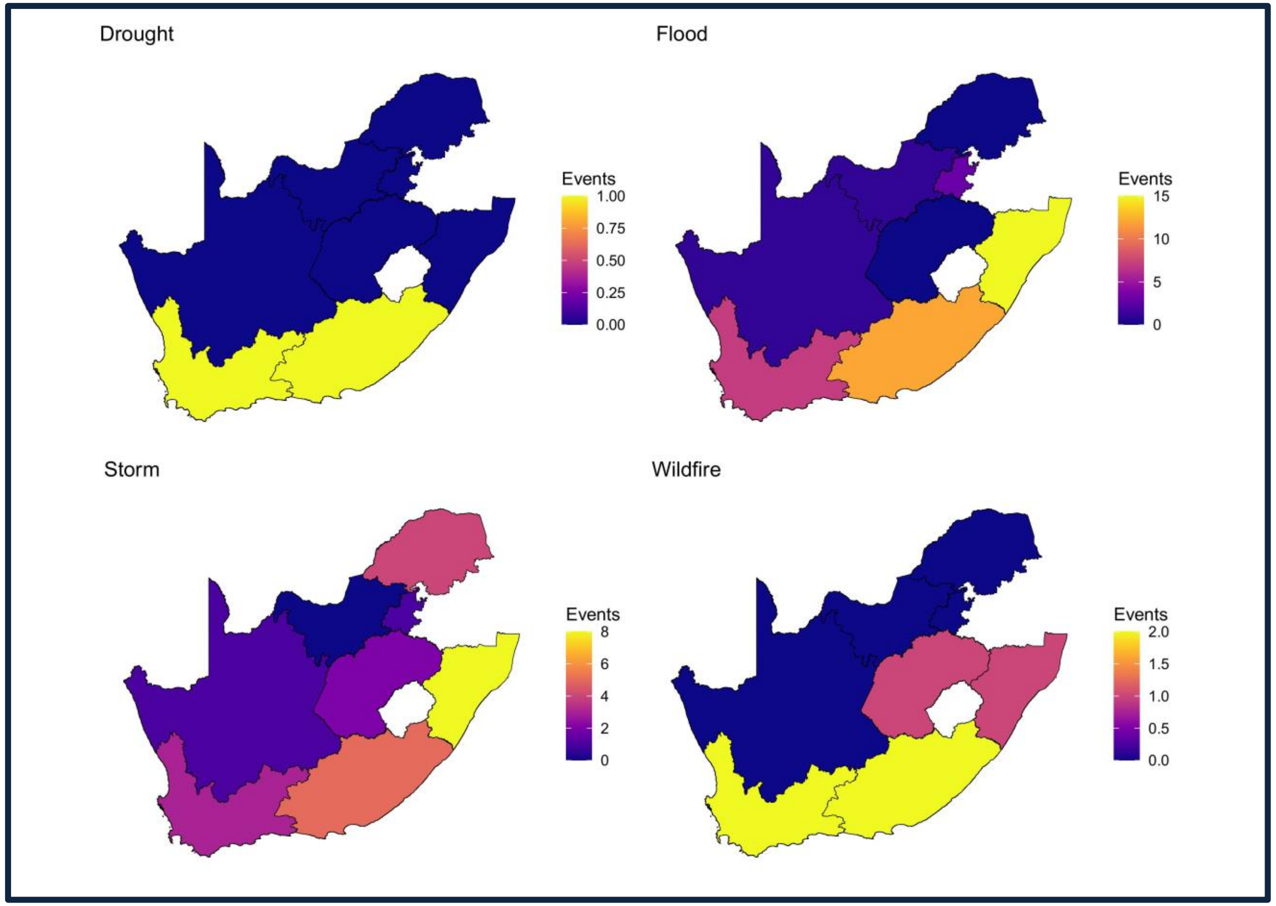
Outline

- Risk profile: Examines climate change trends and historical extreme weather patterns in South Africa
- Evaluate forecast accuracy, infrastructure reliability, dissemination, and the forecast-to-action gap
- Map weather prediction system and forecast accuracy
- Analyse sectoral and socio-economic vulnerabilities
- System level and institutional constraints and systemic Proposals for strengthening South Africa's prediction ecosystem

South Africa Escalating Climate Risk Profile

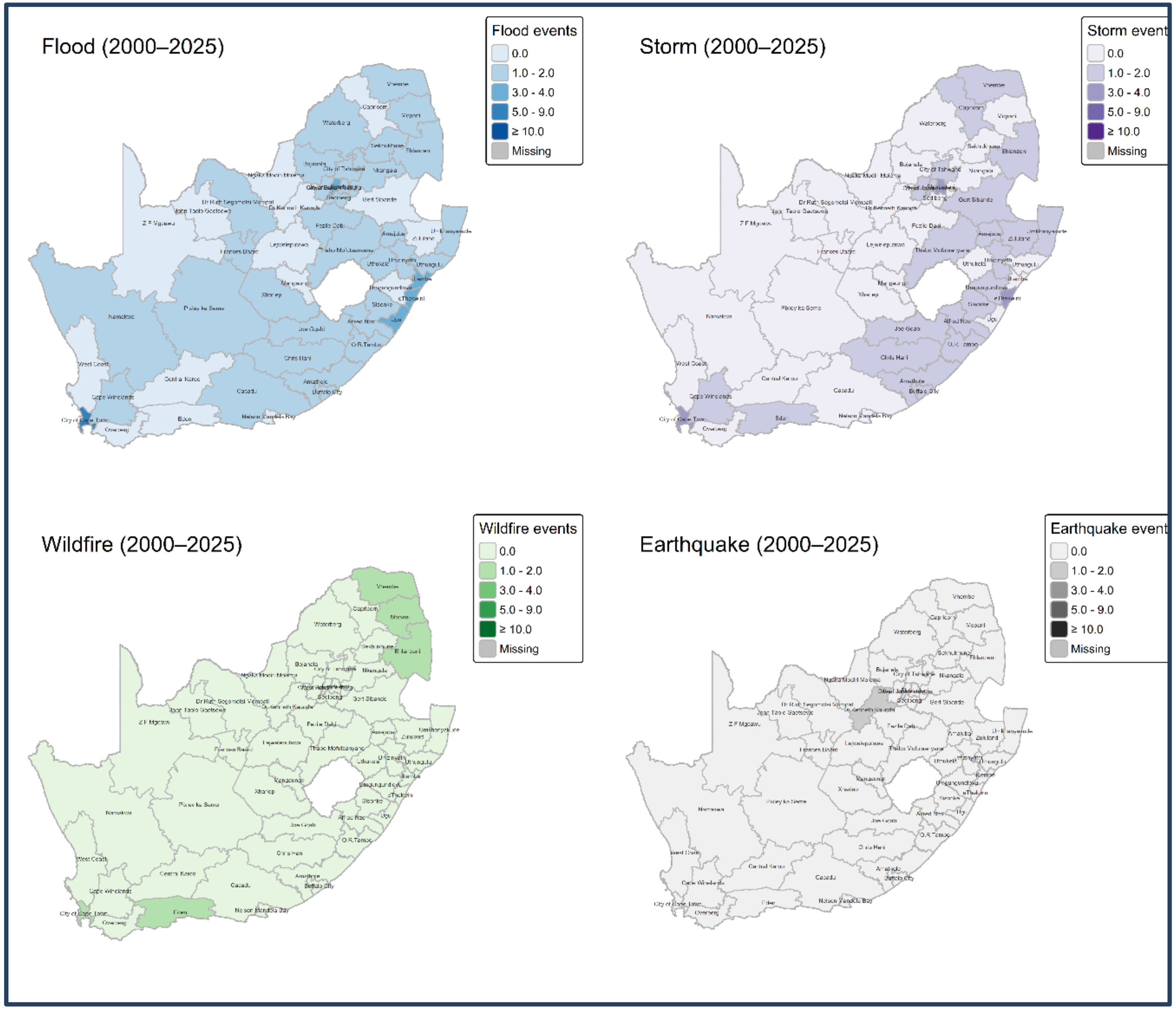
- **Warming Trends**: In 2024, South Africa exceeded the critical **1.5°C global temperature threshold**.
- **Increased Variability**: Recent years show a marked escalation in climate variability; 2011–2025 saw 51% of all extreme events recorded since 2000
- **Regional Burden**:
  - ➢ Coastal provinces (KZN, Eastern Cape, Western Cape) carry a disproportionate share of high-impact extreme weather events
  - ➢ KZN and Eastern Cape are repeatedly hit by tropical systems and floods.
  - ➢ Western Cape faces variable winter rainfall, recurrent droughts, and summer wildfires
  - ➢ Inland provinces increasingly face extreme heat, drought, and wildfire risk.
- Are forecasting systems delivering sufficiently localised and reliable information where risks are highest?

Key Trend: Droughts affect the highest population volume, while floods account for most fatalities and financial damage.



Major Extreme Weather Events and Impacts

- Major events include:
  - 2015–2018 Day Zero drought: R16bn agricultural losses and 40 000 jobs lost.
  - 2017 Knysna wildfires: R3.3bn damage and widespread evacuation.
  - 2022 KwaZulu-Natal floods: Over 450 deaths and R17bn infrastructure damage.
  - 2025 Eastern Cape floods: 90 deaths and thousands displaced.
- In many cases, forecasts were issued, yet losses remained severe due to:
  - Limited localisation of warnings
  - Insufficient lead time at district and community level
  - Weak communication and last-mile delivery
- Persistent losses point to systemic and institutional failures, not only climatic severity.



Why Forecast Effectiveness matters

Between 2000 and 2025, South Africa recorded more than 100 weather-related disasters.

> 31 million people were affected, with economic damages exceeding R180 billion

Climate-related shocks affect employment through job losses, reduced working days, disrupted production cycles, and business closures.

Effective forecasting reduces losses by enabling early action, preparedness, and adaptive decision-making.

Forecast accuracy alone is insufficient if warnings do not reach users or fail to trigger action.

Forecast system reform should prioritise loss reduction and equity, not marginal gains in model accuracy.

- South Africa’s forecast challenges stem from systemic constraints:
  - Ageing Infrastructure: Outdated RADAR and observation systems reduce forecast accuracy.
  - Fragmented institutional coordination across national and local levels
  - Unequal access to climate information across regions and sectors

Weather Predictions System Mapping

Scientific Success vs Structural Fragility

Metric	2019/20	2021/22	2022/23	2023/24	2024/25
Forecast Accuracy	98.70%	97.70%	98.30%	98.60%	98.70%
False Alarm Rate	9.30%	10.60%	7.10%	10.50%	14.40%
Radar Availability	91.90%	73.90%	52.20%	44.00%	80.00%

- Reported forecast accuracy has remained above 97% in recent years.
- However, radar availability has been highly volatile, dropping to as low as 44–52% in some years.
- Radars are central to real-time storm detection and nowcasting, calibration and validation of short-range models, enhancing the usefulness of AWS data
- This creates a fundamental tension:
  - **How is high forecast accuracy sustained when the observation systems feeding models are intermittently unavailable?**

Observation Network Components:

Surface Stations: 246 Automatic Weather Stations and 24 Weather Offices.

Rainfall Monitoring: 1,277 manual rainfall stations and 141 automatic rainfall stations.

Upper Air: 11 sounding stations measure atmospheric profiles via weather balloons twice daily.

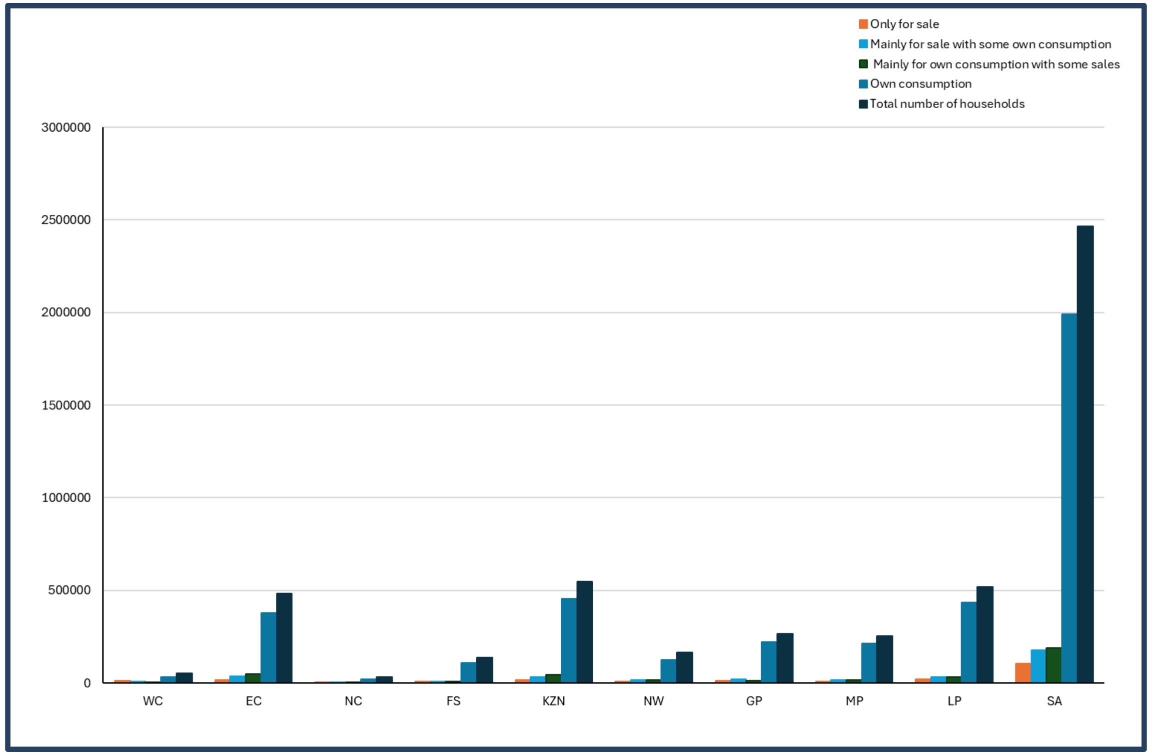
Nowcasting: 14 radars for real-time monitoring of storm development.

- National accuracy metrics may mask localised failures, particularly for fast developing storms, flash floods, and rapidly evolving extreme weather events.
- Forecast credibility depends not only on model performance, but on the stability and uptime of observation infrastructure

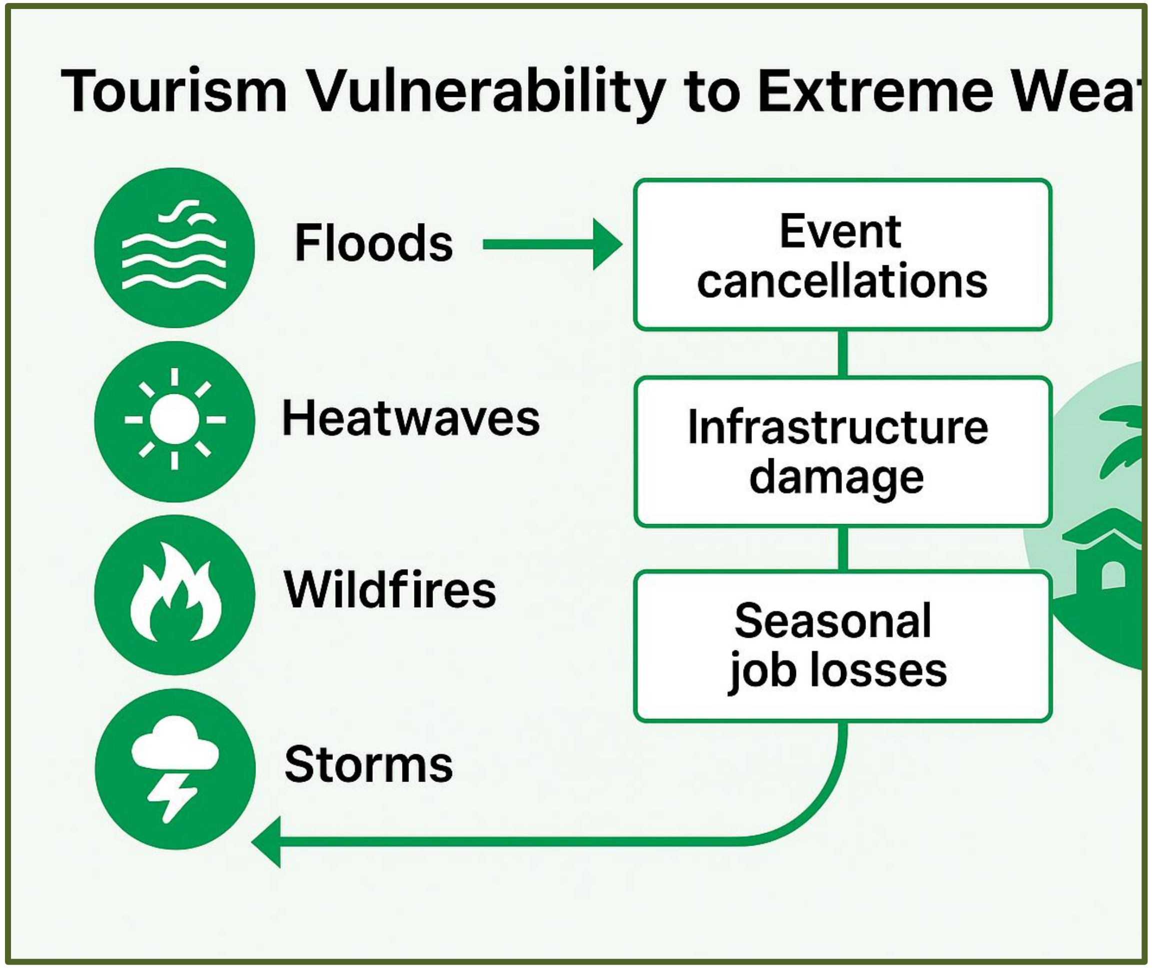
Sectoral Impacts: Agriculture

- Climate info = productive asset affecting irreversible decisions
- **Economic Impact**: Agriculture contracted 16% during the 2015-18 drought; food prices rose ~20%; maize yields reduced by > 25%; accelerated job losses, 2025 EC floods killed 1339 livestock
- **Livestock Sensitivity**: Heat stress >24°C reduces milk production in 2023, slower growth in calves, and lower calving rates
- **The Inequality Divide in Climate Services:**
  - ➢ **Commercial farmers**: ~35 000 farmers; access to premium, high-resolution agromet services from ARC and SAWS
  - ➢ **Smallholder farmers**: 200 000 to 2 million households with large concentrations in KZN, Limpopo and EC; rely on generic public broadcasts
  - ➢ Smallholders have limited financial buffers, limited access to land rights yet overwhelmingly rely on rain-fed agriculture
- Unequal access to climate information reinforces structural inequality in agriculture.

Concentration of Agricultural Production



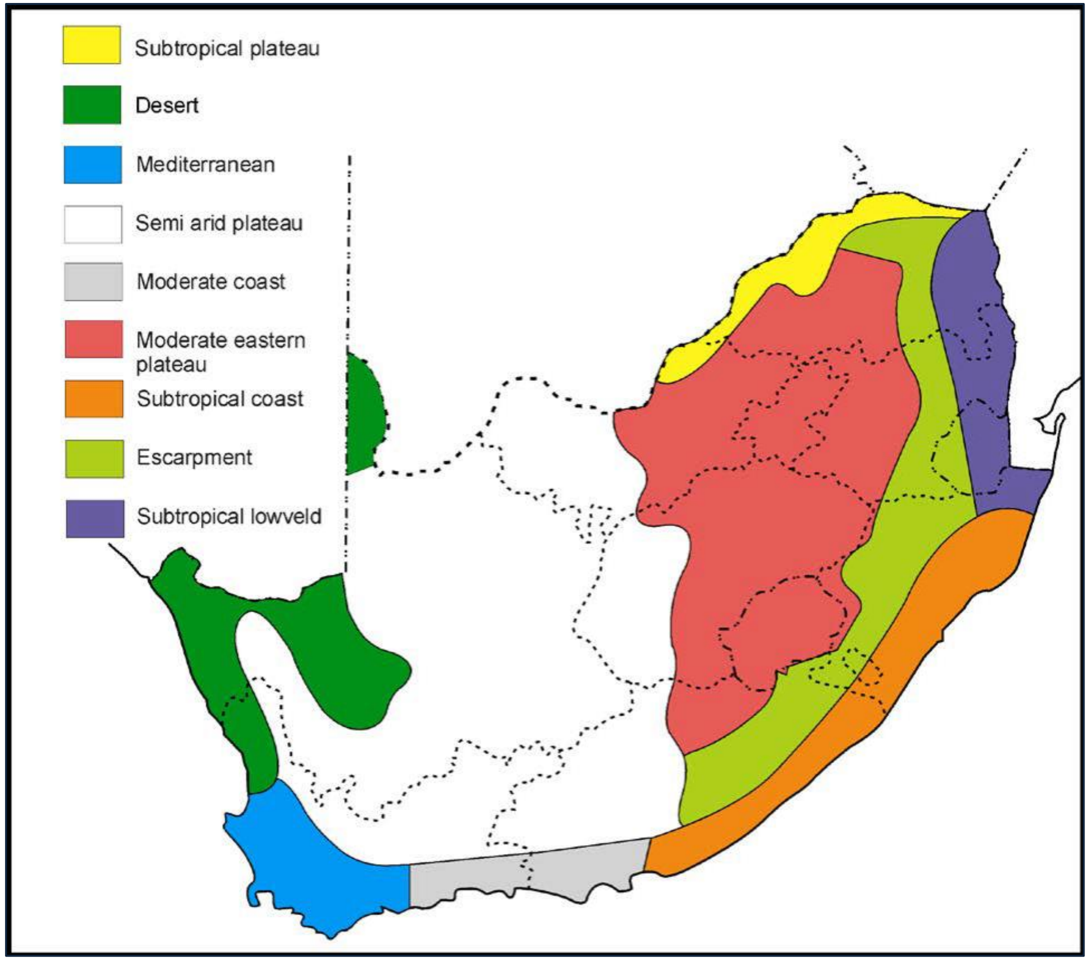
Sectoral Impacts: Tourism



- Tourism is a national, system-wide economic activity highly sensitive to climate variability and extreme weather.
- Extreme events **reduce destination attractiveness**, **disrupt transport**, and **damage natural and built infrastructure.**
- The Day Zero drought, floods, storms, and wildfires demonstrate how climate shocks translate into:
  - ➢ Declines in tourist arrivals and spending
  - ➢ Job losses and income instability
  - ➢ Reputational effects for destinations
- Tourism depends on high-confidence, localised forecasts to manage safety, operations, and seasonal planning.
- Generic or uncertain warnings increase cancellations, closures, and long-term economic losses

Socioeconomic Impact of Extreme Weather

- Extreme weather causes **uneven economic and social losses**, with GDP, jobs, food security, and livelihoods hardest hit in high-risk regions.
- Droughts and floods have **economy-wide effects**, reducing agricultural output, exports, and seasonal employment; the **2015–2018 drought alone led to ~31 000 farm job losses**.
- Poor households are most affected due to **limited insurance and savings**, making weather shocks long-lasting.
- **High-risk climate-vulnerable regions should be prioritised** for investment in forecasting infrastructure, localised warnings, and last-mile communication.



System failures and Proposed Improvements

Observed Systemic Failures Affecting Forecast Accuracy

- Low radar availability
  - ➢ Late or missed storm detection and weaker warnings
- Data gaps and outages
  - ➢ Unreliable baselines and reduced confidence in forecasts
- Delayed escalation and dissemination
  - ➢ Lost lead time and avoidable fatalities

- **Key conclusion**: South Africa does not face a failure of **forecasting science**, but a failure of infrastructure stability, regional coverage, and institutional coordination
- Improving forecast accuracy requires fixing the observation-to-warning chain, not only improving models

- Stabilise and prioritise radar availability in high-risk regions
  - ➢ Commit to ring-fenced funding, faster repair cycles, and preventative maintenance for radar systems covering flood- and storm-prone provinces.
- Strengthen regional observation density where losses are highest
  - ➢ Expand Automatic Weather Stations, rainfall gauges, and mobile sensors in coastal zones, floodplains, and heat-exposed inland districts.
- Integrate datasets across institutions to improve local forecasts
  - ➢ Improve interoperability between SAWS, municipalities, CSIR, ARC, and disaster-risk authorities to enhance data assimilation and situational awareness.
- Link forecast accuracy improvements directly to loss-reduction outcomes
  - ➢ Prioritise investments that improve lead time and localisation for floods, heatwaves, and storms in repeatedly affected regions.

Thank you

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