



Building capacity for Water Resources Management in Southern Africa



BUILDING RESEARCH CAPACITY FOR SUSTAINABLE WATER AND FOOD SECURITY IN DRYLANDS OF SUB-SAHARAN AFRICA

# A decade of water resources research in the data and water limited environments of Zambezi basin

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UNIVERSITY  
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**21<sup>st</sup>  
WaterNet/  
WARFSA/  
GWPSA  
Symposium**

28 October 2020

a. Drylands

a. Food and water security in Zambezi Basin

a. Past decade research in the Zambezi Basin

b. Upscaling and implications on sustainable water and food security

# Drylands

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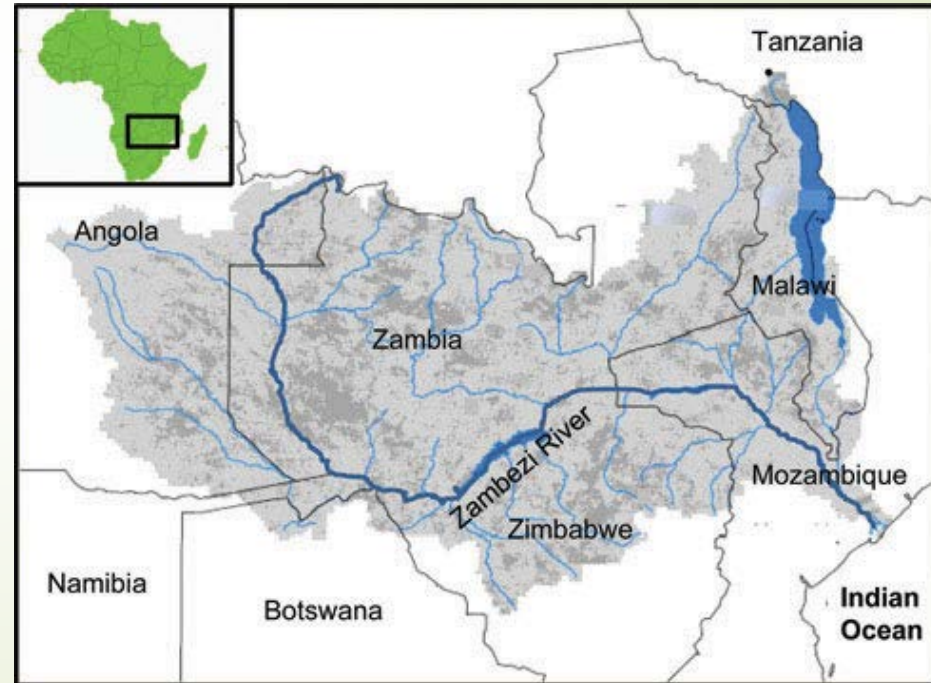
- ❑ The UNEP defines drylands as tropical and temperate areas with an aridity index of less than 0.65.
- ❑ Drylands are defined by a scarcity of water.
- ❑ High variability of rainfall amounts and intensities
- ❑ Prolonged periods of drought



## Zambezi River Basin

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- Over 50 million inhabitants, largely dryland
- Floods and droughts
- Food and water security
- Land use and climate
- Largely ungauged
- Research policies do not often touch the communities



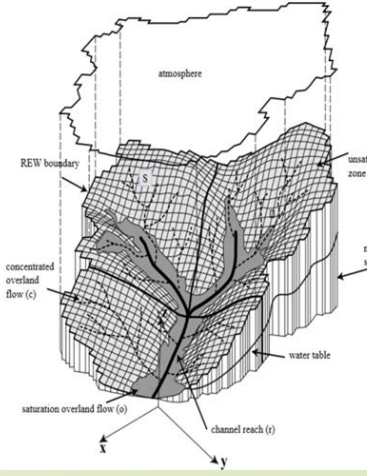
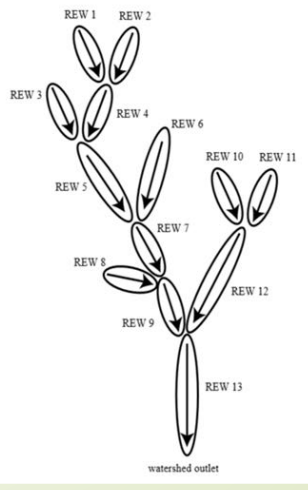
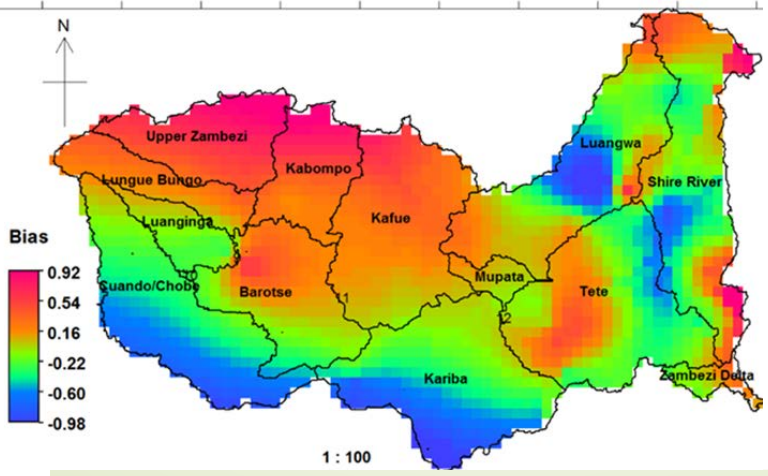
# **Rainfall estimation in the Zambezi Basin**





# Rainfall estimation

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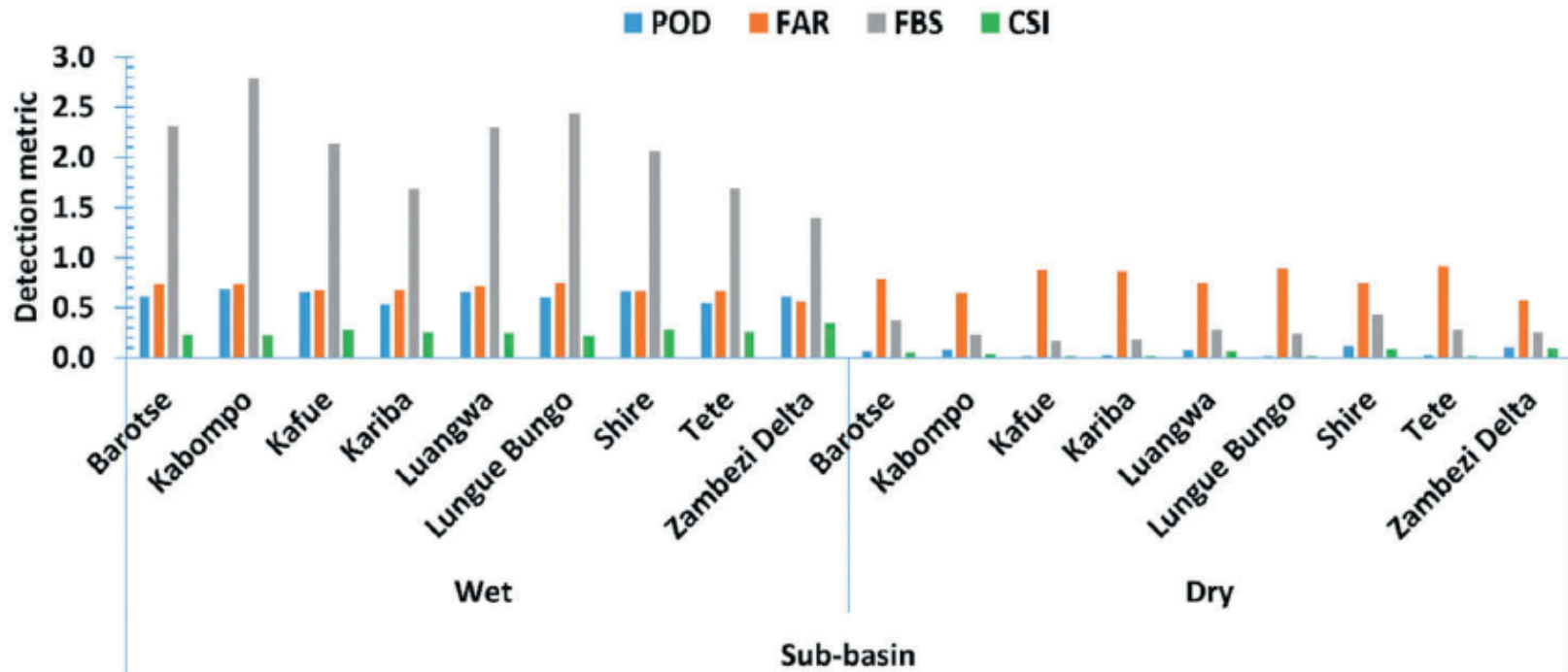


So how much does it rain ?



# Satellite rainfall important in water limited environments

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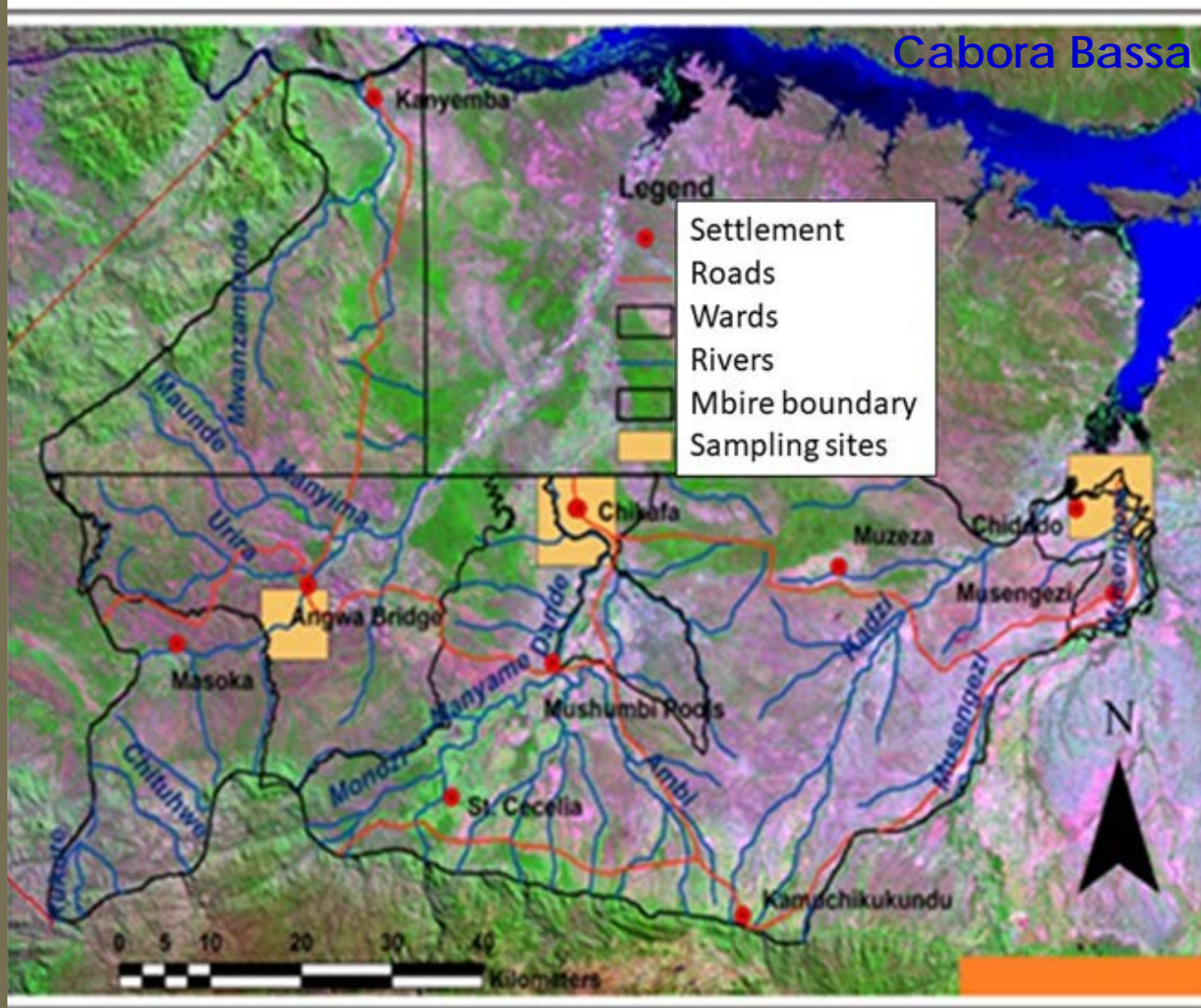
- ❑ Increased use of the products at research and universities
- ❑ Local authorities, national water authorities in past decade have adopted SRES for their operations
- ❑ If adequately packaged can impact on food security as well
- ❑ Caution is that institutions should not relax in improving gauging



**Spatio-temporal soil  
moisture variation along the  
major tributaries of Zambezi  
River**

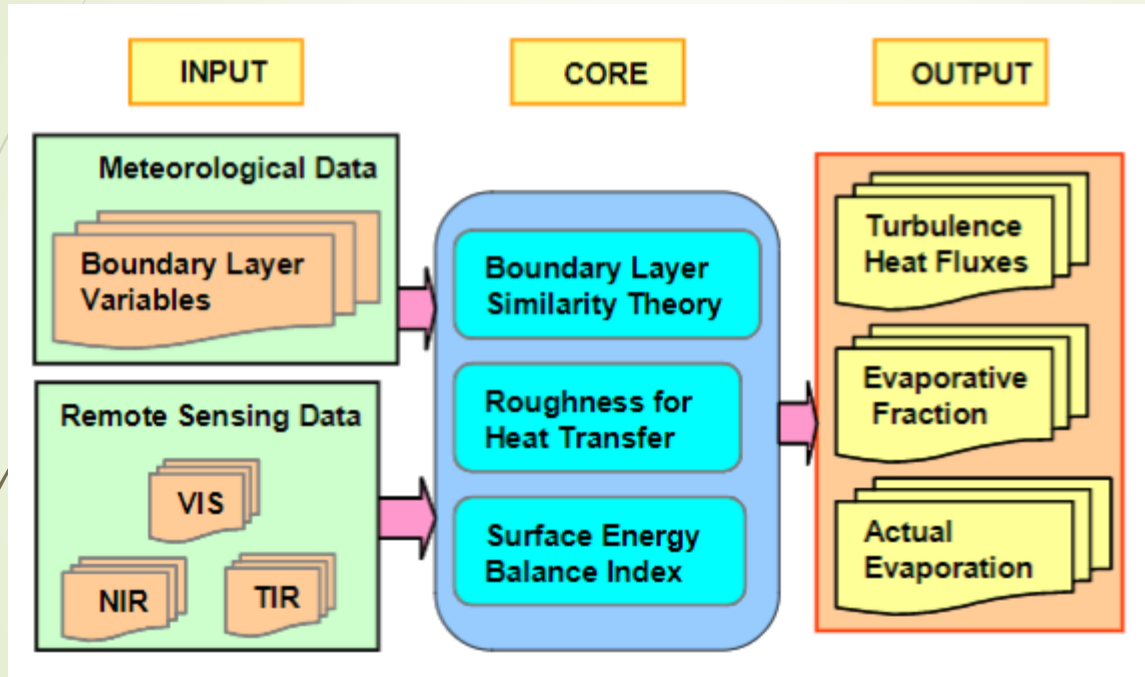
# Soil moisture retrieval guided by topography and river network

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- ❑ Knowledge of soil moisture dynamics in floodplains provides:
- ❑ scientific insights towards understanding the functioning of floodplains &
- ❑ Supporting livelihoods through recession farming.

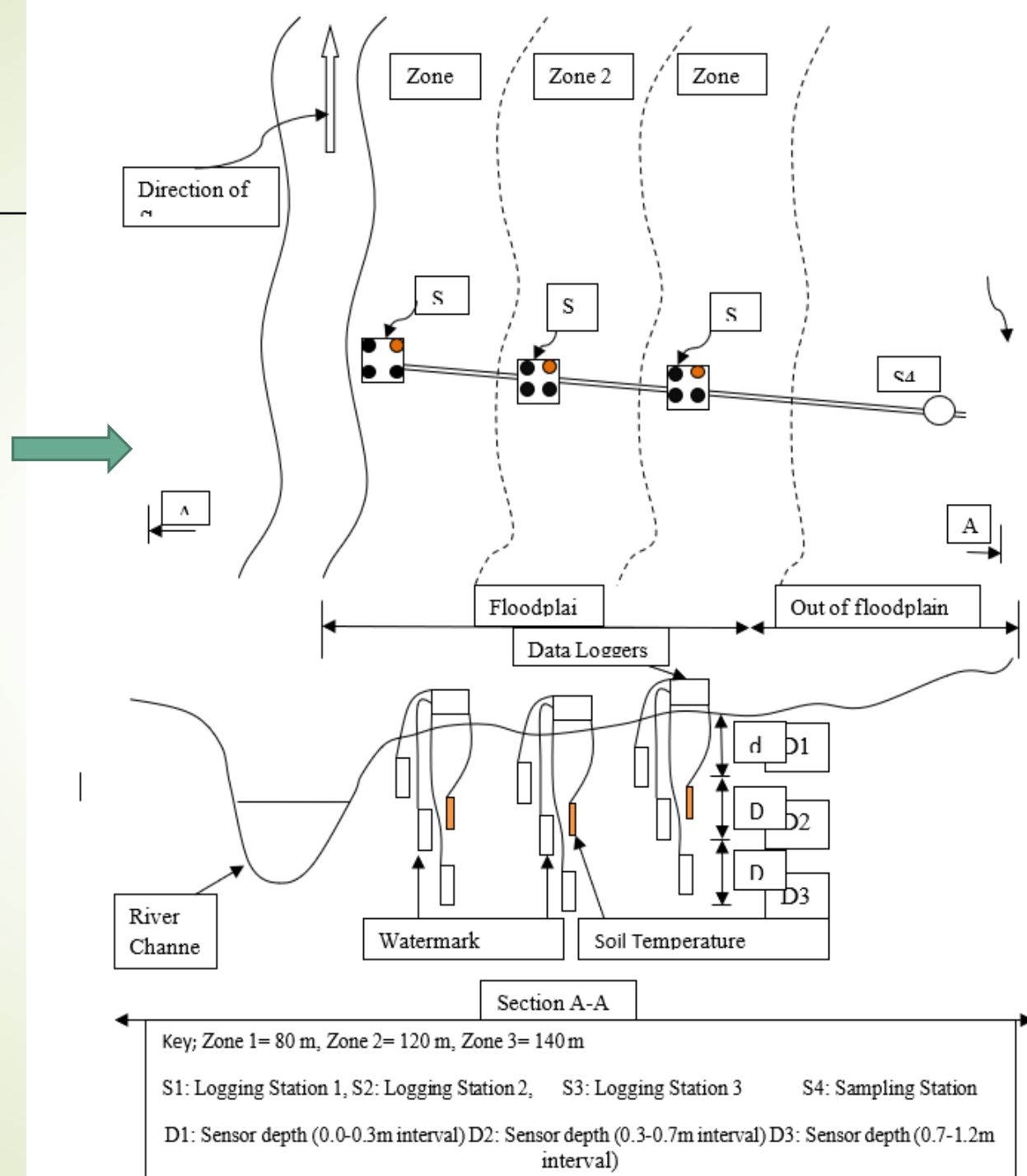
## ❑ Surface Energy Balance System (SEBS)



- ❑ TOPographic driven MODEL (TOPMODEL)
- ❑ Data loggers &
- ❑ Ground based gravimetric measurements
- ❑ An upscaling procedure to improve the comparison

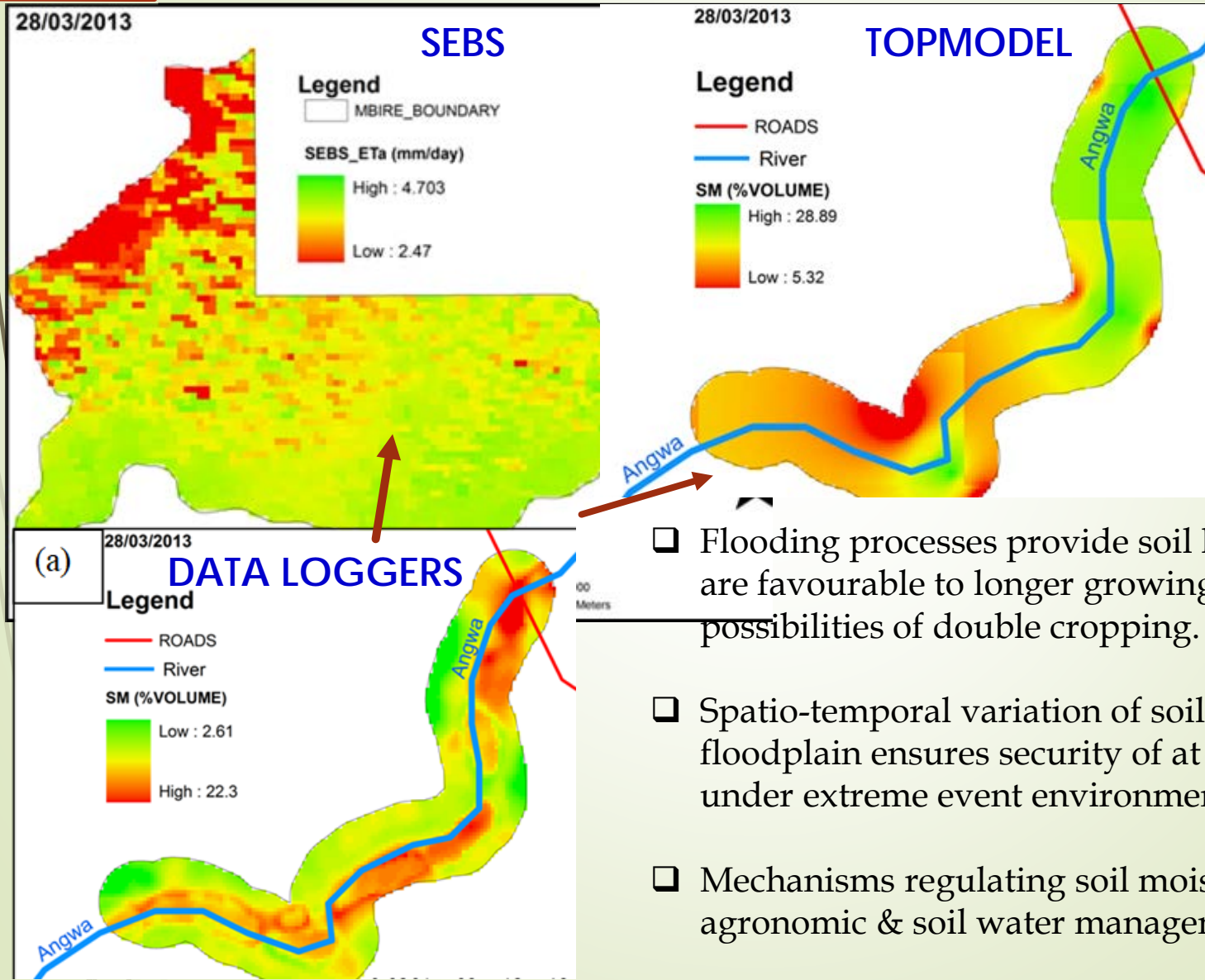


Schematic illustration  
of soil moisture  
logging stations at a  
Zambezi tributary



# Spatial variation of soil moisture important in drylands

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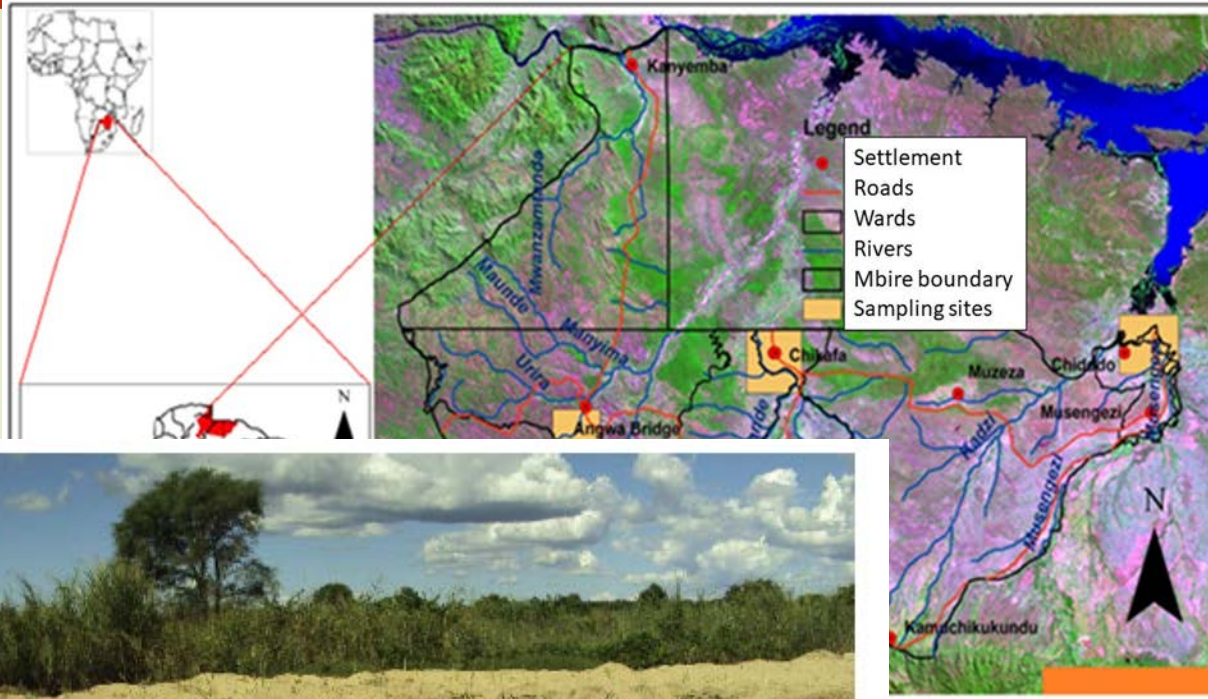
- ❑ Flooding processes provide soil hydrodynamics that are favourable to longer growing seasons and with possibilities of double cropping.
- ❑ Spatio-temporal variation of soil moisture across floodplain ensures security of at least some harvest under extreme event environments such as flooding.
- ❑ Mechanisms regulating soil moisture dynamics affect agronomic & soil water management practices

# Land evaluation for floodplain agriculture



# Land suitability assessment

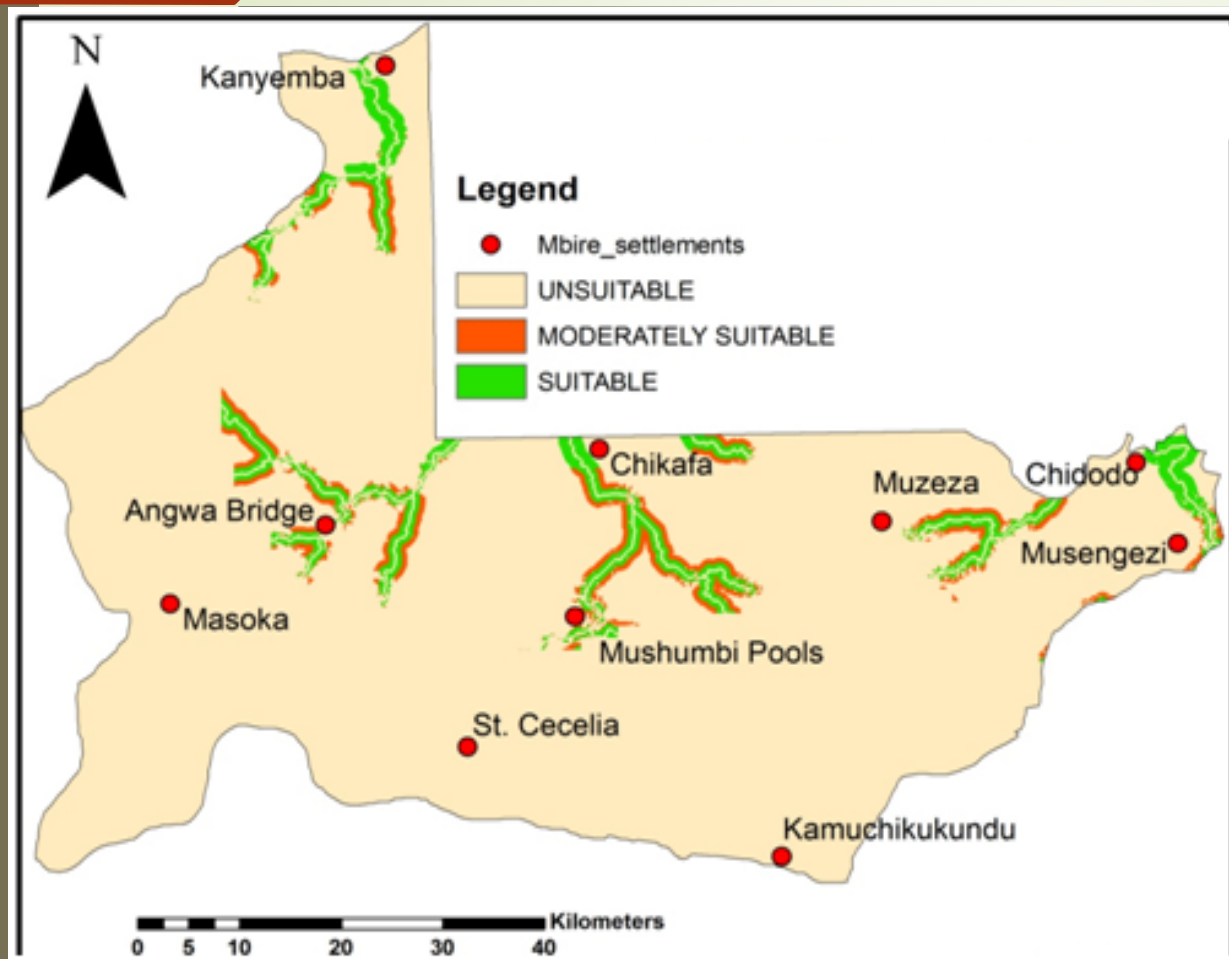
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- Land suitability analysis for flood recession farming
- Performed in a GIS environment
  - ✓ soil moisture maps
  - ✓ distance from stream network
  - ✓ vertical channel distance
  - ✓ land use/cover datasets
  - ✓ Soil properties

## Land evaluation for floodplain agriculture

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- Suitable areas for recession farming identified
- Most suitable land is located close to the Zambezi River tributaries due to the effect of back flows on residual soil moisture accumulation
- Information crucial to farmers
- Ensures food security
- Environmental considerations.

**Landcover & Climate change  
&  
Hydrological impact  
assessment Zambezi River  
basin**

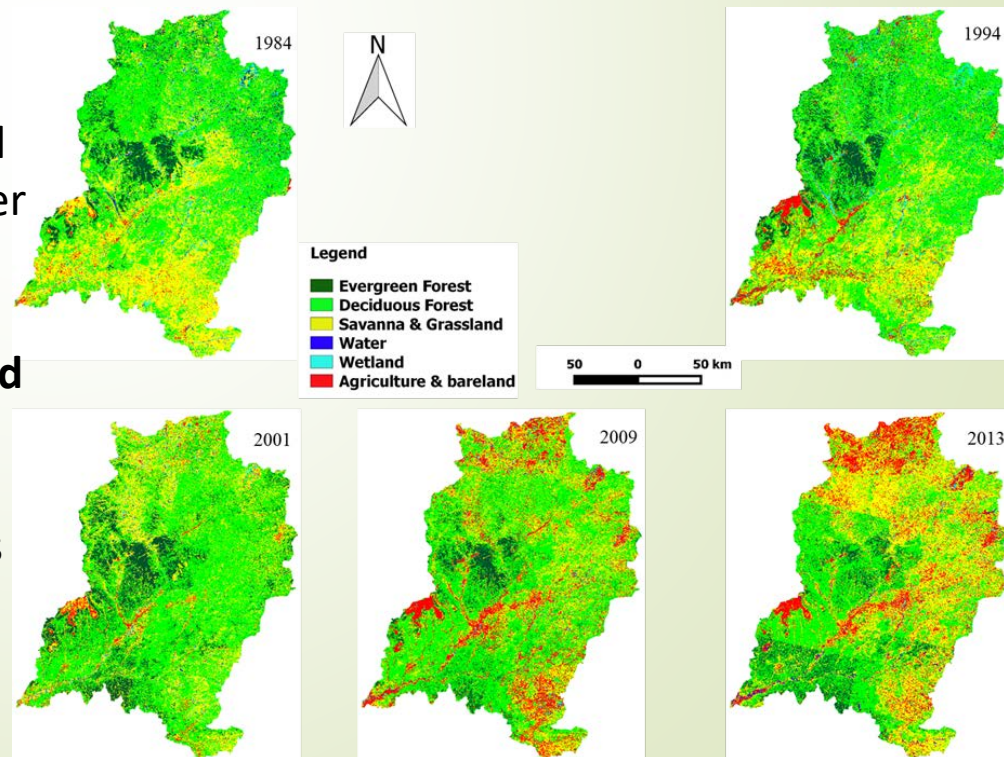
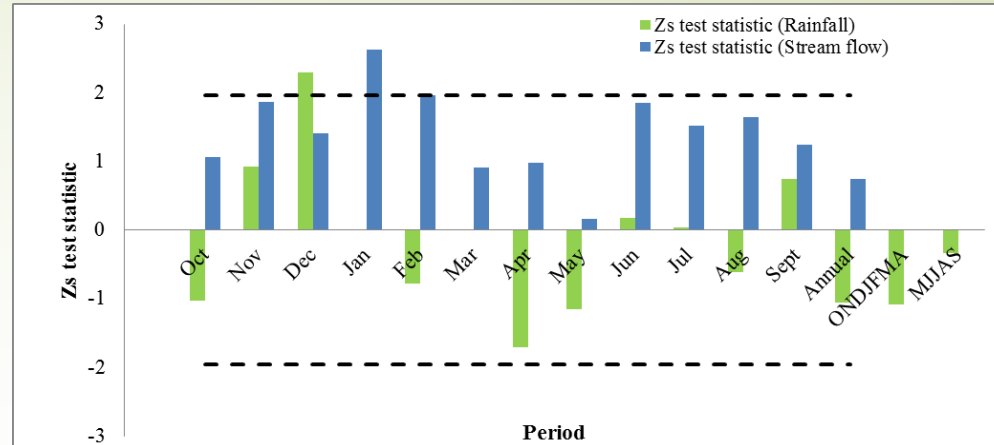


- ❑ Recent reports on the remote and inaccessible Zambezi River Basin suggest that the runoff regime has changed over the past decades.
- ❑ We identified the causes of the regime change by climate and land cover change.
- ❑ Trend analysis and statistical tests are performed to assess if climate change has affected the basin.
- ❑ Tests are followed by analysis of streamflow characteristics and analysis of land cover changes using Landsat satellite images

# Rainfall, runoff & land cover changes & implications on Kabompo runoff

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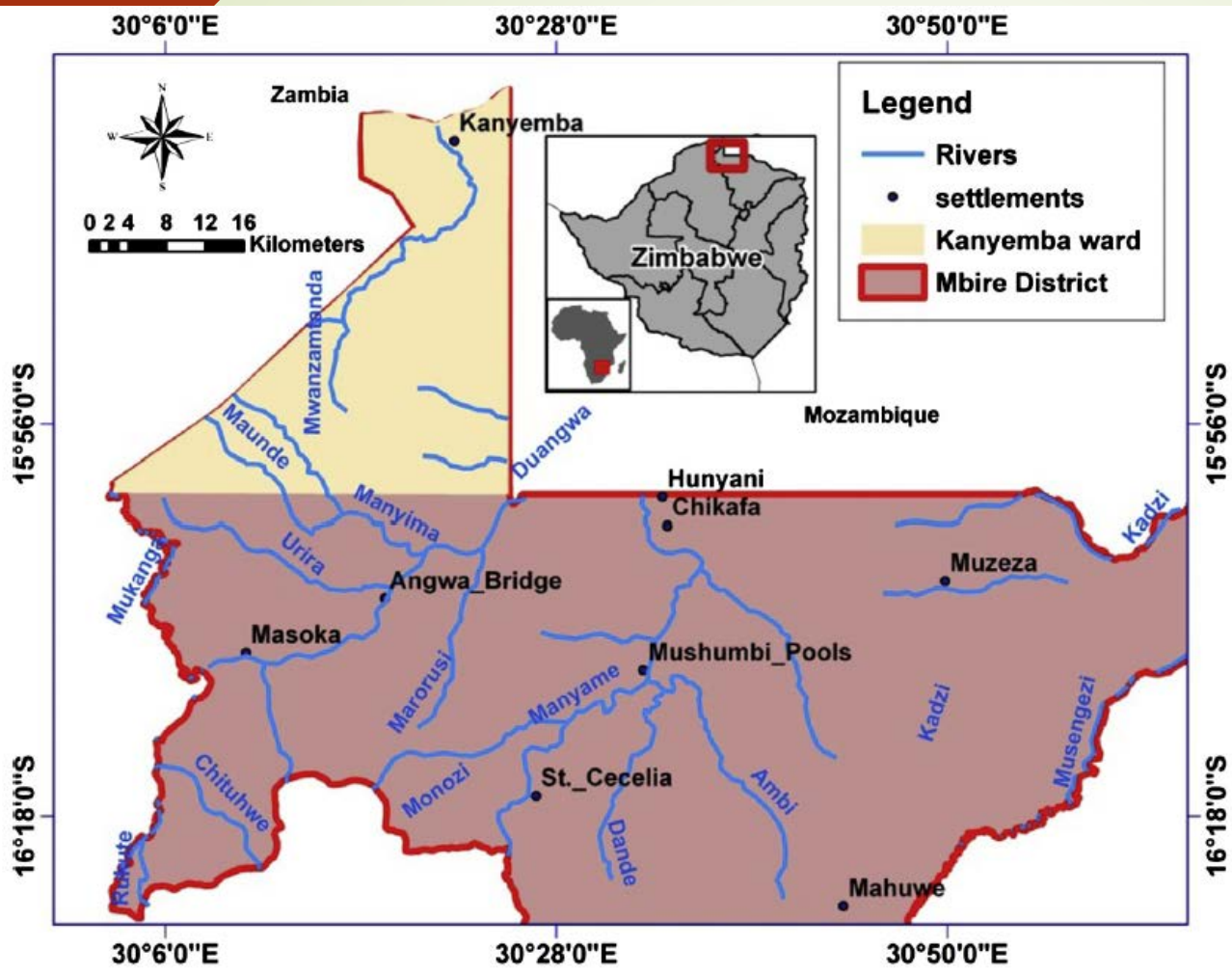
- ❑ Opposing trends in rainfall and streamflow
- ❑ This implies that any change in monthly and annual streamflow is caused by changes in land use change.
- ❑ Conversion of forested area and savannah woodlands in cultivated and grazing lands has implications on water balance
- ❑ **Above have implications on water and food security in data scarce regions**
- ❑ Similar work with hydrological models such as HBV, HEC-HMS in the other Zambezi basin showed similar results



# **Coping with droughts and floods in the fertile Zambezi floodplains**

# Coping with droughts in the Zambezi floodplains

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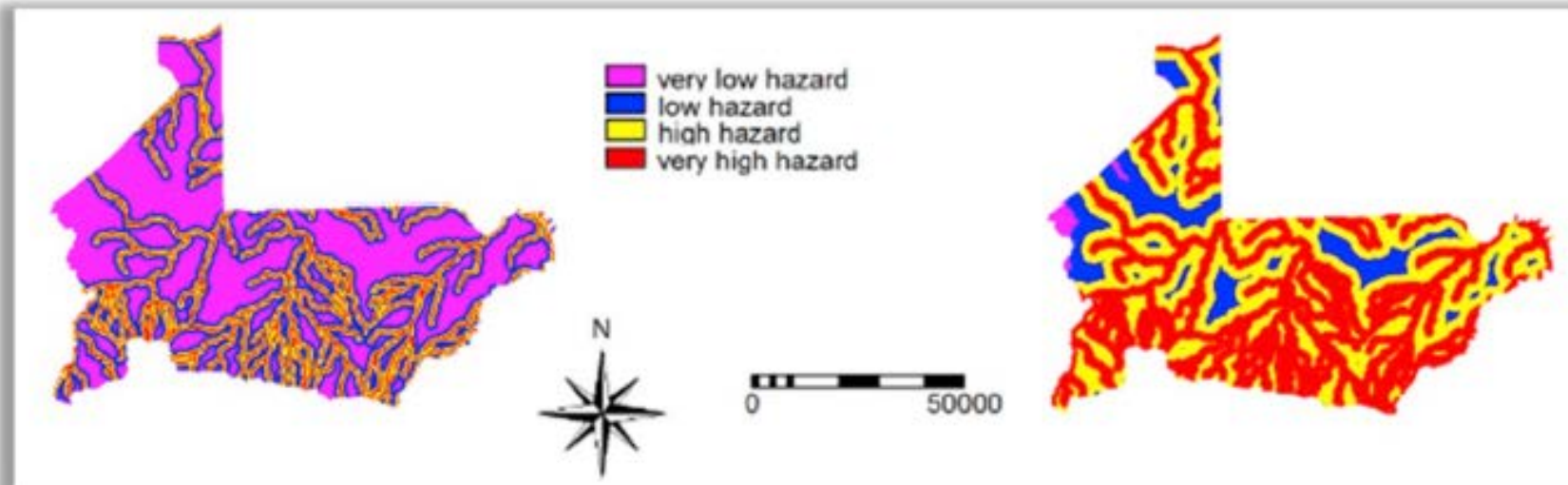
- Coping mechanisms identified
- Tighten adaptation measures
  - ✓ cultivation of drought-resistant crop varieties
  - ✓ Irrigation
  - ✓ off-farm employment opportunities.



# Coping with floods in the fertile Zambezi floodplains



- ❑ Coping mechanisms should involve communities
- ❑ Participatory GIS and earth observation approaches
- ❑ Impactful research that leads to positive policy and practice change in floodplains



## Recommendations for future work

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- ❑ There is much scope and linkage's with Breccia focus themes
  - ❑ *Upscaling sustainable food and water security research in drylands of sub-Saharan Africa*
- ❑ In data scarce drylands, earth observation techniques allows for timely retrieval of water cycle components to improve food and water security
- ❑ Research need to be implemented on the ground via several upscaling approaches
- ❑ Policy makers and communities need to be engaged at every stage of the research process

## Acknowledgements

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Thank you.