# EO technologies for flood mapping and hydrological modelling in Namibia

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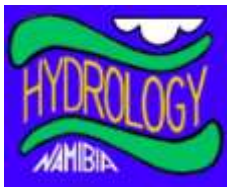
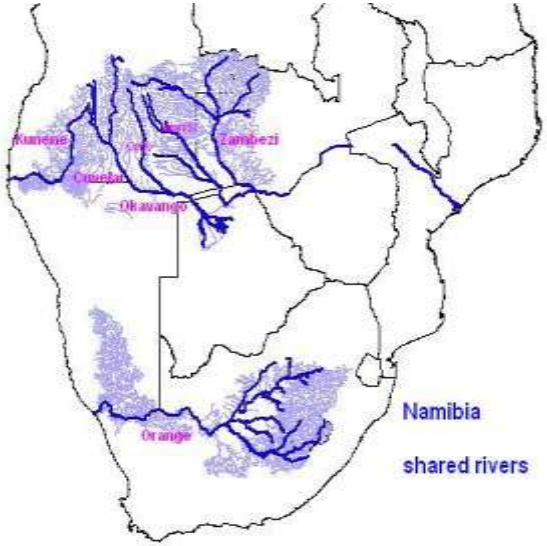



# EO technologies for flood management in Namibia



# EO technologies for flood management in Namibia

## Hydrological trends in Namibia:

- **Precipitations and riverflows seasonal and highly variable**
- **1980s and 1990s rainfalls and riverflows were in general below-average**
- **Since 2000 rainfalls and riverflows have been in general above-average**
- **Exceptionally high rainfalls and floods in 2008, 2009, 2010 and 2011**
  - Windhoek rainfall:
    - 2010/11: > 1,000 mm, highest on record and 3 x normal (350 mm)
  - Zambezi River:
    - 2009: highest maximum (flood peak) since 1969
    - 2010 and 2011: lower peak, but longer duration and higher volume
  - Kwando River:
    - 2010: highest on record
  - Okavango River :
    - 2009 and again 2010: highest maximum (flood peak) since 1969
    - 2011: lower peak, but longer duration and higher volume
  - Cuvelai River :
    - 2008: “highest flood in living memory”
    - 2009: higher than 2008
    - 2010: slightly lower
    - 2011: again higher than 2009
  - Kunene River :
    - 2011: highest on record
- **Combined effects of climate variability and climate change?**

# EO technologies for flood management in Namibia

# EO technologies for flood management in Namibia

MAIN IMPACTS OF FLOODS:

- loss of human lives
- people moving to safer grounds and relocation camps
- waterborne diseases (malaria increase, cholera risk)
- disrupted, damaged and destroyed infrastructure and businesses
- interrupted access to schools, health services and other services
- set back socio-economic progress in the area and for Namibia as a whole

*2009 FLOOD DISASTER IMPACT:*

- *6 (out of 13) Regions in Namibia*
- *677,000 people affected (1/3 of Namibian population)*
- *105 people dead*
- *56,000 people displaced*
- *328 schools affected*
- *94,000 school children affected*

2009 POST DISASTER NEEDS ASSESSMENT (PDNA):

- *Direct damages 136.4 US$ million*
  *Housing, transport, commerce, industry*
- *Indirect losses: 78.2 US$ million*
  *Commerce, industry, agriculture, utilities*
- *Macro-economic impact: 0.6 % on Gross Domestic Product (GDP) of Namibia*
- *Recovery and reconstruction needs: 622.1 US$ million*

## EO APPLICATION 1: AREAL PRECIPITATION MONITORING

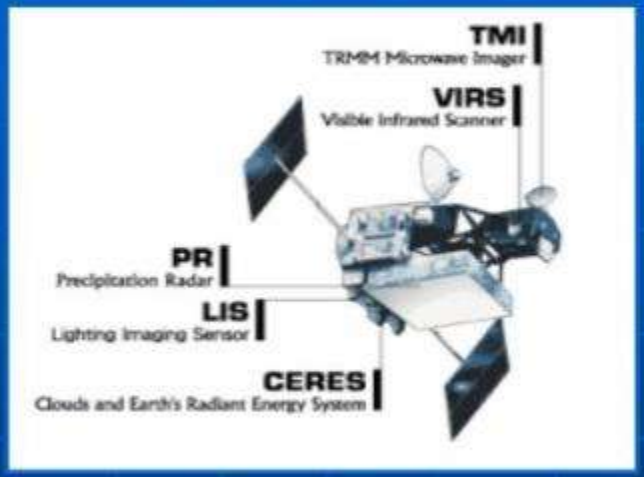
- Physics of convective storms:
  vertical build-up → cooling → condensation
- Infra-red sensors indicate temperature and rainfall potential
- Combination with other bands that reflect cloud physics + moisture conditions
- Calibration issue

USED IN NAMIBIA

- MeteoSat satellite:
  - 15 minutes interval cloud images
- Eumetsat website:
  - Near-real time images and interpretation – also at night
- Various analytical processing systems - TRRM, FEWS, SWFDP, (SAR)FFGS, SERVIR, GWADI:
  - Cumulative rainfall estimates for previous 1, 3, 6, 24, 48, 72 hours
  - Calibration for Namibia? – at least qualitative image

# Principle of TRMM

- **Tropical Rainfall Measuring Mission (TRMM) is a low orbit satellite launched in 1997 by JAXA & NASA**
- **Has 5 sensors for precipitation measurement**
- **Sensors are:**
  - Visible Infrared Scanners (VIS)
  - TRMM Microwave Imager (TMI)
  - Precipitation Radar (PR)
  - Clouds & Earth's Radiant Energy System (CERES)
  - Lightning Imaging Sensor (LIS)




*Tropical Rainfall Measuring Mission (TRMM) satellite*

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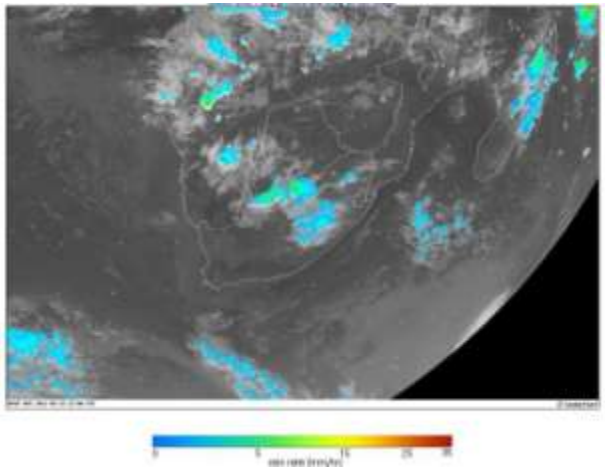
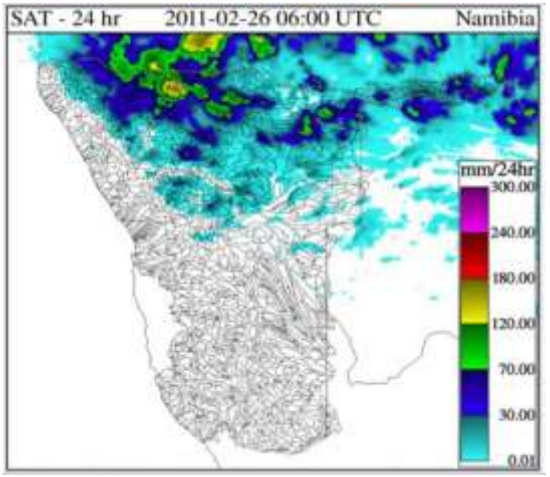
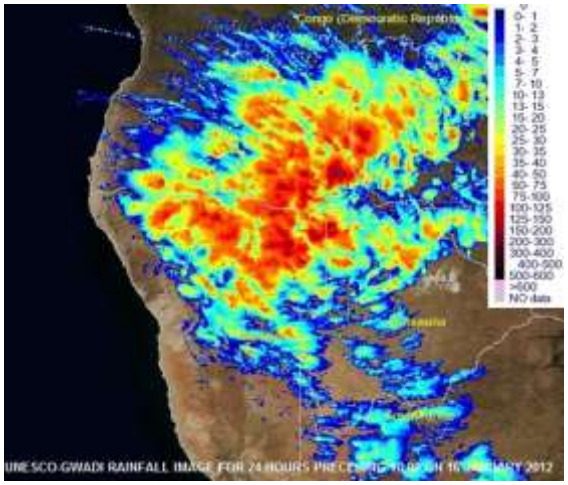
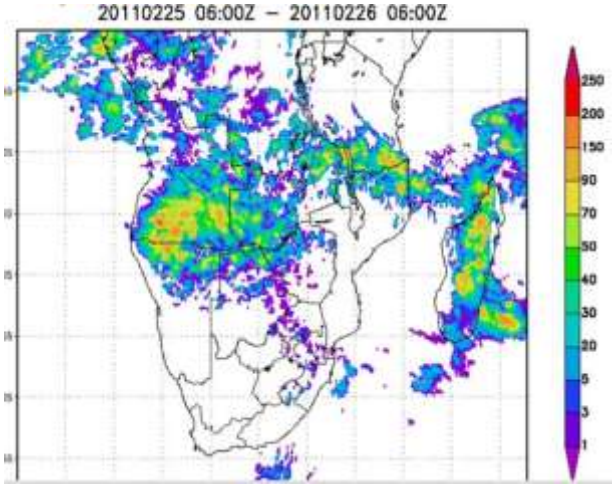
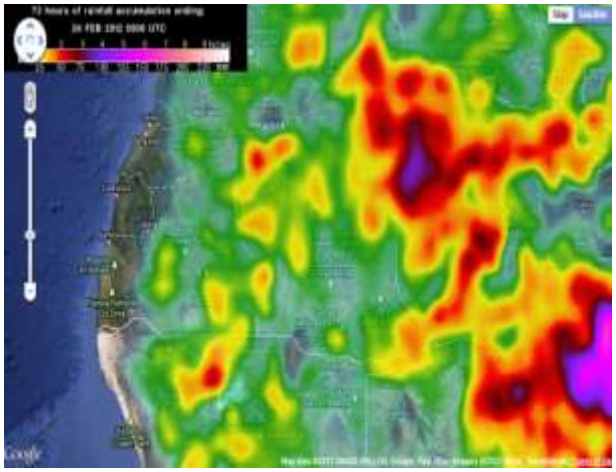




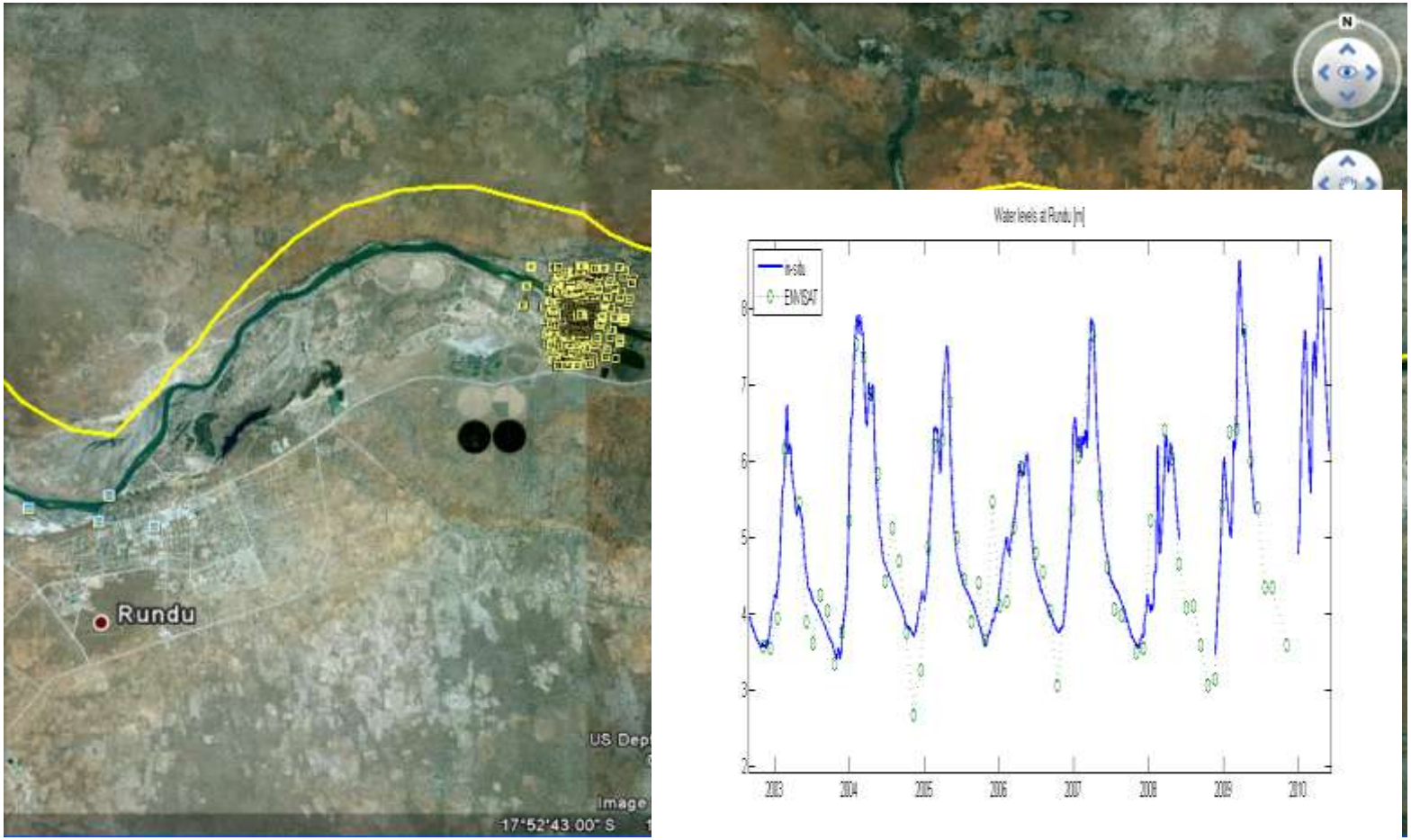


## EO APPLICATION 2: RIVERFLOW MONITORING

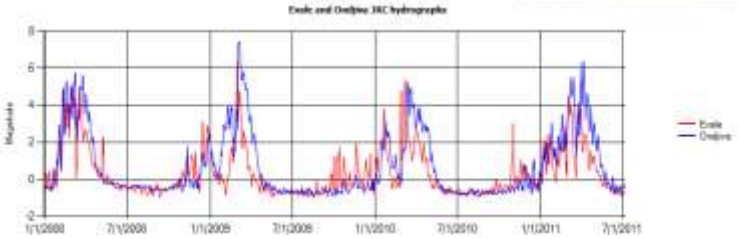
- Direct monitoring of waterlevels
  - In application for large lakes and rivers
  - In reconnaissance phase for Namibia (TIGER-NET)
  - Challenges: required width, location with direction, frequency, accuracy – absolute and relative
- Direct monitoring of flow widths (with conversion to levels)
  - Examples in literature (China)
- Indirect monitoring of flow widths (ditto) from pixel moisture
  - JRC-EU + DFO-NASA
  - **Successfully applied in Namibia for Cuvelai (and Zambezi)**
  - Challenges: suitable sections, local rainfall, spikes

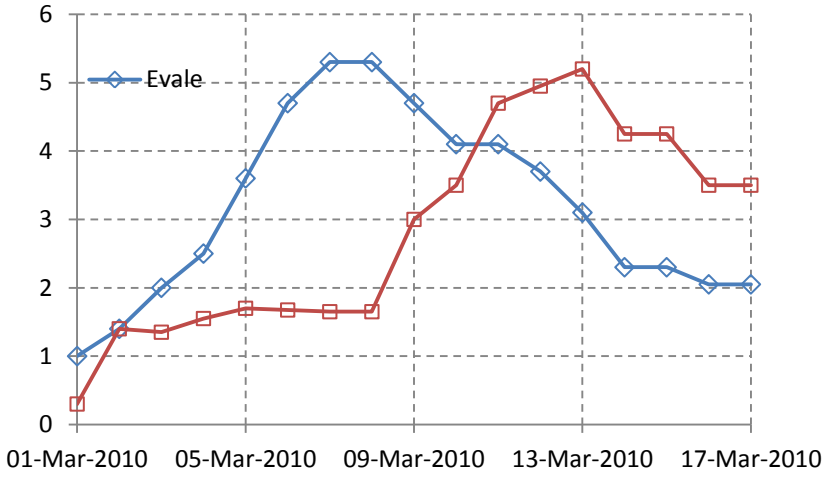
# EO technologies for flood management in Namibia



# EO technologies for flood management in Namibia

- JRC: experimental global flood detection and monitoring
  - Passive microwave remote sensing
  - AMSR-E and TMI sensors: multiple observations per day
  - Surface water changes
  - Pixels of 10x10km²
  - Very sensitive

# EO APPLICATION 3: FLOODMAPPING

## Applications

- Upstream floodwarning
- Drainage patterns
- Damages to infrastructure
  - Roads
  - Water carriers
- **Areal flood extent**
  - Preparedness
  - **Response**
  - **Long-term planning** – mitigation and measures

## Used in Namibia

- Optical:

  **MODIS**/Rapidfire (NASA), LandSat (NASA), Aster (USGS), **EO-1** (NASA). Sumbadilasat (CSIR-SAC), **SPOT** (CNES) – FormoSat (NSPO), WorldView and QuickBird (DigitalGlobe)

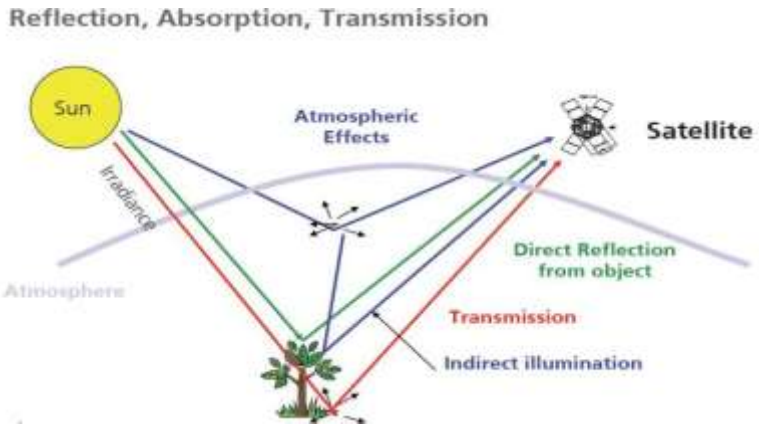
- Radar:

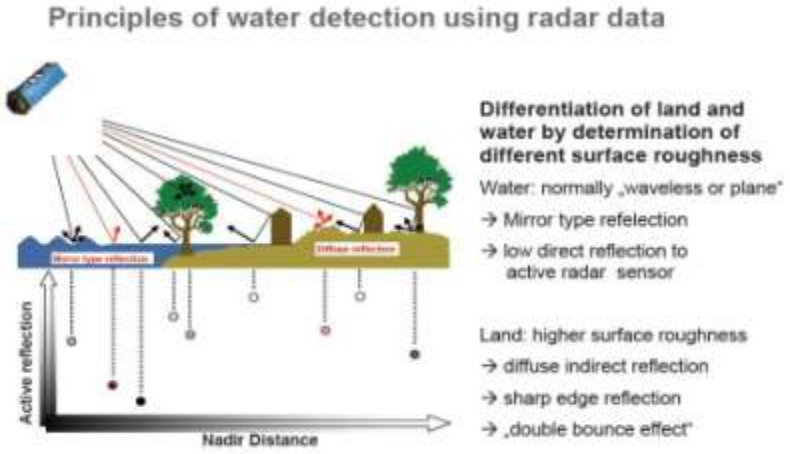
  Envisat SAR (ESA), Palsar/Alos (JAXA) , **RadarSat** (CSA), TerraSar (DLR)

# EO technologies for flood management in Namibia

## Selection of products

- Frequency of overflights
- Access to acquisition of scenes
- Near-real time availability of scenes
- Processing services/capabilities
- **Area covered <-> resolution**
- **Optical <-> Radar**
- **Cost**
- **Space Charter activation**



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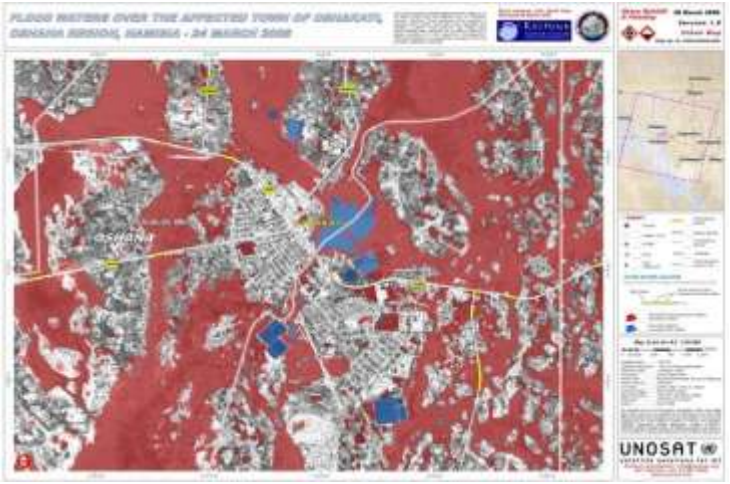


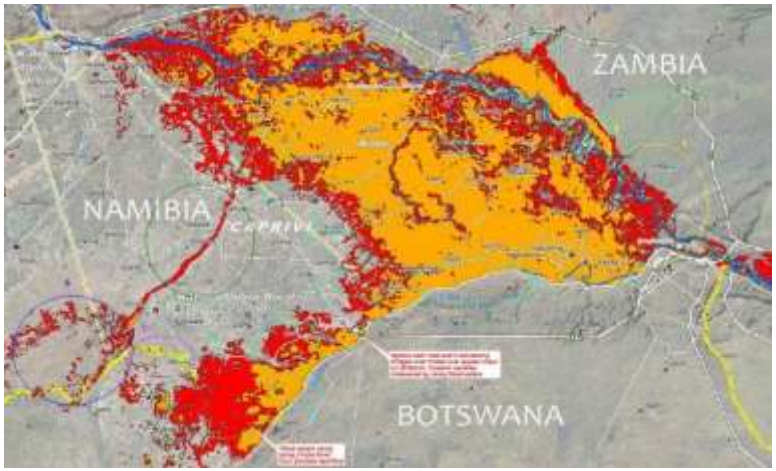

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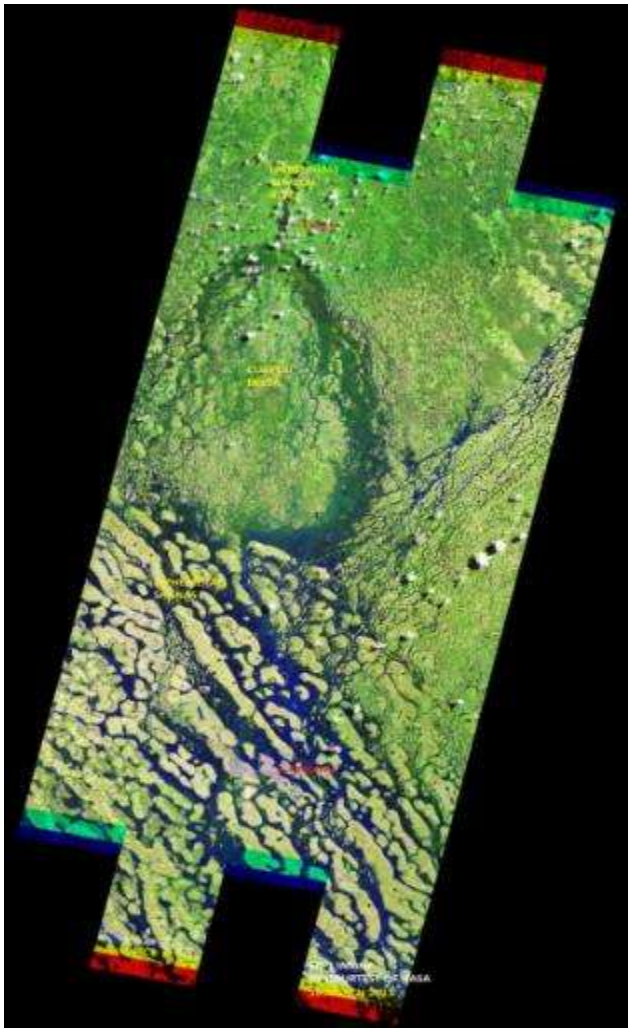
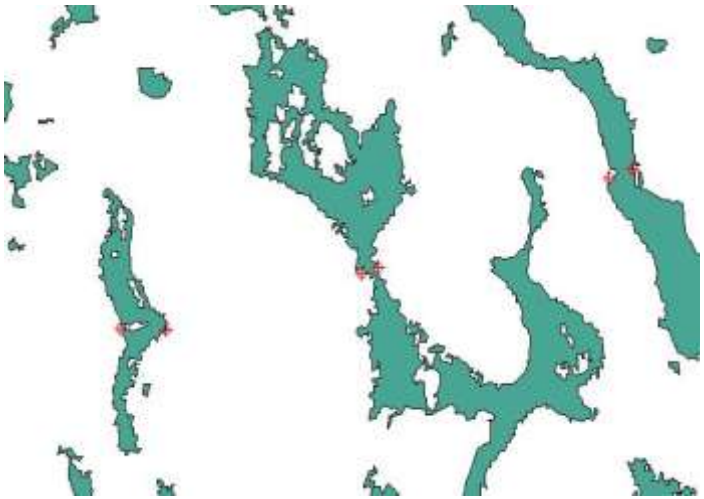
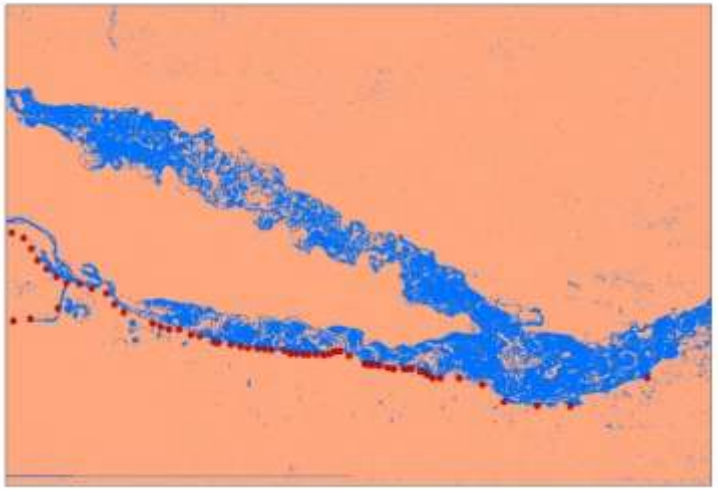


# EO technologies for flood management in Namibia

## Characteristics of radar remote sensing

- Advantages compared to optical remote sensing
  - All weather capability (small sensitivity to clouds, light rain)
  - All-day and night operation (independent from sun illumination)
  - No effects of atmospheric constituents (multi-temporal analysis)
  - Sensitivity to dielectric properties (water content, biomass, ice)
  - Increased sensitivity to surface roughness
  - Accurate measurements of distance (interferometry)
  - Sensitivity to target structure (use of polarimetry)



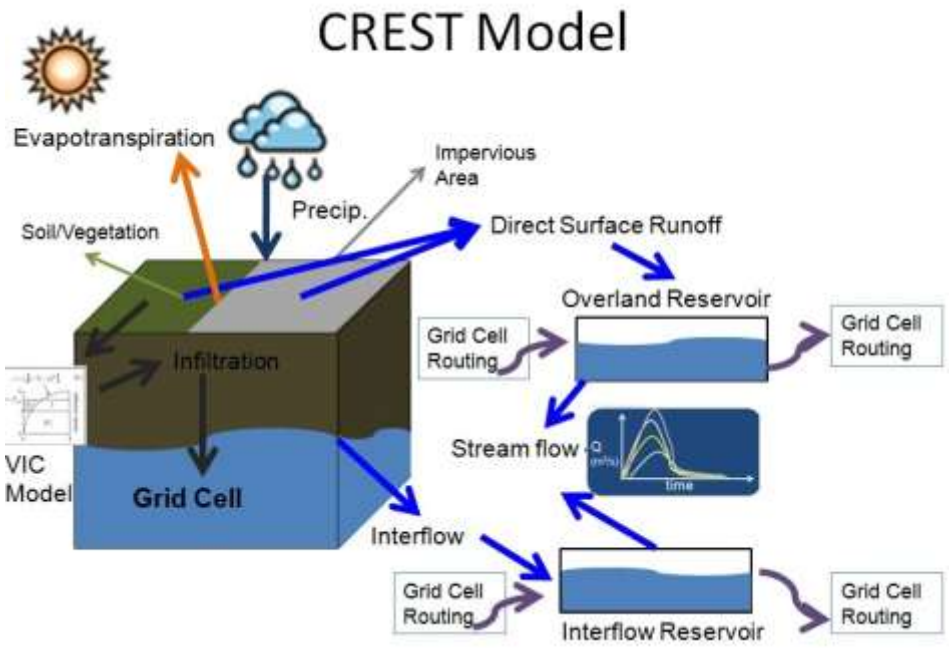


# EO APPLICATION 4: FLOOD MODELING/FORECASTING

## Testing phase

## Use near-real time information for:

- **Rainfall**
- Soil moisture
- Catchment conditions (vegetation)
- Evaporation/ evapo-transpiration



Merci

Obrigado

Thank you

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