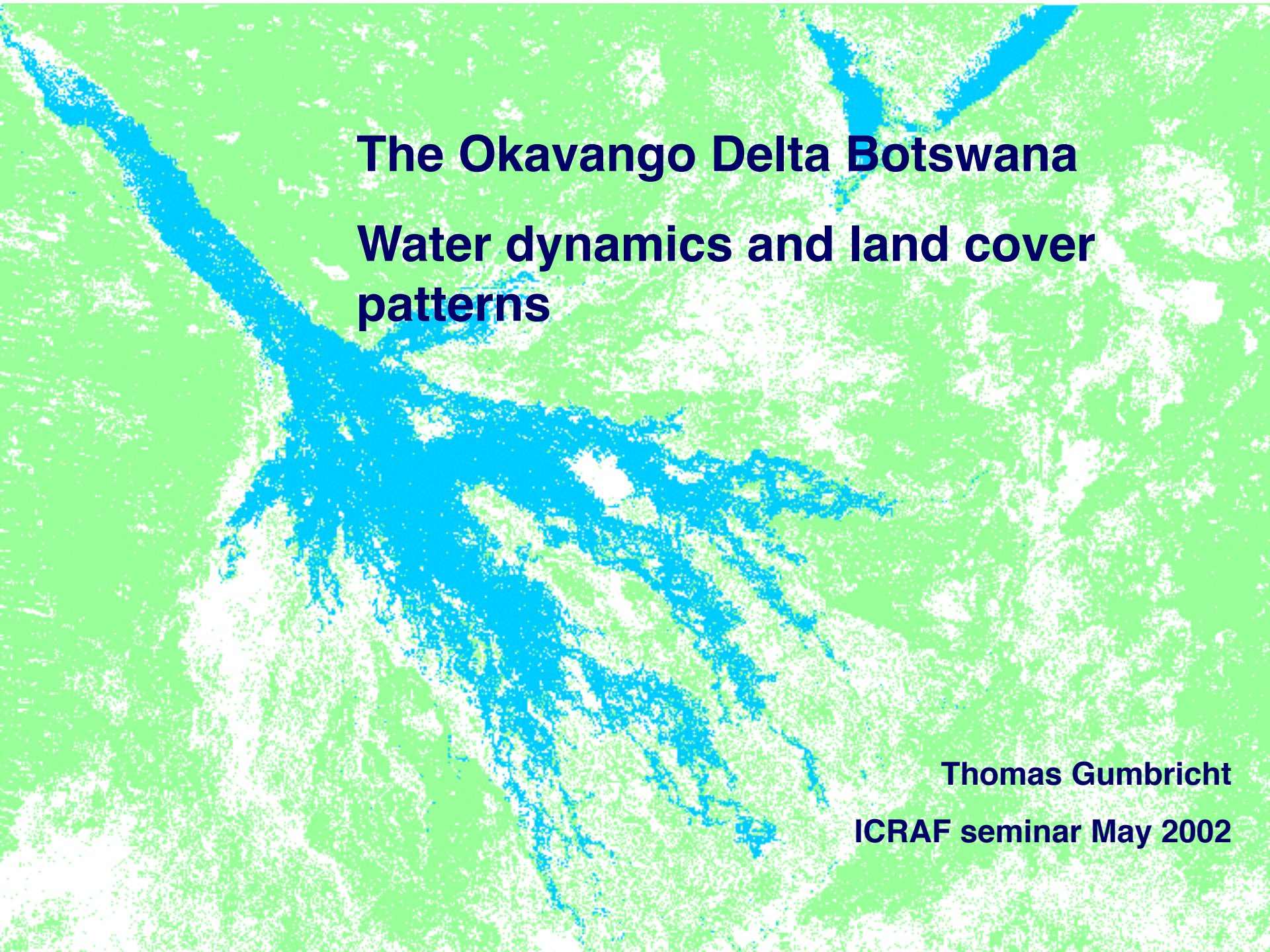


The Okavango Delta Botswana

Water dynamics and land cover patterns

Thomas Gumbricht

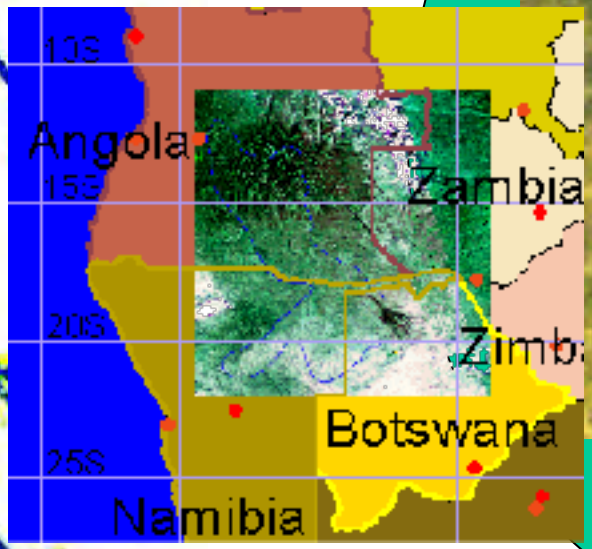
ICRAF seminar May 2002

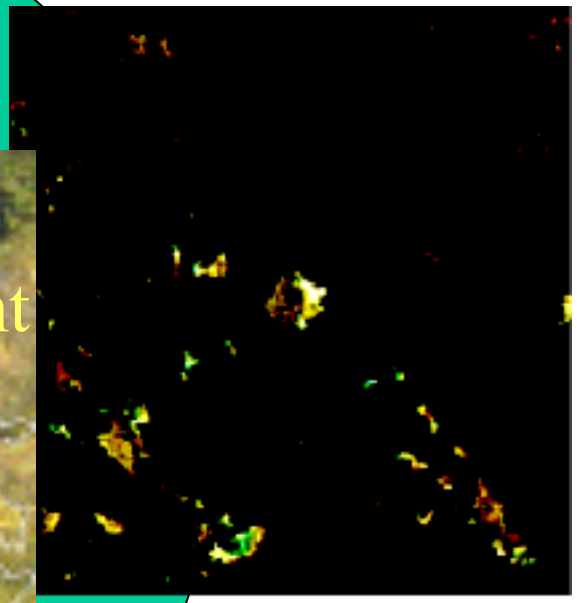
Three ”nested” hierarchical scales for portraying the natural geography of the Okavango Delta

Component scale

Main Scale

Constraining scale





The Delta

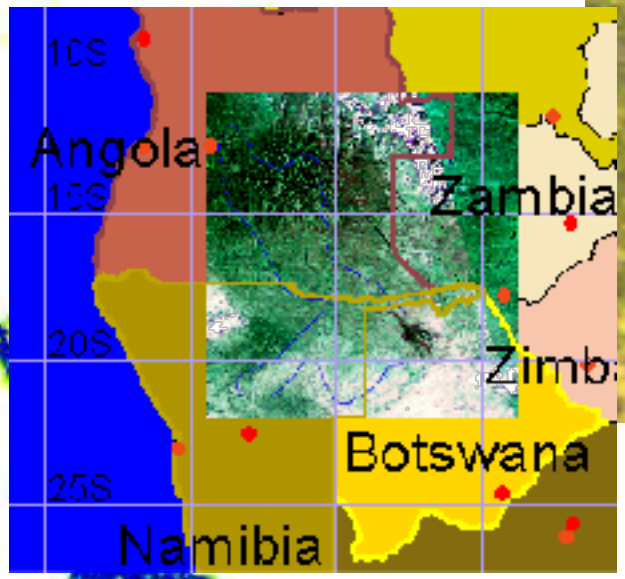
Islands, channels and lakes

The Catchment

The natural science perspective:

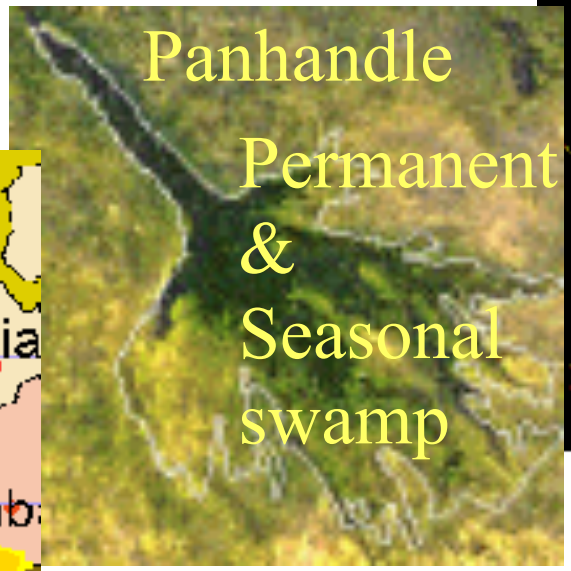
Scale related problems of the Okavango Delta

Climate variation and change. Plans for abstraction and damming of water



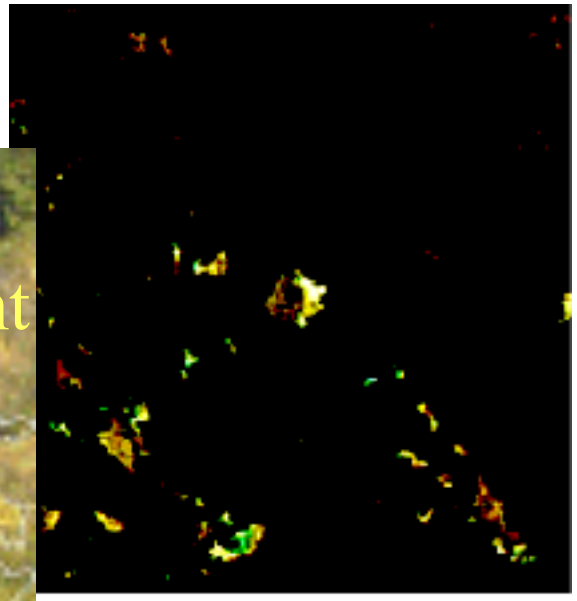
The Catchment

Poor knowledge of hydrology and floods



The Delta

Poor quantitative estimates



Islands, channels and lakes

The political perspective:

The Okavango Delta – Africa´s largest oasis

Angola

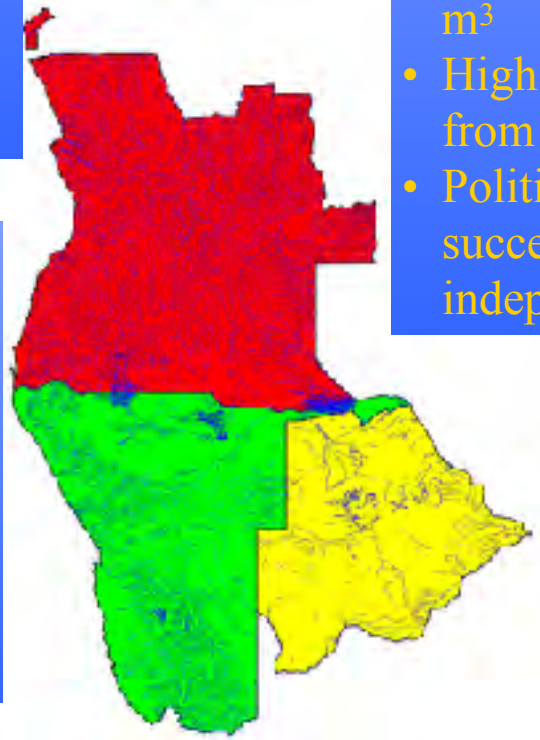
- Highlands: Humid tropical climate
- Rainfall: 1000 mm/a
- PET: 1500 mm/a
- Total annual renewable resources per capita: 14300 m^3
- High potential for hydropower generation
- Political instability

Botswana

- Arid or semiarid conditions
- Rainfall: 450 mm/a
- PET: 1800 mm/a
- Total annual renewable resources per capita: 1800 m^3
- High income generation from tourism
- Politically and economically successful since independence

Namibia

- Arid to hyperarid conditions
- Rainfall: 300 mm/a
- PET: 1800 mm/a
- Total annual renewable resources per capita: 3600 m^3
- Water scarcity threatens further development

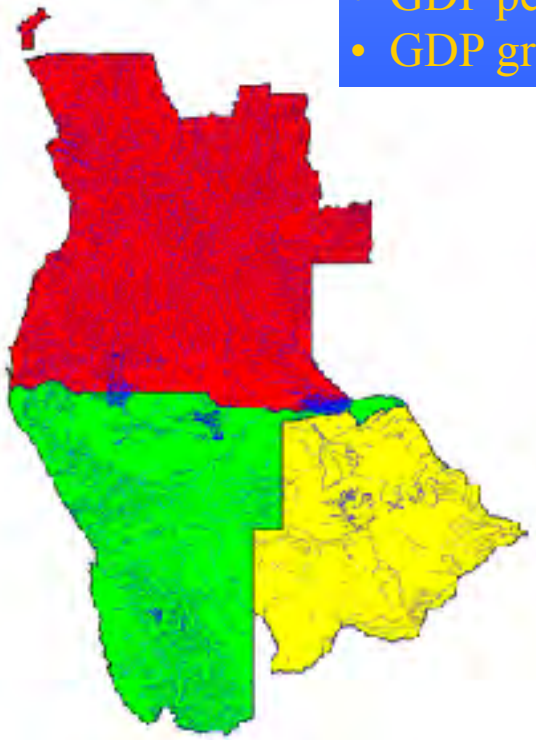


The socio-economic perspective:

The Okavango Delta – Jewel of the Kalahari

- Angola
- Population: 10.4 M
- Pop. growth rate: 2.15%
- Pop. doubling time: 33 yr
- Area: 1.25 M km2
- GDP per capita: 1000 US$/ yr
- GDP growth rate: 4.9% (2000)

- Botswana
- Population: 1.6 M
- Pop. growth rate: 0.47%
- Pop. doubling time: 148 yr
- Pop. growth pre HIV/AIDS: 4-5% (=16 yr doubling time)
- Area: 0.6 M km2
- GDP per capita: 6600 US$/yr
- GDP growth rate: 6.0% (2000)



- Namibia
- Population: 1.8 M
- Pop. growth rate: 1.4%
- Pop. doubling time: 50 yr
- Area: 0.83 M km2
- GDP per capita: 4300 US$/yr
- GDP growth rate: 4.0% (2000)

The integrated system perspective:

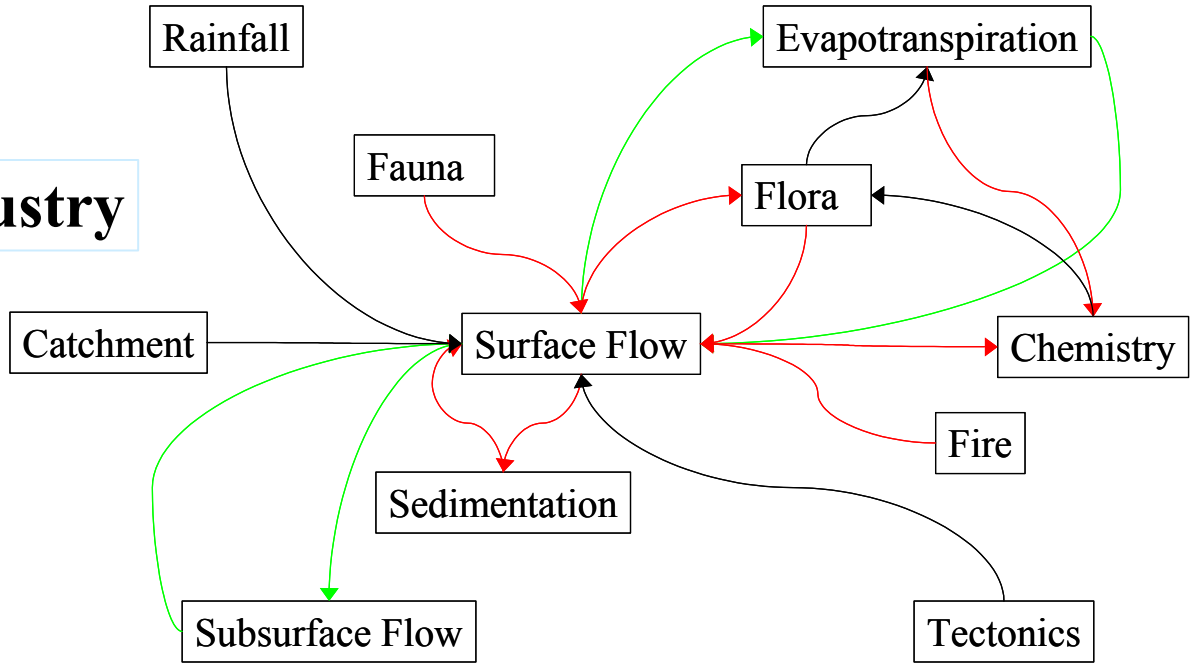
The Okavango Delta – Africa´s last eden

Domestic Use

Climate Change

Mining

Industry

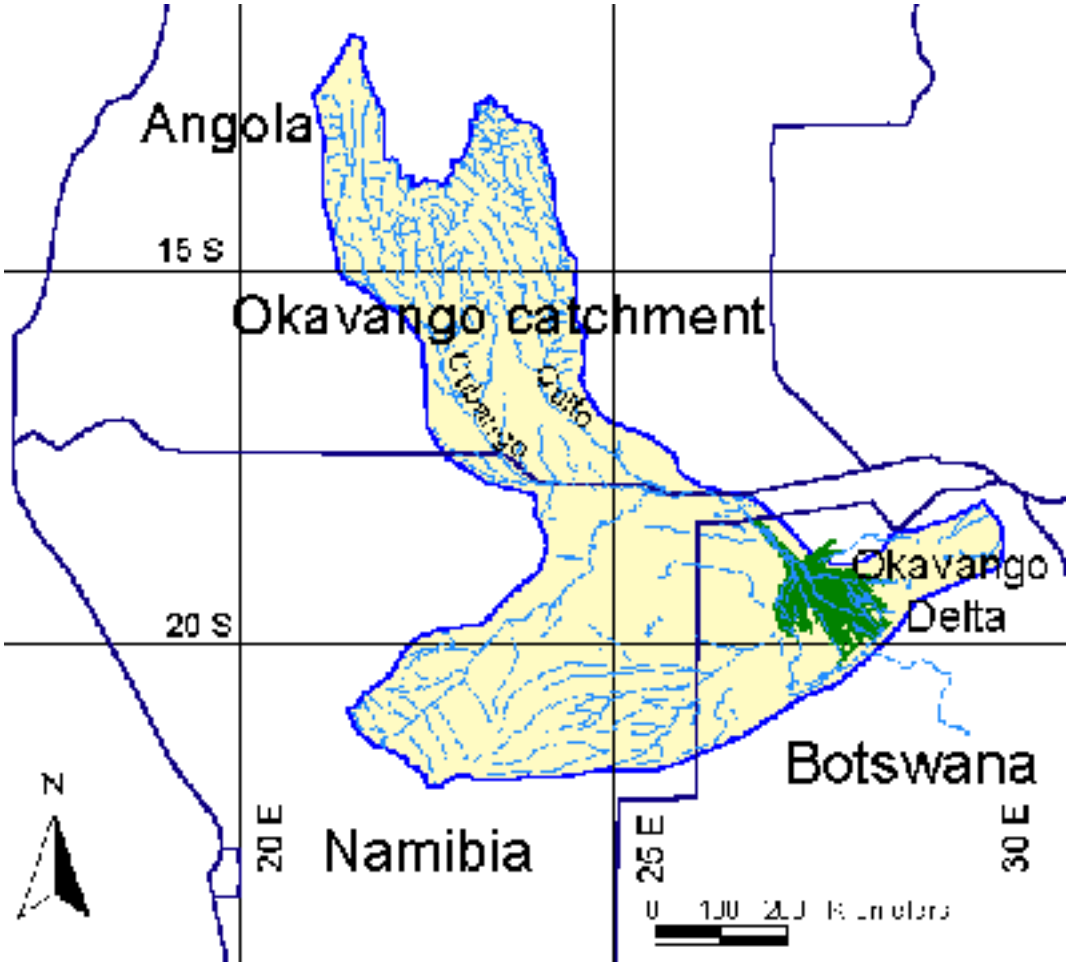


Morphological Engineering

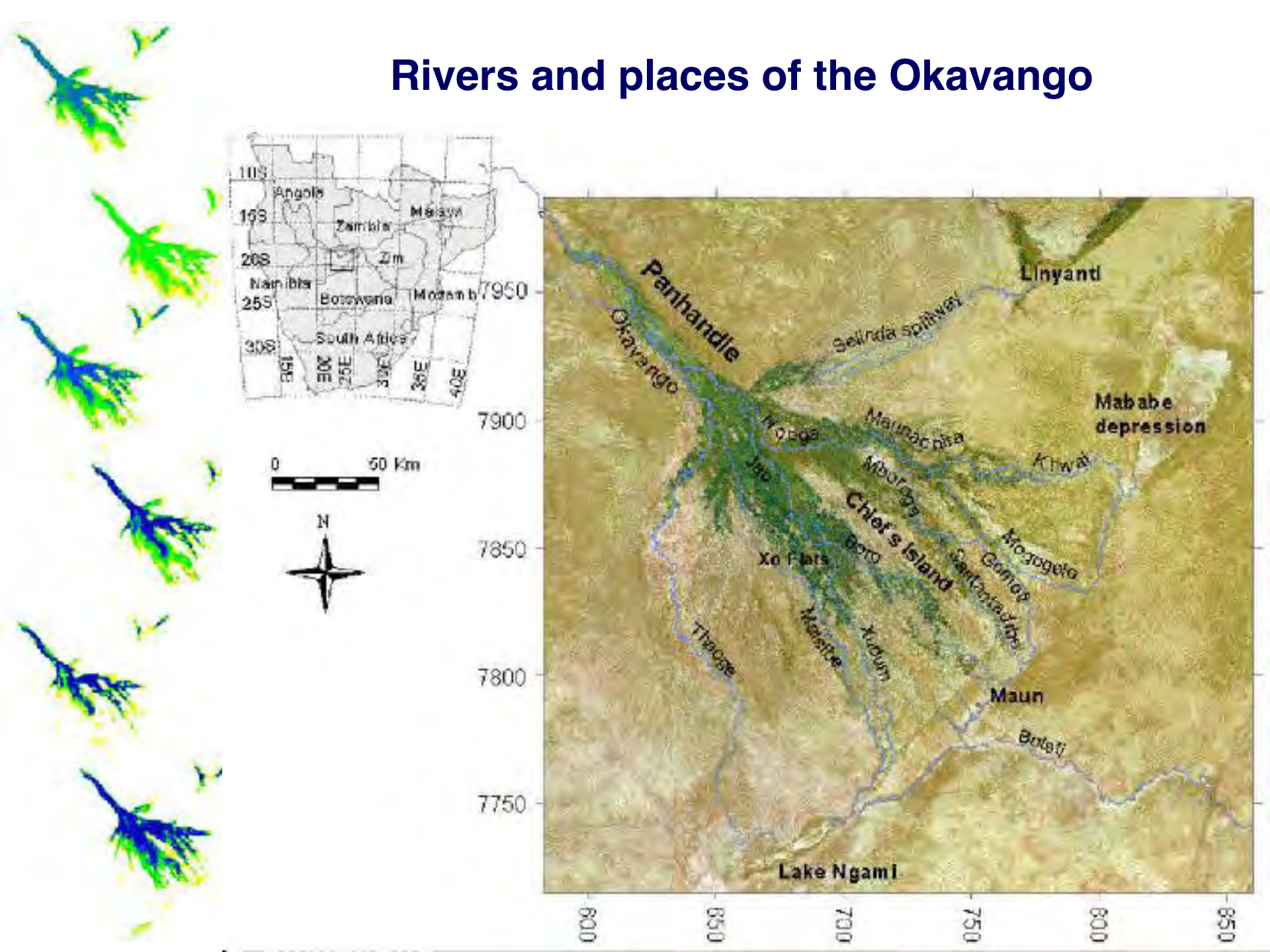
Tourism

Hydropower

Catchment area



Rivers and places of the Okavango



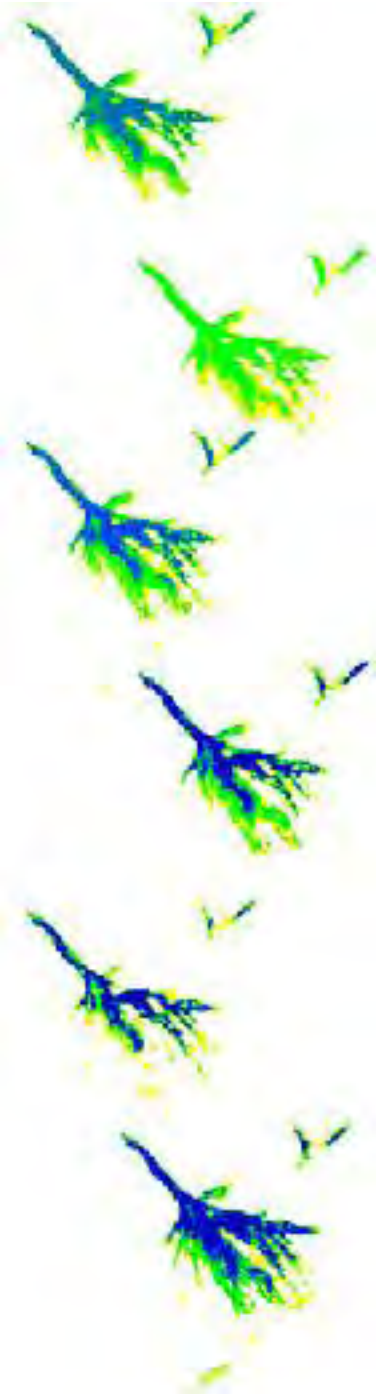

Panhandle


Permanent swamps


Seasonal swamps


Seasonal swamps, channels

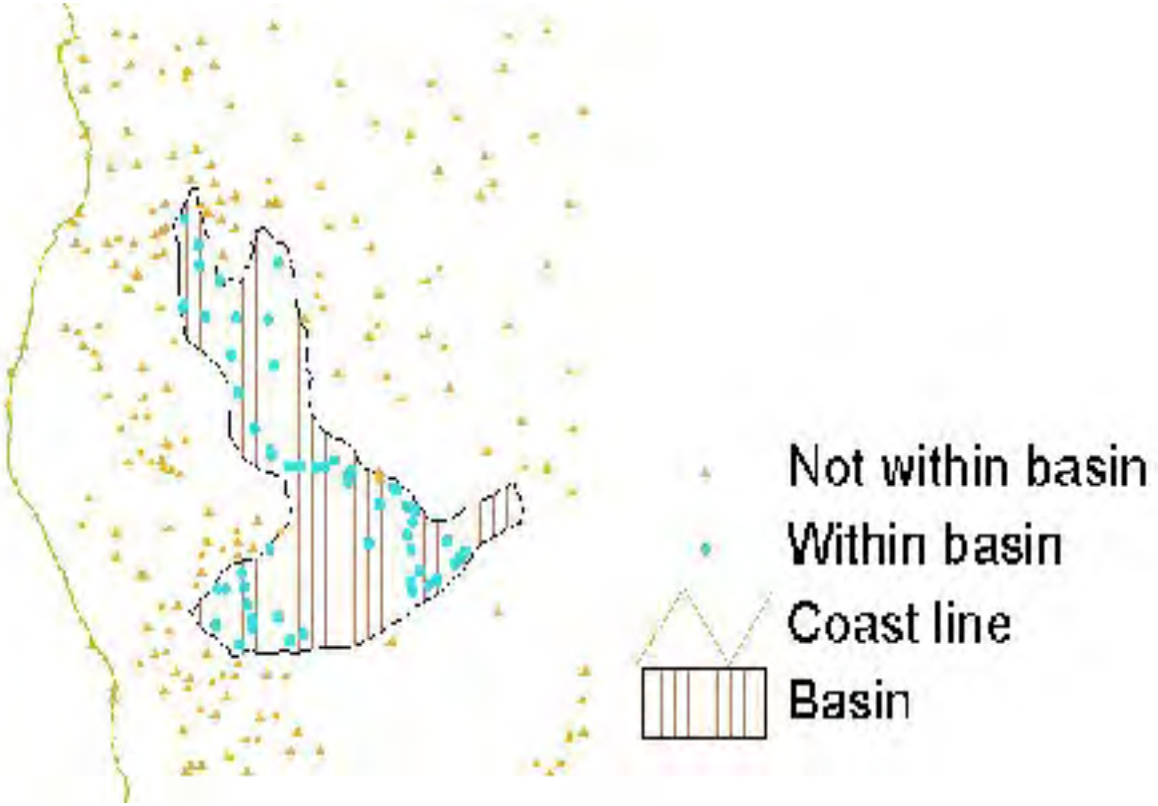
Seasonal swamps, during flood



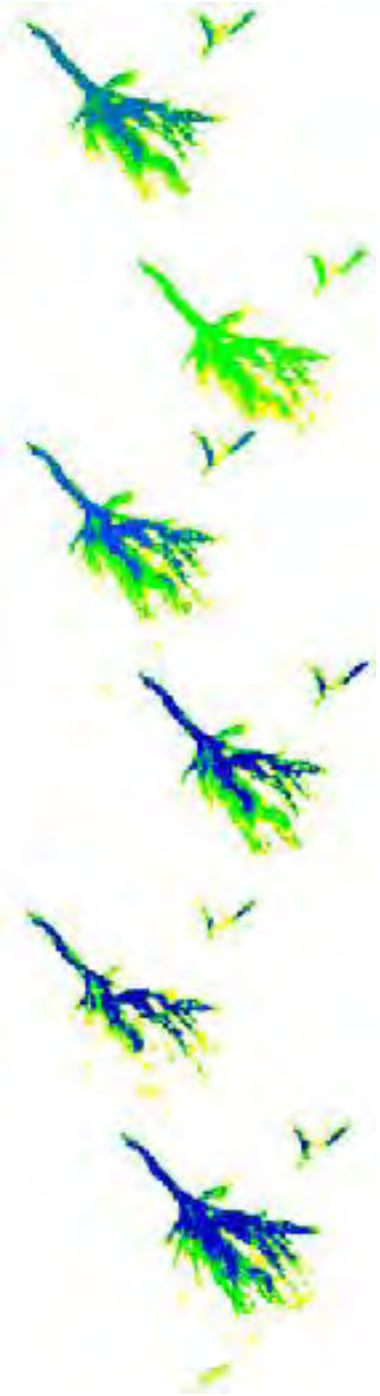
Modeling the water dynamics of the Okavango

- Water balance over the basin
- Inflow at the Panhandle
- Topography of the Delta surface
- Landcover and microtopography of the Delta surface
- Evapotranspiration and water balance of the Delta
- Historical records of inundation
- Salinity balance
- Channels, wetlands and islands directing flow
- The shifting of flow routes

Precipitation over the basin 1900 to 2000

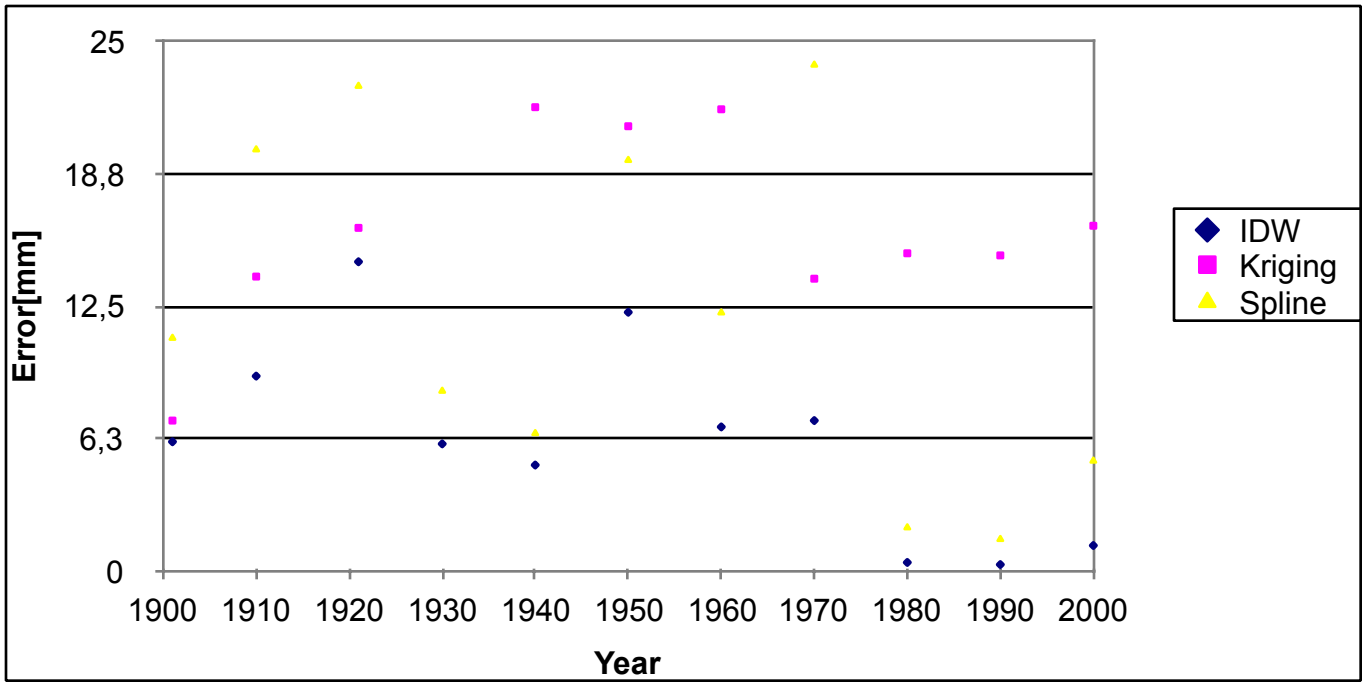


Rainfall interpolation over the basin in ArcView

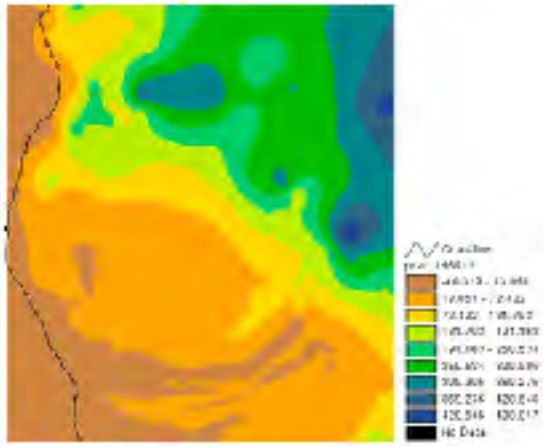


Just to remind Thomas on a side step

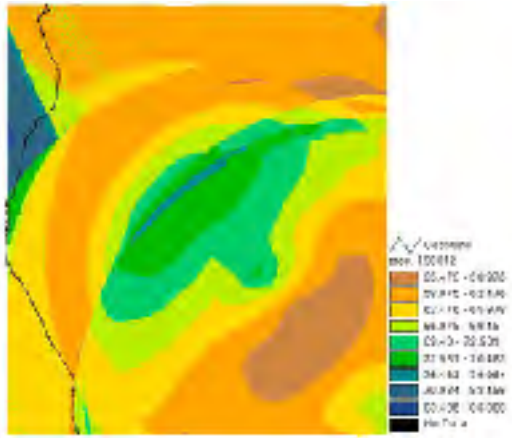
Cross-correlation of precipitation estimates for different interpolation methods



IDW results for 1969 (pre-war) and 1980



Dec
1969

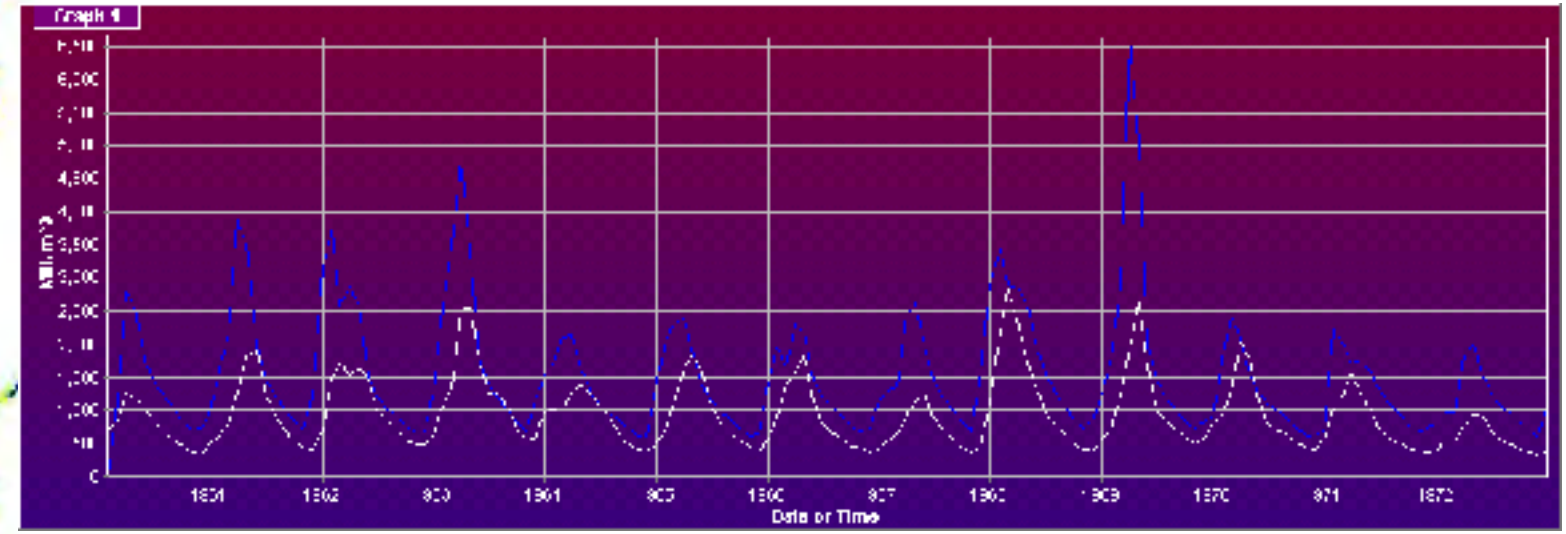


Dec
1980

Further developments:

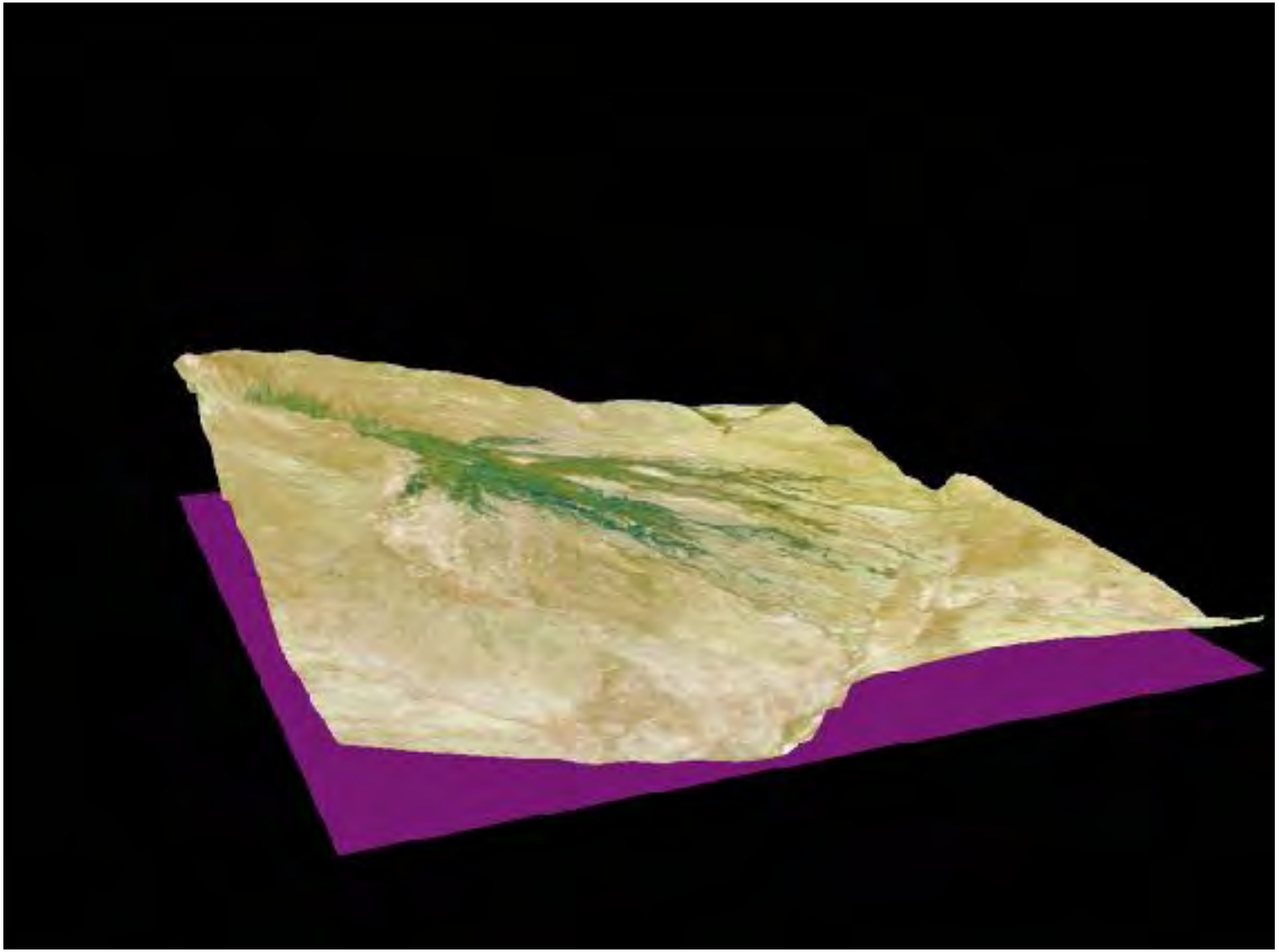
- FEWS precipitation estimates (meteosat CCT)
- TRMM precipitation estimates
- NOAA-AVHRR derived NDVI as a proxy for rain

Pitman model for basin runoff – input to the Panhandle

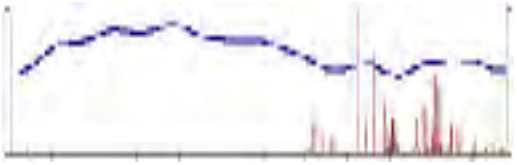


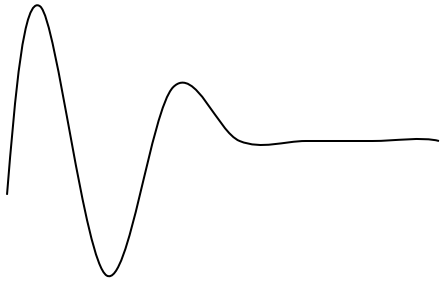
First results for the Mukwe station (Angola) 1961 to 1972 (blue measured, white modeled)

Topography and water flow



Topography and water flow

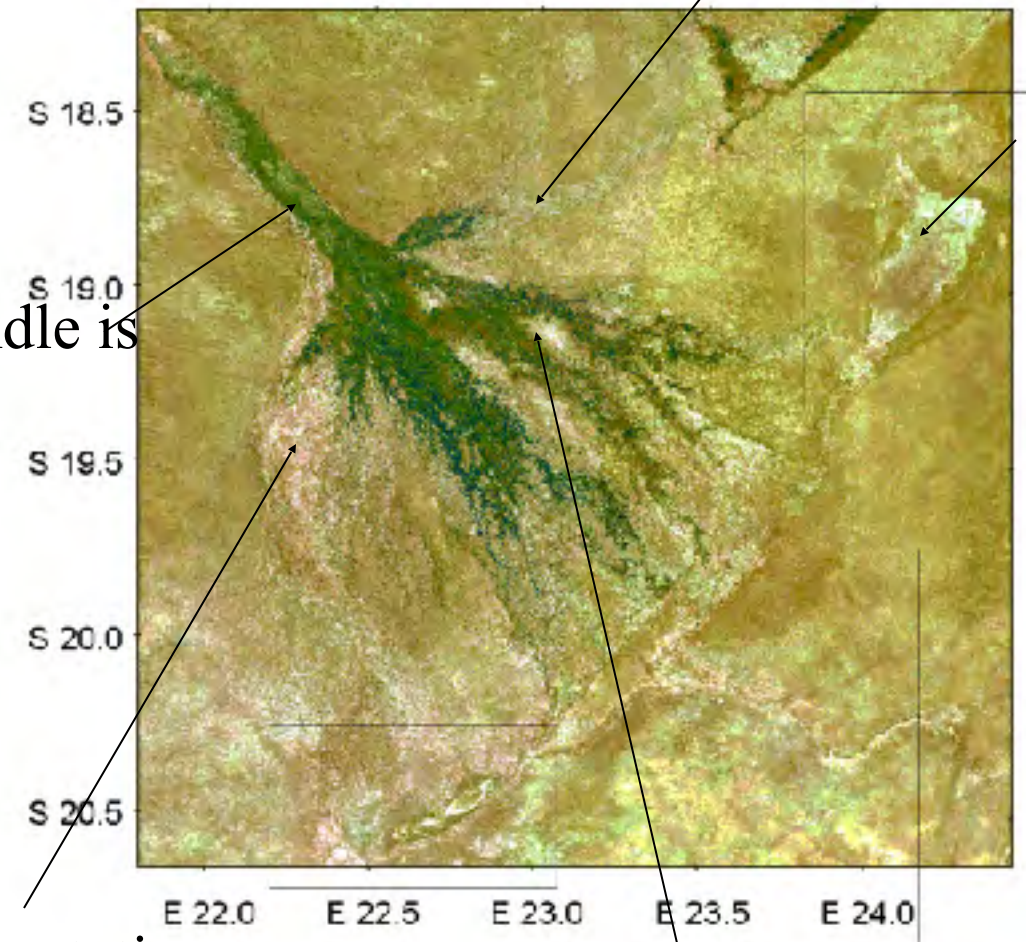




This page is to remind Thomas on what to do next!

Water flow and topography

Eventually the Delta will drain to Zambezi?



The region is seismically active

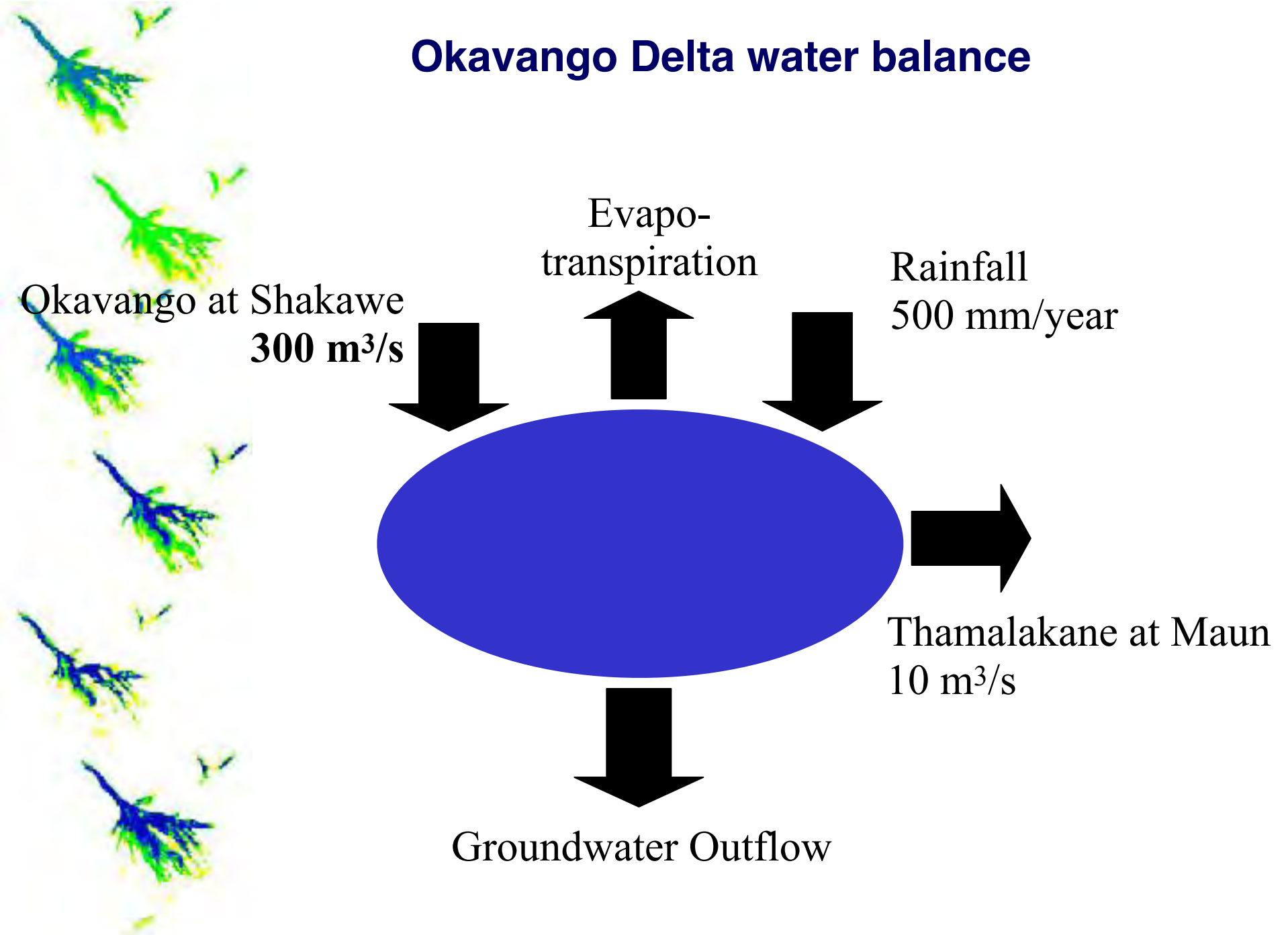
The Panhandle is a graben

Sedimentation reshapes the delta continously

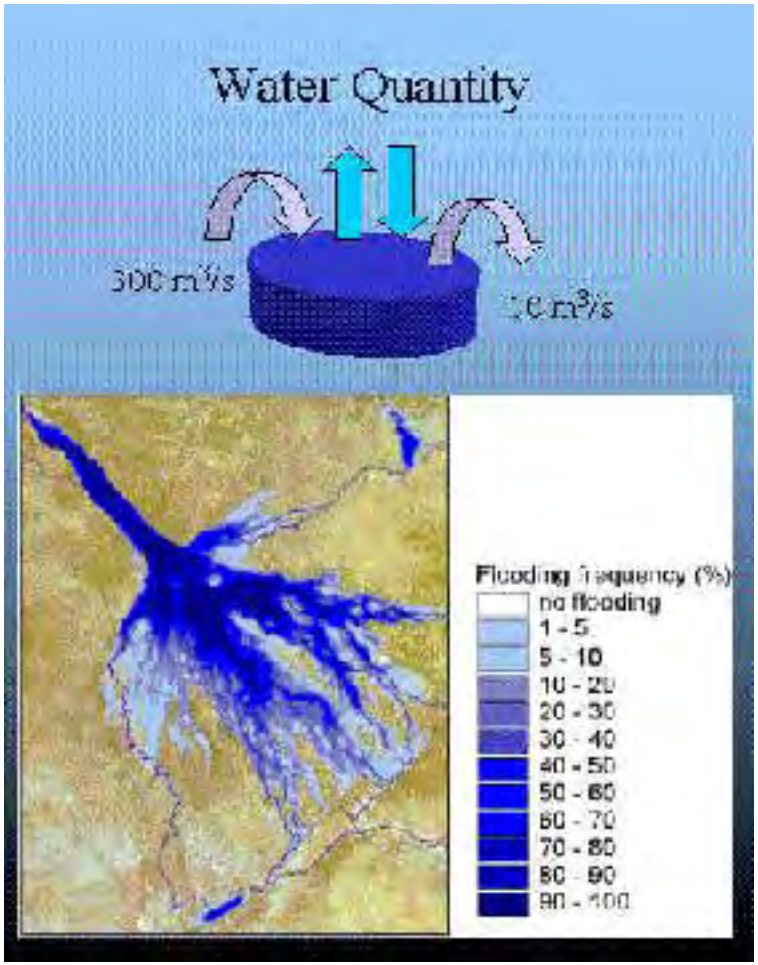
Channel blockage triggers channel death and birth

Topography of the Okavango Delta

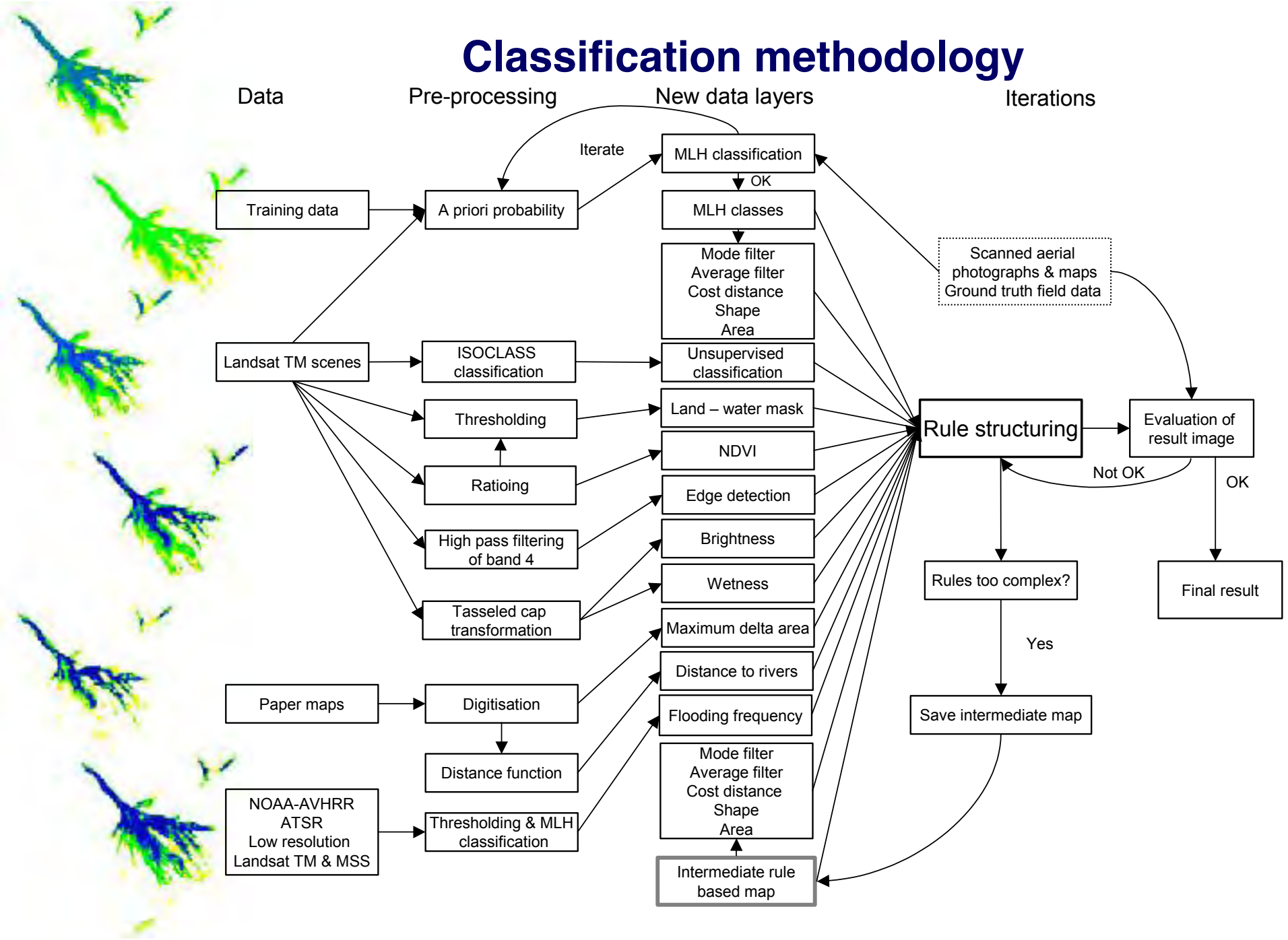
Okavango Delta water balance



Landcover and microtopography – parameterisation of hydrological models of the Delta



Classification methodology



Water = -2.5 m below reference level

Permanent Swamp = -2.0 m below reference level

Primary floodplain = 1.5 m below reference level

Secondary floodplain = 1.0 m below reference level

Grassland = reference level

Salt pan = 0.5 m below reference level

Dry Grassland/Salt Pan

Occasionally flooded grassland = 0.5 m below reference level

Grassland (with occasional flooding)

Salt pan = 0.5 m below reference level

Dry Grassland/Salt Pan (with flooding)

Riverine forest = 0.5 m above reference level

Dry woodland = reference level

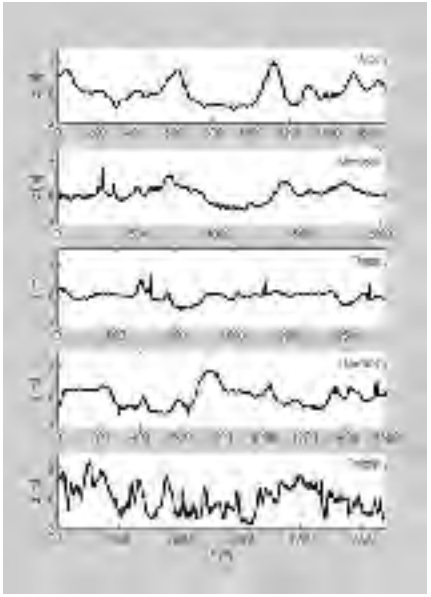
Dry Woodland (dominated by Mopane)

Dry woodland = reference level

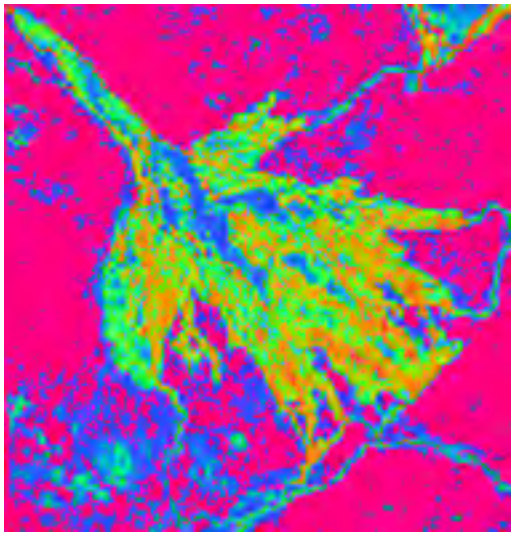
Dry Woodland (dominated by Acacia)

Landcover ecoregions

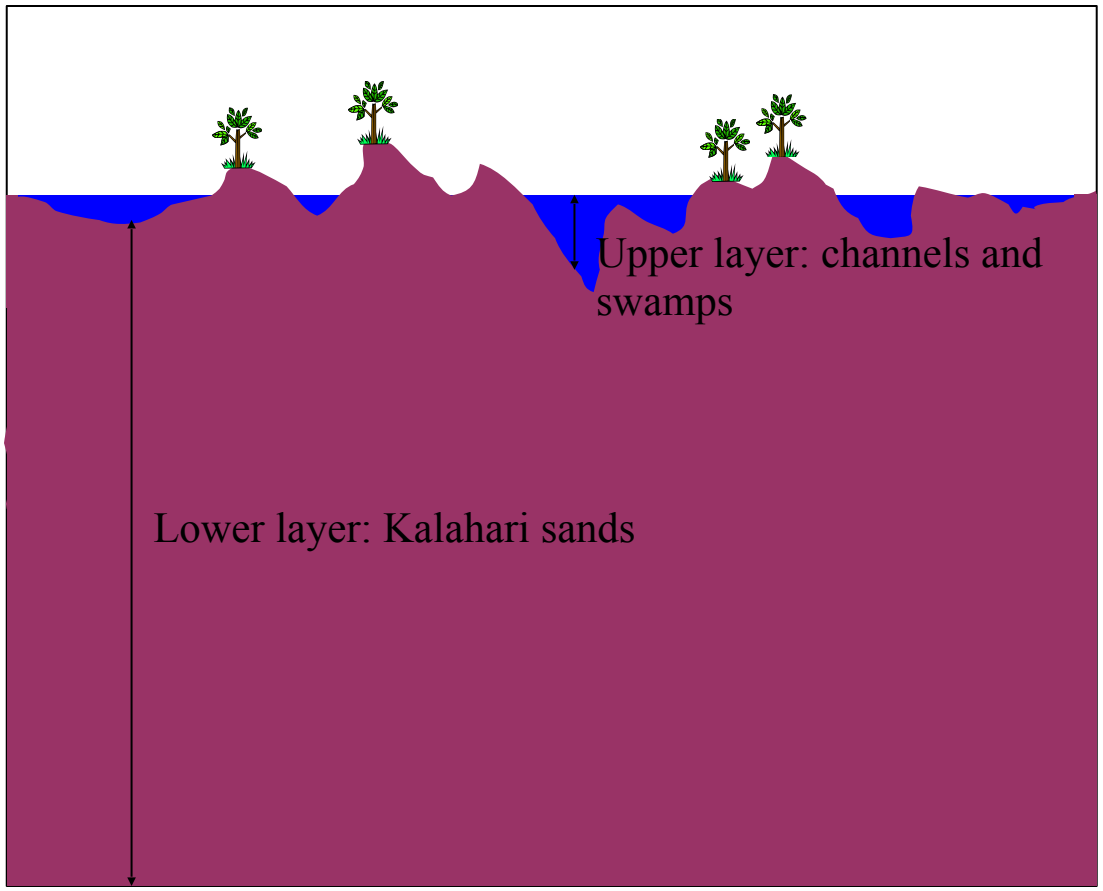
Surveyed profiles



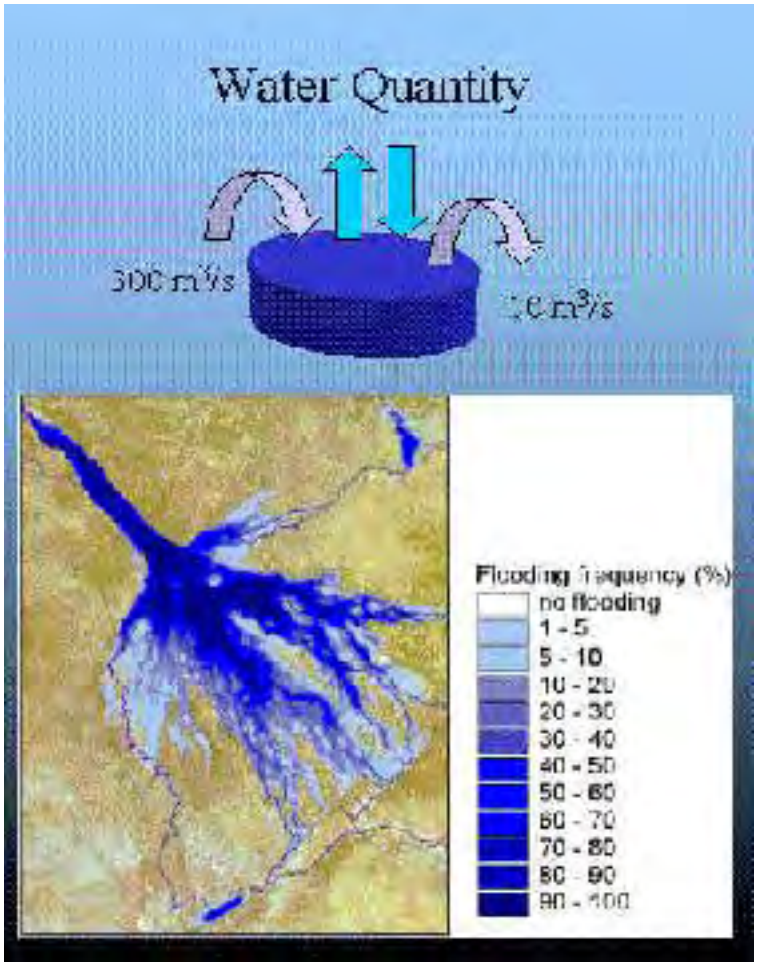
Microtopography



2 layer modflow model of the Okavango Delta



Precipitation and evapotranspiration – driving variables of the Delta water balance



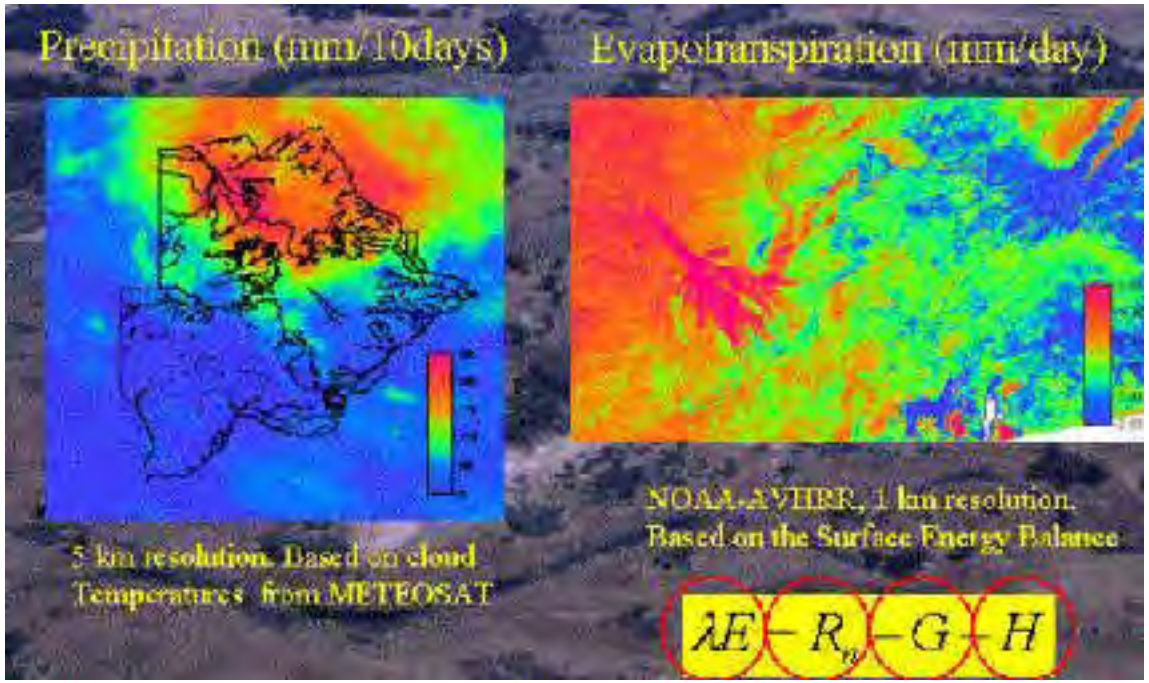
Field data for accurate point measurements of surface energy balance (evapotranspiration)

Net radiometre

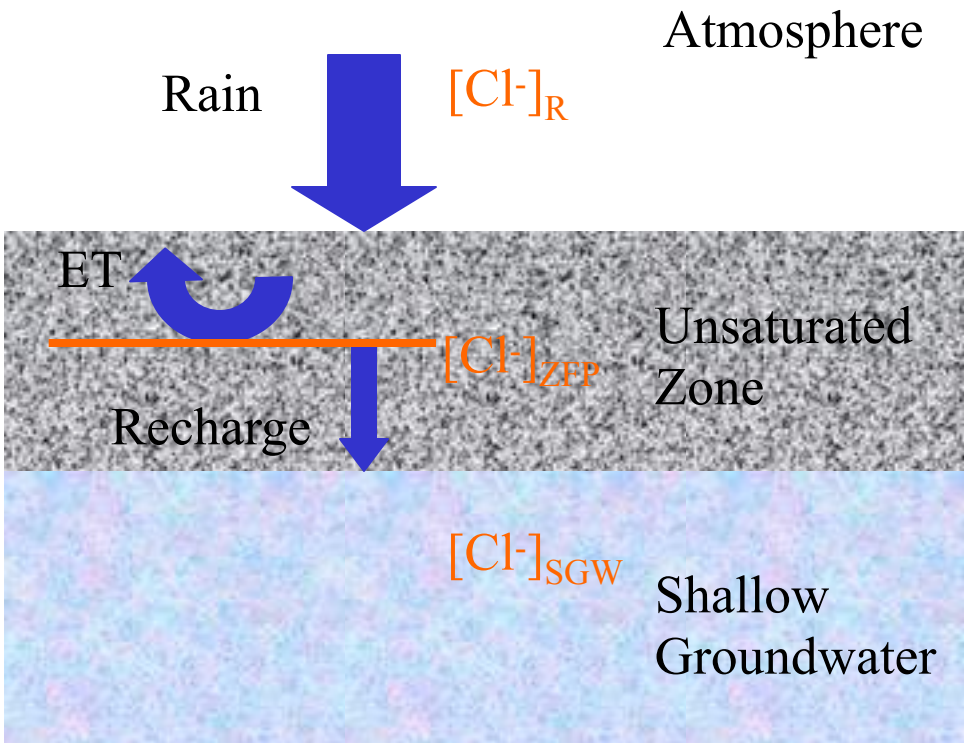
Microclimate station

At least 1 station for each land cover class

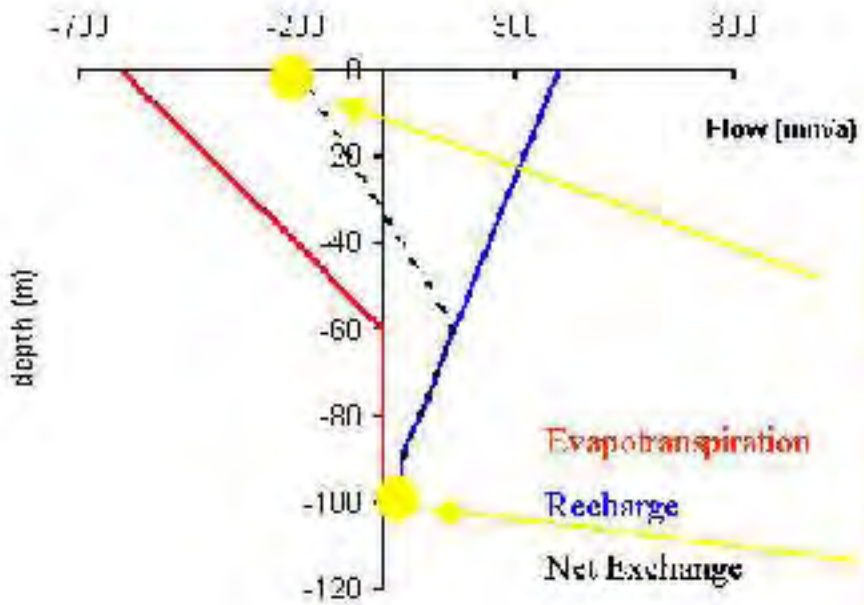
Remote sensing for estimating spatial distribution of precipitation and evapotranspiration



Field data for estimation of net recharge



Parameterisation of evapotranspiration, recharge and net exchange

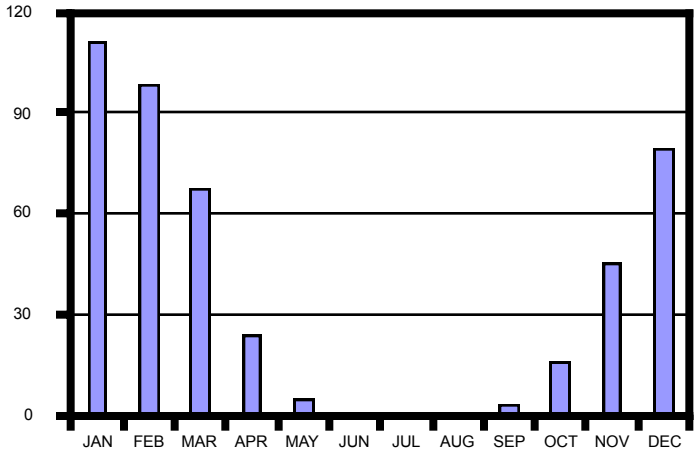


Measurement of ET and P via Remote Sensing

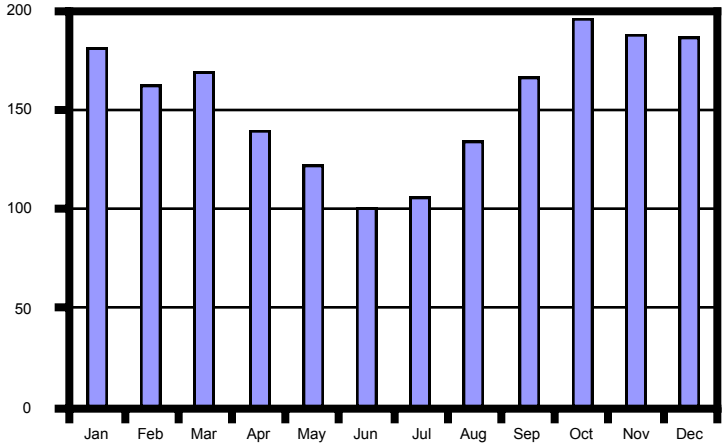
Chloride Method or other tracer methods

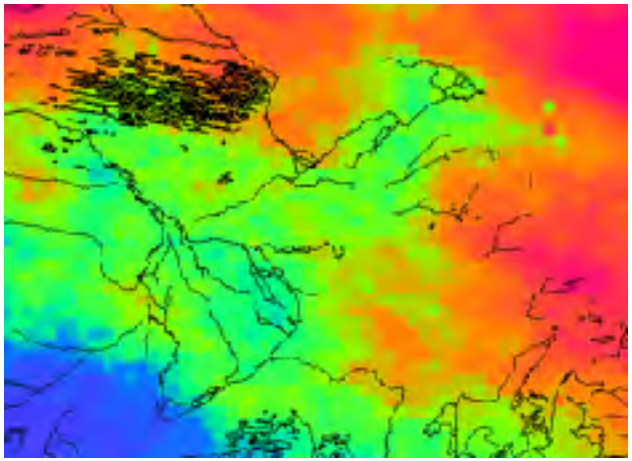
Vertical water balance of the Okavango Delta

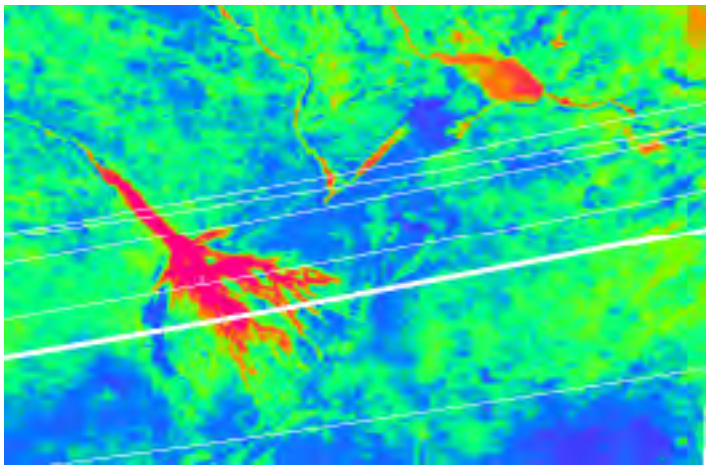
Rain



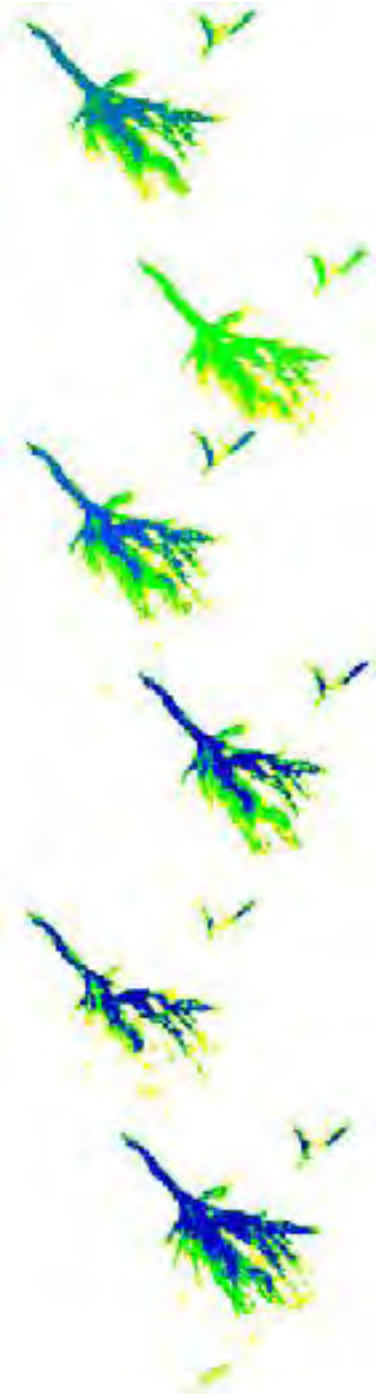
PET

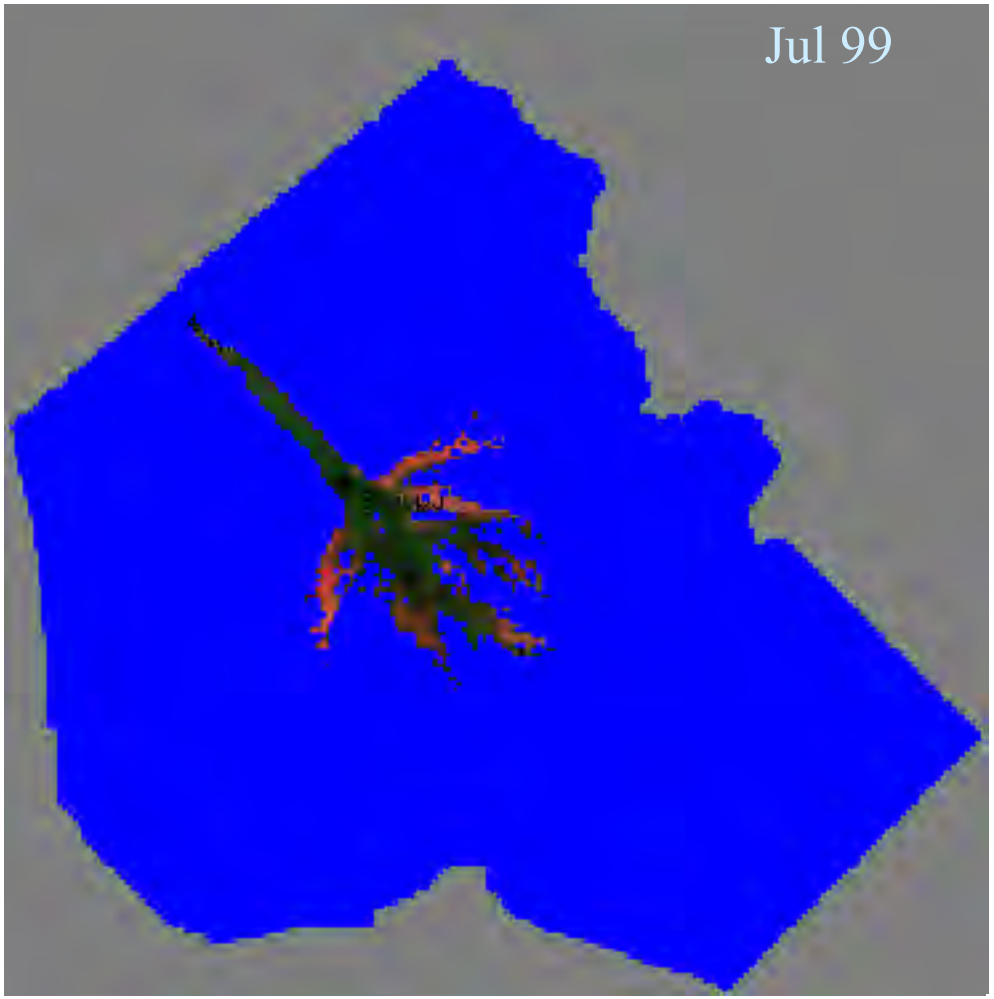






2 layer modflow model of the Okavango Delta
Preliminary tests



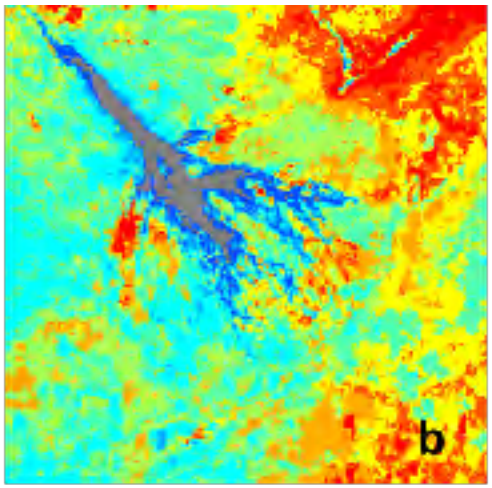


Calibrating and validating the Delta model

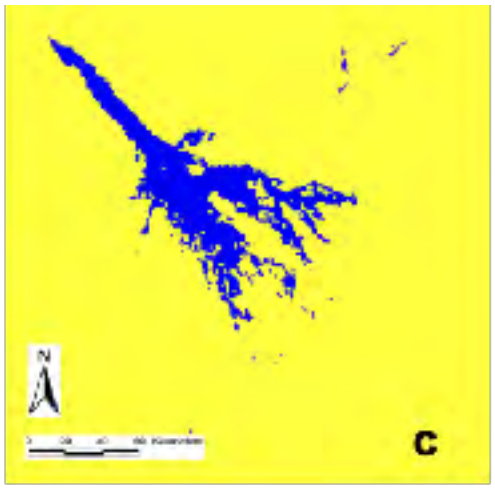
Classification of historical flood area

Unsupervised classification of ~ 400 satellite images (NOAA AVHRR, ERS-2 ATSR), and supervised classification of Landsat MSS / TM (subset of ~ 3000 images)

AVHRR

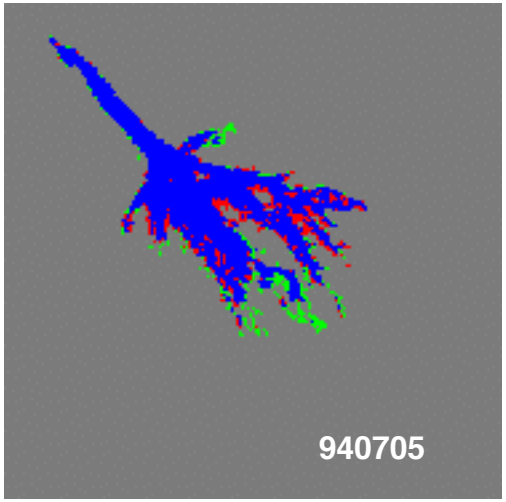


Unsupervised classification

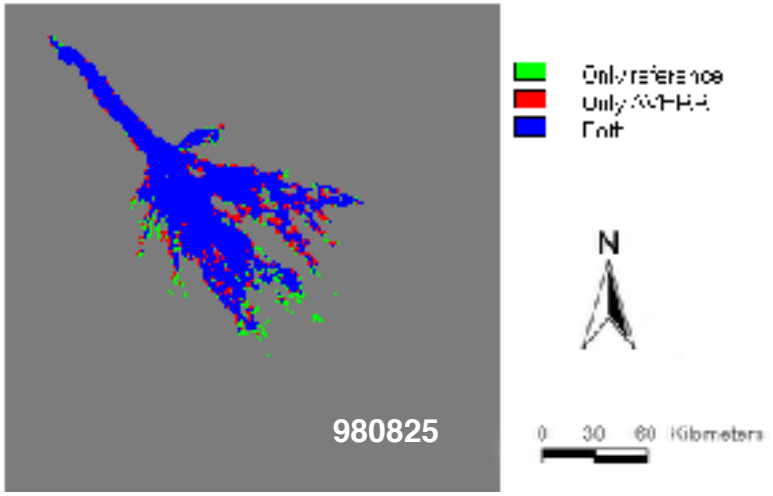


Manual reclassification

Evaluation of AVHRR against Landsat TM & ATSR

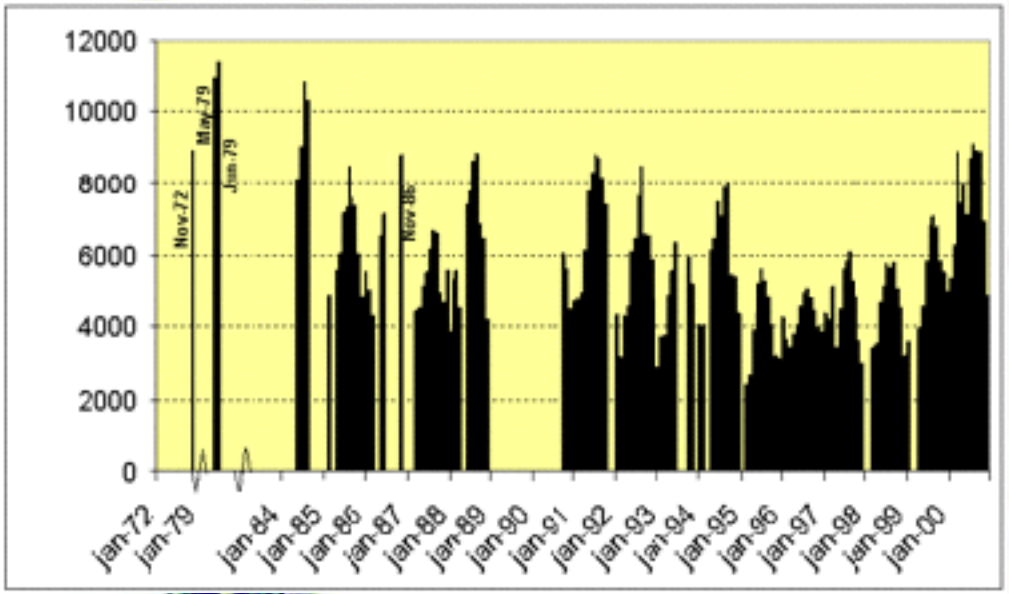


AVHRR vs. Landsat TM

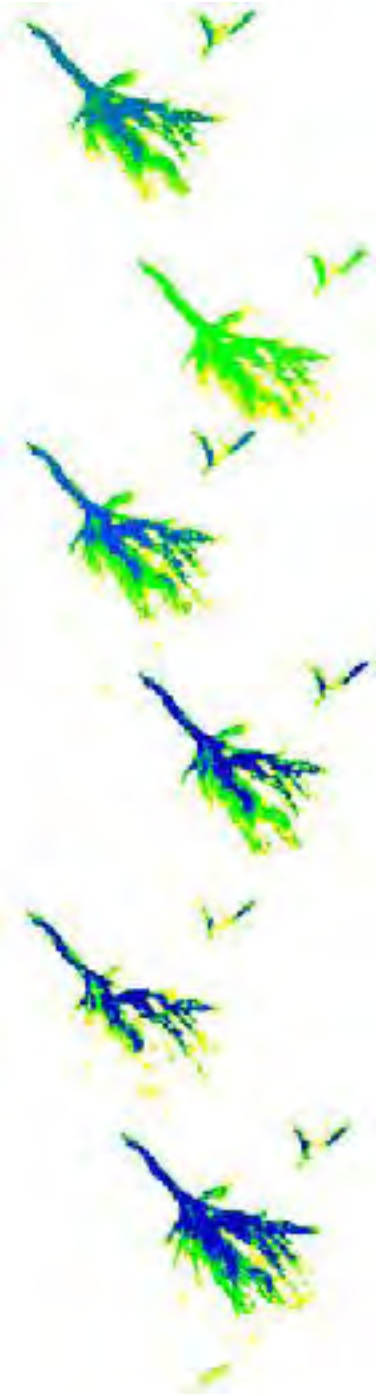


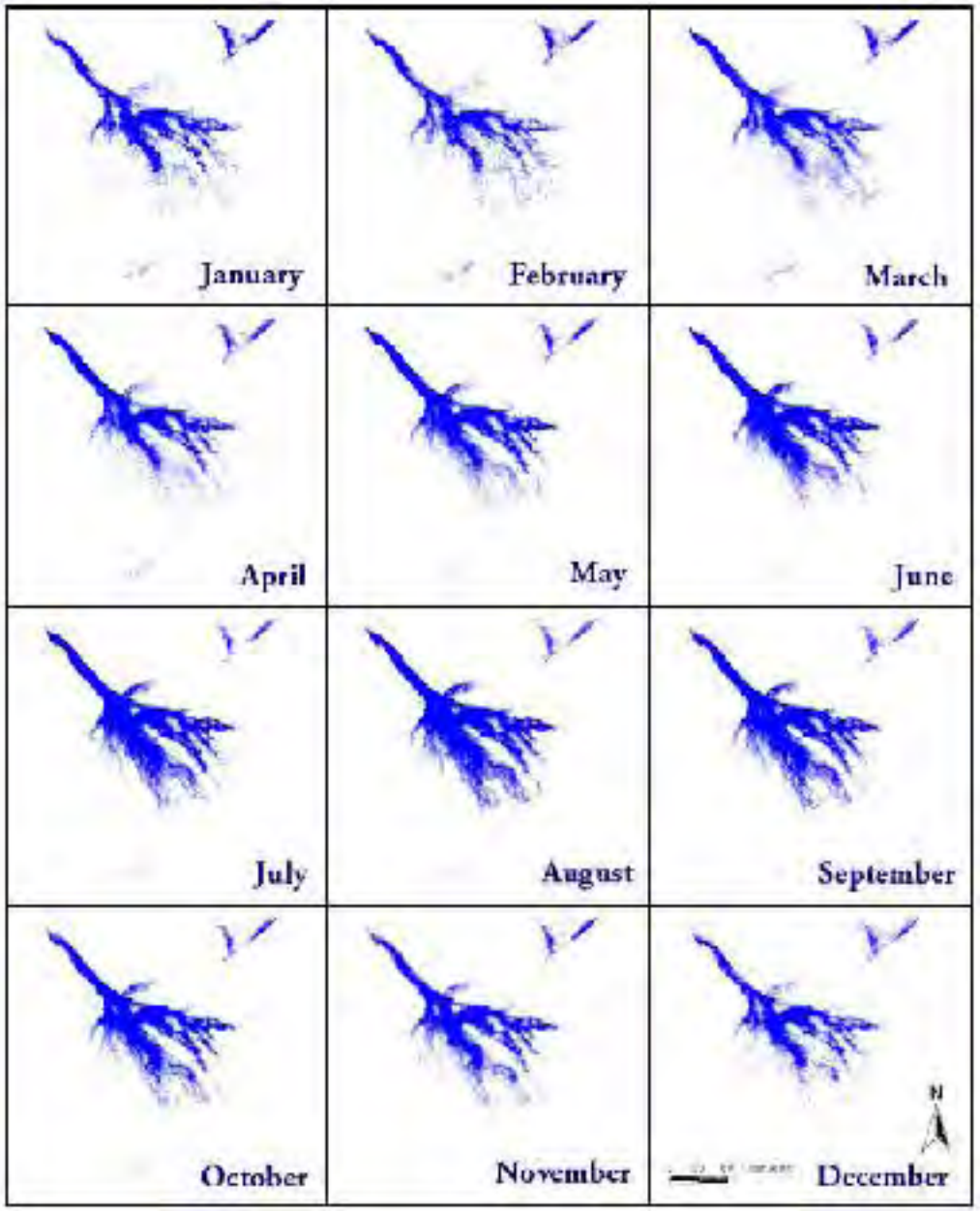
AVHRR vs. ATSR

Flooding, years (1985-2000)

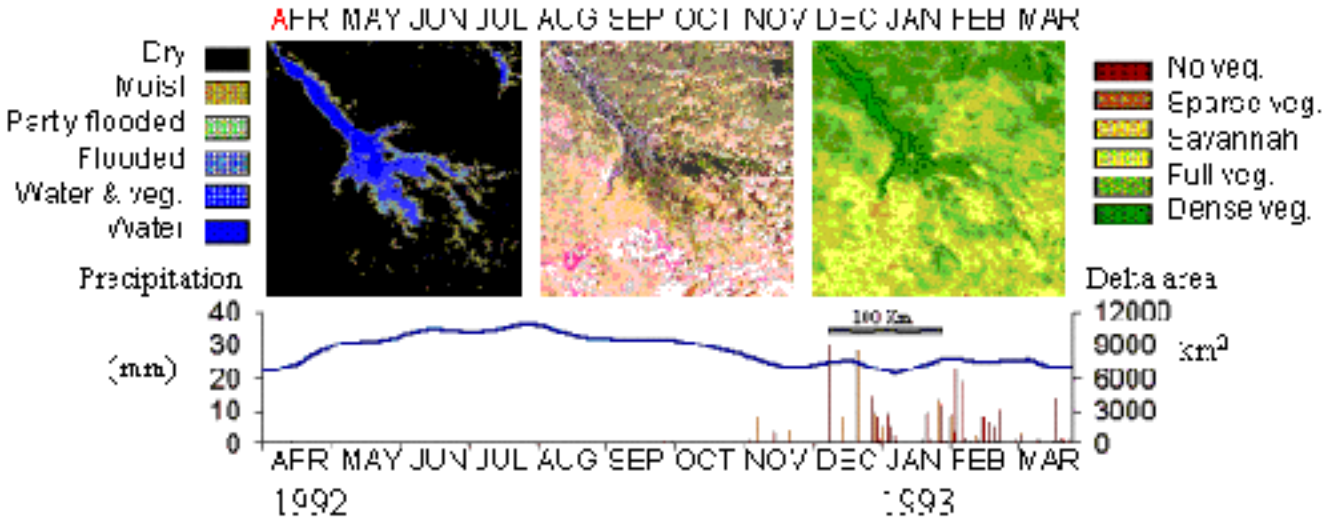


Flooding, month (1985-2000)





Okavango Delta water balance 1992/93



Matter balance and islands – redirecting water flow on different time scales

Primary islands built from accumulation of clastic sediments

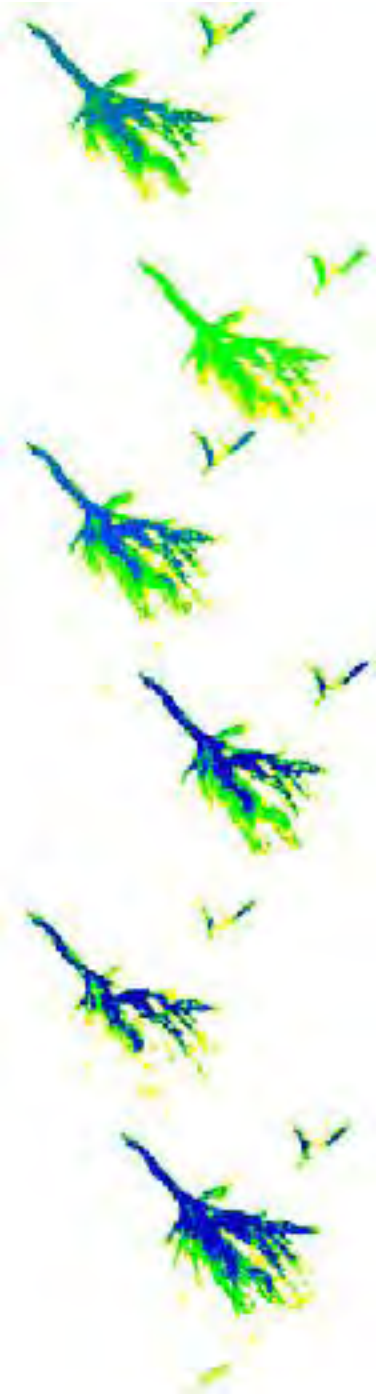
Island types

Inverted channel island

Primary islands built from accumulation of clastic sediments

Island types

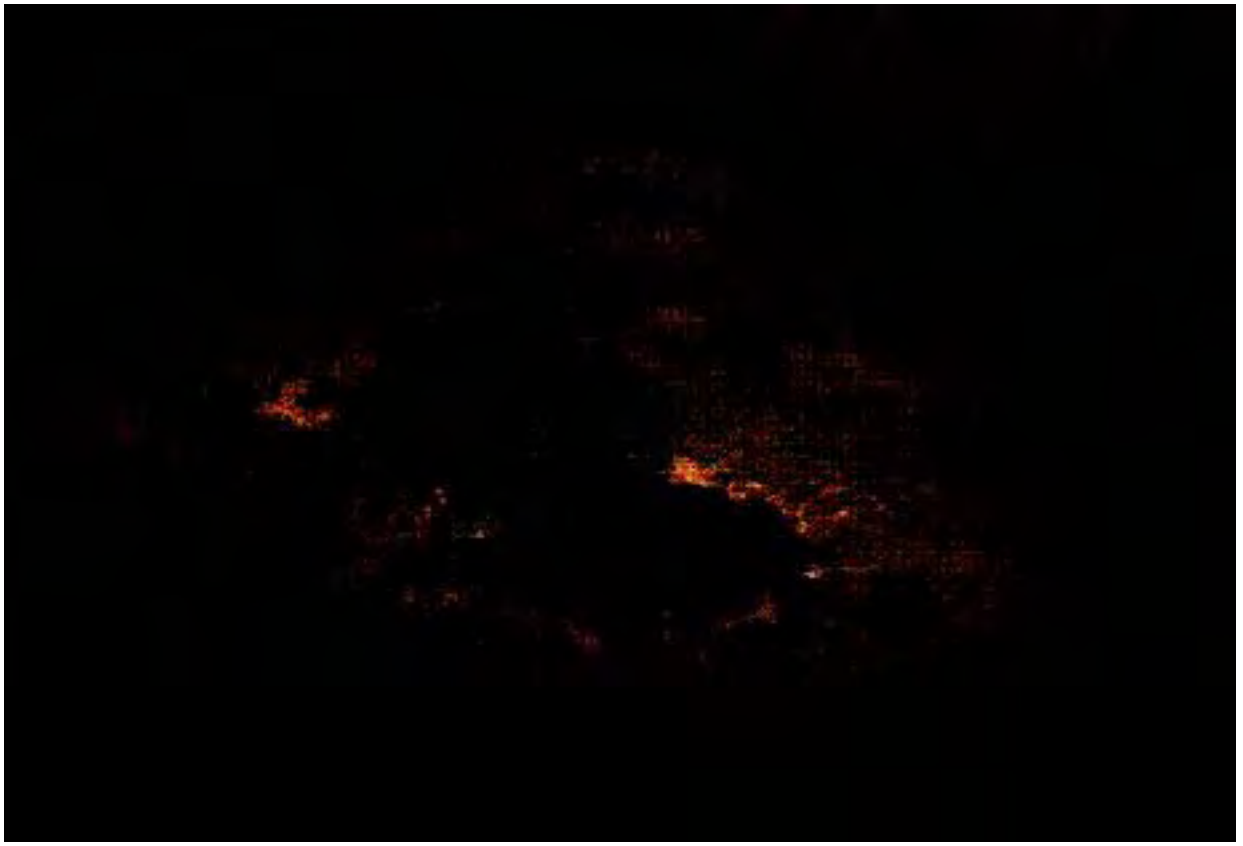
Scroll bar island



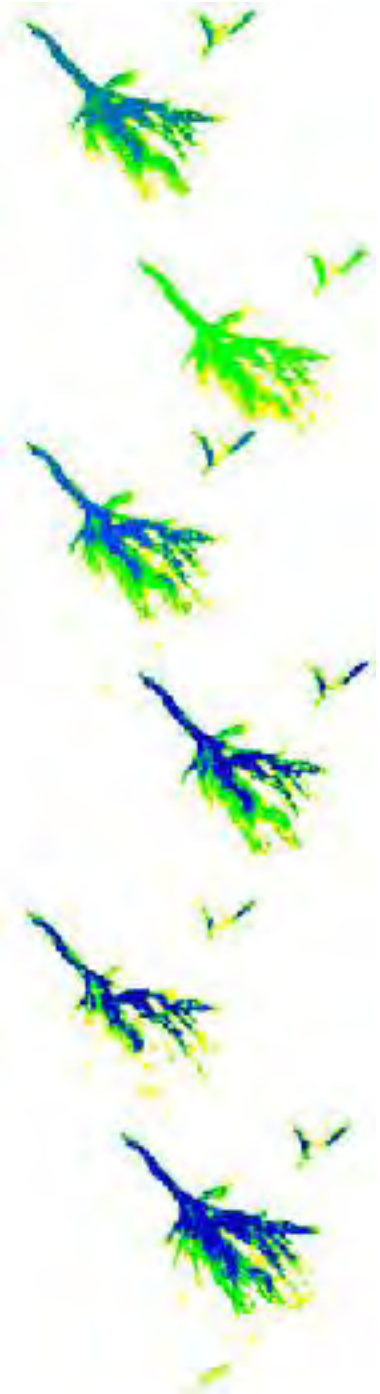
Primary islands built from accumulation of clastic sediments

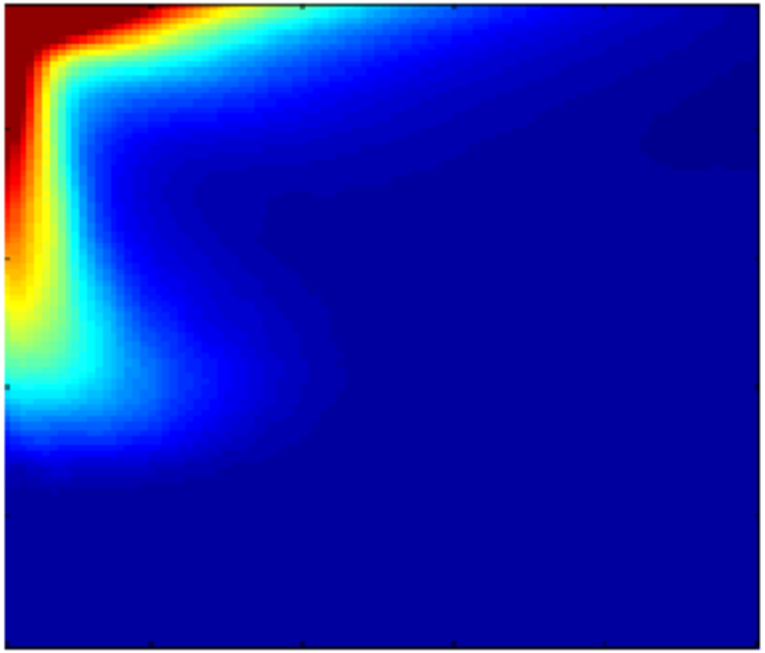
Island types

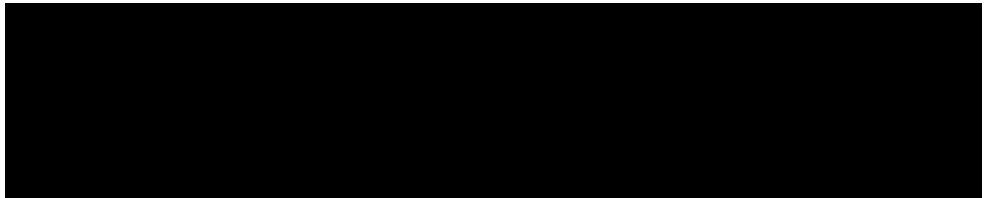
Anthill island



Evapotranspiration, salinity balance and island secondary growth







Secondary islands grown from precipitation of chemical sediments

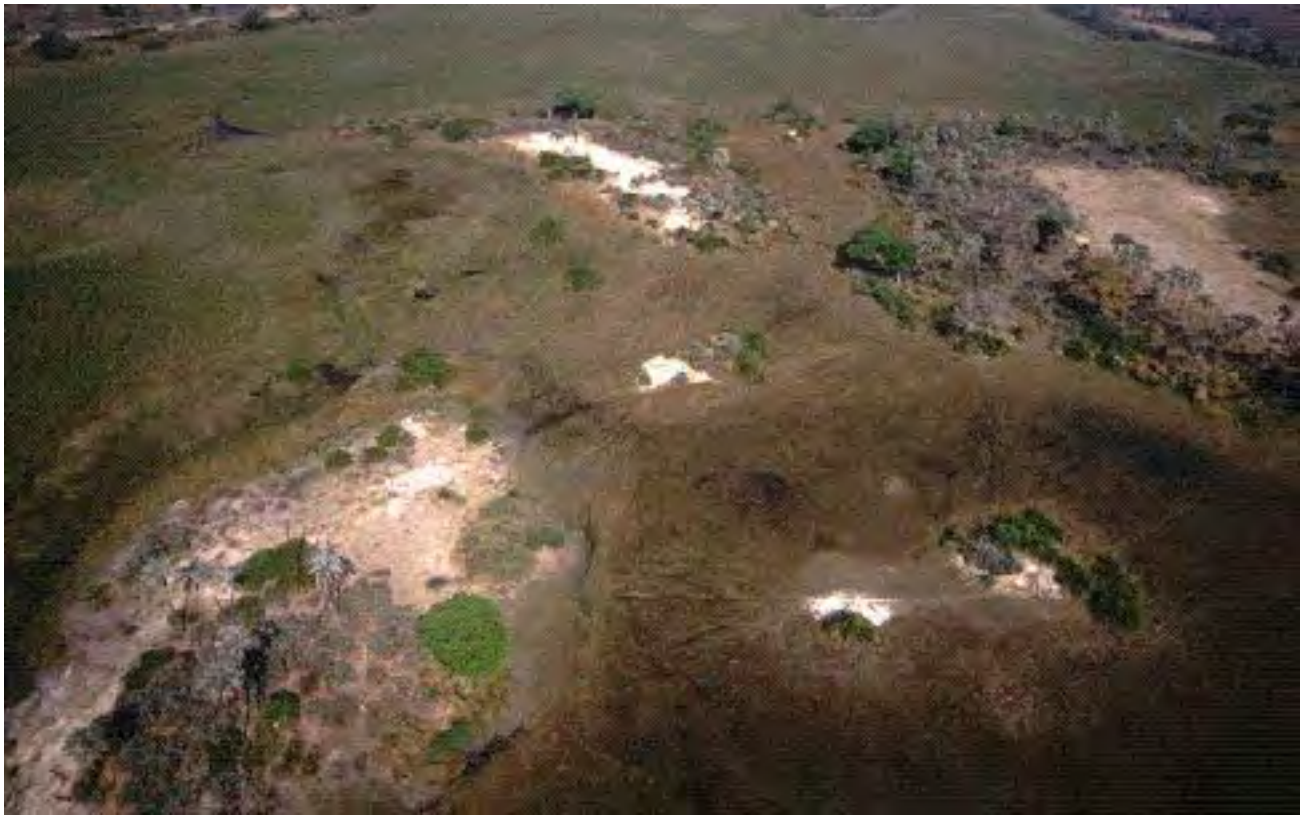
Island types

Riparian forest island

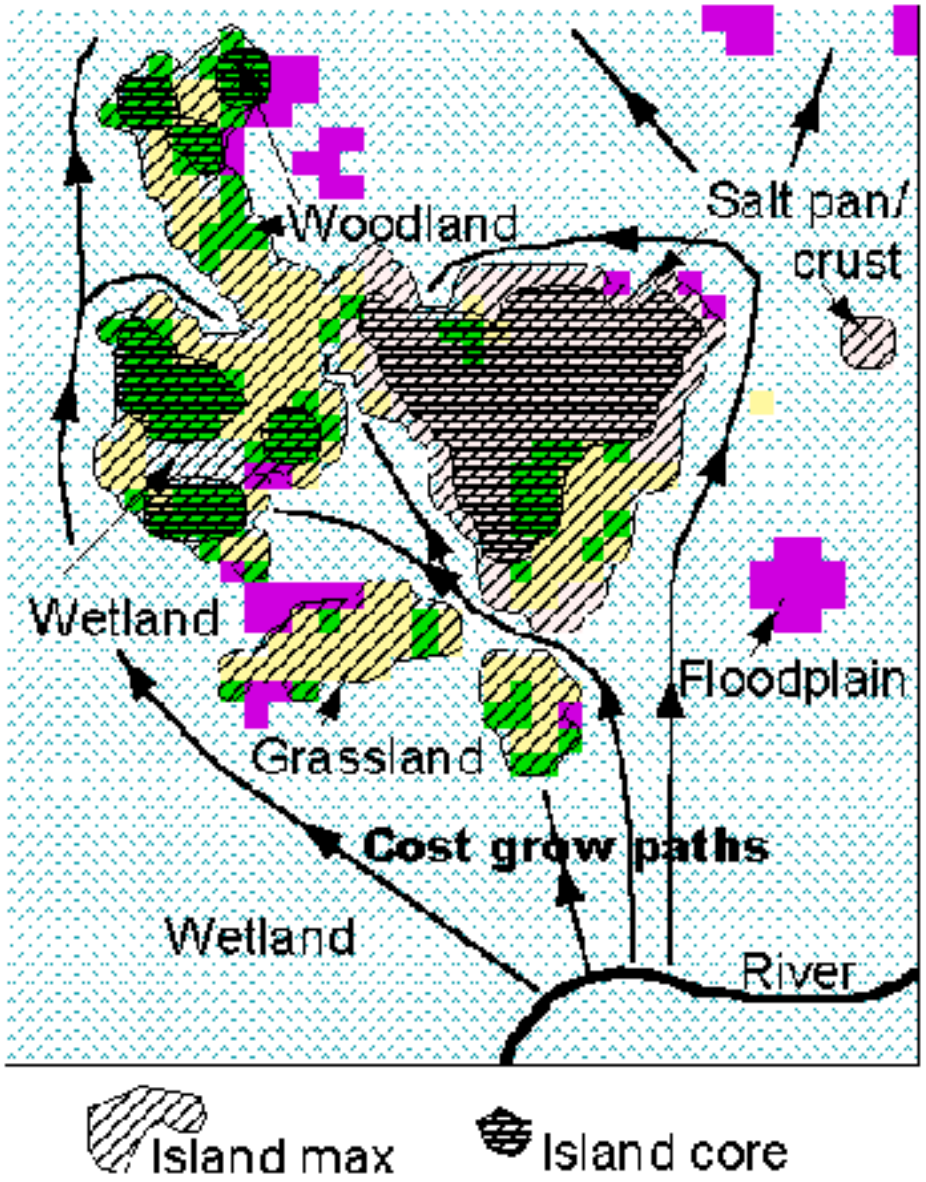
Secondary islands grown from precipitation of chemical sediments

Island types

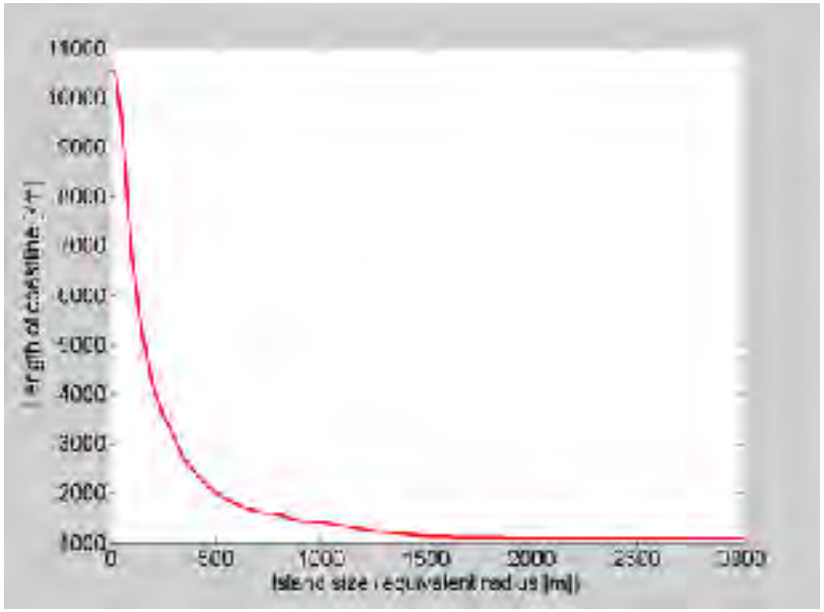
Salt islands



Island delineation

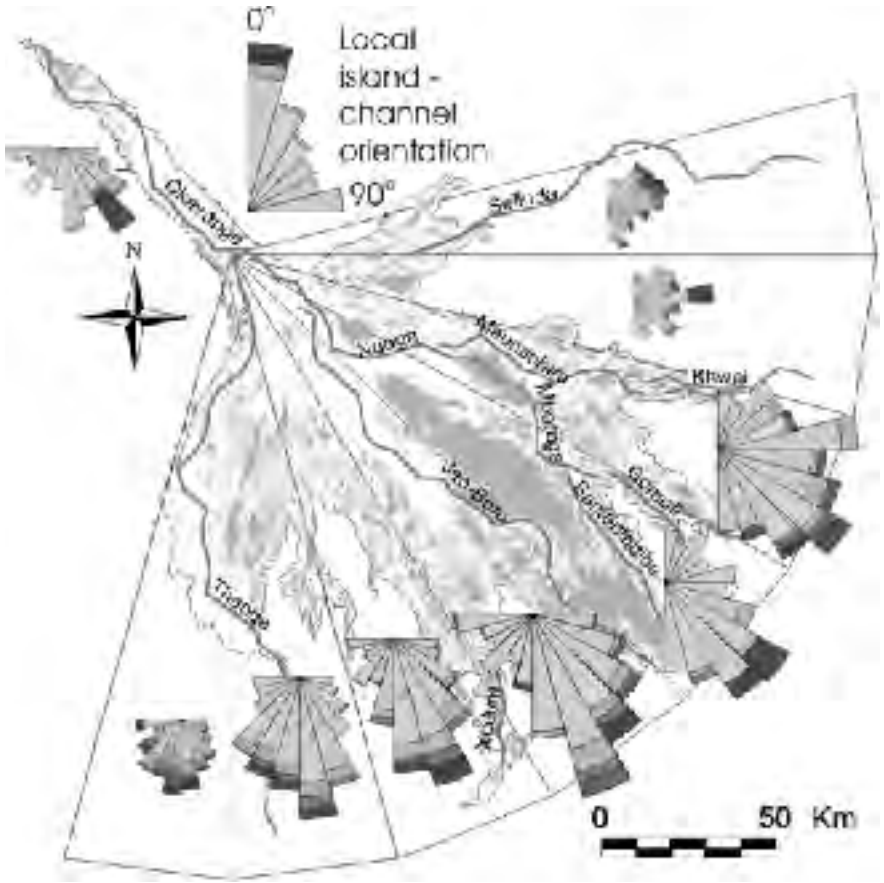


Salt Balance: Coastline from Remote Sensing



Order of magnitude correct

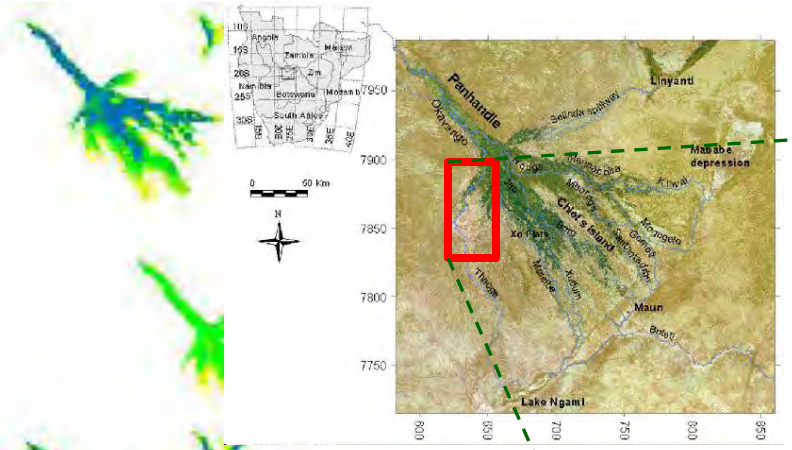
Island orientation – interacting with water flow over the Delta surface

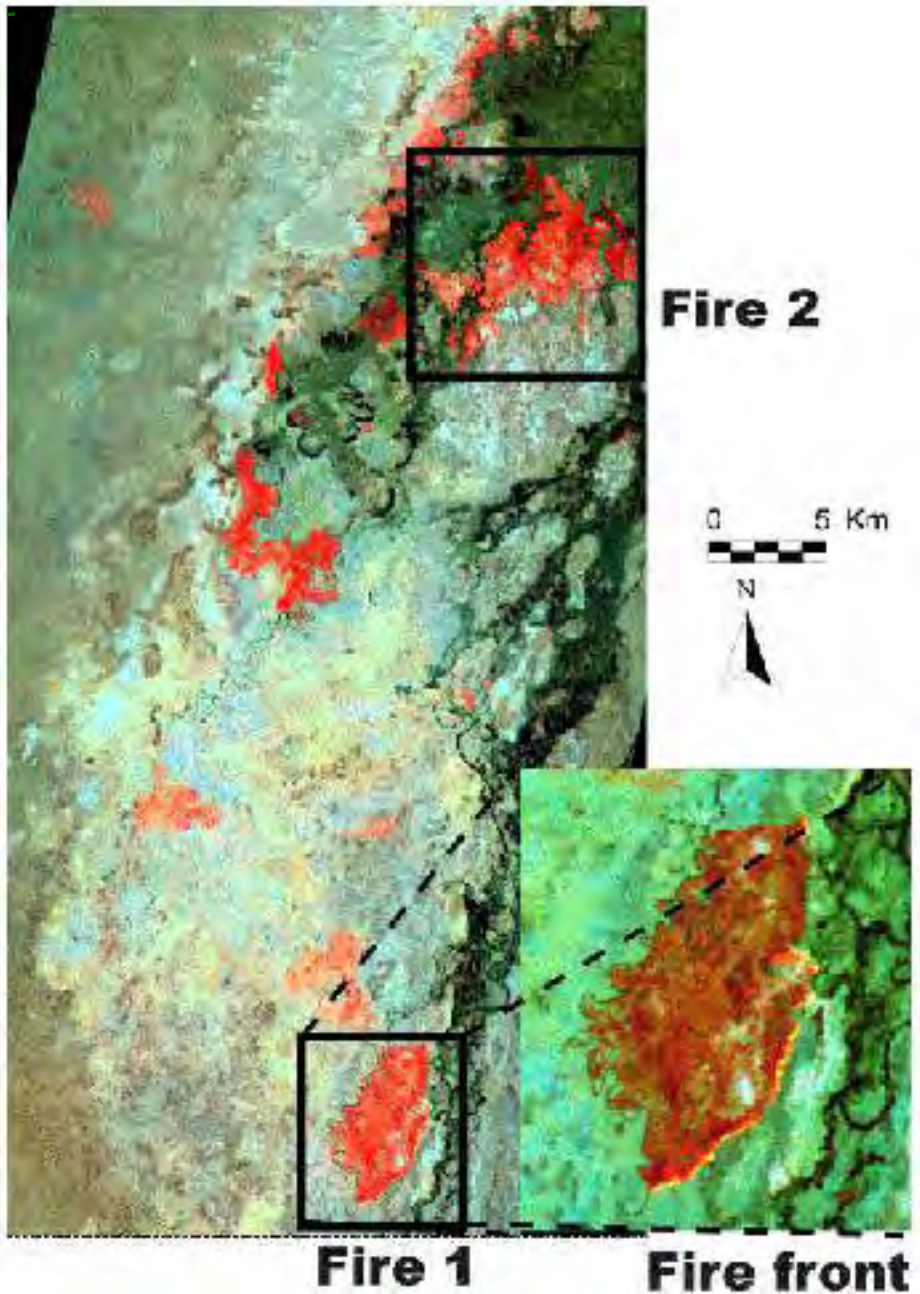


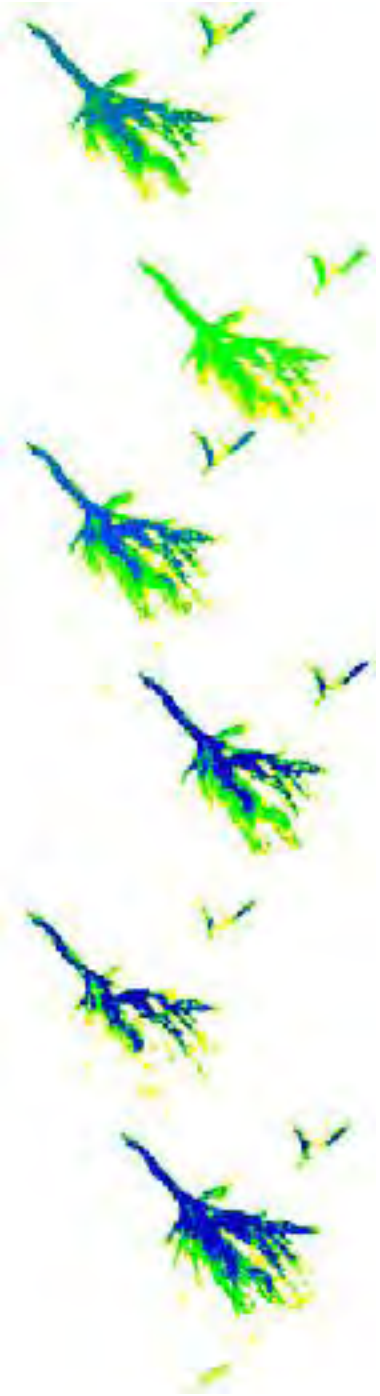
Peat fires – evidence of changing flow routes

Accumulation of organic material in swamps flanking the channels - dries and catches fire following channel failure

MODIS Airborne Simulator

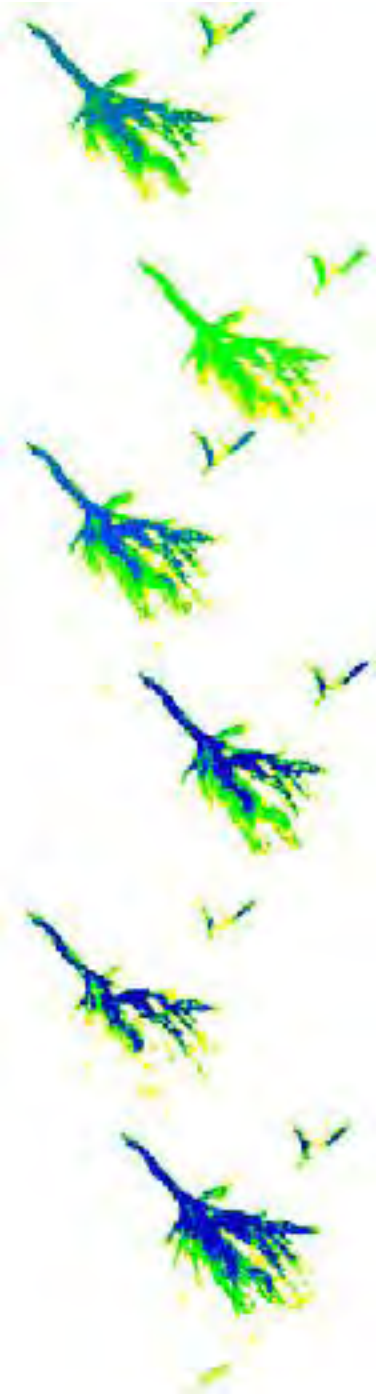






Conclusions

- Predictive hydrological modeling of the Okavango basin
- Predictive hydrological modeling of the Okavango Delta
- Predicitve modeling of the Okavango Delta salt balance
- Integrated system perspective necessary
- How can all this information be disseminated and used?



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