

Time series of inundation in flood-pulsed wetlands from satellite imagery



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Changes in semi-arid savanna ecosystems

- Predominant type of change: *conversion of grasslands and woodlands into shrub and bush savannas.*
- DRIVERS OF CHANGE:
 - *Water availability including flooding*
 - Fire
 - Herbivory
 - Grazing
 - Logging



Flooding as a driver of ecosystem change

- Relevance for semi-arid savanna research
 - Relatively little research
 - Research in Okavango Delta: decreased flooding leads to invasion by woody vegetation (Ringrose et al., 2007)
 - Key informant interviews – past variability
 - Climate change predictions – future variability
- Confounding factors
 - Long vs. short-term climatic and hydrologic variability
 - Upstream vs. local precipitation regimes
 - Variable water sources



Focus on Chobe River Basin

□ Internationally:

- Transboundary watershed
- Core area in the Kavango-Zambezi Transfrontier Conservation Area

□ Regionally:

- 94% of Botswana water resources allochthonous
- Flow connected to:
 - Zambezi
 - Kwando
 - Kavango
- Region's main economic driver (Chobe National Park)

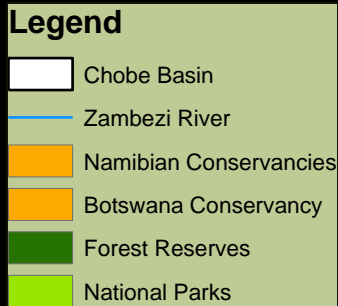
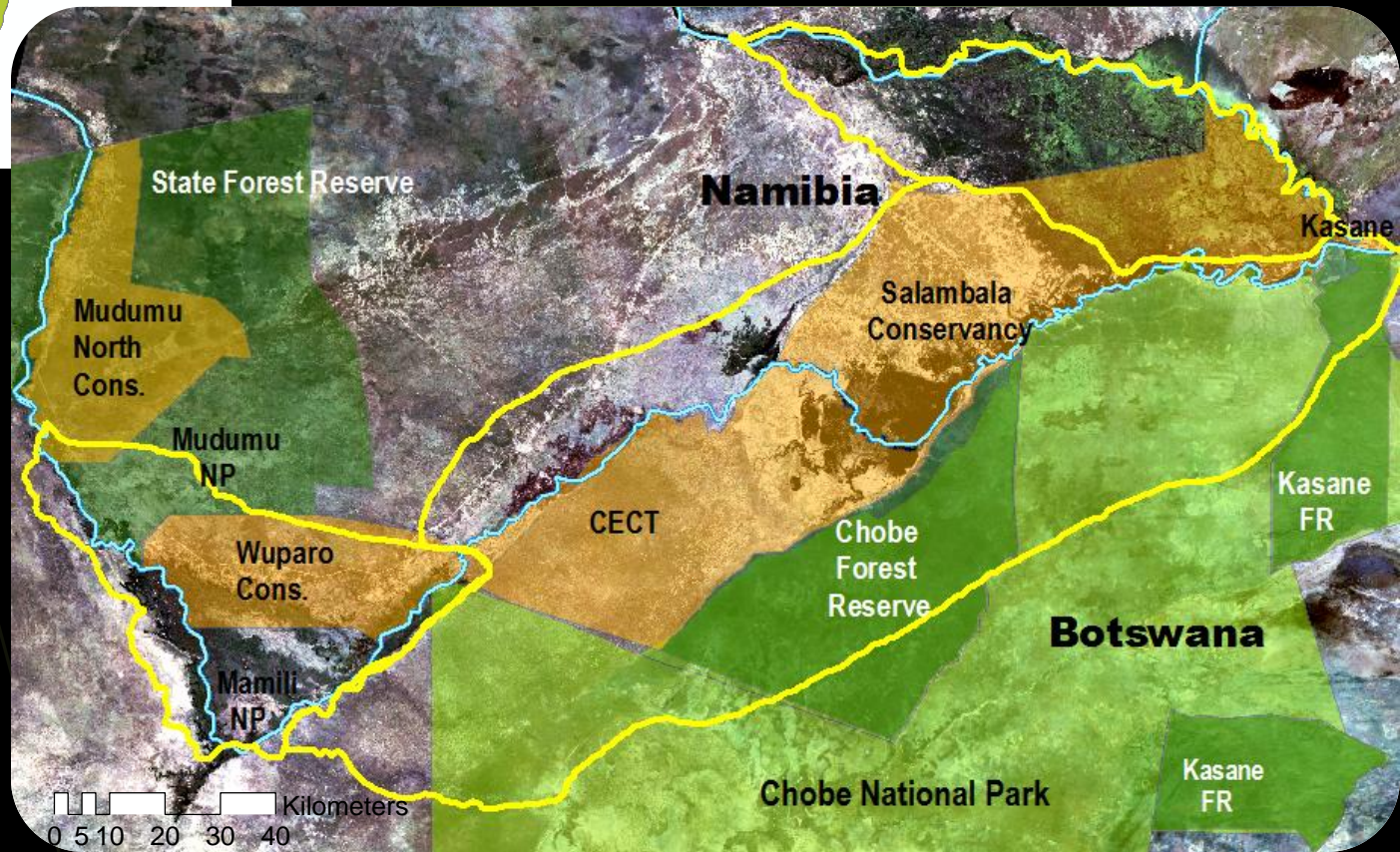
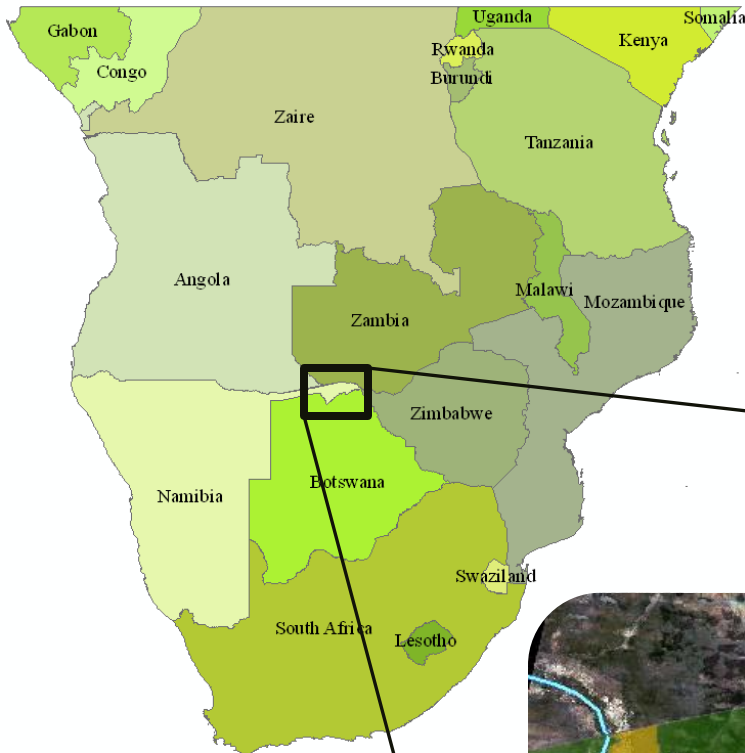
□ Locally:

- Mosaic of land uses
- Changes in ecosystem – key informant interviews
- Economic changes ongoing in the basin



CHOBE RIVER BASIN

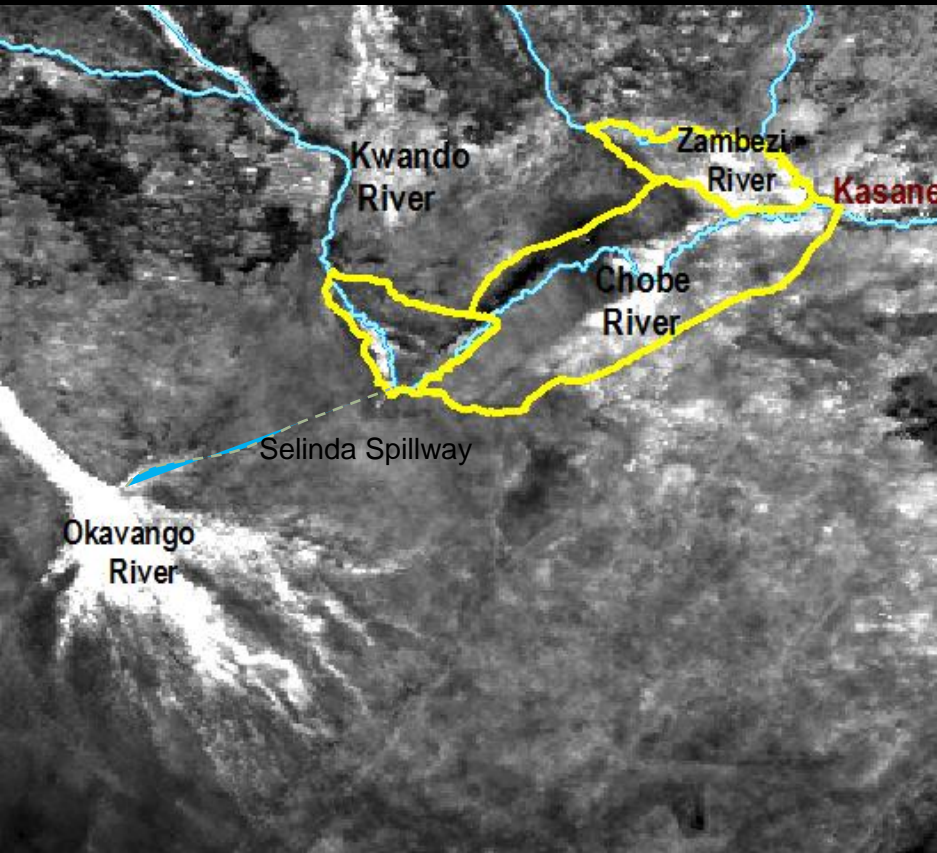
At the Heart of the Kavango-Zambezi Transfrontier Conservation Area



Chobe water utilization scenarios

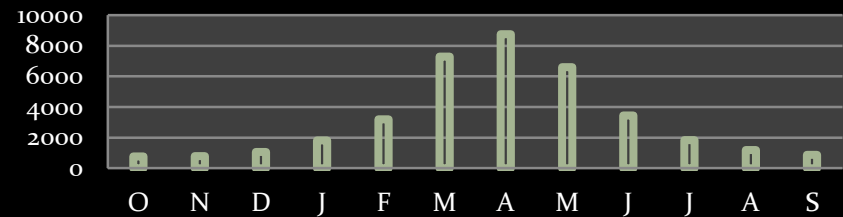
- **Proposed water abstraction from the Chobe/Zambezi system near Kasane in Chobe District, Botswana**
- **495 million m³/year requested for agricultural and domestic purposes by 2020**
- **Chobe/Kwando basin accounts for ~10% of Mean Annual Runoff of the Zambezi River**
- **Decrease of flood recession agriculture highlighted as high impact factor**

Intra-annual flow variability in three basins linked to Chobe River



Typical hydrographs

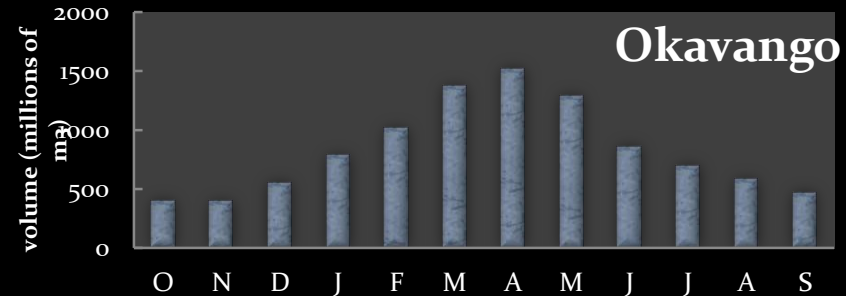
Zambezi

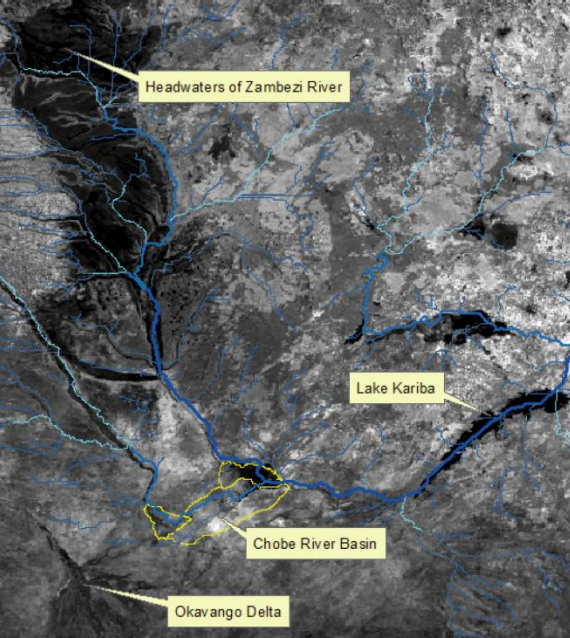


Kwando

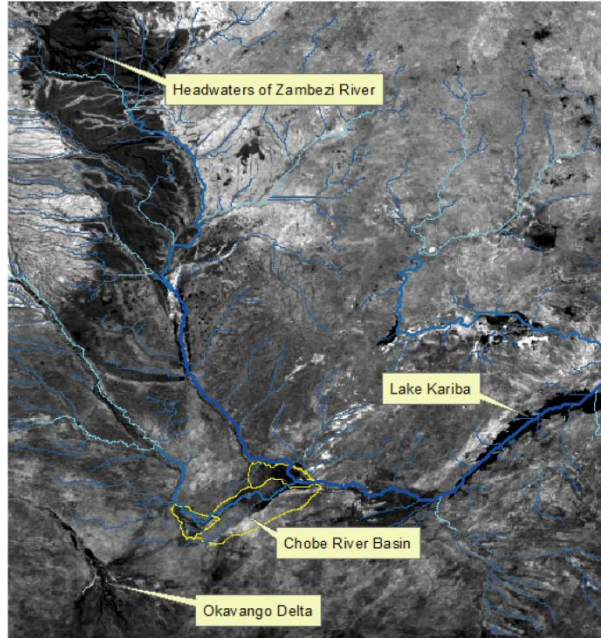


Okavango

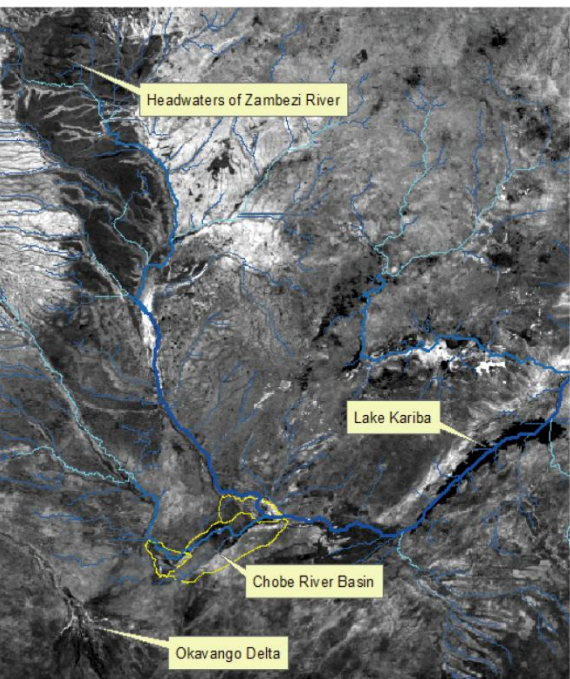




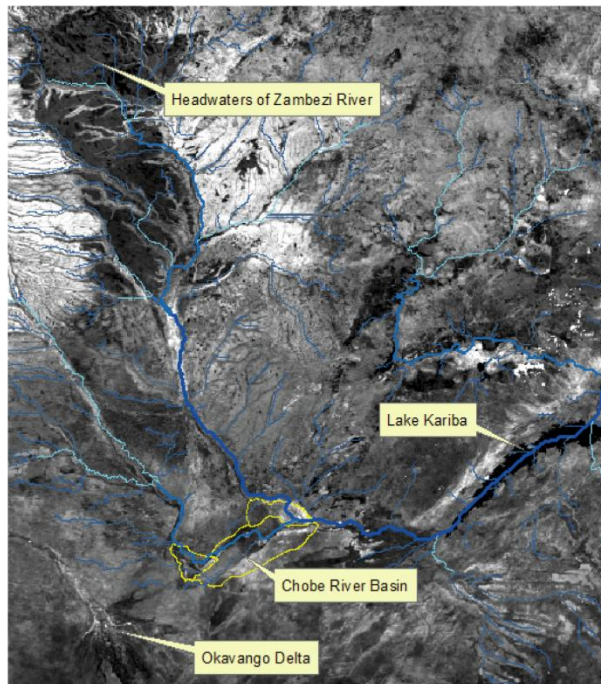
MODIS EVI Image for March 21 (DOY 081), 2008



MODIS EVI Image for April 22 (DOY 113), 2008



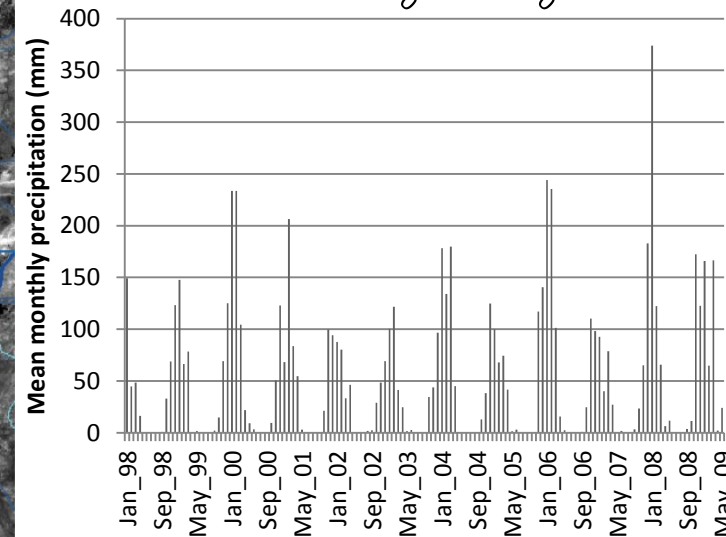
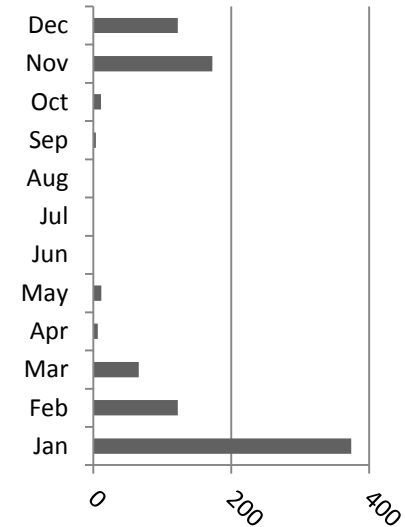
MODIS EVI Image for May 24 (DOY 145), 2008

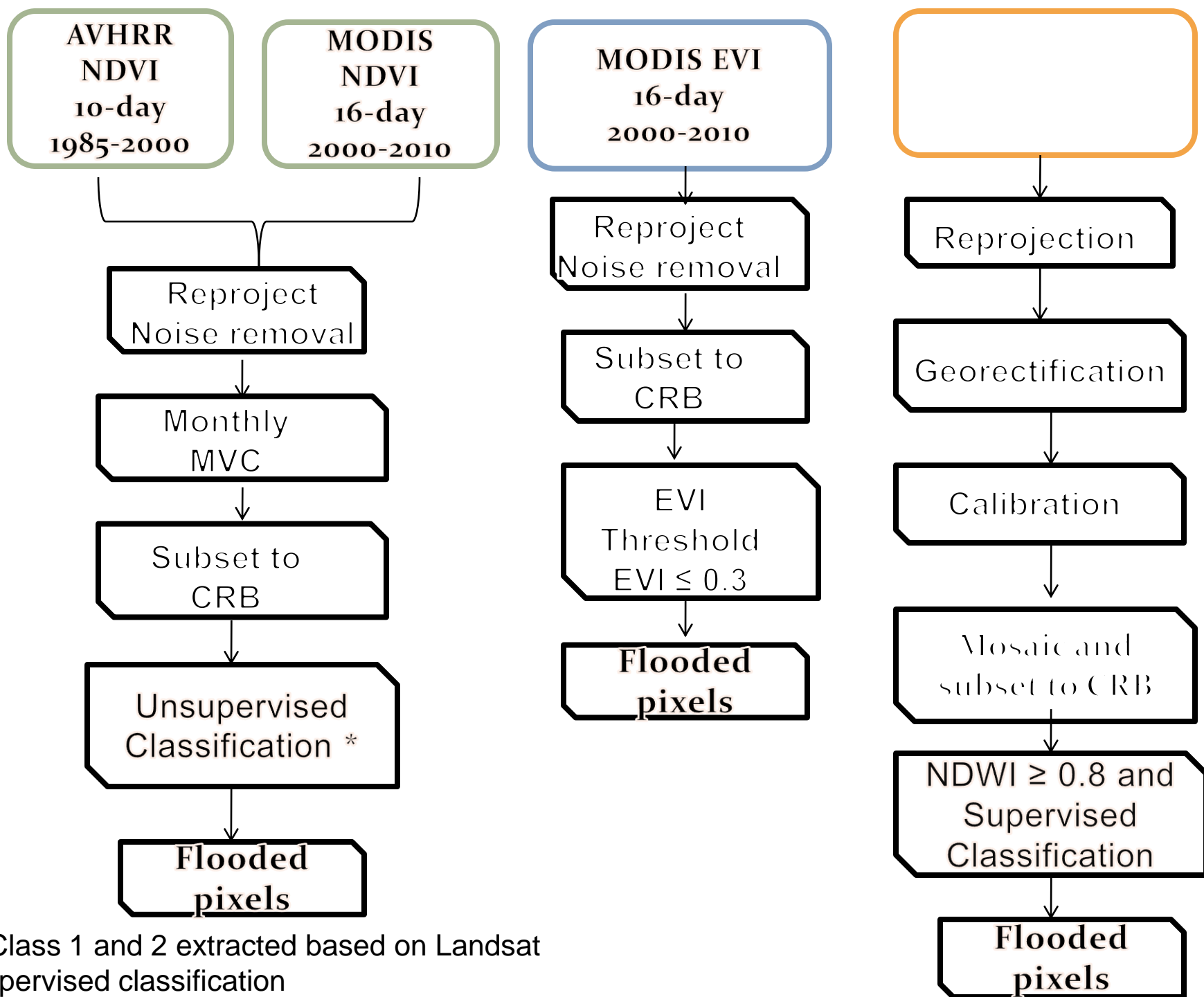


MODIS EVI Image for June 25 (DOY 177), 2008

Flooding extent methodology:

MODIS EVI data
TRMM precipitation data
Zambezi River discharge data



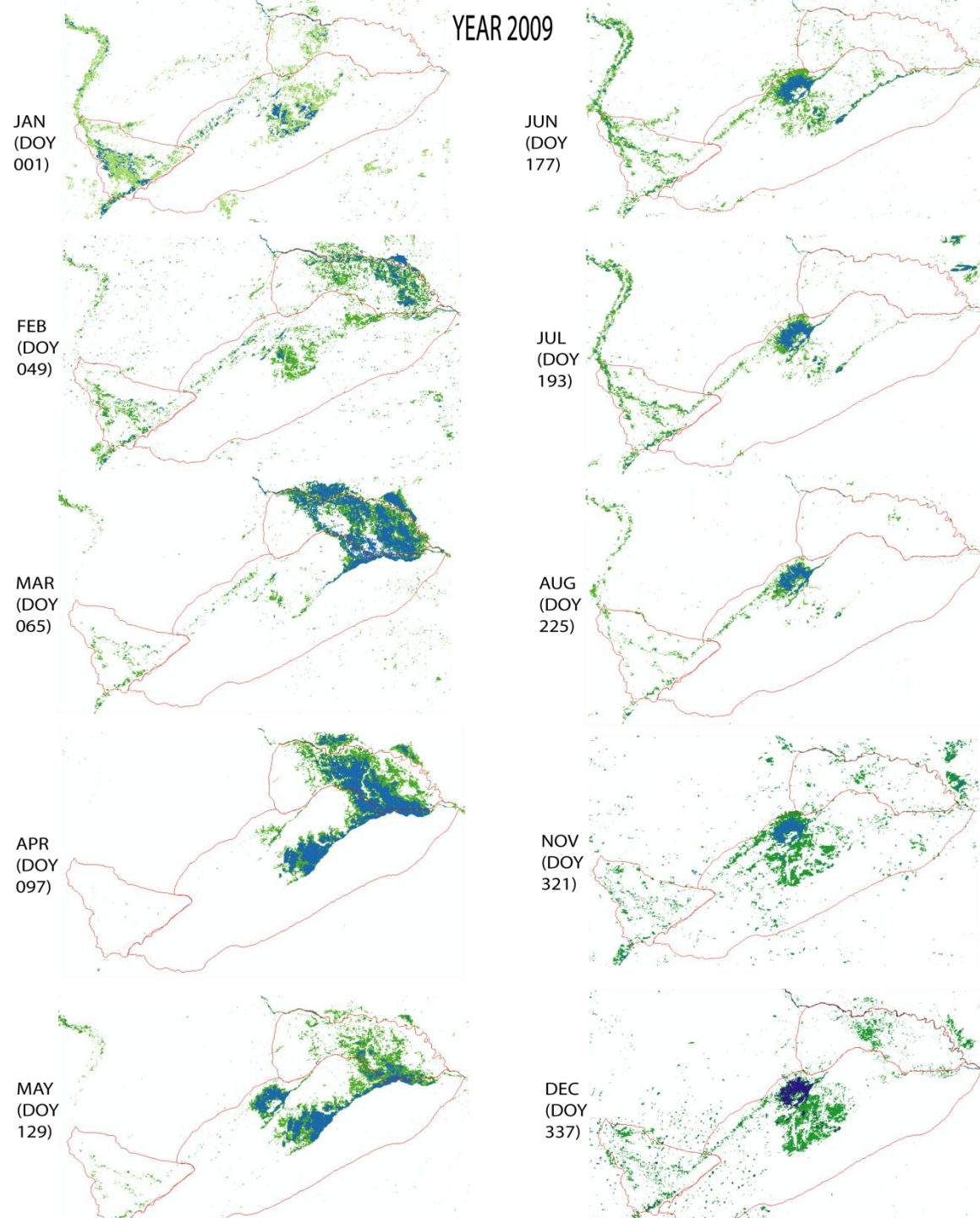


* Class 1 and 2 extracted based on Landsat supervised classification

Objective 1

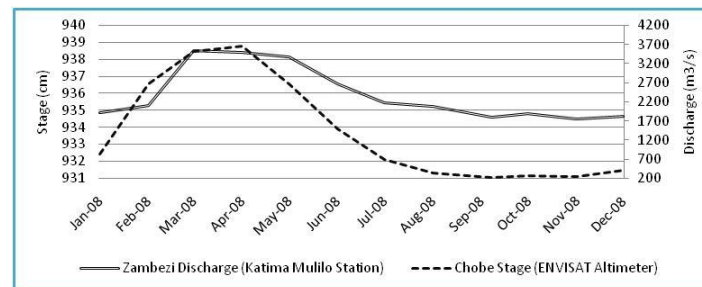
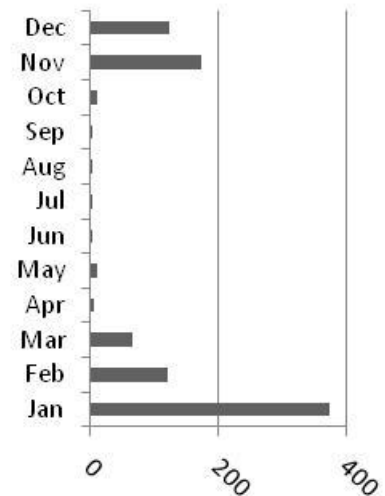
To map the intra-annual spatial distribution of the flood pulse in the Chobe River relative to runoff in the Zambezi and Kwando Rivers and regional precipitation.

YEAR 2009

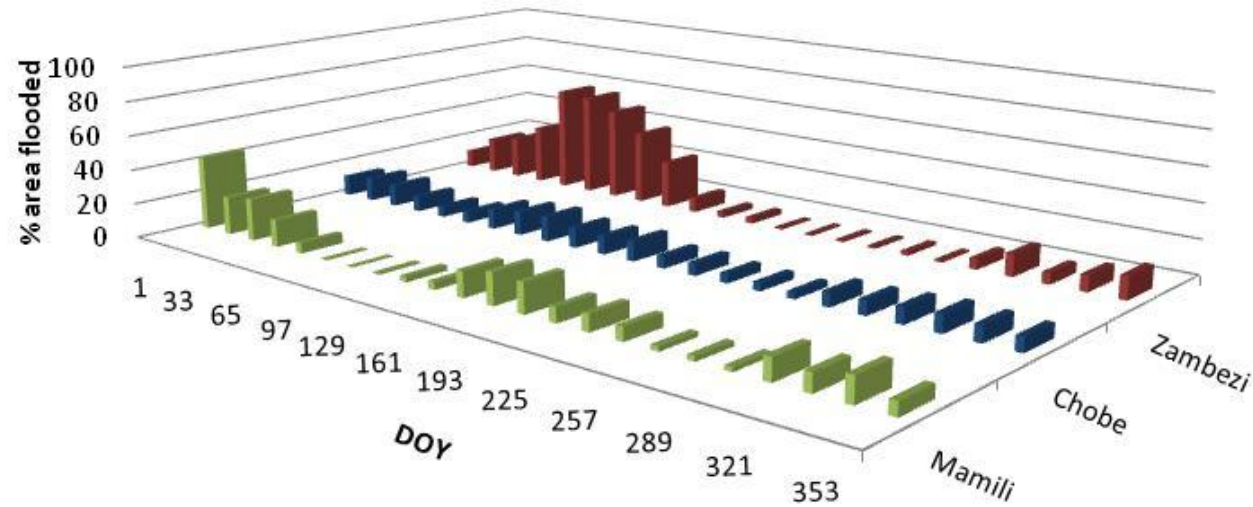
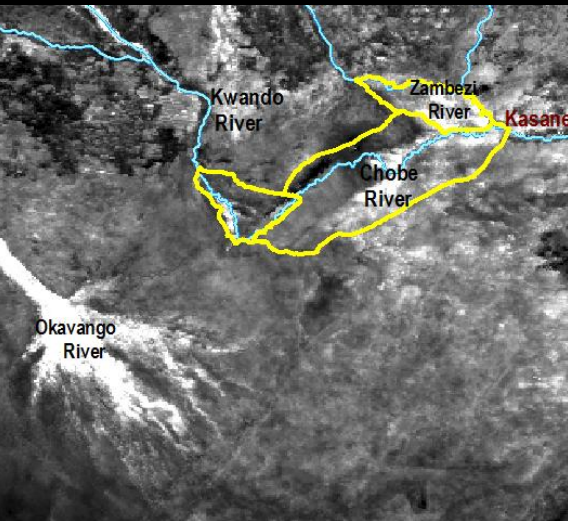
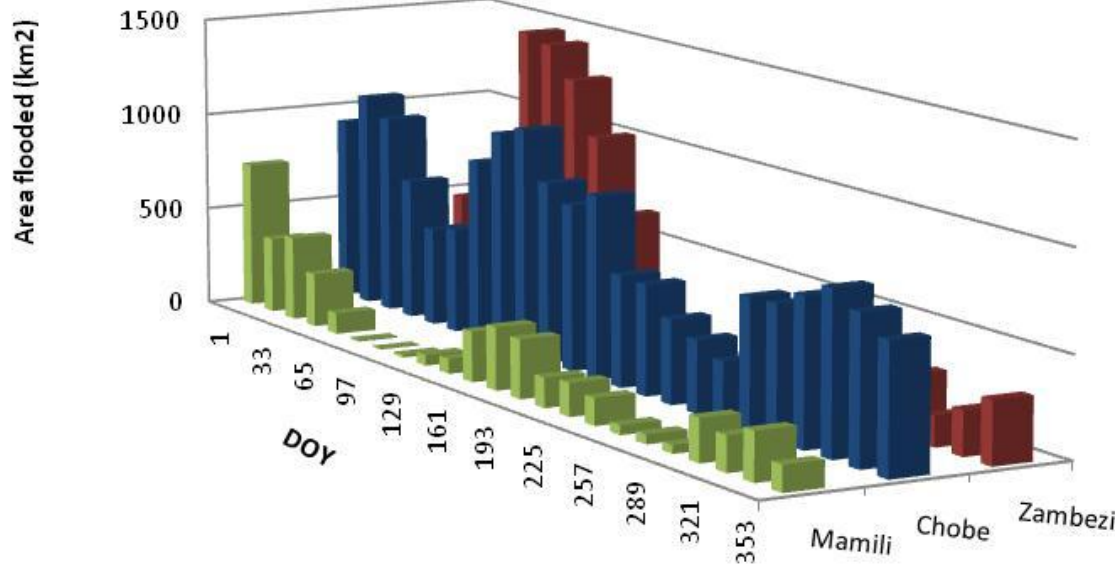


Spatial distribution of inundation in the Chobe-Zambezi-Mamili system during a given year

Precipitation and discharge distribution

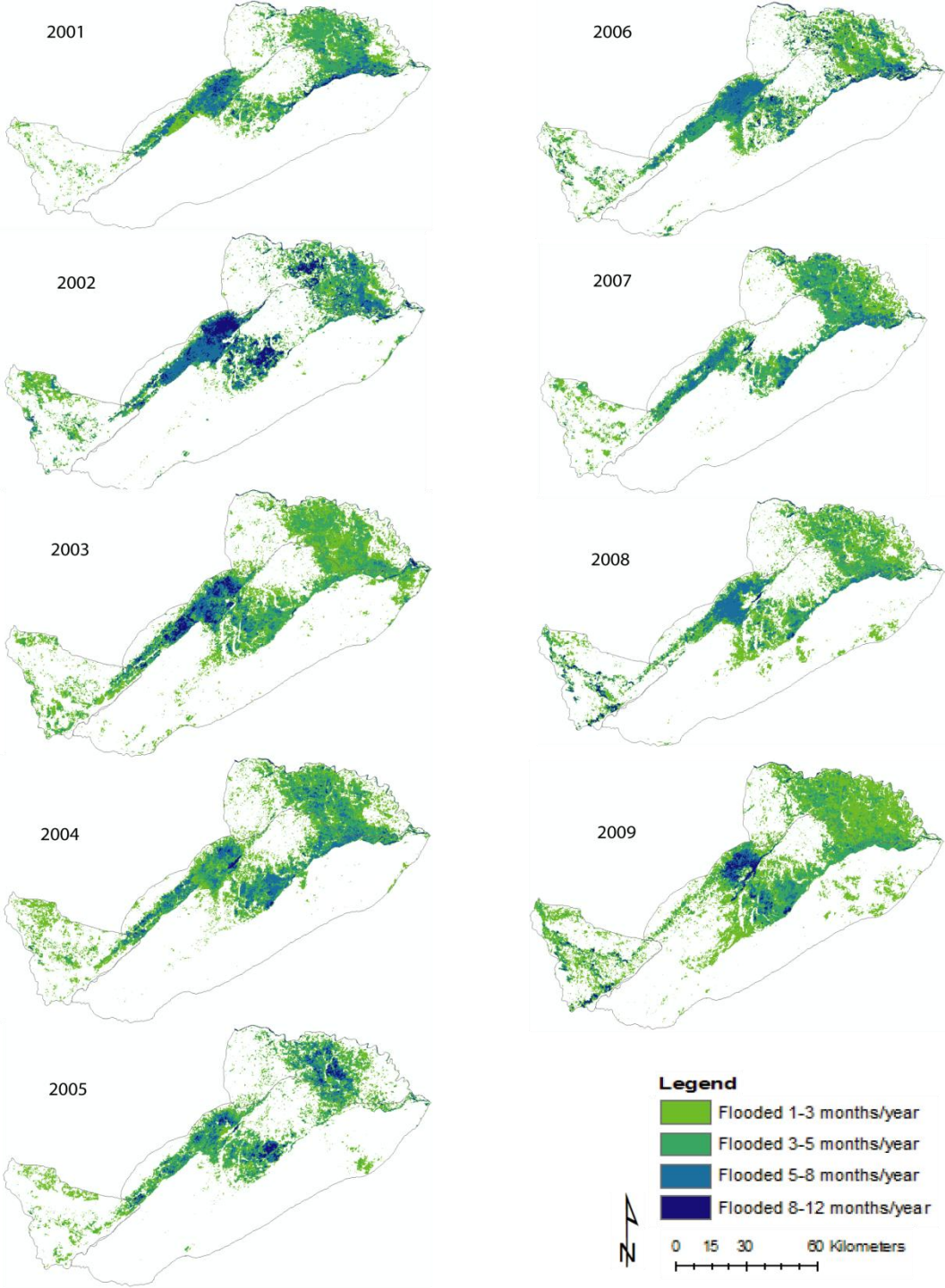


The movement of the flood pulse in CRB



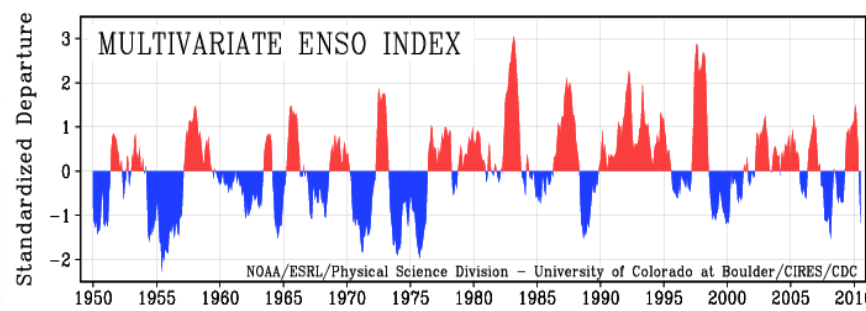
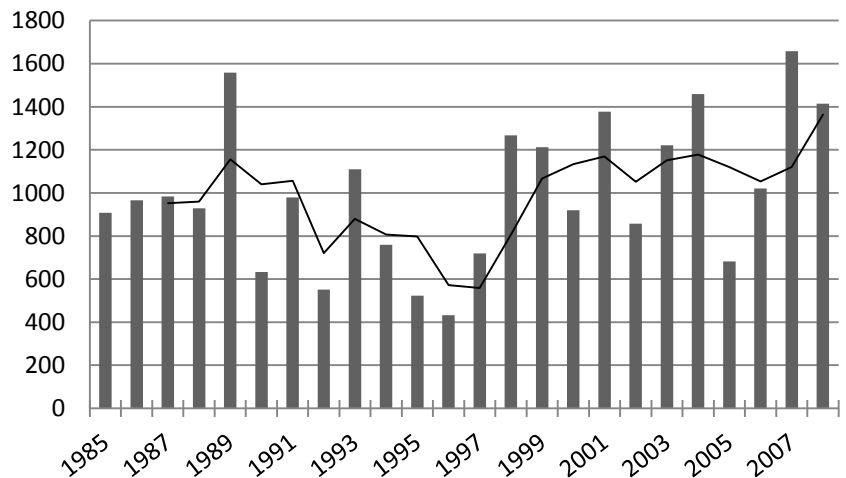
Objective 2

To reconstitute the inter-annual distribution of the flood pulse in Chobe River Basin and create a Flooding Extent Index (FEI).



The spatial extent of flooding (**flooding extent index**) calculated for individual years for the Chobe River Basin from MODIS EVI data for the period 2001 to 2009.

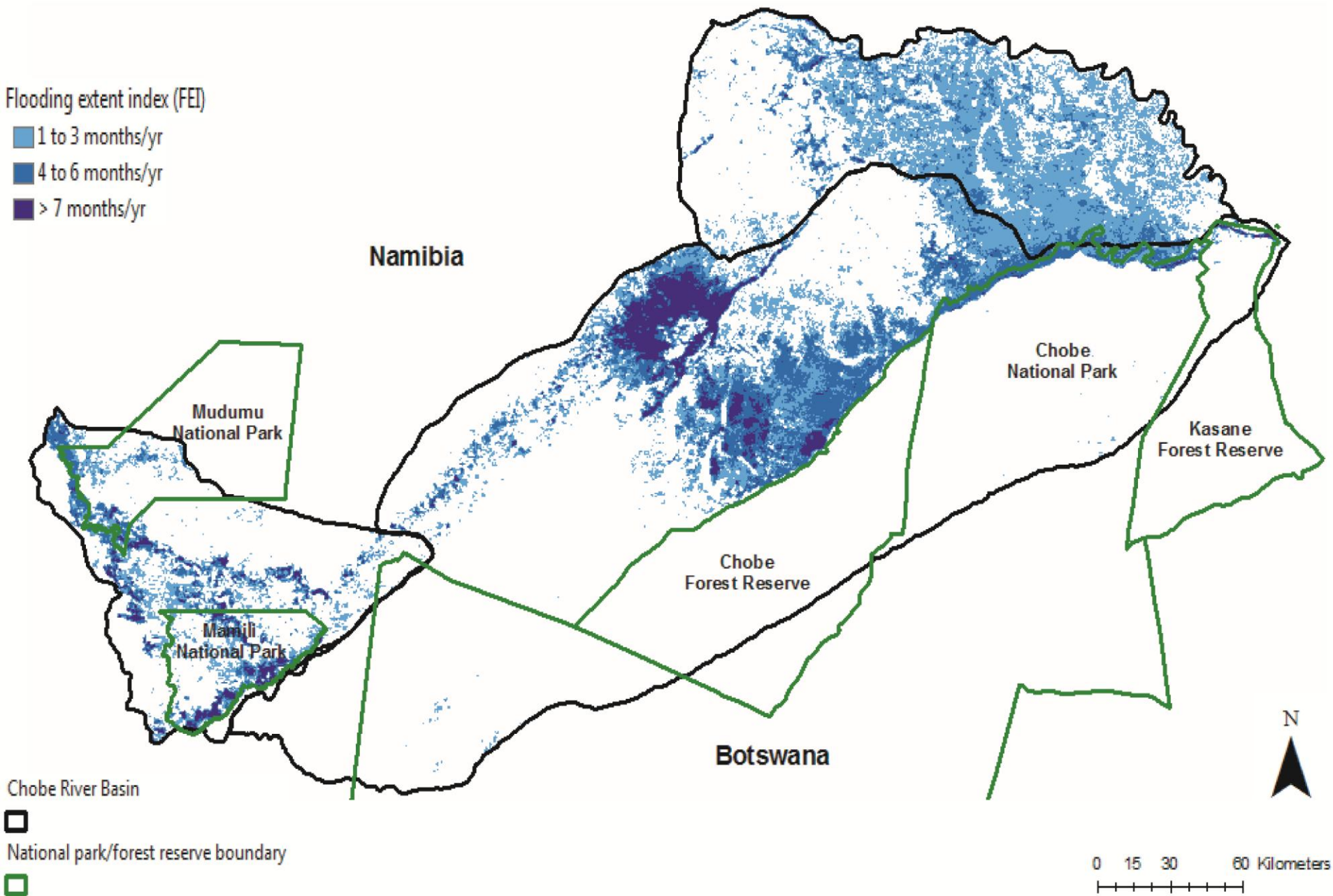
Mean annual discharge (m³/s)



Flooding extent index (FEI) calculated based on MODIS EVI data from 2000 to 2009 in Chobe River Basin

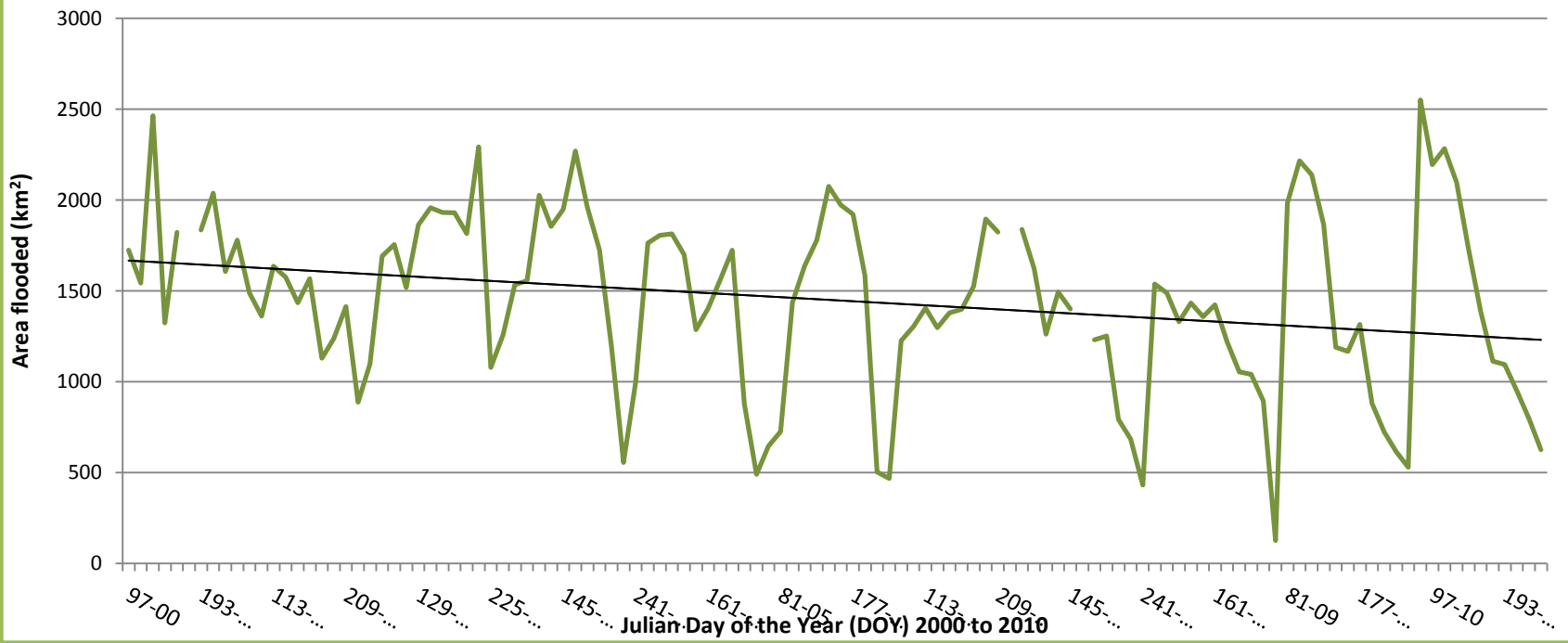
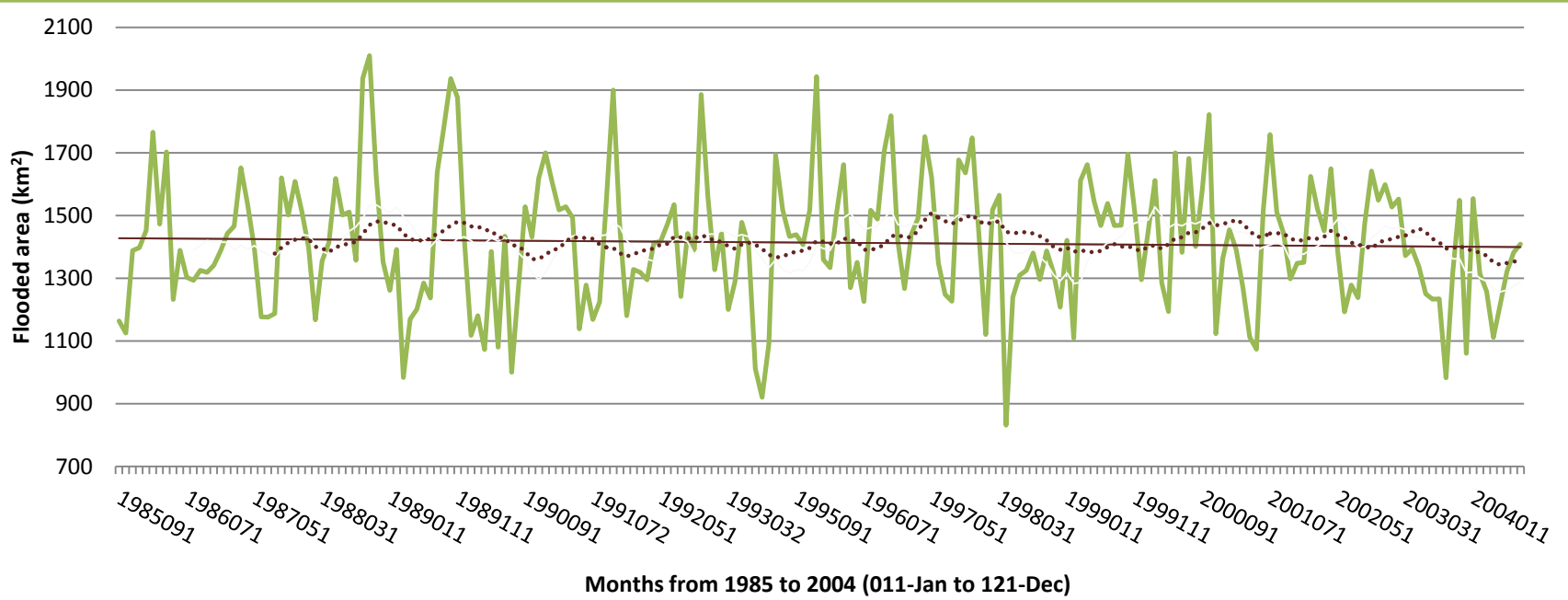
Flooding extent index (FEI)

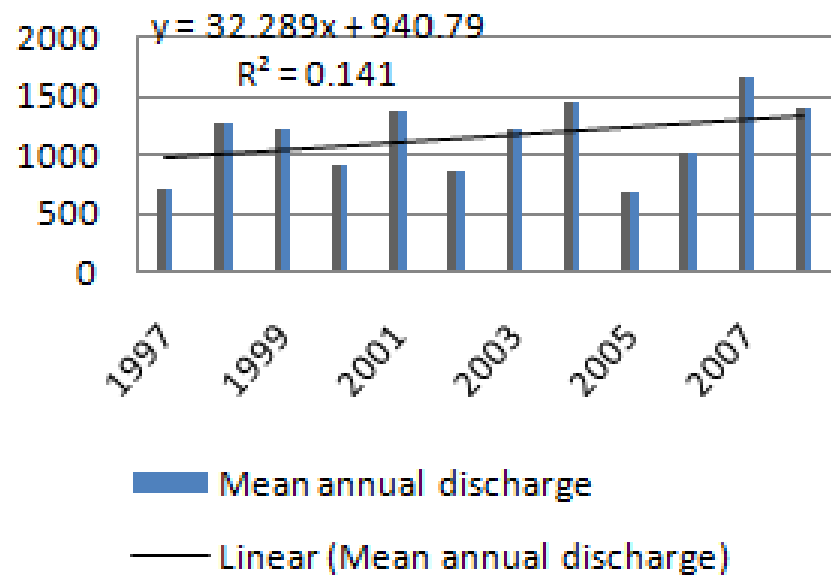
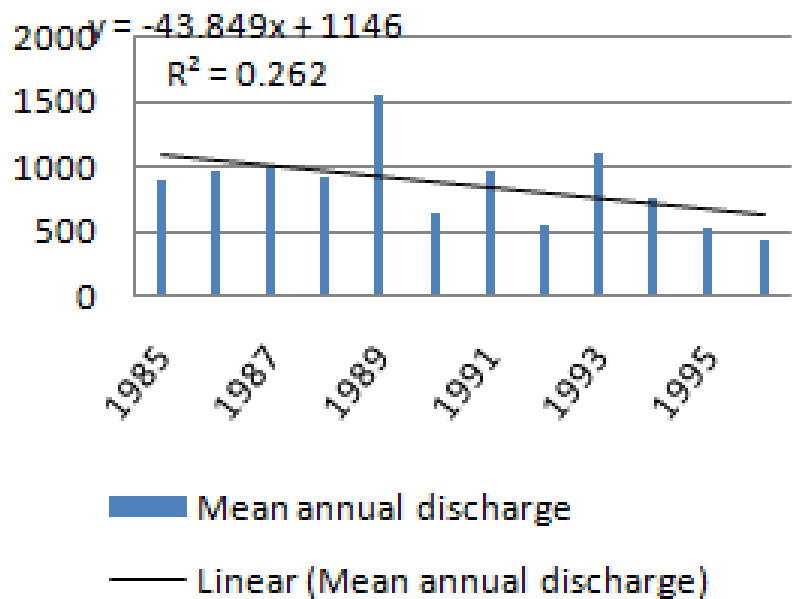
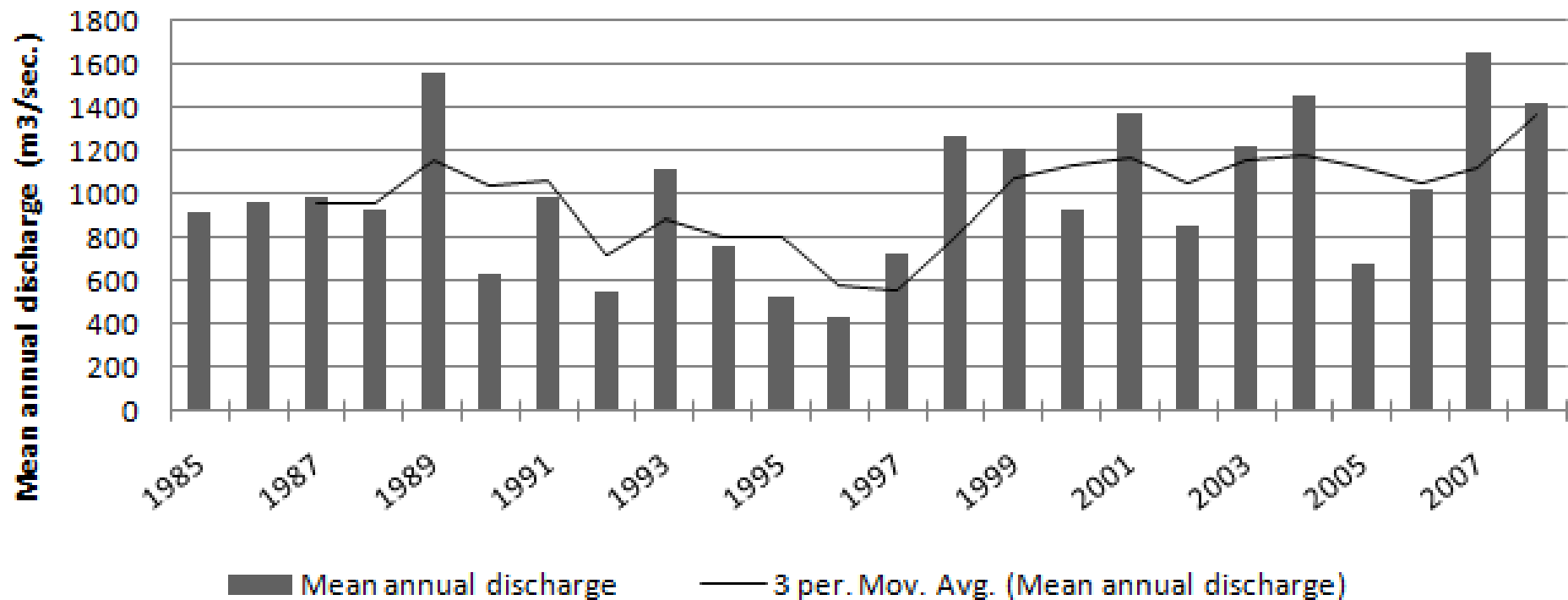
- 1 to 3 months/yr
- 4 to 6 months/yr
- > 7 months/yr



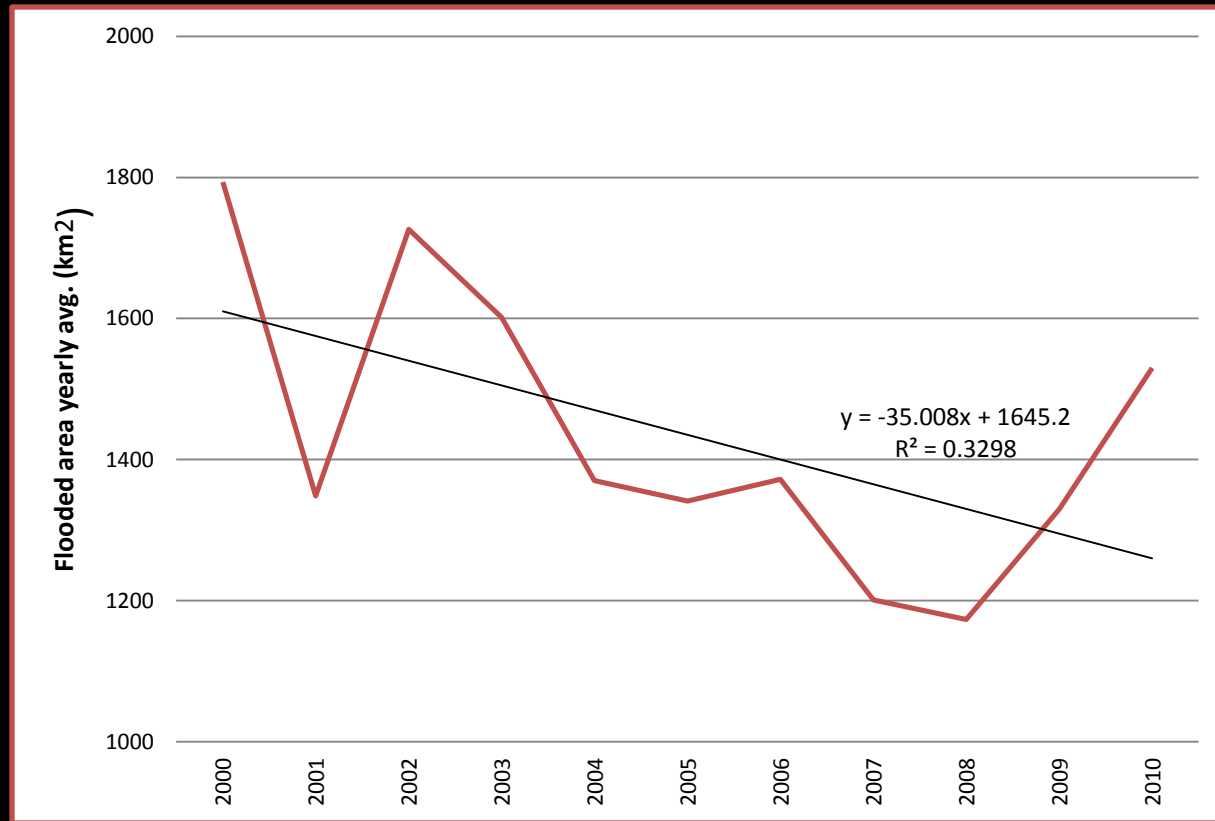
Objective 3

To conduct a longitudinal analysis of changes in the spatial extent of flooding in Chobe River Basin.





Flooded area aggregated to yearly values from 2000 to 2010 in CRB



Summary

- Chobe River Basin:
 - key water resource for Botswana (domestic and irrigated agriculture) and communities in Eastern Namibia
- Key informant interviews:
 - changes in the extent of flooding and vegetation structure in floodplain areas (increasing shrub encroachment)
- Satellite imagery and river discharge analysis:
 - decreasing trend in extent of flooding from 1985 to 2009 (~ 5%)
 - 2-month lag between highest discharge in Zambezi River and highest extent of flooding in Chobe Basin
- Climate change predictions for Southern Africa:
 - decreasing annual precipitation and stream runoff
- **Future work:**
 - determine the relationship between changes in flooding extent and grassland to scrubland conversions in the Chobe floodplain

Acknowledgments

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