Climate and Human Impacts on Water Resources in Africa

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Goal -- Use satellite and ground-based data and numerical models to better understand drivers of water resource variability in semi-arid Africa

Specific objectives:

1. Quantify land use/land cover history since 1950
2. Model impacts of climate and humans on water over last 50 years
3. Investigate applications of satellite tools and numerical models for assessment of near-term water resources

1. Quantify land cover/use history

Problem: need to create spatially explicit data of land cover for semi-arid Africa

- *Cropland parcels tend to be small and dispersed*
- *Moderate-resolution satellite data seems to be inadequate*
  - *Wall-to-wall Landsat classification expensive*
- *Crop census data is not spatially explicit*
- *No one data source is adequate*

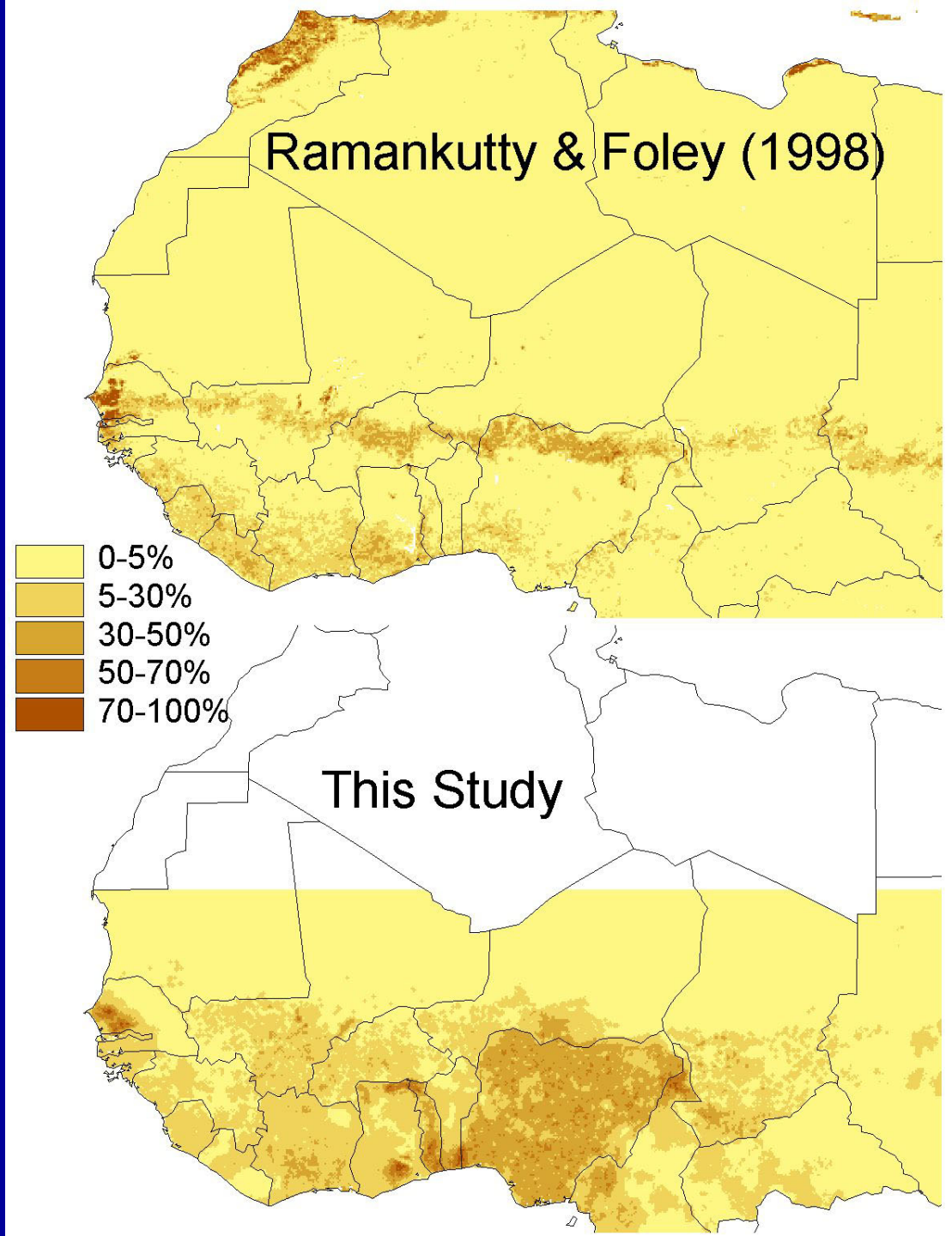
Solution: merge available data to get improved product

- *Combine satellite, agricultural and population census data*

Original product

New product

RESULT--Much better representation of spatial distribution of crop areas and cropping intensity



2. Model variability of runoff, discharge, and surface waters

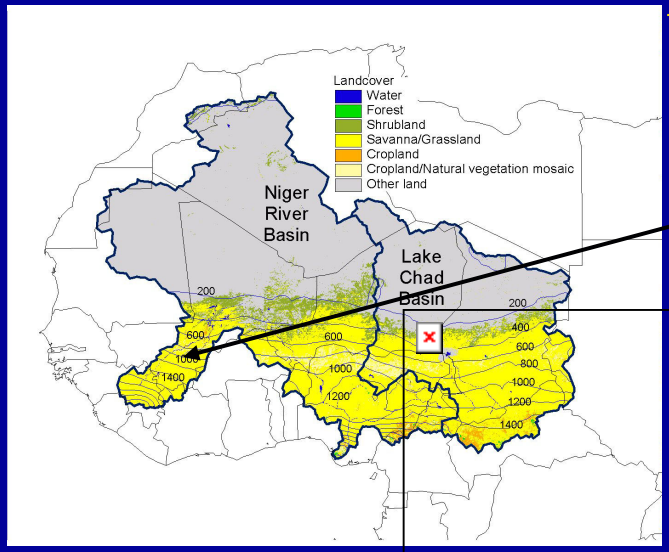
Problem: simulating runoff and discharge in semi-arid regions difficult

- *Runoff is less than 5% of precipitation*
- *Dynamics of soil infiltration and root water stress become very important*
- *Evaporation from wetlands and rivers large part of budget*

Solution: improve IBIS and HYDRA models

- *Include Green-Ampt function to improve soil water infiltration*
- *Represent deep root profile - 5% of roots > 2m depth*
- *Allow for variable root water uptake (compensation for dry soil layers)*
- *Use cellular automata to simulate flow across land surface*

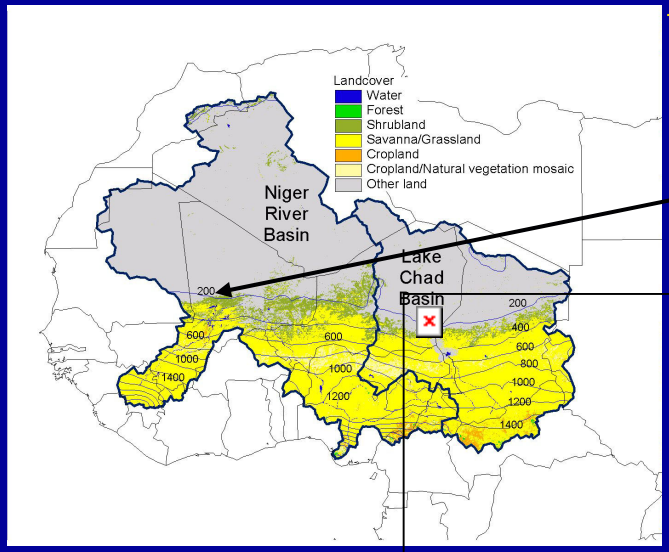
Discharge



Niger Basin at Douna

Better simulate inter-annual variability and persistent long-term wet and dry period **upstream** of large wetland complex

Discharge



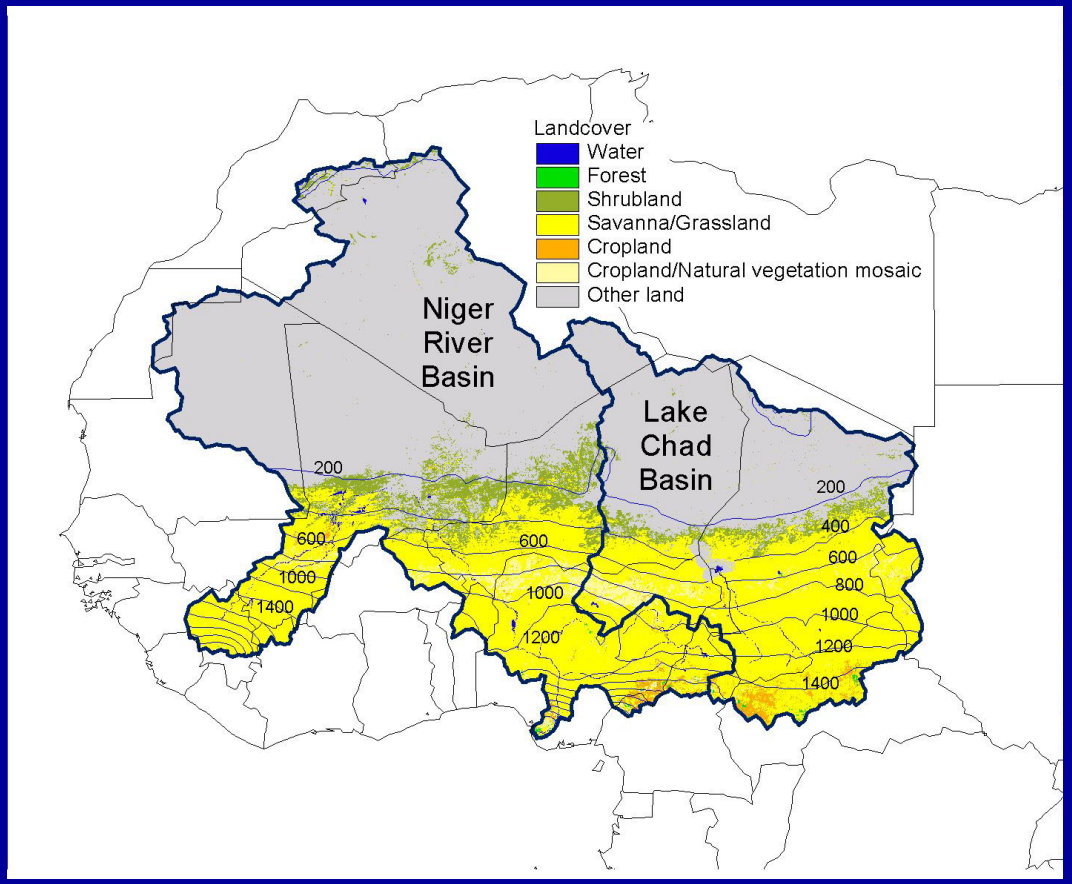
Niger Basin at Dire

Better simulate inter-annual variability and persistent long-term wet and dry period **downstream** of large wetland complex

3. Evaluate tools for near-term prediction

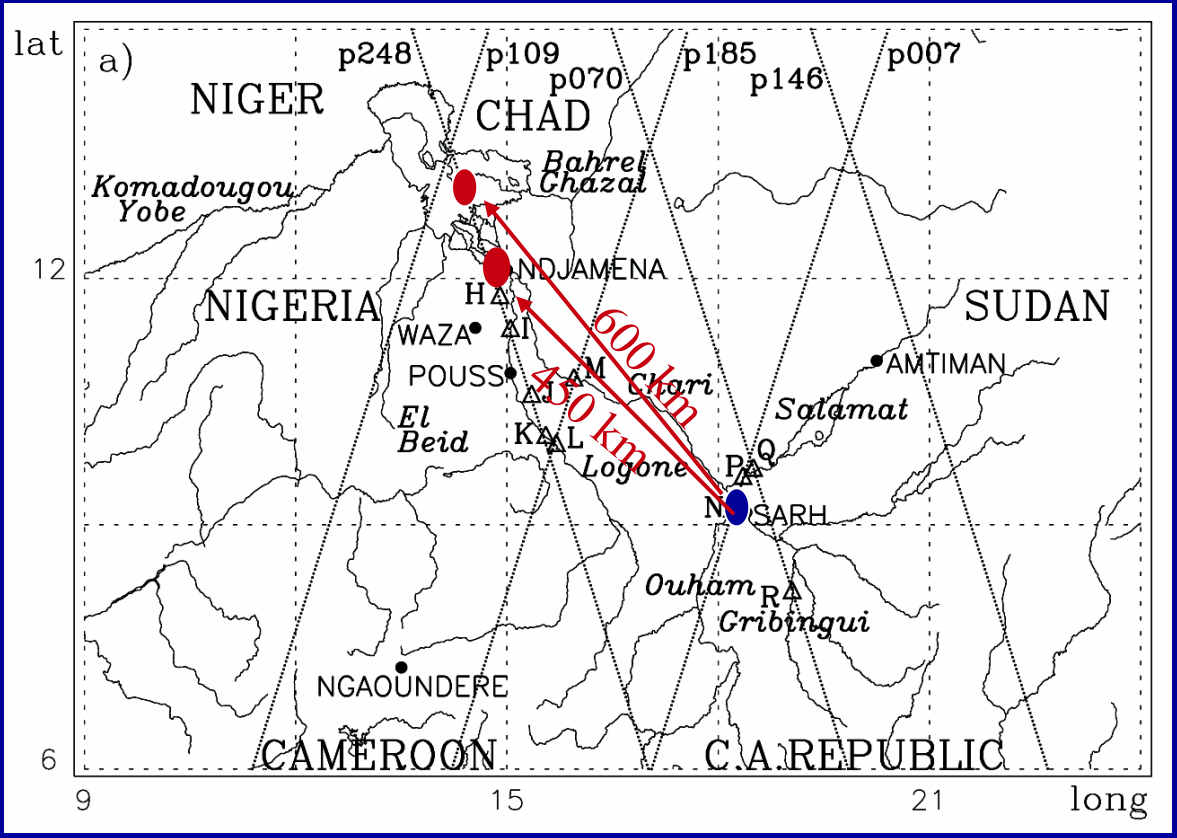
Problem: predict seasonal water resources in Lake Chad Basin

- *Population dependent on seasonal fluctuation of Lake Chad water level*
- *Inter-annual variability can be large and impacts livelihoods*
- *Advance knowledge may be of use locally*



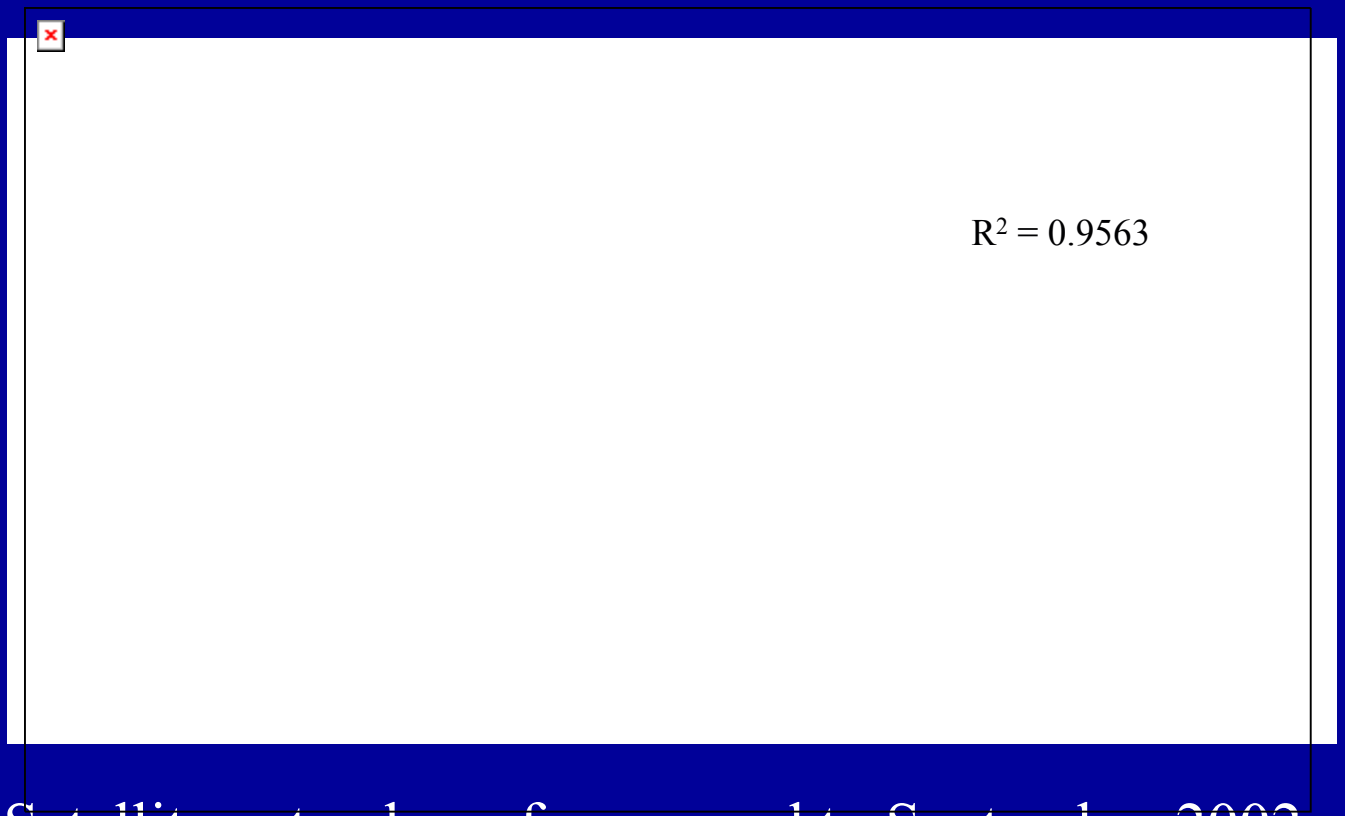
Solution: use satellite radar altimetry from upstream location and calibrate with downstream data to provide downstream discharge and height

- *Calculate downstream discharge and height from upstream water height*
- *Predictive due to travel-time of water from upstream to downstream*
- *Fast - get results potentially within days*



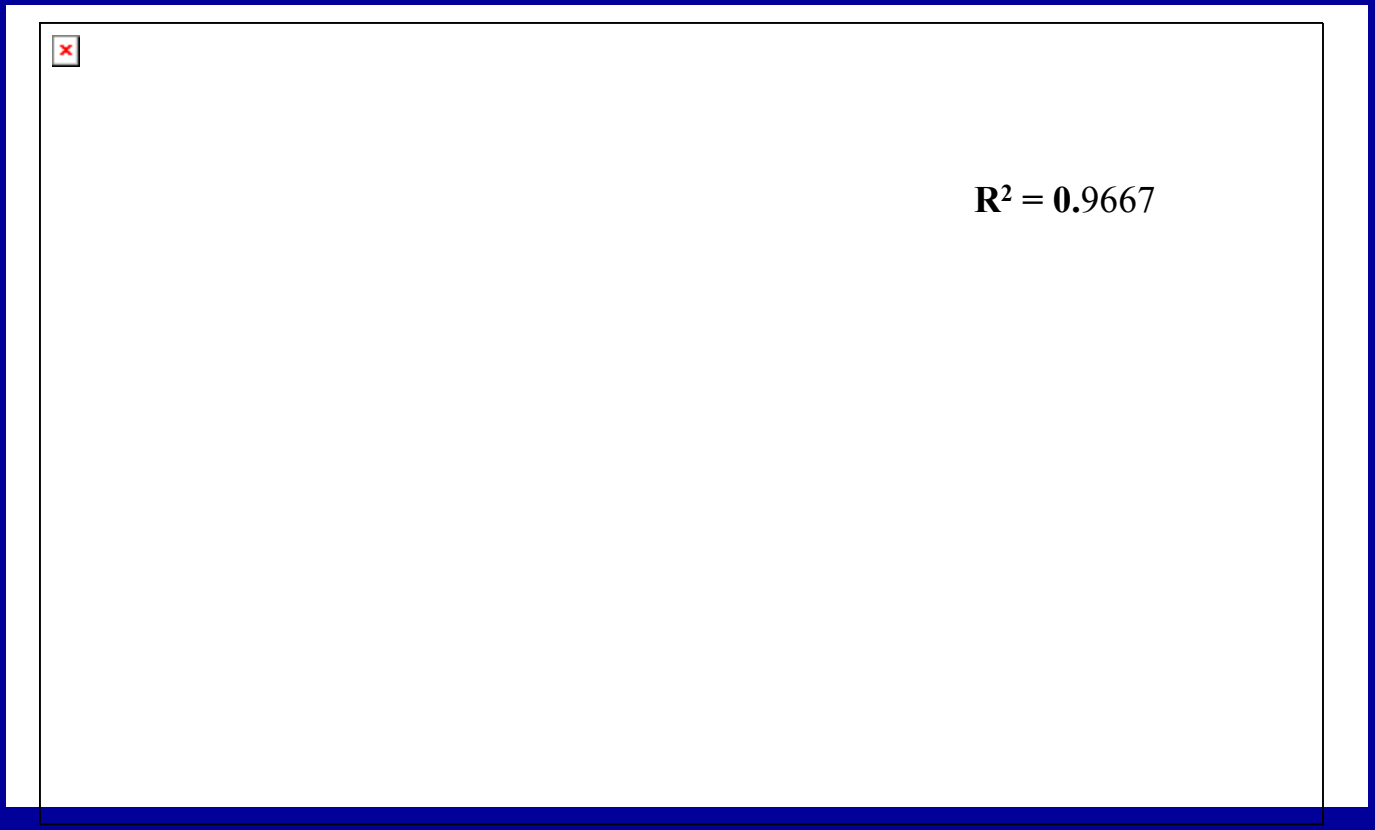
Derive discharge from altimetry

-apply ground-based rating curve



- Satellite extends surface record to September 2002
- Satellite product is 10 days in advance (450 km apart) of ground observation

Lake Height



- Predict height on lake from satellite altimetry data 600 km upstream
- Satellite product is 39 days in advance of lake level change

Future

- Develop land cover/use history (since 1950) on same procedures
- Perform simulations to better understand role of land use/cover changes in last 50 years in water resource variability
- Merge satellite predictive tools with models to get more explicit predictions of river discharge, wetlands, lake height and area
- Set up near-real time product of discharge and height

Conclusions

- Current moderate resolution satellite products can not differentiate between crop and natural vegetation in semi-arid Africa
- Merging Landsat imagery with population density and crop census data provides good estimate of crop intensity and location
- Improvements to ecosystem models provides more accurate simulation of soil moisture, runoff and discharge in semi-arid Africa
- Satellite radar altimetry at upstream locations accurately predicts discharge of Chari River 10 days in advance, and height of Lake Chad 39 days in advance