

An aerial photograph of a river winding through a lush, dense tropical forest. The river is dark and calm, reflecting the surrounding greenery. The forest is composed of various types of trees, including palm trees, creating a rich, textured canopy. The lighting is soft, suggesting a slightly overcast day or a shaded forest environment.

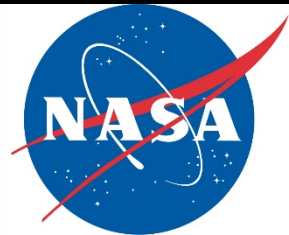
Characterizing hydrological processes within the data-scarce environment of the Congo Basin and applications

Yolande Munzimi
University of Maryland

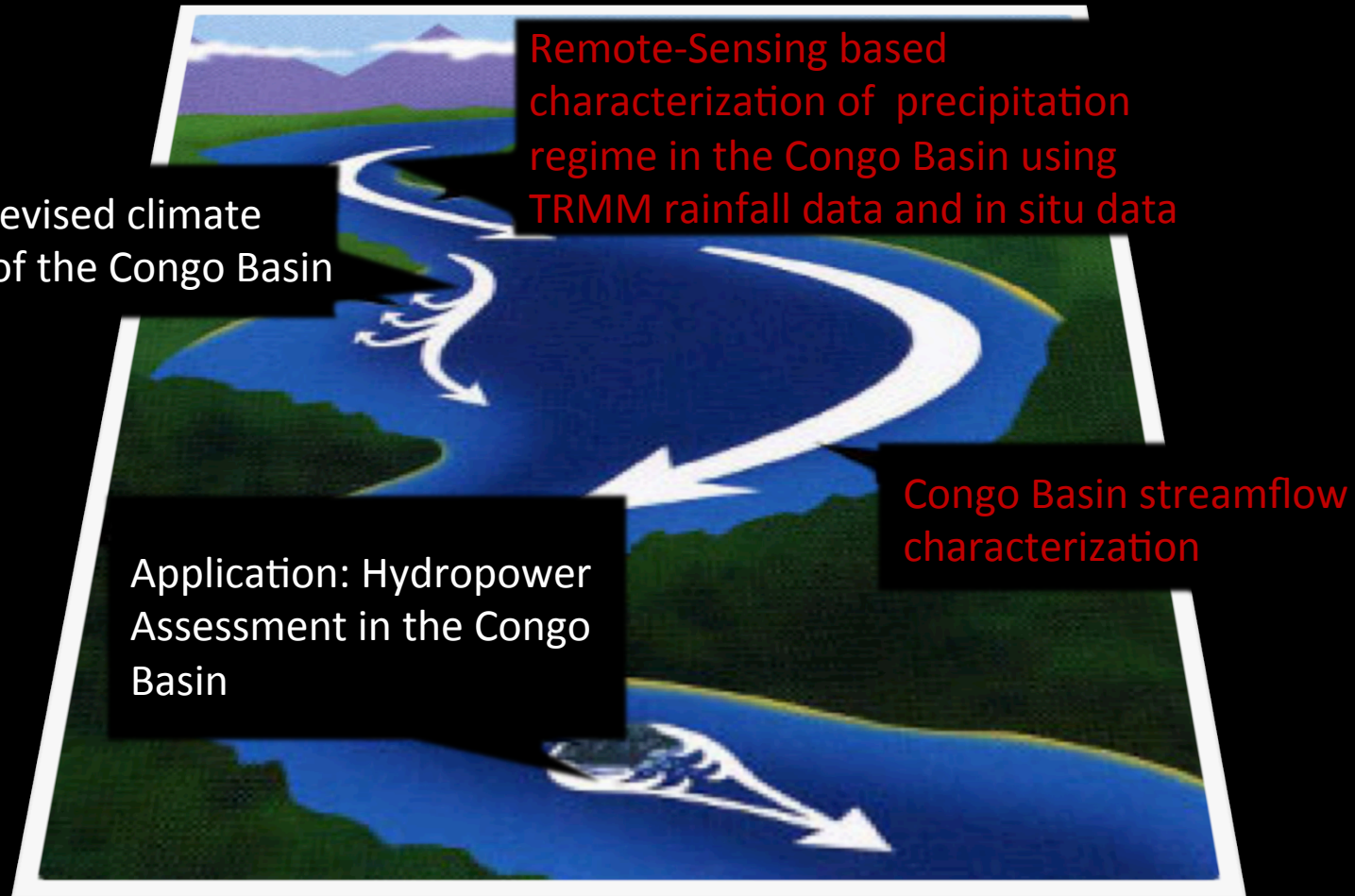
**15th CBFP Partners Meeting and Related Side Events:
Yaounde, Cameroon**

June 18, 2015

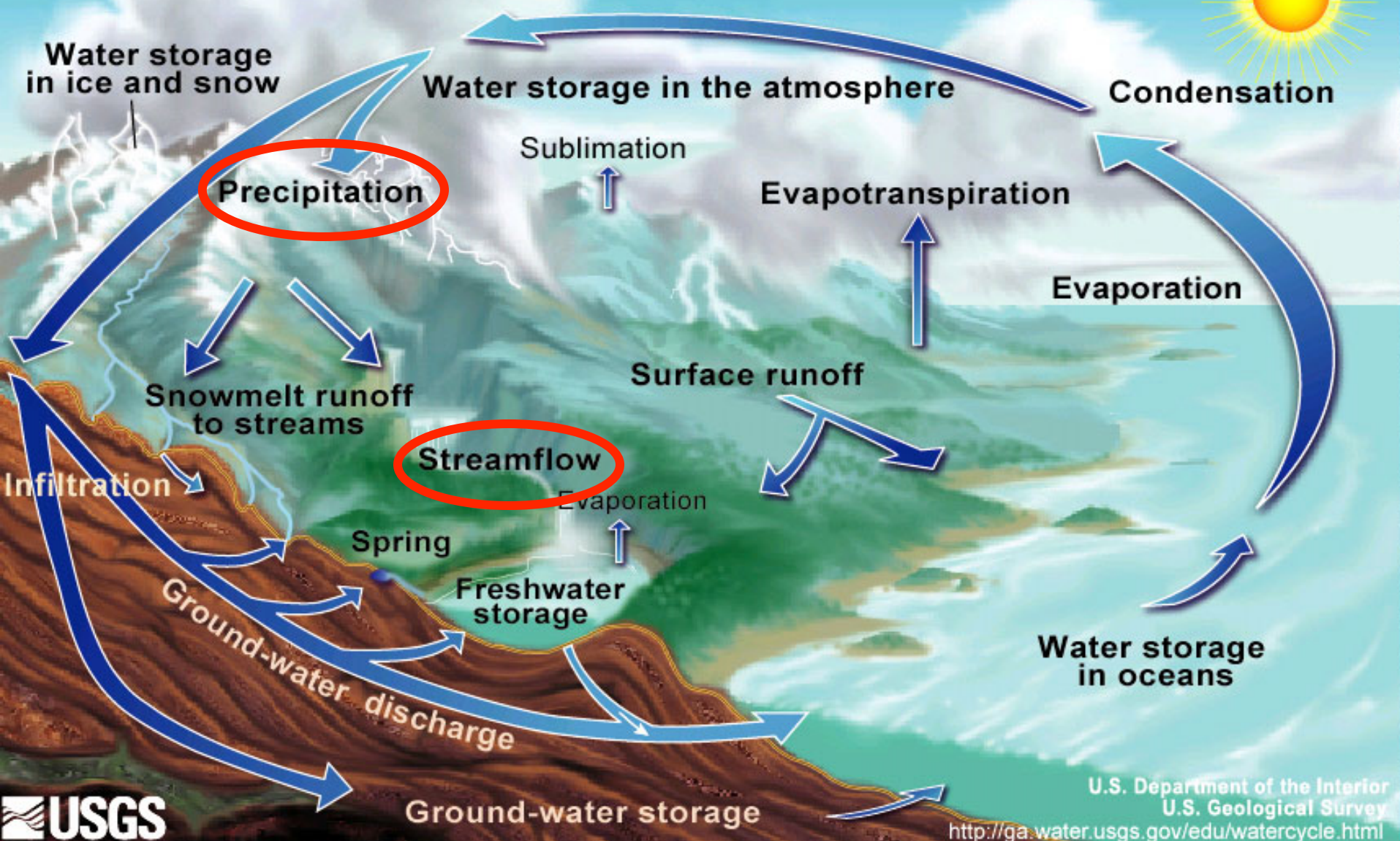
- Ph.D. in the Department of Geographical Sciences of the University of Maryland
- Funded by:
 - ✓ USAID/CARPE (Central African Regional Program for the Environment)
 - ✓ NESSF (NASA Earth and Space Science Fellowship)



Research flow



The Water Cycle



Why study the complex processes?

2.

with forms of
management

4. Natural

**Comprehensive understanding of the
processes - Baseline information
Proper management of water resources**



Congo Basin

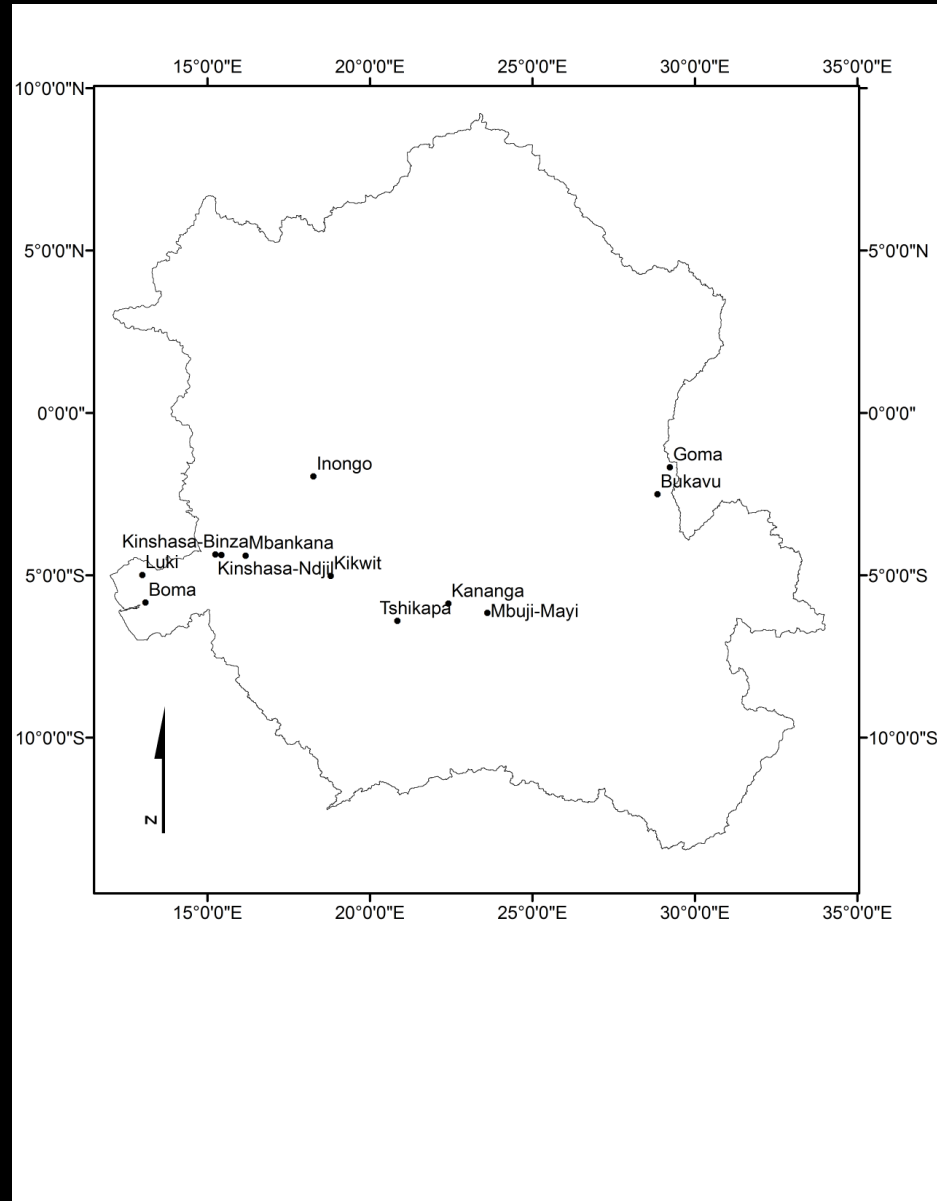


- Second largest river of the world
- Surface area of 3,680,000 km² shared by 9 countries
- Length: 4,700 km
- Discharge: 41,800 m³/s; constant flow (regime stable) but shows interannual variability
- The heart of the Basin: equatorial climate with no dry season; 1500-2000 mm/yr of rainfall
- Drainage area mostly in tropical rainforest (1400 mm/yr)
- Convective and stratiform precipitation are predominant
- Very limited evapotranspiration due to not so high temp
- Water surplus: precipitation > evapotranspiration
- Vital resource in the water stressed continent
- Shortage of the ground-based hydrometeorological data: sparse stations network deteriorating and unevenly distributed; limited number of stations

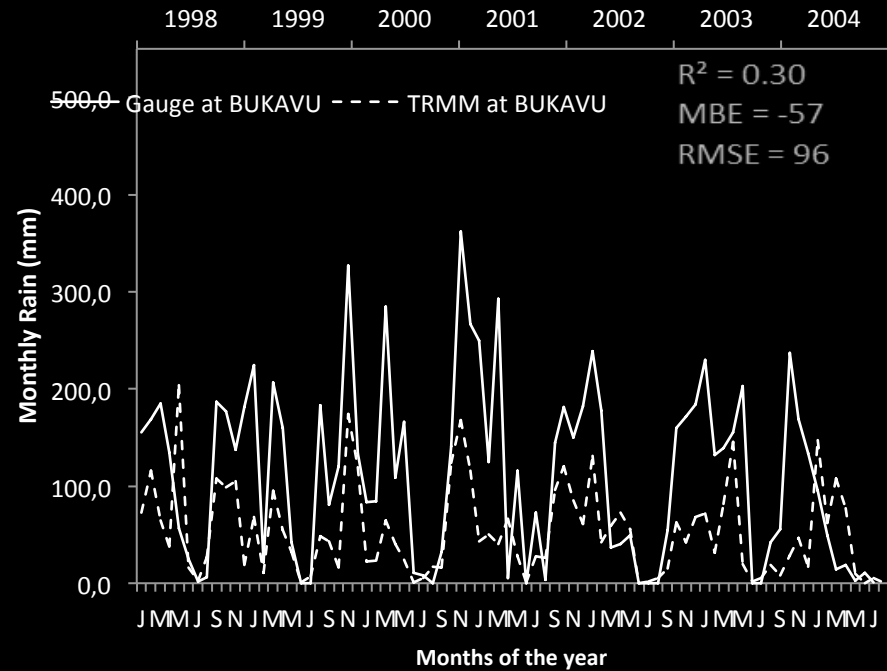
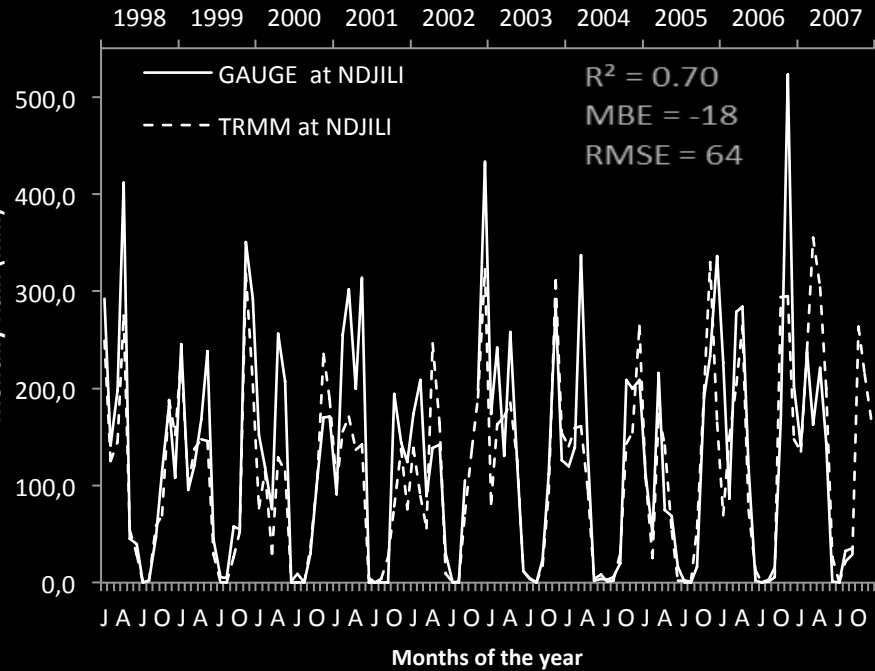
TRMM precipitation estimates

- Joint NASA/JAXA Tropical Rainfall Measuring Mission (TRMM)
- Quantification rainfall patterns
 - Algorithm, Rainfall- & temperature-based climate classification
- Characterization streamflow
 - Hydrological model (GeoSFM) implementation, calibration and validation, hydropower estimation

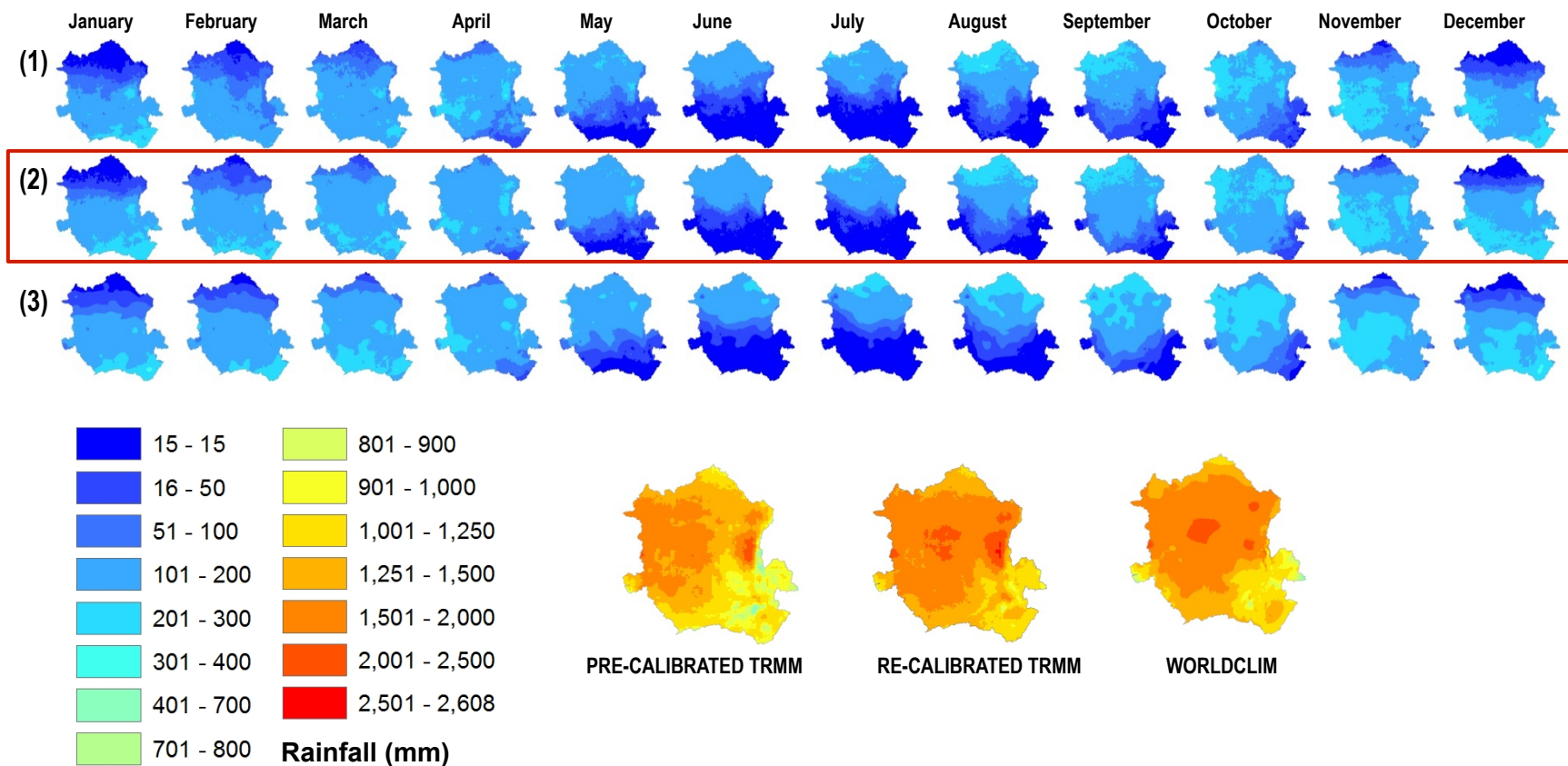
Result 1: Data evaluated



The Congo Basin with in black circle, the 12 precipitation gauge stations locations in study.



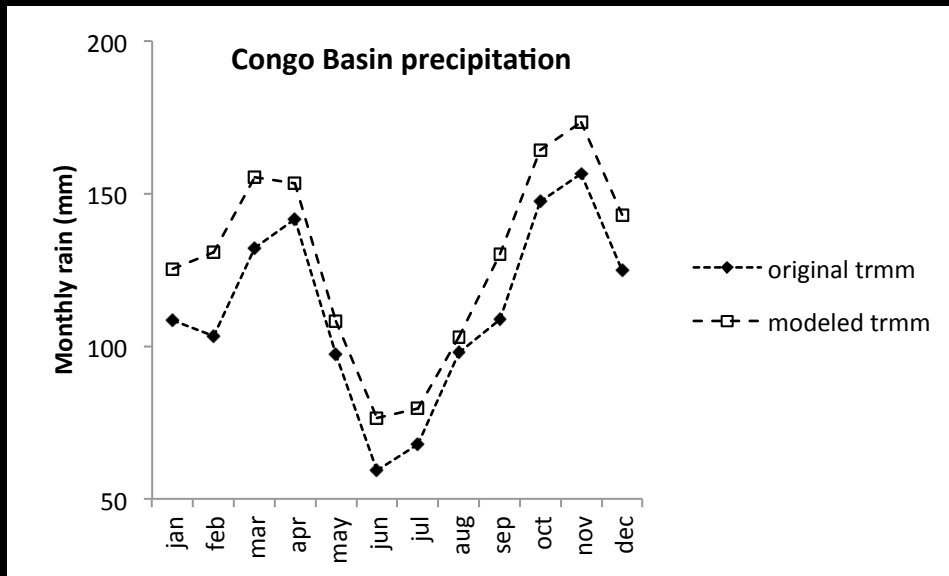
Result 2: Rainfall regime - Data calibrated



Mean precipitation for the 12 months of the year and annually; monthly mean of pre-calibrated TRMM (1) and monthly mean of re-calibrated TRMM (2) are compared against monthly mean of WORLDCLIM precipitation data (3). The 10 year time series of original and re-calibrated TRMM and TRMM 3B43 monthly data were averaged to depict the Basin-scale rainfall regime. The position of the basin across the Equator subjects the Congo to an alternate seasonal pattern between the southern and northern hemispheres.

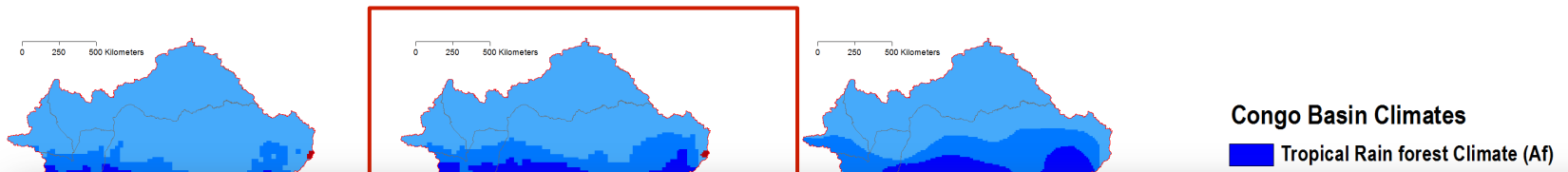
Result 3: Rainfall regime - calibrated and validated

Rainfall regime monthly averages for the Congo Basin



- All months gain precipitation
- Seasonal rainfall regime driven by the passage of the Intertropical Convergence Zone (ITCZ) results in two local rainy and dry seasons of varying length and intensity.

Result 4: Climate classification map





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Yolande A. Munzimi, Matthew C. Hansen, Bernard Adusei, and Gabriel B. Senay, 2015: Characterizing Congo Basin Rainfall and Climate Using Tropical Rainfall Measuring Mission (TRMM) Satellite Data and Limited Rain Gauge Ground Observations. *J. Appl. Meteor. Climatol.*, **54**, 541–555.
doi: <http://dx.doi.org/10.1175/JAMC-D-14-0052.1>

Characterizing Congo Basin Rainfall and Climate Using Tropical Rainfall Measuring Mission (TRMM) Satellite Data and Limited Rain Gauge Ground Observations

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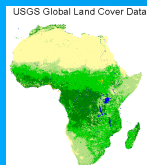
Streamflow Characterization

Geospatial Stream Flow Model (GeoSFM)

Terrestrial and Sub-surface data



FAO Soil Data-KS,
WHC, Depth,
Texture,
Imperviousness



Land Cover

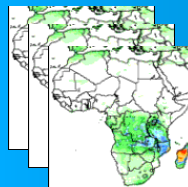


Elevation Data

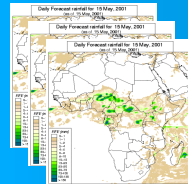


Vector Data
such as rivers,
basins,gauges

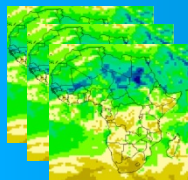
Hydrologic time series data



Rainfall
Estimates

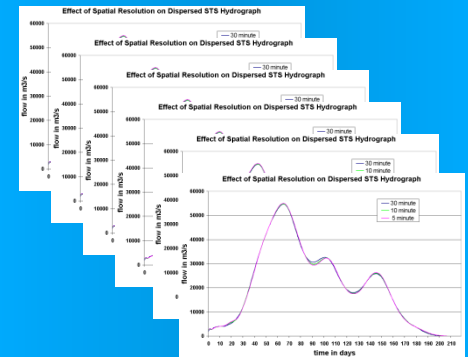


Rainfall
Forecasts



PET

Hydrographs

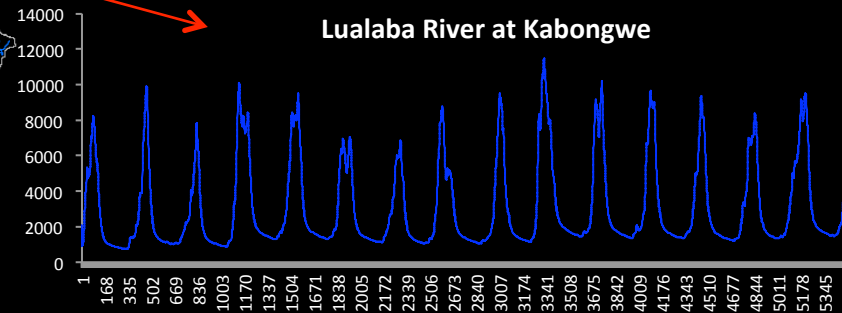
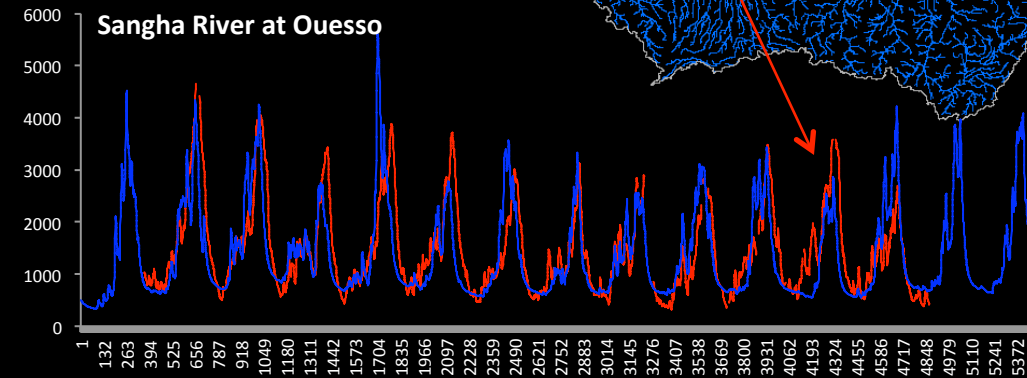
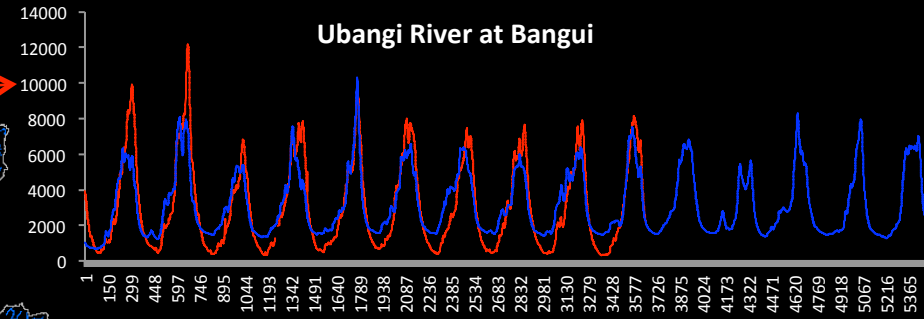
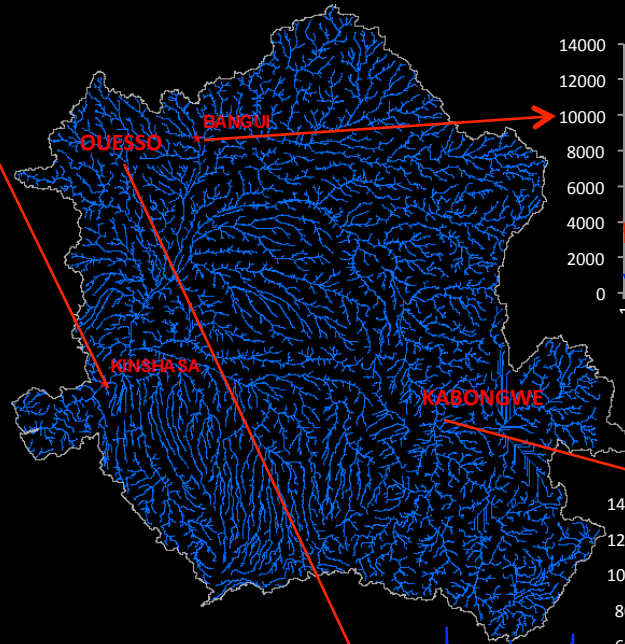
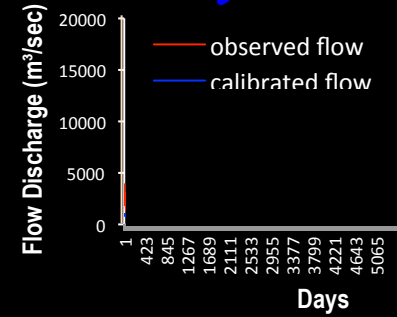
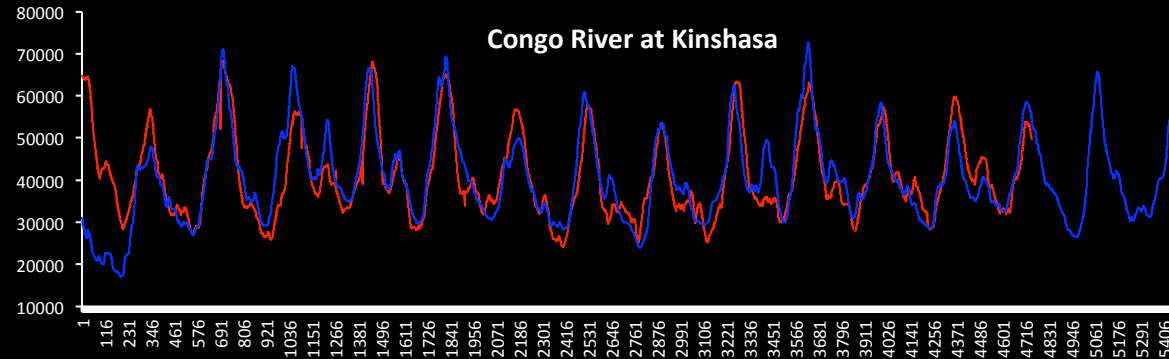


Time series of runoff and flow

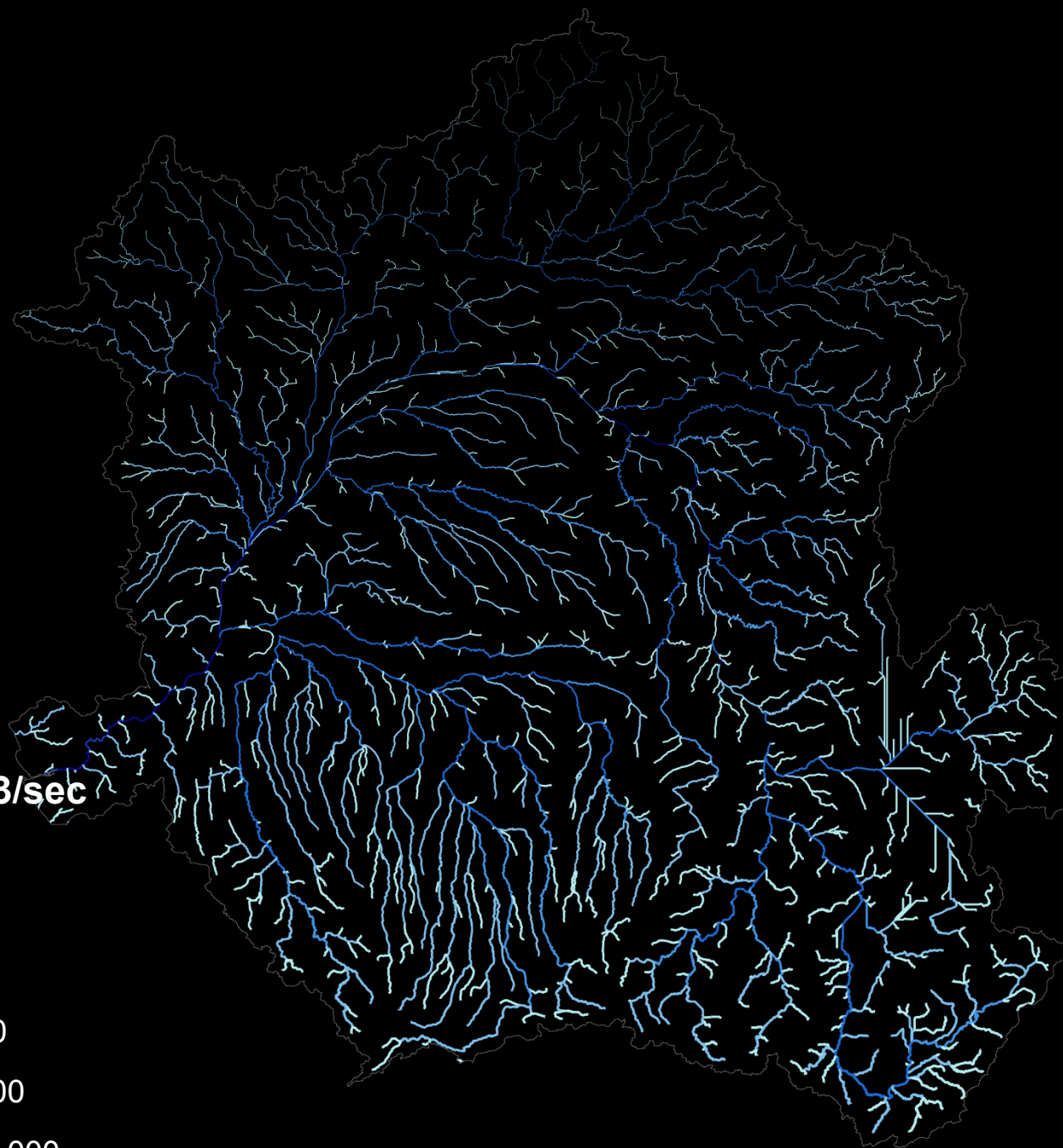
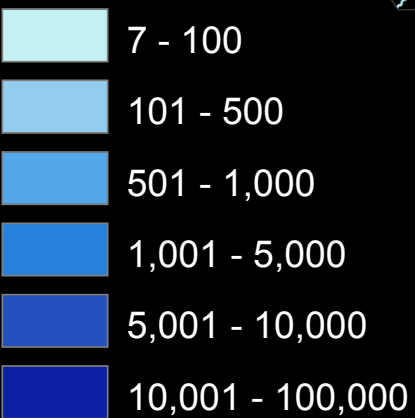
Input

Output

Streamflow hydrographs (m^3/sec)

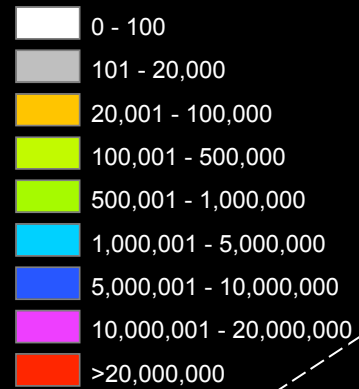


**Daily average
Discharge in m³/sec**



Congo - Hydropower potential gross estimation

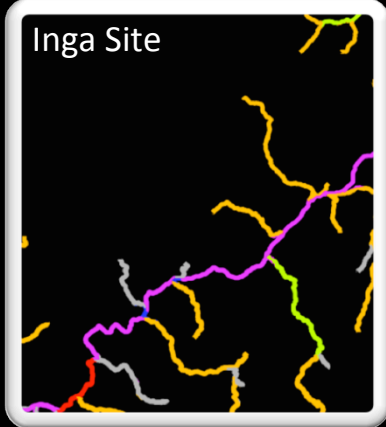
Hydropower Potential Kilowatt (KW)



Ubangi
(Bangui)

Boyoma Falls

Inga Site

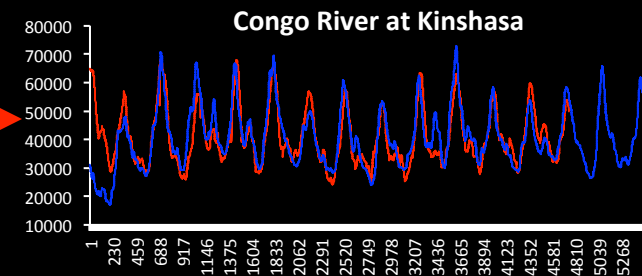
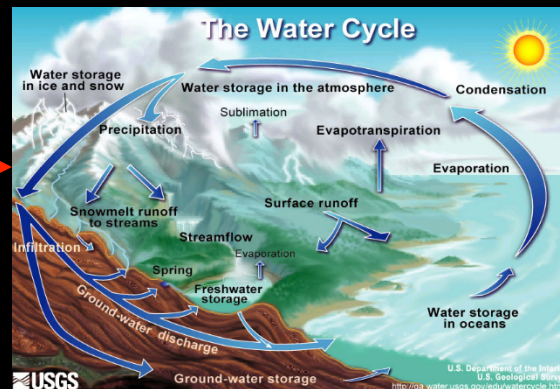
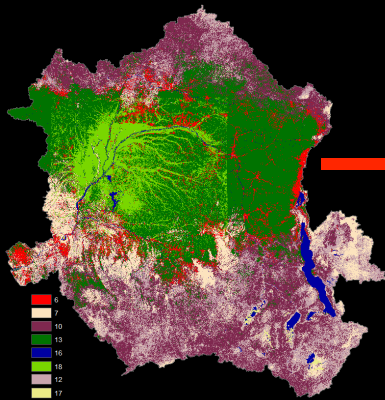


Hydrological response to Land Cover and Land Use Change

We exploring the influence of potential future deforestation on the streamflow of the Congo River – Land surface processes and atmospheric feedbacks

Assumption:

Depending on the scale, deforestation reduces evapotranspiration and increases streamflow (small scale) or at large scale atmospheric feedbacks may significantly reduce regional precipitation and decrease discharge



Conclusion

1. More in situ stream and precipitation gauge data are needed to properly characterize river flows of Central African watersheds, information that is essential to properly manage as well as monitor these resources.
2. The rivers of Central Africa are vital resources for an otherwise water stressed continent. Potential adverse impacts of land use changes and infrastructure on river flows and water quality must be considered when planning for development.