Hydrologic Calibration of the SWAT Model for African River Basins using GRACE data

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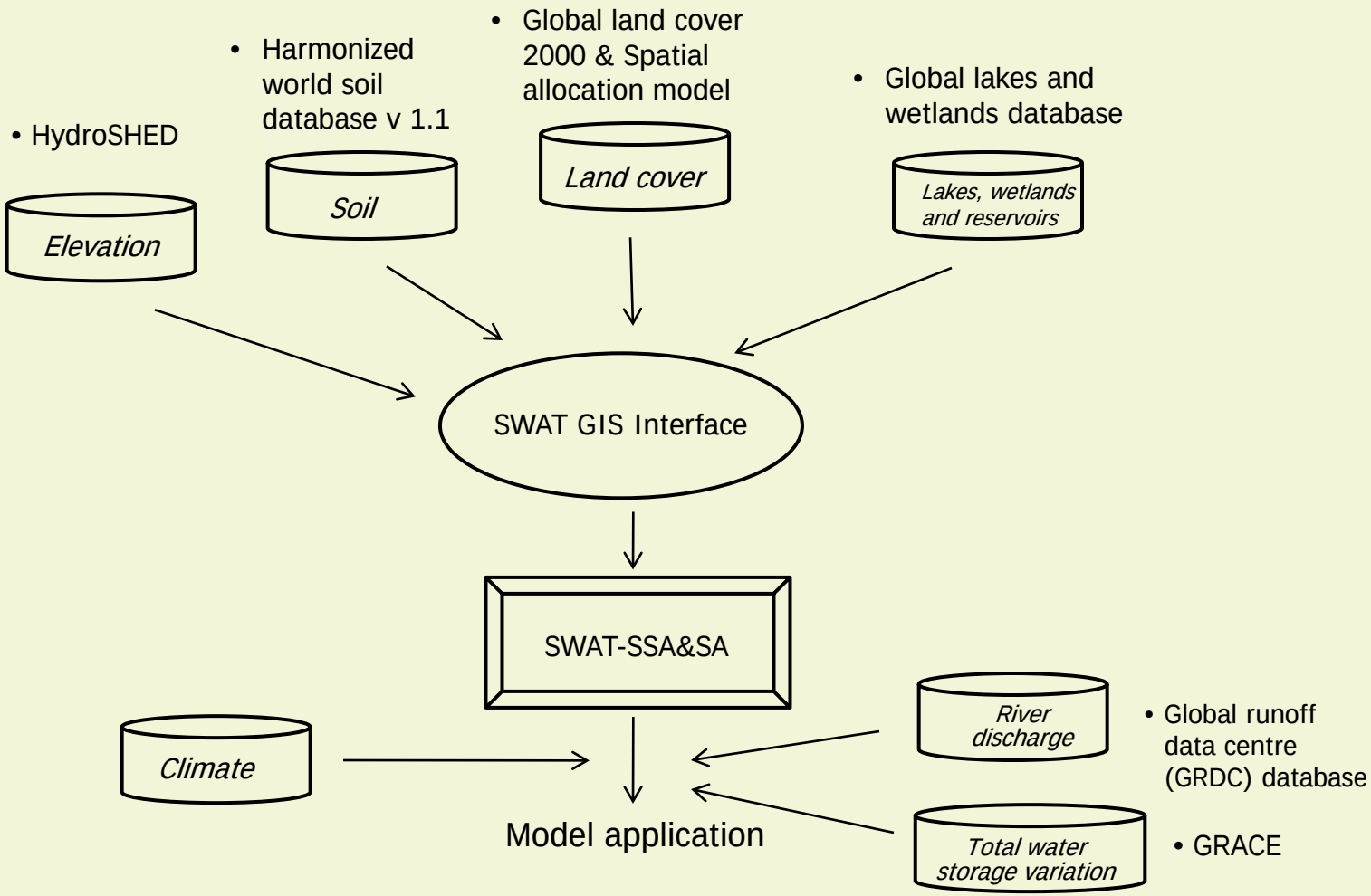
Agricultural Water Management Solutions

- Identify promising investment options for smallholder irrigation in Sub-Saharan Africa and South Asia

Data challenges in the development of SWAT applications for Sub-Saharan Africa and South Asia



Gravity Recovery and Climate Experiment (GRACE)

- A twin satellite system in GRACE mission

Distance between two satellites ⇨ Earth's gravity field & mass distribution variation ⇨ Total water storage variation

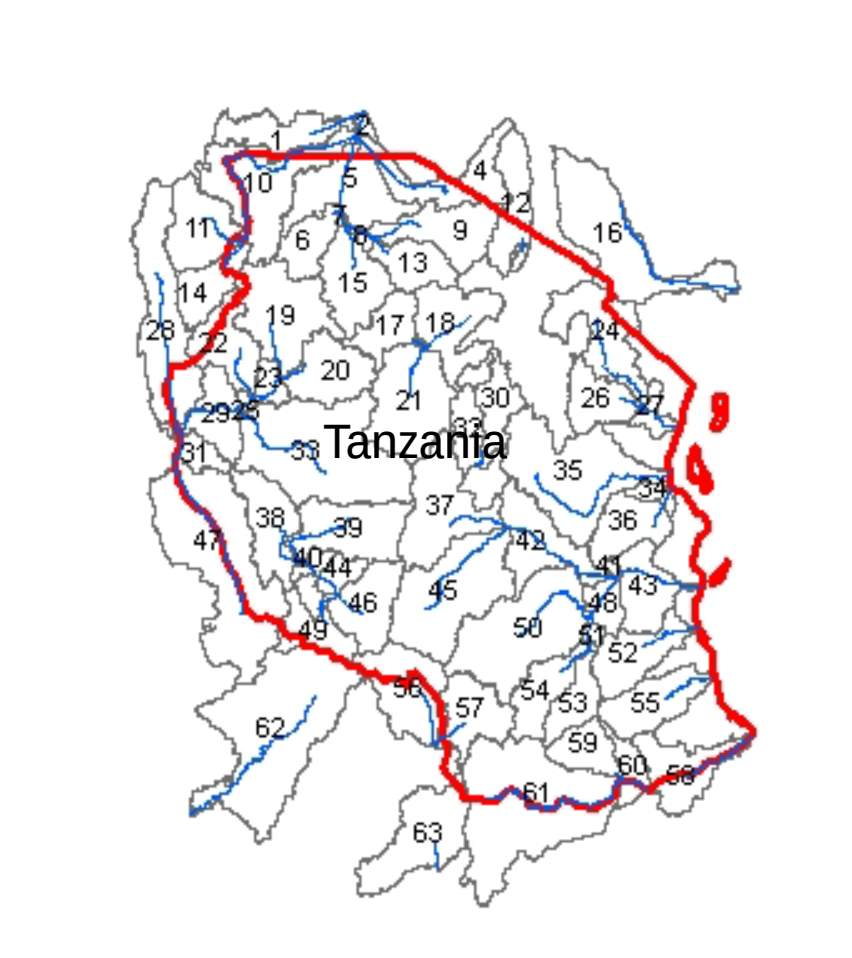
- Total water storage variation

— Snow/ice
— groundwater
— soil water
— surface water (in rivers, lakes, wetlands and reservoirs)

- Errors in GRACE data processing

— Measurement error
— Aliasing error
— Leaky error

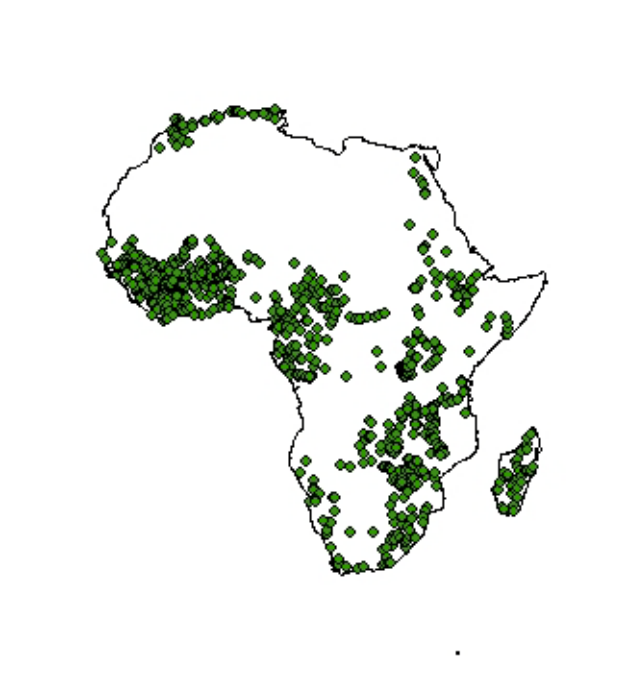
SWAT-Tanzania model

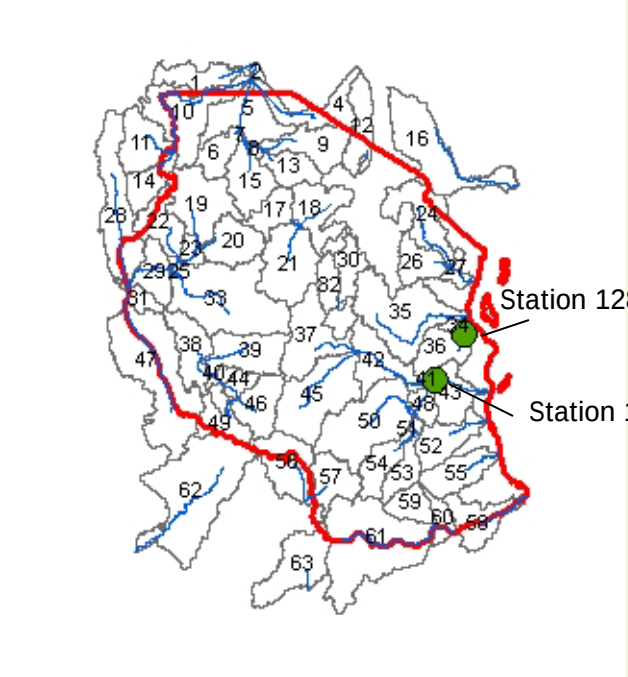


— Area: 1.15×10^6 km^2

— subbasins: 63

GRDC stations





Source: Global Runoff Data Centre (GRDC)

Calculation of the total water storage variations (TWSV) in SWAT modeling

$$V_{total}=V1+V2+V3+V4+V5+V6$$

V_{total} —the total water storage

V1 — the water storage in snow pack

V2 — the water storage in soil profile

V3 — the groundwater storage in aquifers

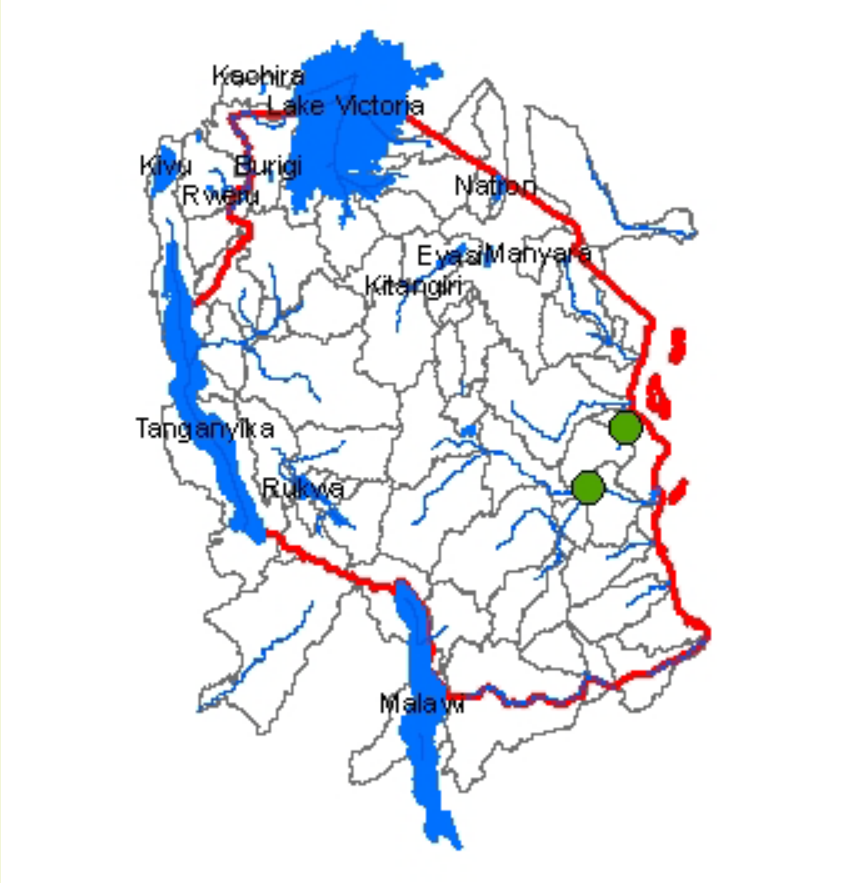
V4 — the water storage in river channel

V5 — the delayed released surface runoff

V6 —the water storage in lakes and reservoirs

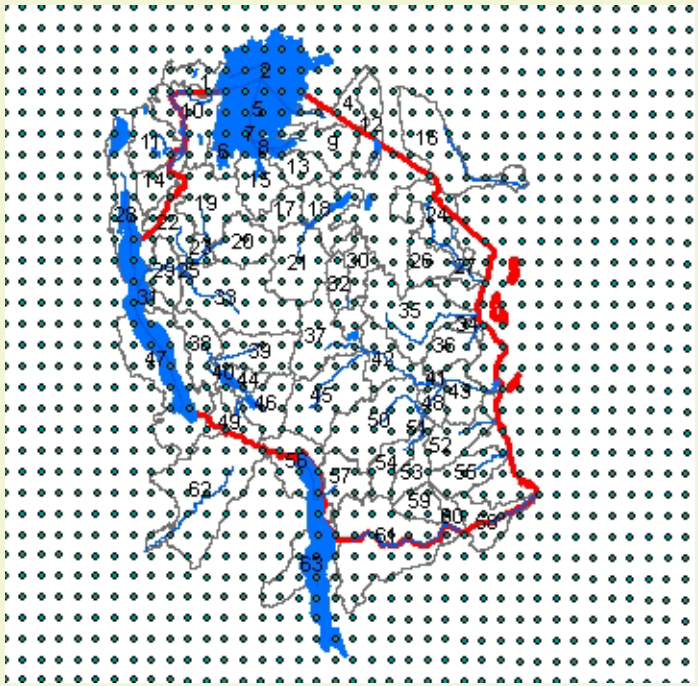
$$TWSV=V_{total}-\overline{V}_{Total}$$

Mass correction

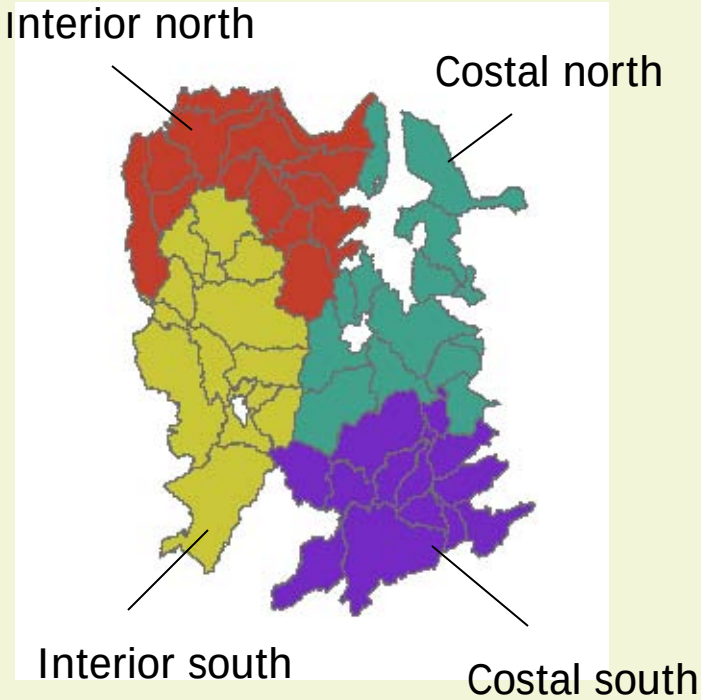


— Mass correction was made to remove the effects of the large lakes in GRACE data processing

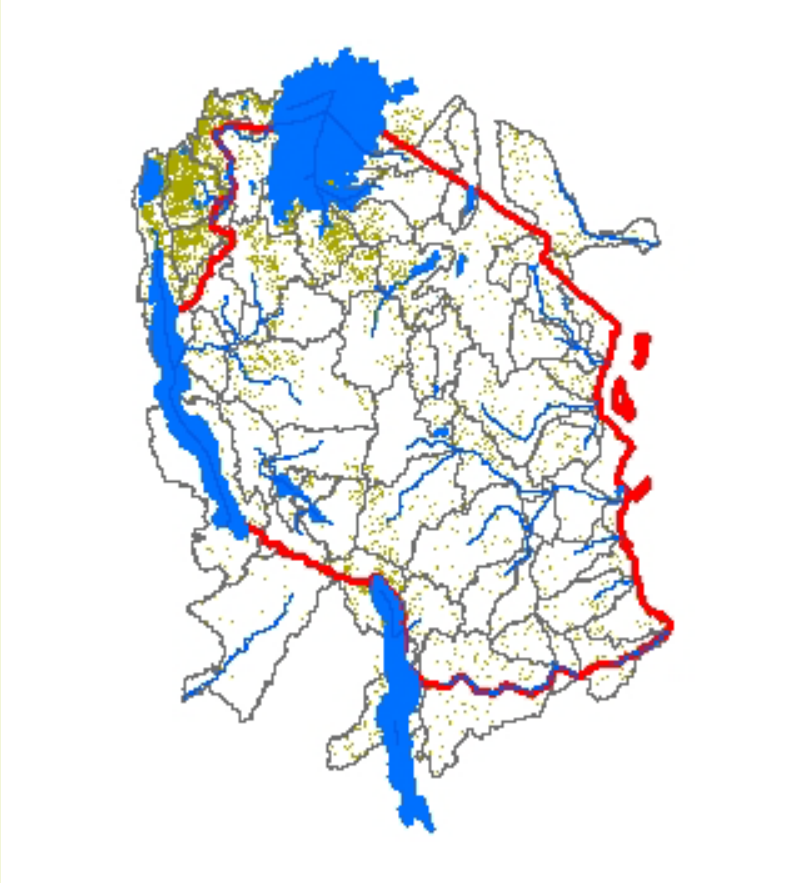
Filtering and zonation



$0.5^0 \times 0.5^0$



Irrigation



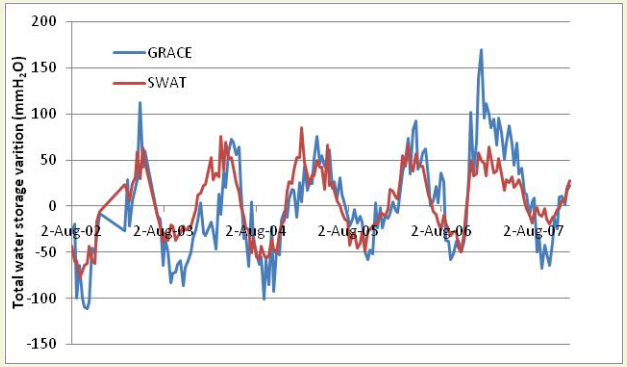
— Irrigation was not simulated in SWAT-SSA (Sub-Saharan Africa) model, but will be modeled in SWAT-SA (South Asia) model

Calibration parameters

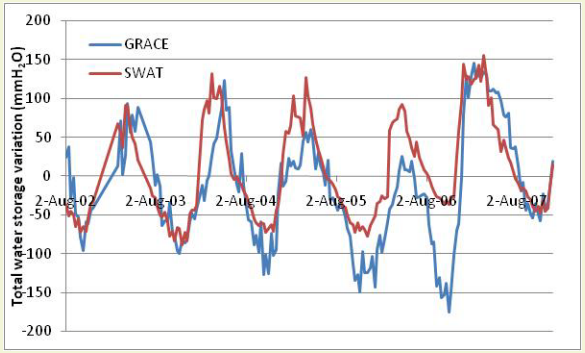
CN2_1: SCS curve number for open grassland with sparse shrubs
CN2_2: SCS curve number for deciduous woodland
CN2_3: SCS curve number for closed deciduous forest
CN2_4: SCS curve number for deciduous shrubland with sparse tree
CN2_5: SCS curve number for closed grassland
CN2_6: SCS curve number for cropland
ESCO: Soil evaporation compensation factor
GW_DELAY: Groundwater delay (days)
GW_REVAP: Groundwater “revap” coefficient
ALPHA_BF: Baseflow alpha factor (days)
REVAPMN: Threshold depth of water in the shallow aquifer for "revap" to occur (mm H_2O)
GWQMN : Threshold depth of water in the shallow aquifer required for groundwater flow to occur (mm H_2O)
SURLAG: Surface runoff lag coefficient
SOL_AWC: Available water capacity of the soil layer (mm H_2O/mm soil)
SOL_Z: Depth from soil surface to bottom of layer (mm)
SOL_HC: Soil saturated hydraulic conductivity (mm/Hr)

Calibration results

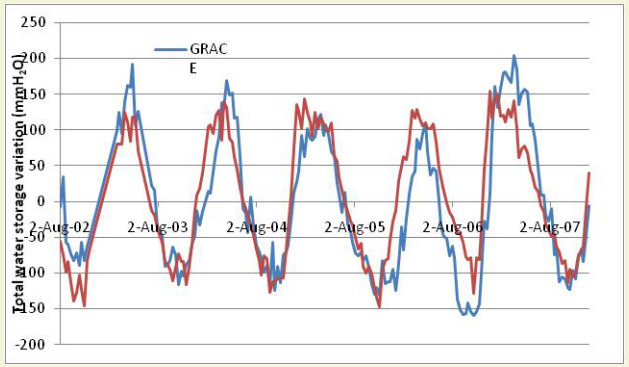
Interior north



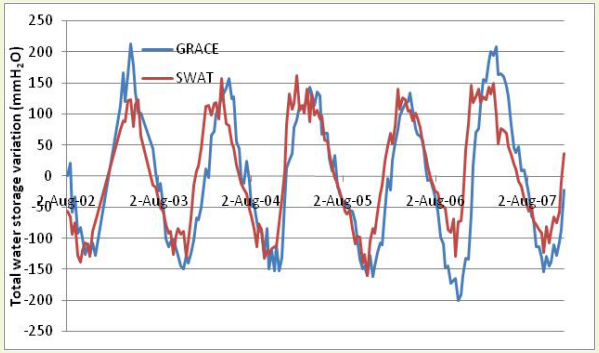
Costal north



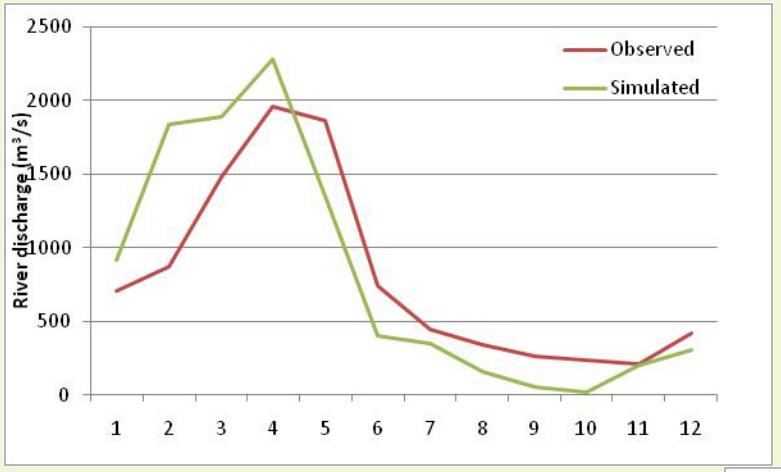
Interior south



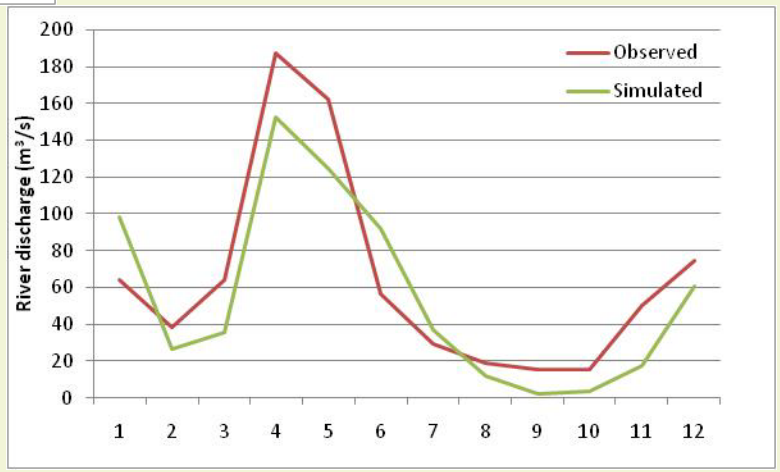
Costal south



Calibration results



Station 1286900



Station1289450

Future work

- To complete the calibration of the SWAT model for entire Sub-Saharan Africa and South Asia

- Uncertainty analysis

Thanks & Questions?