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DEPARTMENT OF HYDROLOGY AND HYDRAULIC ENGINEERING

An adaptation to the vegetation growth module of SWAT for tropical condition

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Motivation

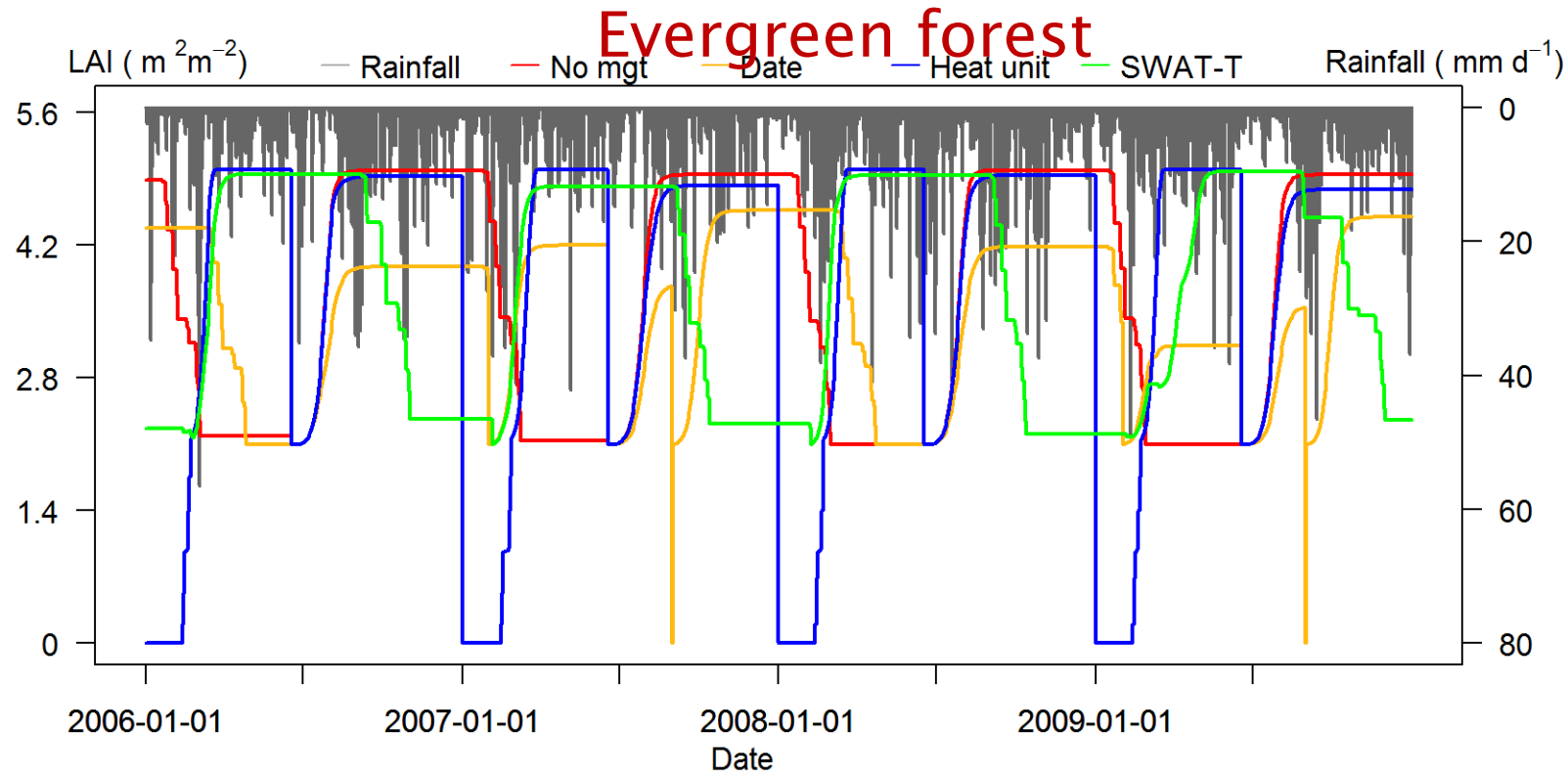
The Soil and Water Assessment Tool (SWAT):

- One of the most widely applied eco-hydrological models in the tropics and elsewhere.

- However, the vegetation growth module is not suitable for simulating the Leaf Area Index (LAI) dynamics for trees and perennials in the tropics.

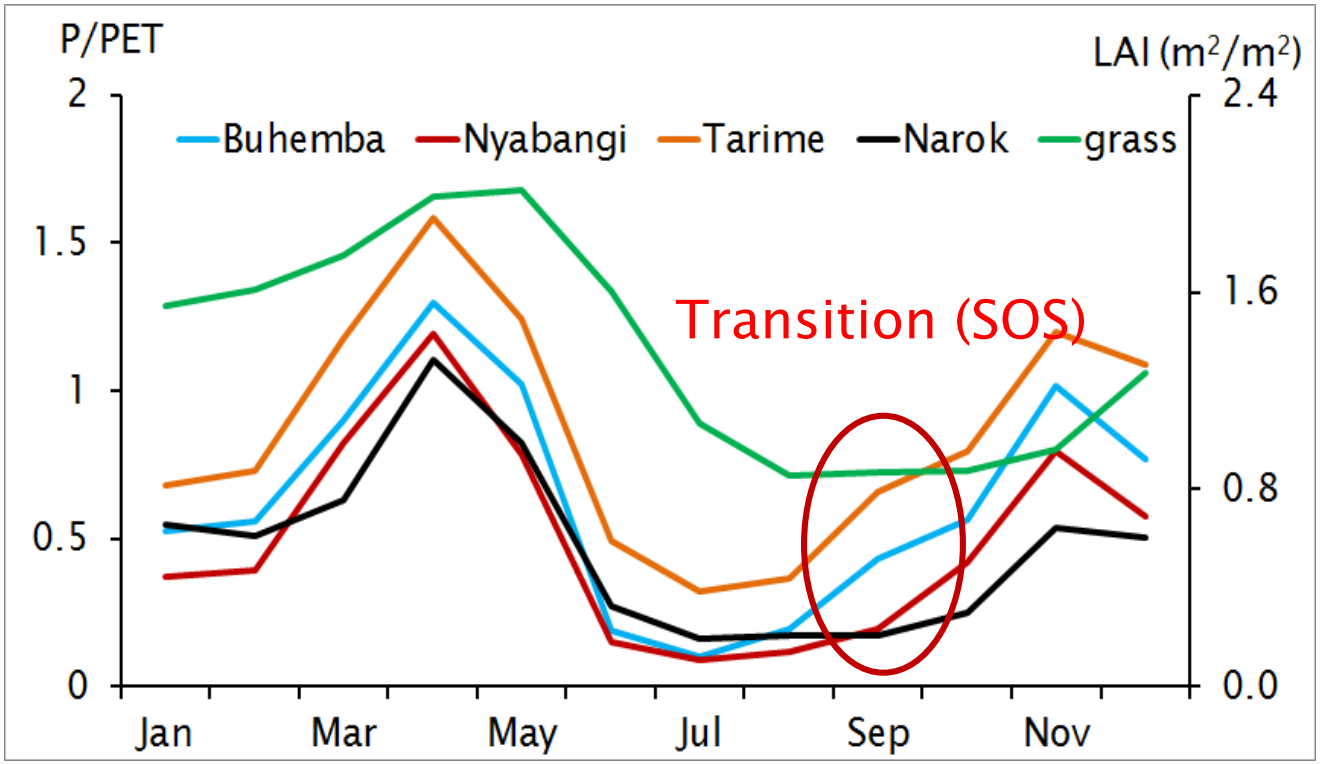
Temperature vs Rainfall (via soil moisture)

Only few studies address the growth cycle limitations



Parameter adjustment / Shifting dormancy / Soil moisture

Soil moisture Index (SMI) can be a trigger for new growth cycle



$$SMI = \frac{\sum_{i=1}^{N} P}{\sum_{i=1}^{N} PET}$$

Modifying SWAT vegetation module for tropics (SWAT-T)

- For HRU located between 20^0 N and 20^0 S:
  - If the simulation day is within SOS_1 and SOS_2, the SMI is calculated as the ratio of P to PET.
  - If the SMI exceeds or equals 0.5, a new growing cycle for trees and perennials is initiated.
  - In case the SMI is still below the threshold (i.e. 0.5) at the end of SOS_2, a new growing cycle is initiated immediately after the last date of SOS_2.
- For HRU located outside 20^0 N and 20^0 S:
  - Default plant growth

Application to the Mara Basin

Study area overview

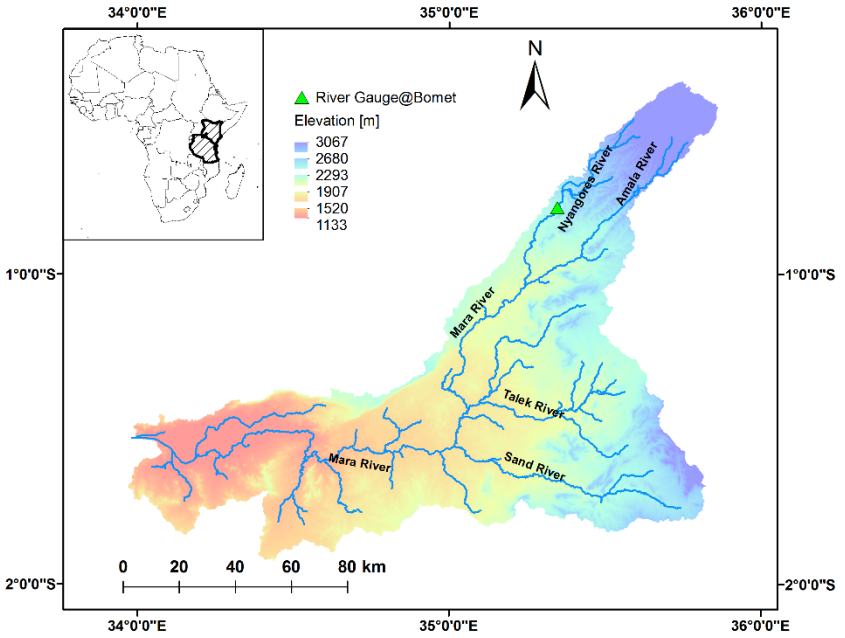
Basin area : 13400 km^2

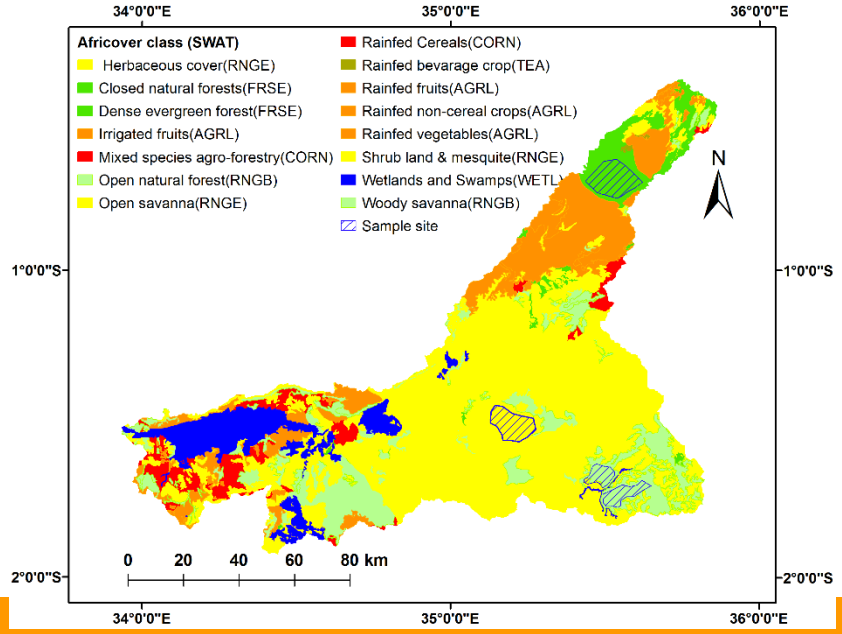
Annual rainfall: 600-1750 mm

Temperature: 25-28 ^{0}c

Dominant soils: Andosols & Planosols

Dominant cover : Grassland





Mara SWAT-T model

- Spatial input: →30m SRTM DEM
  → Africover map
  → HWSD soil map

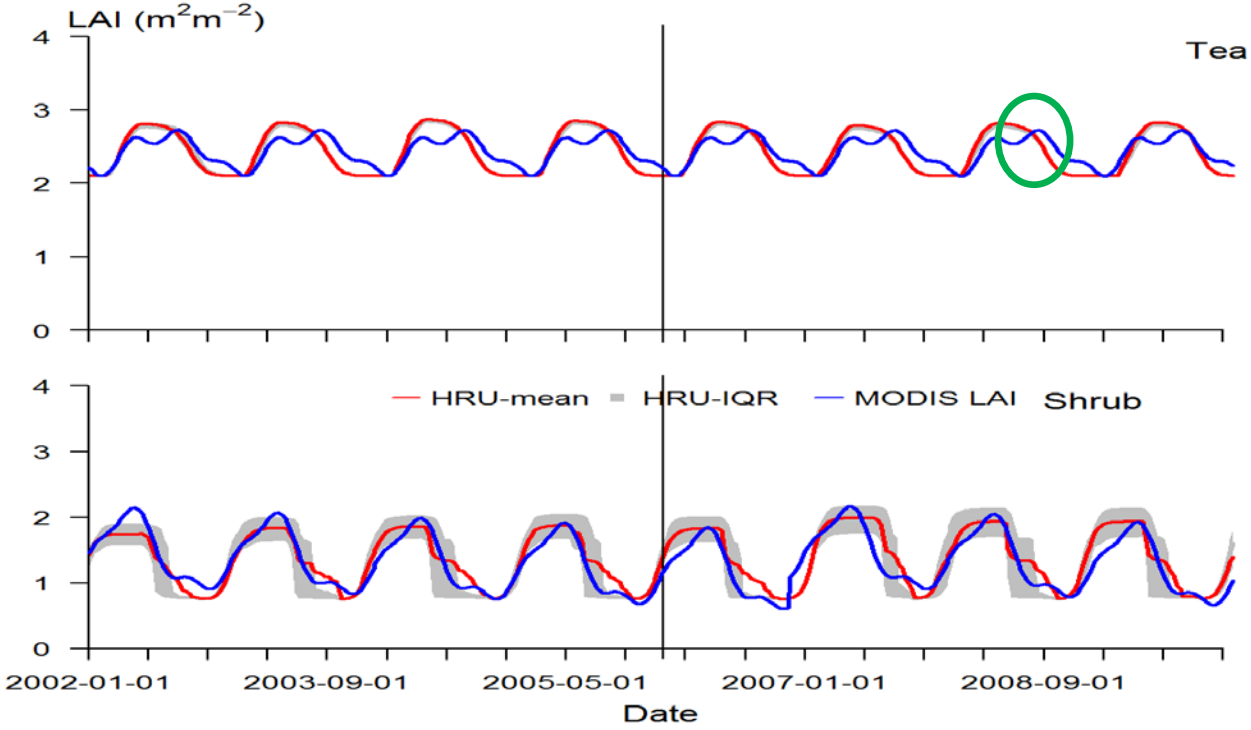
- Model: → 89 sub-basins
  → 1500 HRUs

- Forcing: → bias-corrected satellite rainfall
  → PM based PET using GLDAS weather data

Calibration and evaluation approach

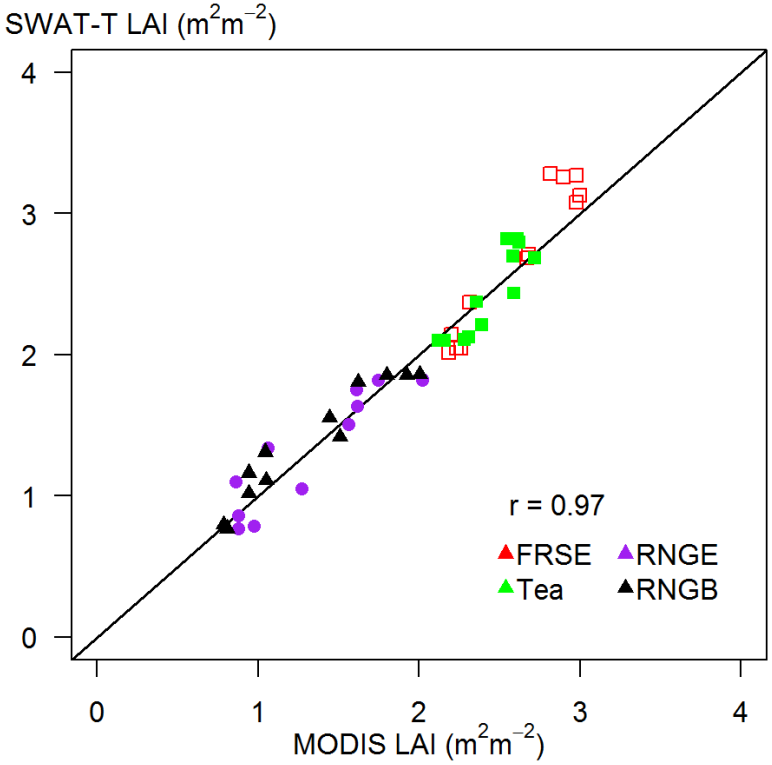
- Selected SWAT parameters related to vegetation growth, ET and streamflow are calibrated manually
- Calibration (evaluation) period:2002-2005 (2006-2009)
- Evaluation data: i) 8-day MODIS LAI
  ii) 8-day SSEBop ET→ thermal-based ET
  iii) daily streamflow
- Performance evaluation: KGE, r and pbias

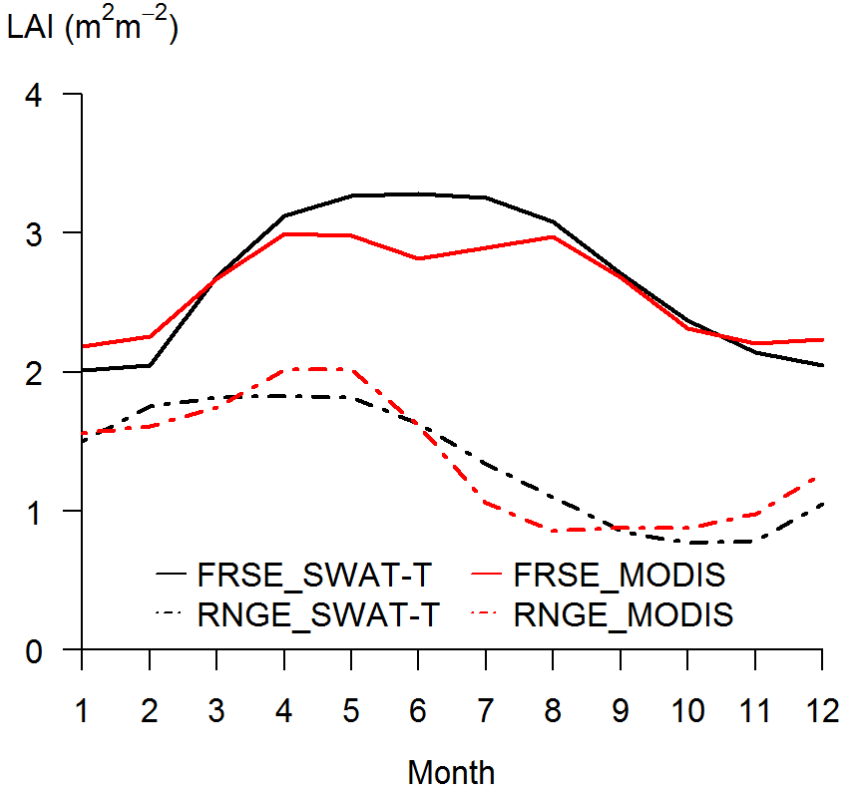
Performance of the LAI simulation



	Calibration (Validation)			
	FRSE	**Tea**	**RNGE**	**RNGB**
r	0.94 (0.93)	0.83 (0.83)	0.89 (0.86)	0.92 (0.88)
%bias	1.5 (0)	0.1 (0.2)	-3.7 (-0.4)	-1.3 (4.6)
KGE	0.50 (0.62)	0.42 (0.44)	0.86 (0.85)	0.88 (0.86)

The seasonal vegetation growth pattern

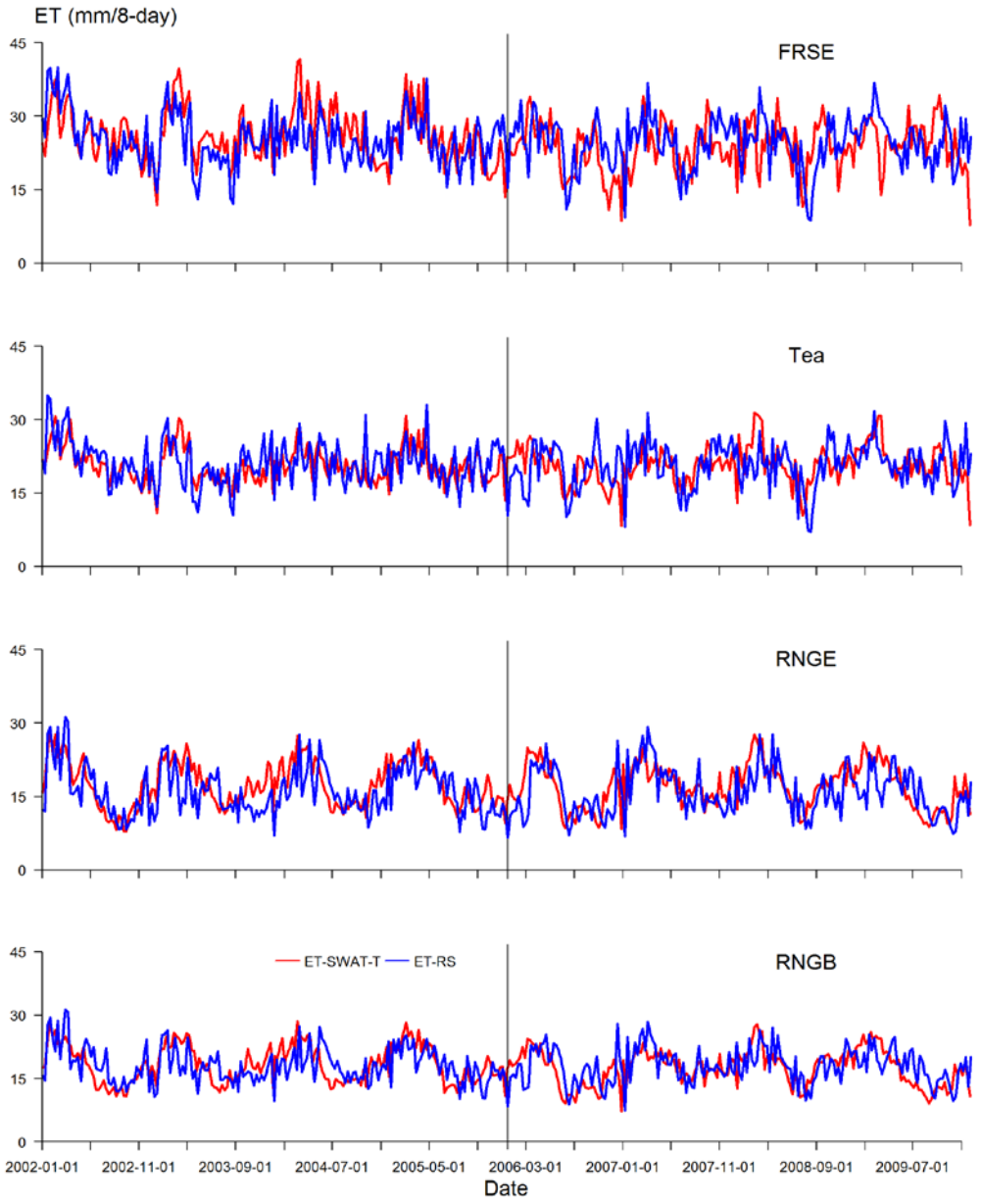




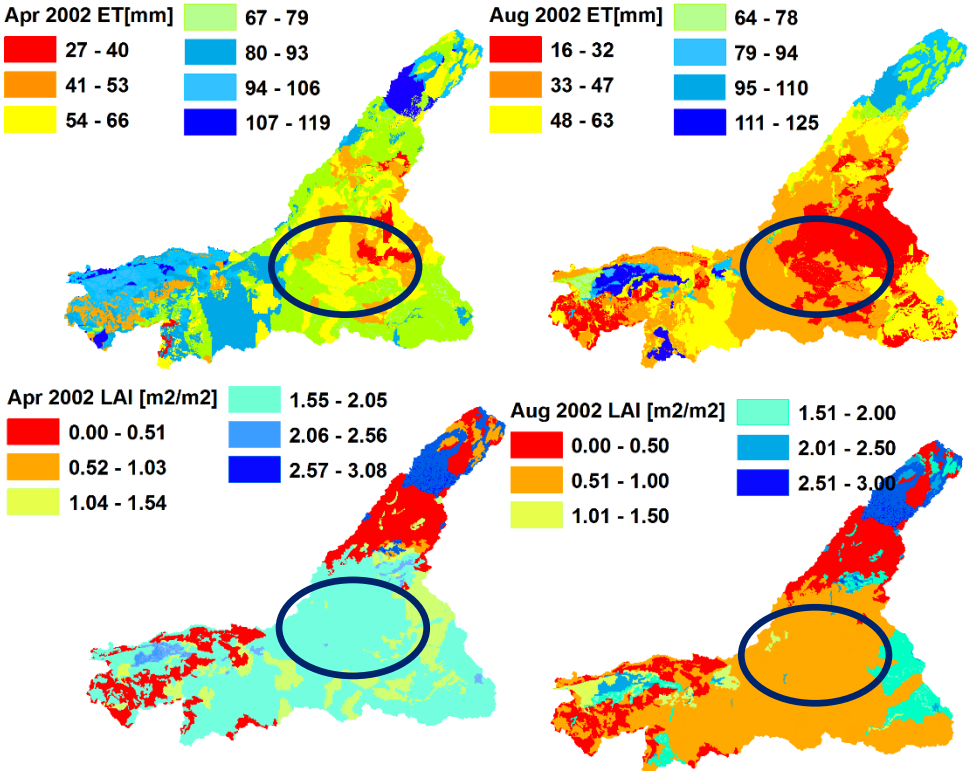
There is a good match in average monthly LAI from MODIS and SWAT-T

ET simulation skill

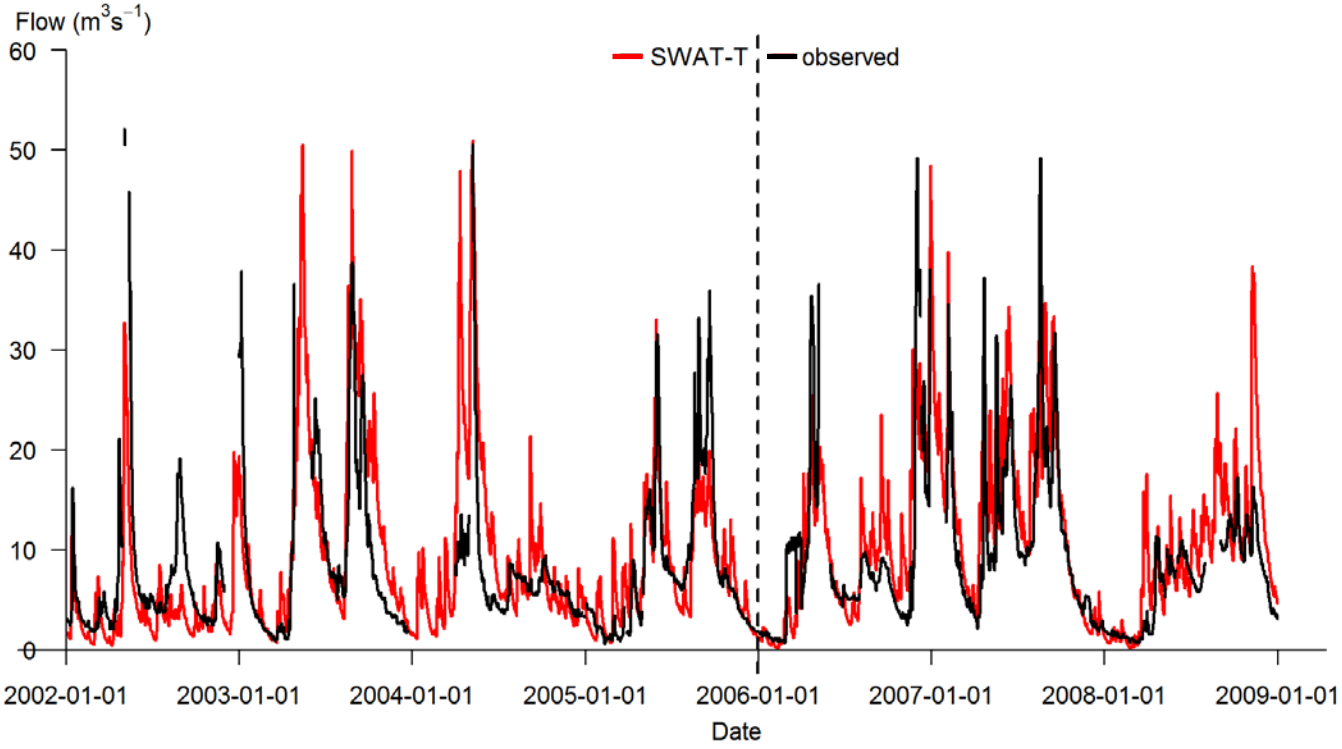
Calibration (Validation)		
	FRSE	**RNGE**
r	0.71 (0.68)	0.72 (0.77)
%bias	3.7 (6.6)	7.8 (11)
KGE	0.71 (0.67)	0.69 (0.74)



Spatial ET and LAI simulation for dry and wet months



Streamflow simulation



Calibration (Validation)	
r	0.72 (0.76)
%bias	3.5 (15.5)
KGE	0.71 (0.71)

Conclusions

- The SMI can be a reliable new growth cycle trigger annually.
- The SWAT-T model simulated LAI compared well with smoothed MODIS LAI at 8-day.
- The model simulated the water balance components with fair statistical measures.
- The proposed vegetation growth module can be a robust tool for simulating the vegetation growth cycle else where in the tropics.

Thank you