Integrated Models to Enhance Water Productivity Estimates: A Pathway to Climate -Smart Agriculture in Awash Basin, Ethiopia

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Motivation

Agriculture

- ☞ Backbone of Ethiopia's economy
- ☞ 44% GDP
- ☞ 85% labor force
- ☞ Climate resilient agriculture (NDP)

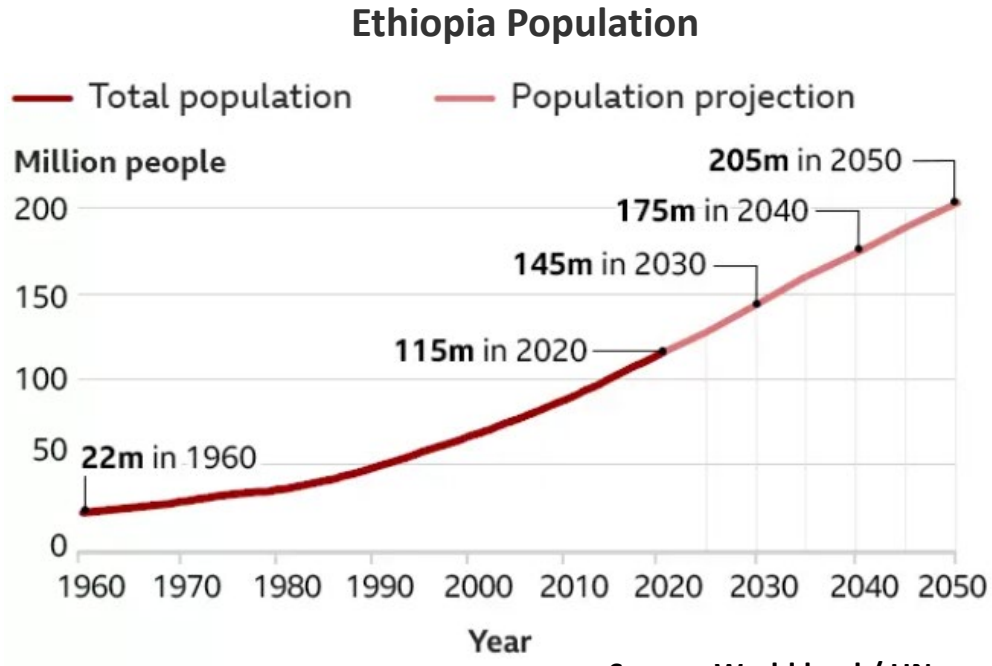
Ethiopia aspire to double agricultural productivity

Low agricultural productivity

Labor intensive

Challenge

- ☞ Increased water demand
- ☞ Availability of agricultural water decline



Source: World bank/ UN

Climate change impact on agriculture

Food security at risk

Research Questions

1. To what extent integrated agro-hydrologic models help improve water productivity estimation?

2. How can we use integrated agro-hydrologic models to co-design climate adaptation strategies

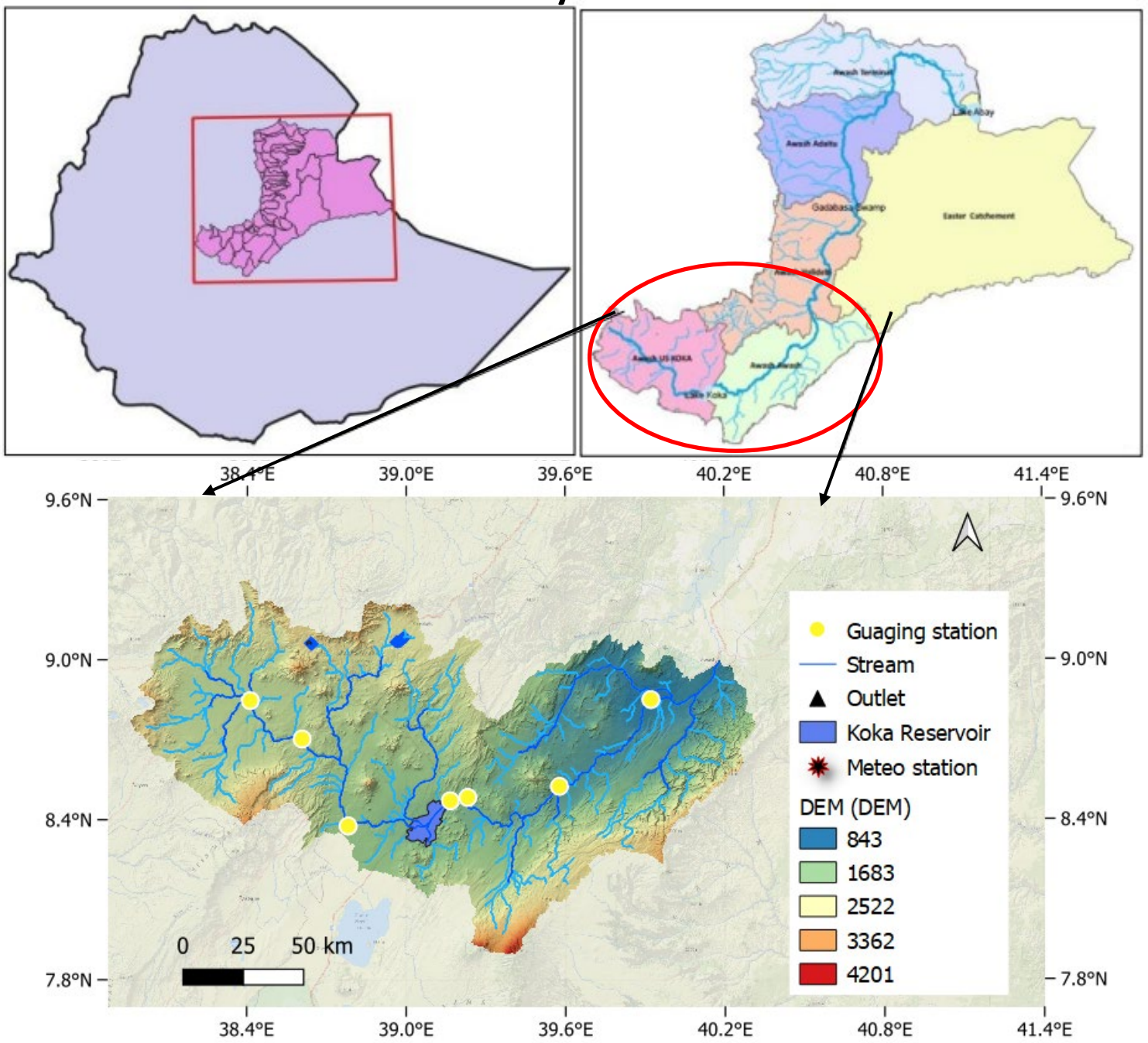
Potential climate adaptation measures

Conjunctive use of surface water and groundwater

Crop diversification/ crop type change

Adjusting planting date

Study Area

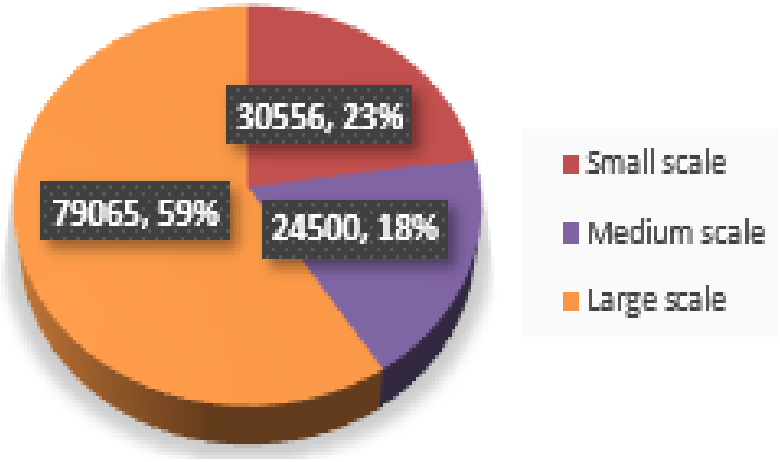

38.4°E
39.0°E
39.6°E
40.2°E
40.8°E
41.4°E
9.6°N
9.0°N
8.4°N
7.8°N
Guaging station
Stream
Outlet
Koka Reservoir
Meteo station
DEM (DEM)
843
1683
2522
3362
4201
0 25 50 km

Awash River basin

Water Resource Potential

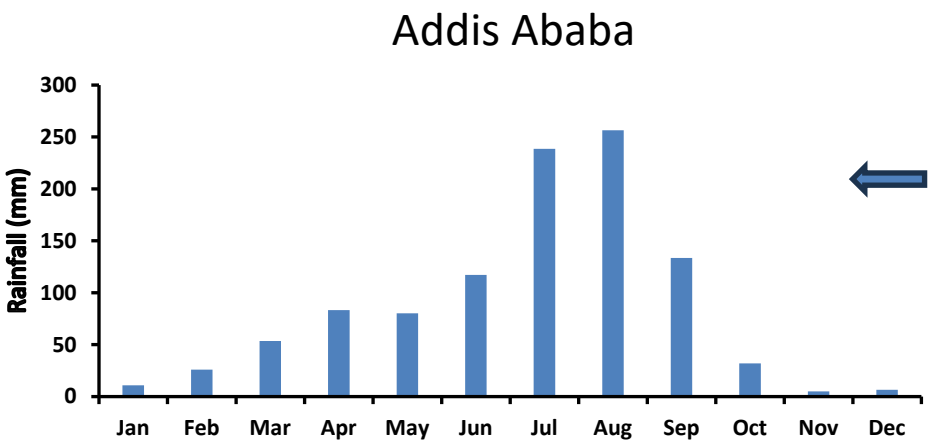
Water Sources	Water Resource Potential (BCM)
Surface water	4.6
Groundwater	10.3
Open water available	3.6
Others	0.27
Total	**18.77**

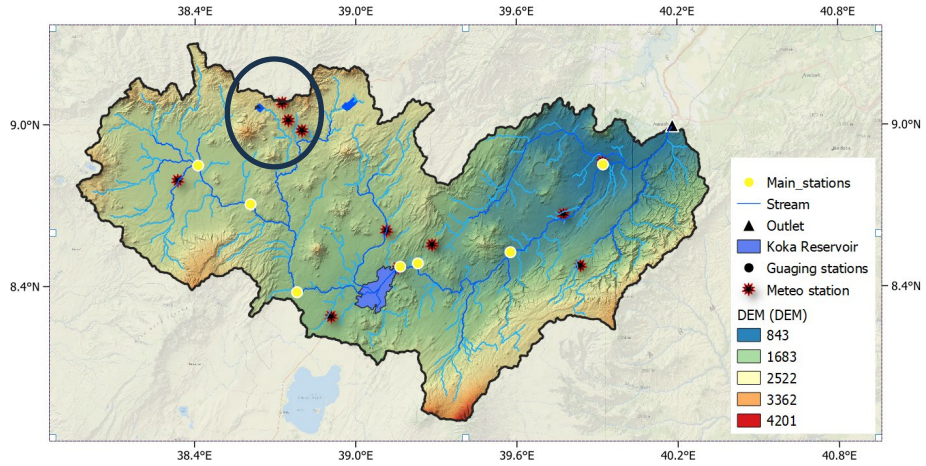
Irrigation Potential in Awash River Basin in ha

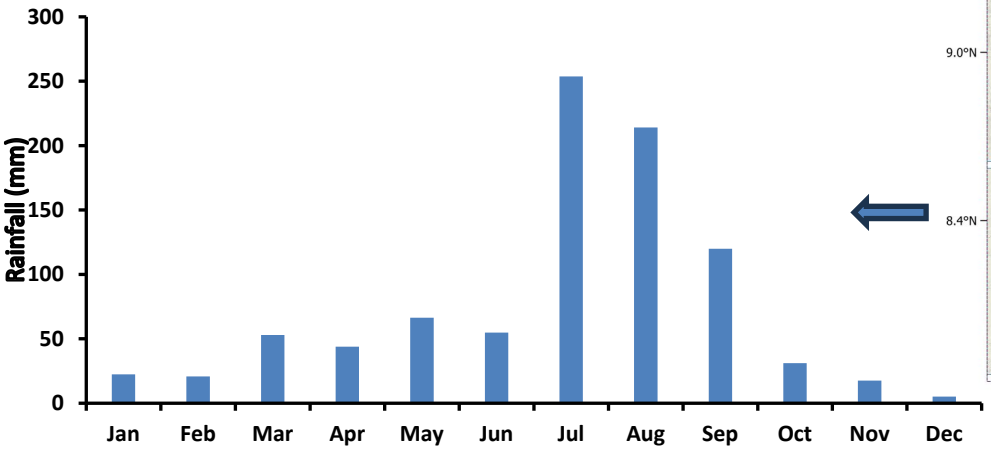


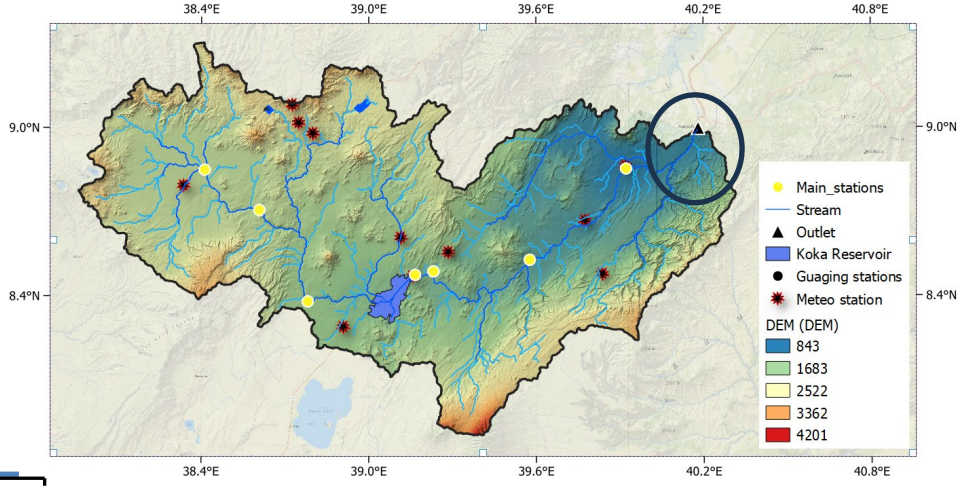
- Irrigation efficiency which varies from 30 to 55 %
- FAO monitored Irrigation scheme - facing water stress
- Water availability projected to decline under CC (Moti et al., 2020 and Kinfe, 1999)

Climate characteristics









Method and Materials

- Modeling – Agro-hydrologic , hydrologic -
  (SWAT+, MODFLOW, APEX)
- Remote sensing – Wapor database (ET),
  Copernicus (LAI)
- Field monitoring – farm management with the
  help of expert
- Soil moisture sensor

SWAT+ Model setup

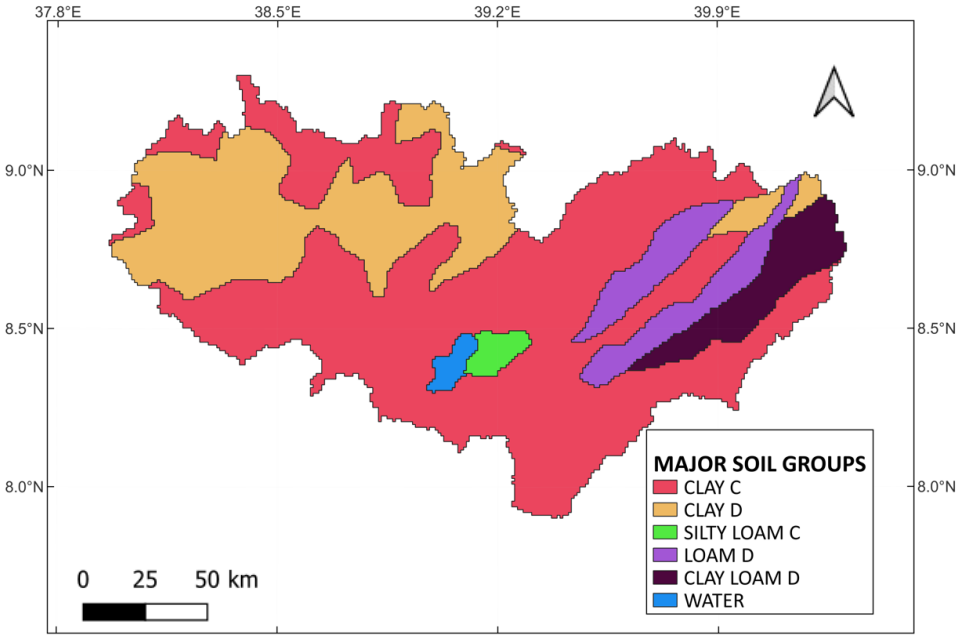
- Weather data (observed)
  - 1990 – 2019
  - Missing data filled with TAMSAT dataset (Fenta et al 2018)
  - Weather generation

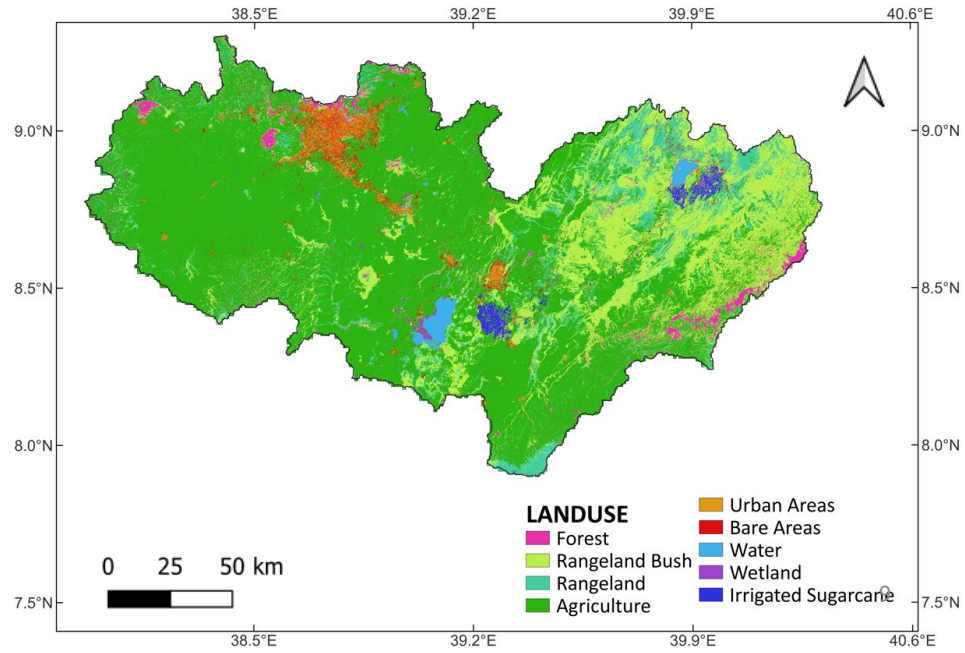
- Spatial data layer

  DEM – (30m)

  Landuse map – CGLS (10m)

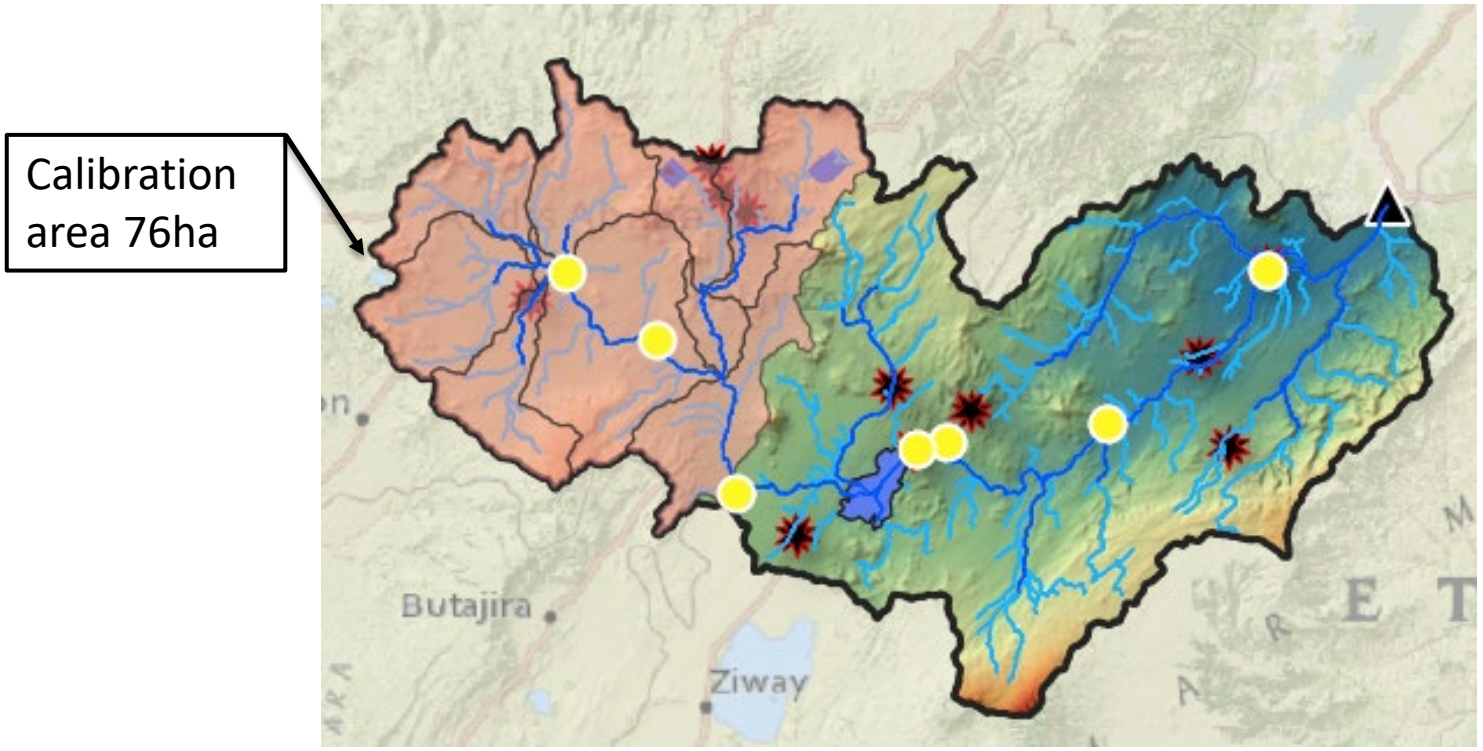
  Soil map – FAO 1km





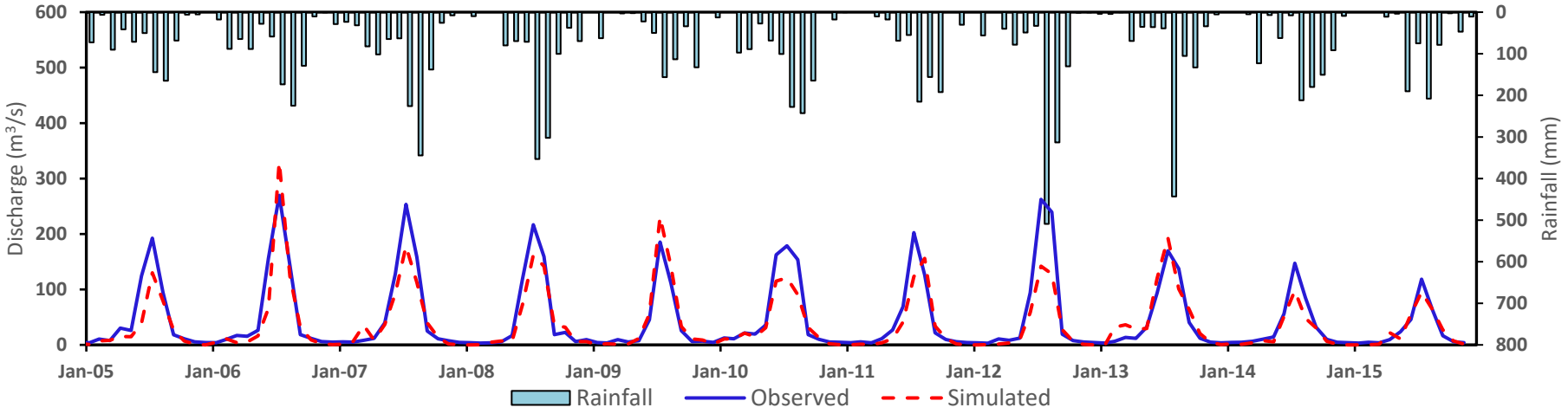
Model Calibration

- SWAT+ model improvement
  - Irrigated sugarcane with (Wapor(30m) irrigated sugarcane **16453ha**
  - Reservoir release – average flow rate implemented using decision table
  - Irrigated sugarcane – implemented in decision table

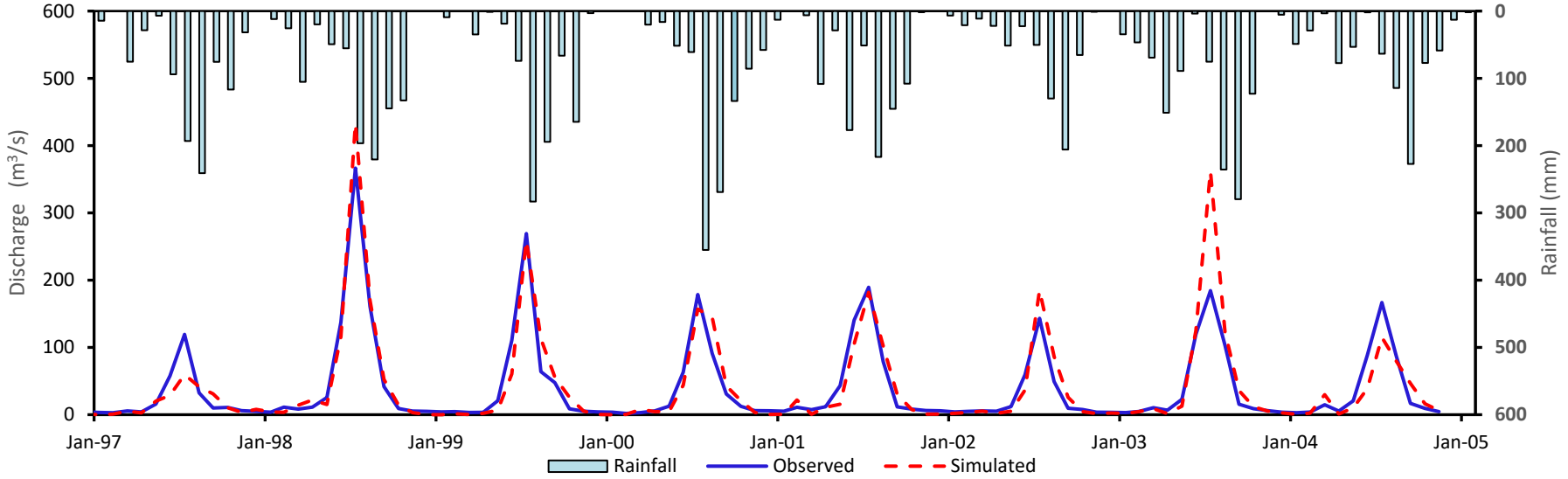


Hydrological Calibration

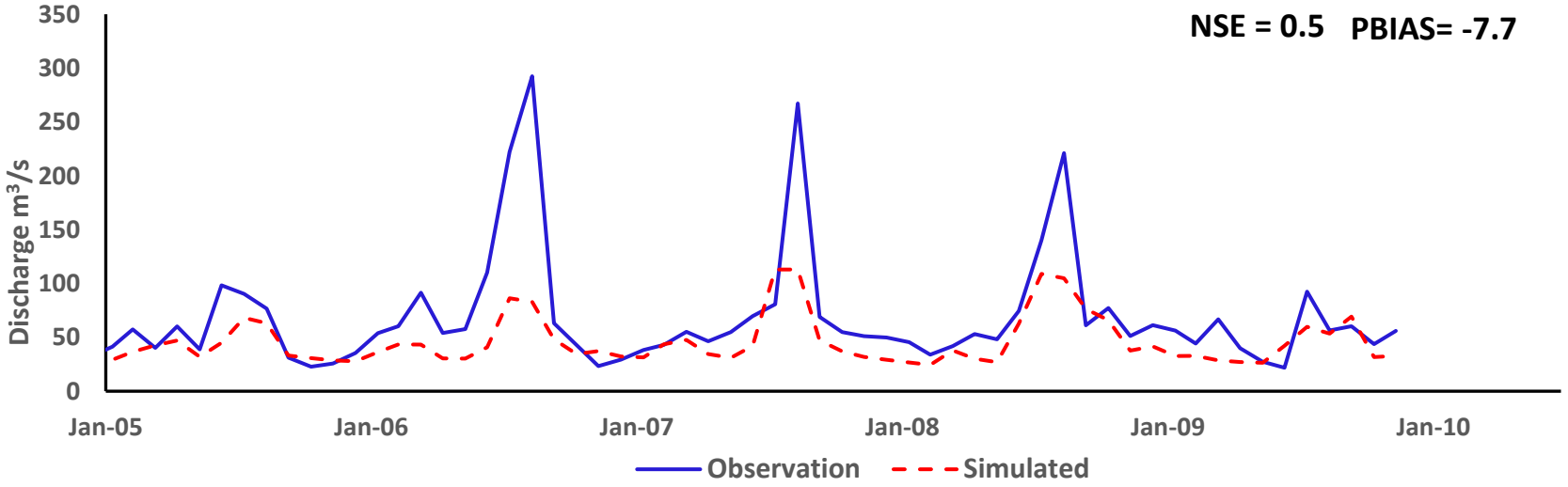
NSE = 0.82 PBIAS= -17%



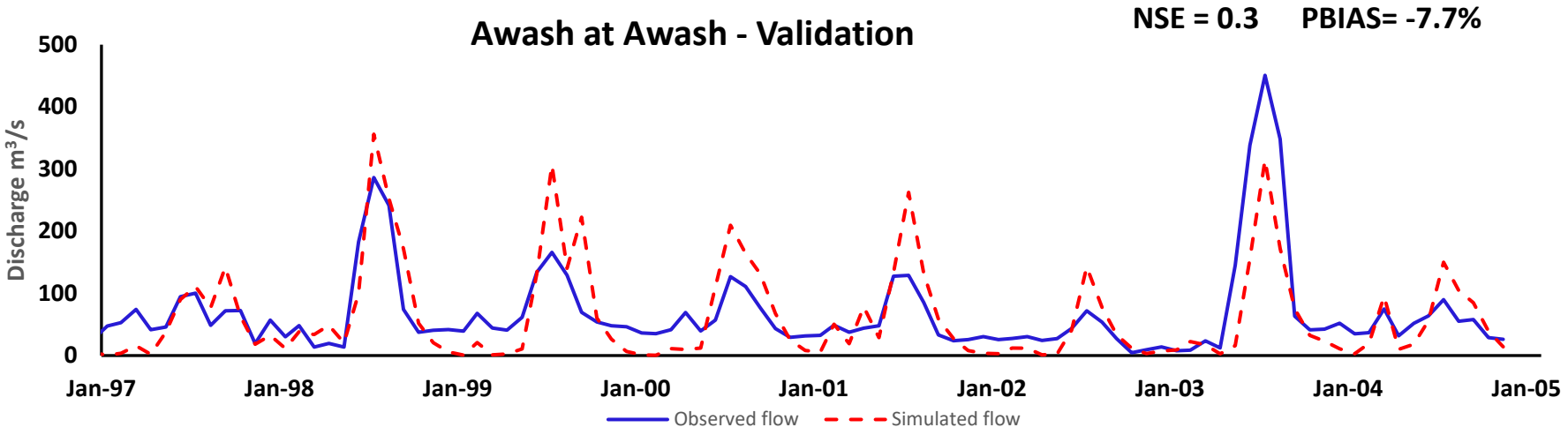
NSE = 0.83 PBIAS= 3.7%



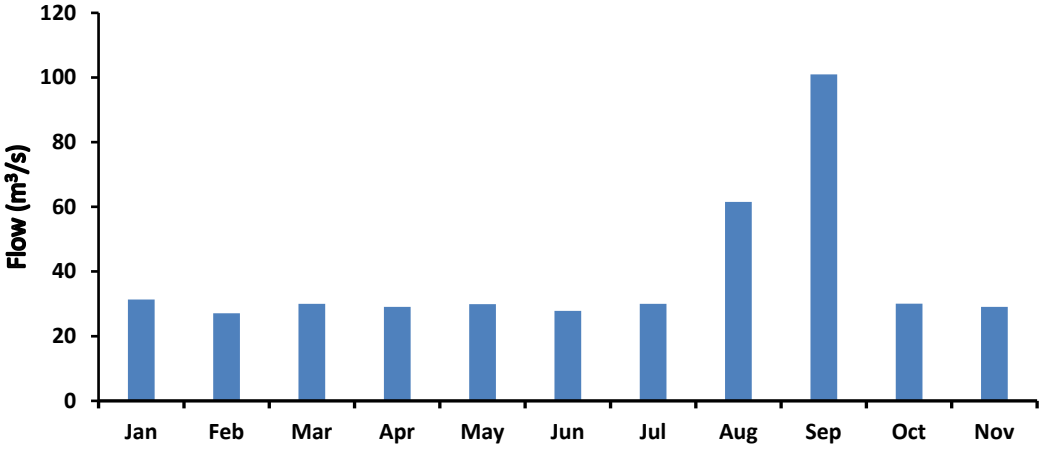
Awash at Awash Station - Calibration



Awash at Awash - Validation



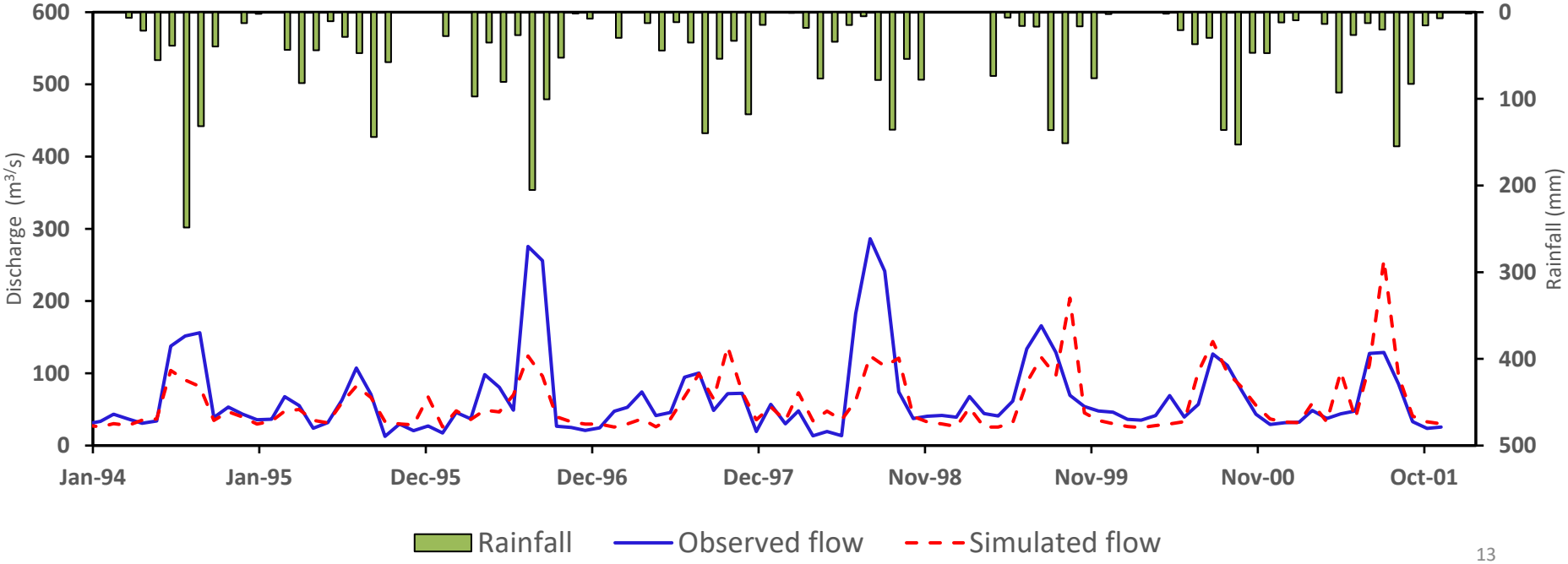
Calibration after Reservoir Release



Source: Tadesse M. 2020

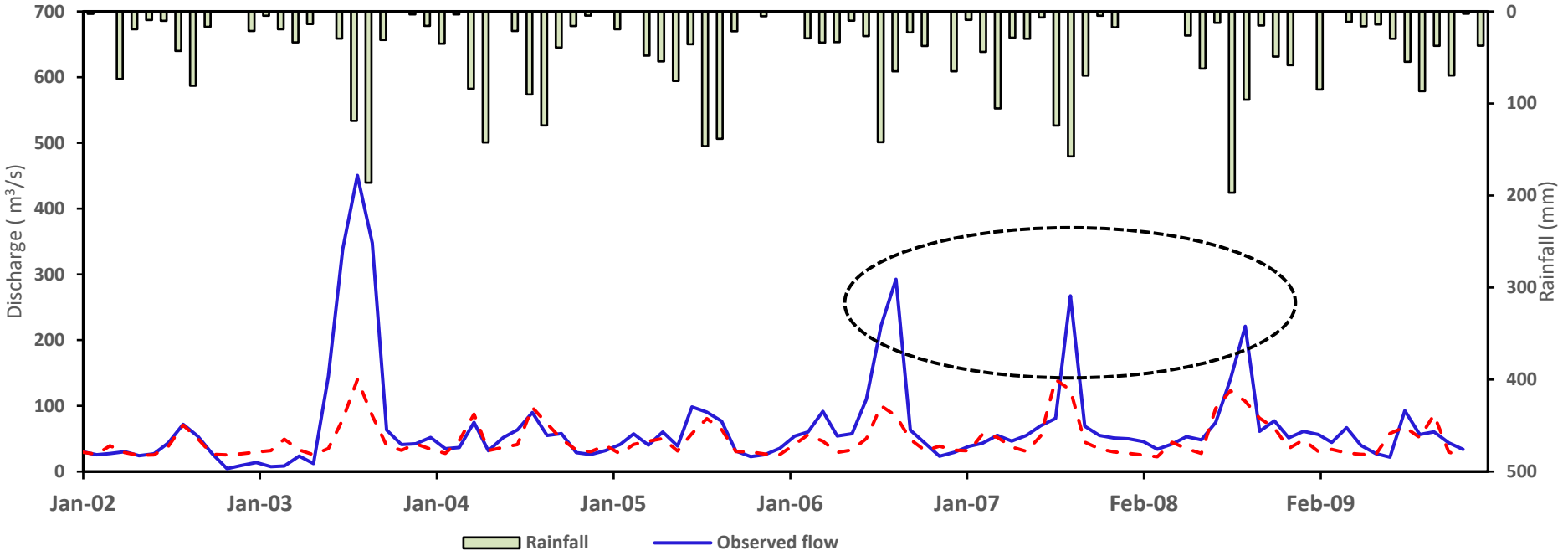
Koka Reservoir

NSE = 0.4 PBIAS= -17.2%



Awash at Awash validation

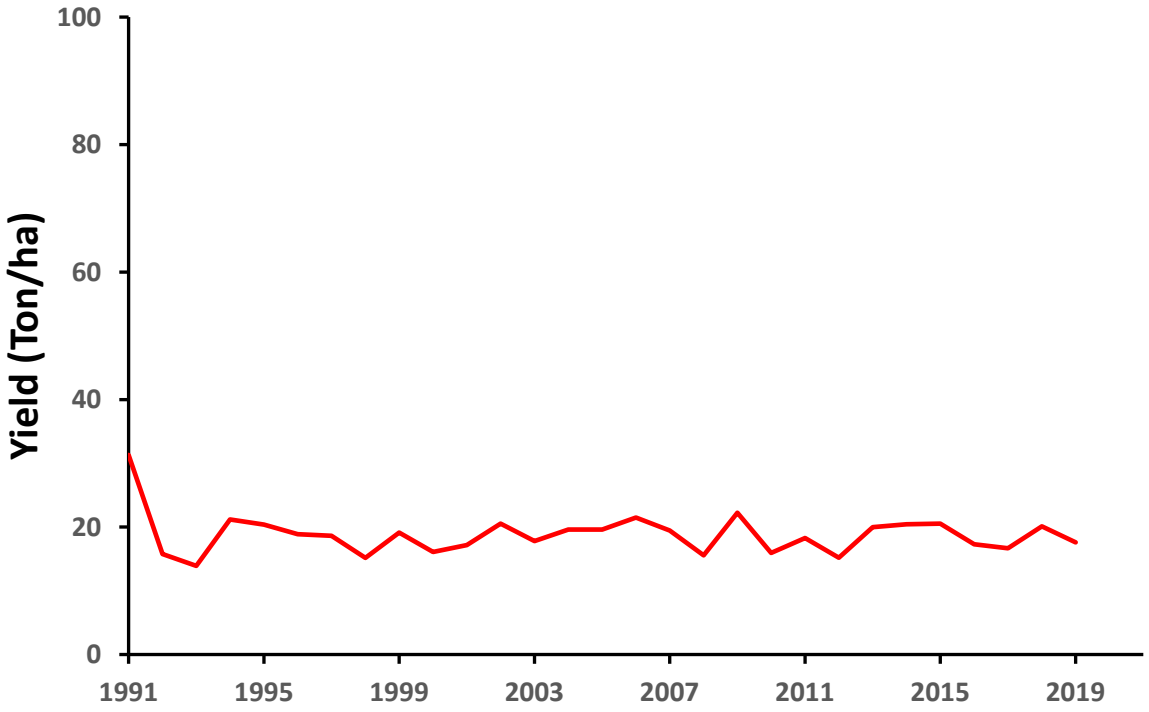
NSE = 0.3 PBIAS= -22%



Simulated Sugarcane Yield

- Crop stress
  - ✓ Water stress
  - ✓ Nutrient
  - ✓ Temperature

- Simulated Yield ~ 1/3 of annual average yield



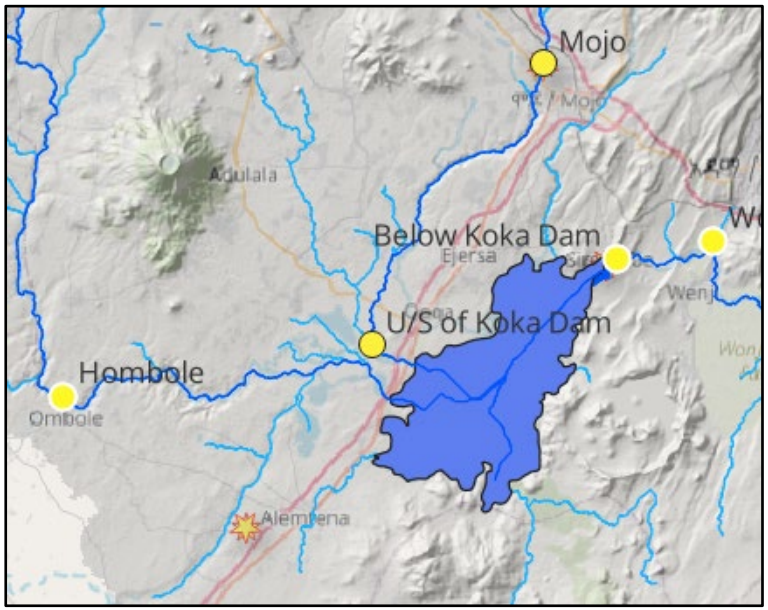
Conclusion

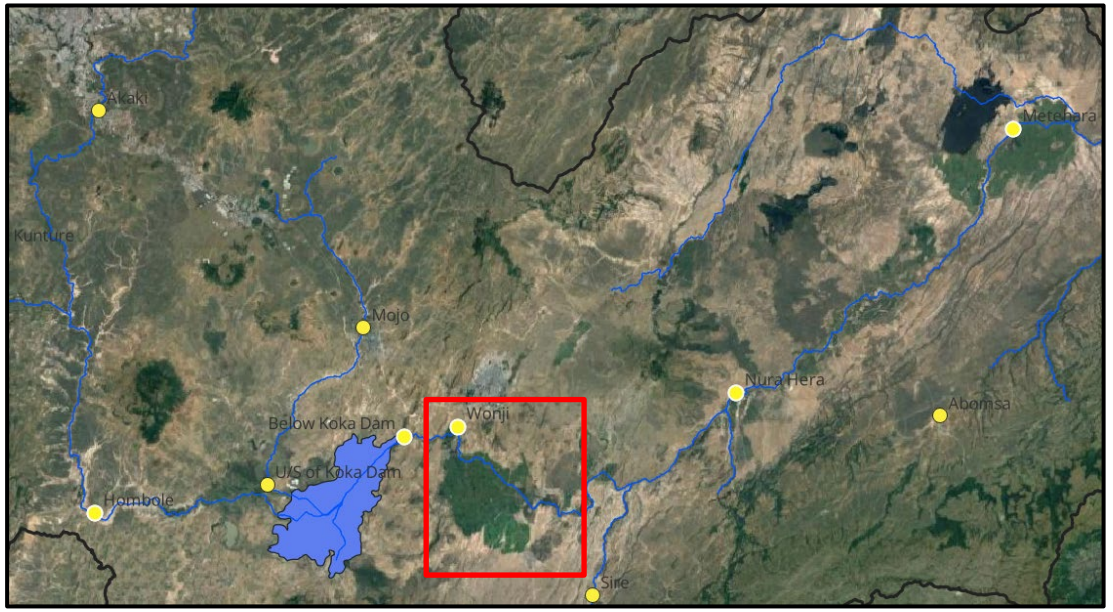
- SWAT+ model can potentially be used for
  - large scale water productivity assessment
  - Data scares region

- Good representation of hydrological processes and plant growth process
- Farm management / crop management operation
- Collaboration

Future work

- Improving reservoir release operation – reservoir water balance





- Detail crop management implementation using APEX

- Climate change scenario – CMIP6 bias corrected 0.5^{o} (~50km) – Potsdam Institute (PIK)

Thank you for your attention

Question and suggestion

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