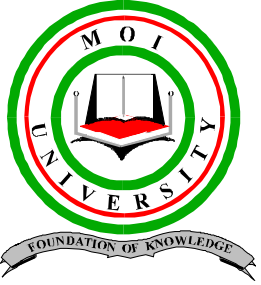


Modelling Runoff with Satellite Data

Nyandwaro Gilbert Nyageikaro

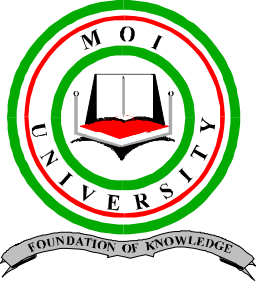
Patrick Willems

Joel Kibiiy



Outline

- Background information
- SWAT model development
- The model sensitivity analysis and calibration
- Calibration of satellite weather data
- Conclusions

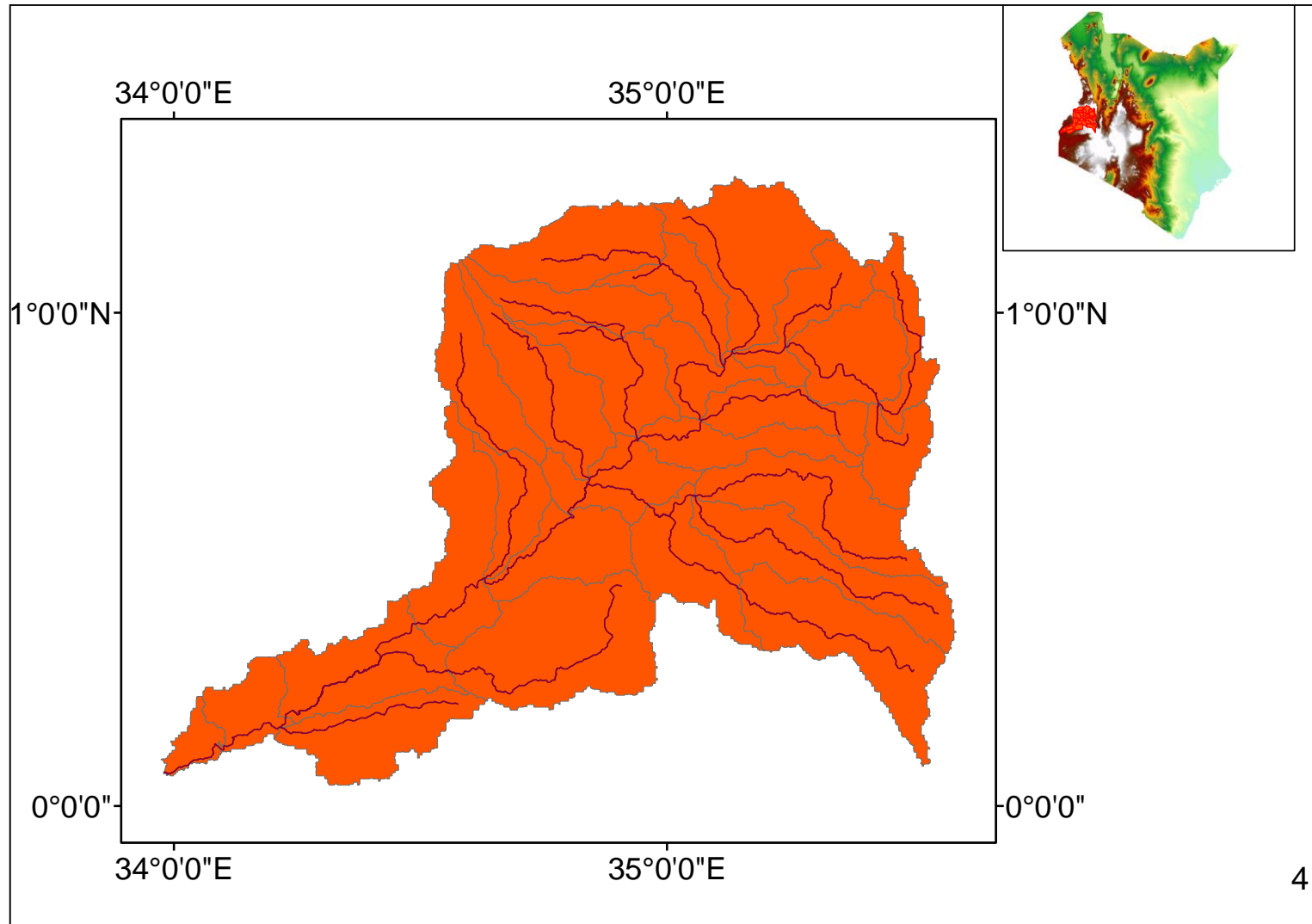


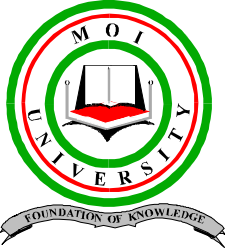
Background Information

- Both floods and droughts have negative effects...
- Floods cause destruction of property and displacement of people.
- Hydrological modeling can help mitigate these effects.
- **Lack of sufficient data is a challenge**
- Aim: to develop a **calibration technique for satellite-based weather data.**
- Research based on **nzoia basin** (about 12,800km²)
Western kenya.



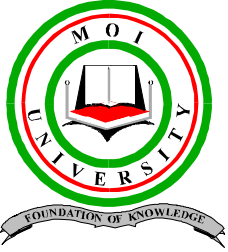
Background Information...





Background Information...

- Basin part of Lake Victoria of the larger Nile basin
- Located mainly in agricultural zone.
- Basin is mainly tropical humid.
- Mean annual rainfall varies from about 1070 mm to 2200 mm
- Mean monthly rainfall trend of two maxima over the year: April-May and July-November respectively
- Altitudes: 4000m-1000m a.s.l



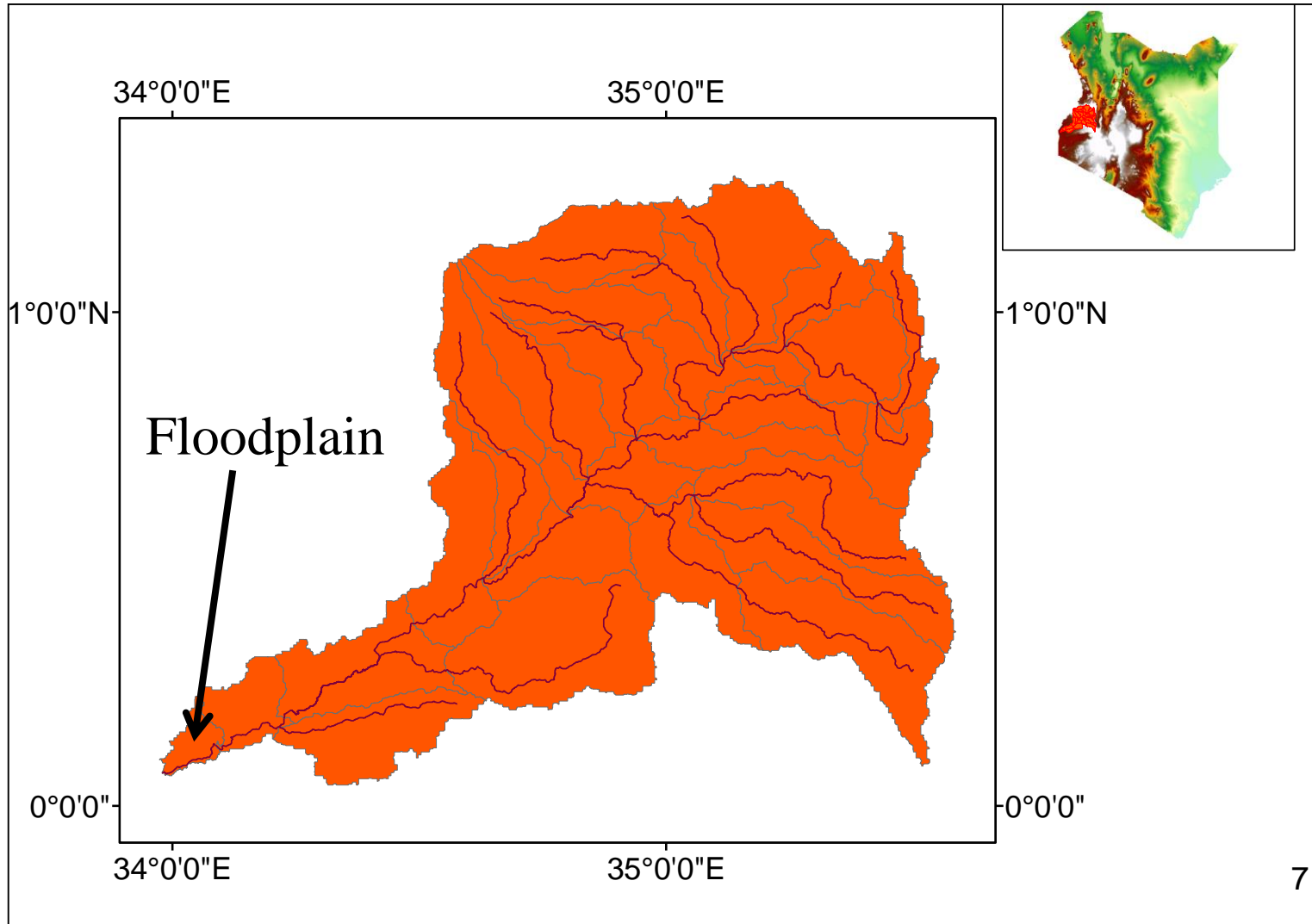
Background Information...

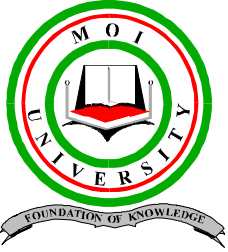
Hydrological challenges facing Nzoia basin:

- Flooding in the lower reach (popularly known as Budalangi area)
- Floods almost on annual Occurrence
- Breaching of dykes – old and poorly maintained
- Deaths and displacement of people; Destruction of property.



Background Information...





Background Information...

“Budalang'i residents edgy as river Nzoia breaks banks”

“People are worried because of the volumes of water which have already burst the River banks. Floods are likely to occur if the water overpowers the dykes,”

[Daily Nation, April 14, 2013]

2008 Flood: Destruction of property



2006 Flood: Damaged dyke



2006 Flood: Displaced people

2006 Flood: Destruction of Property



Fig.: Flooding at the Lower Reaches of Nzoia

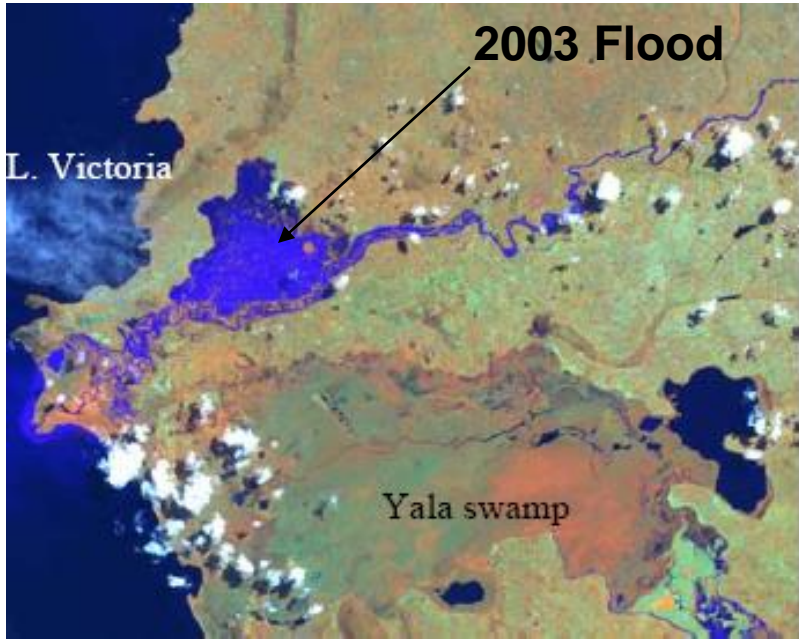
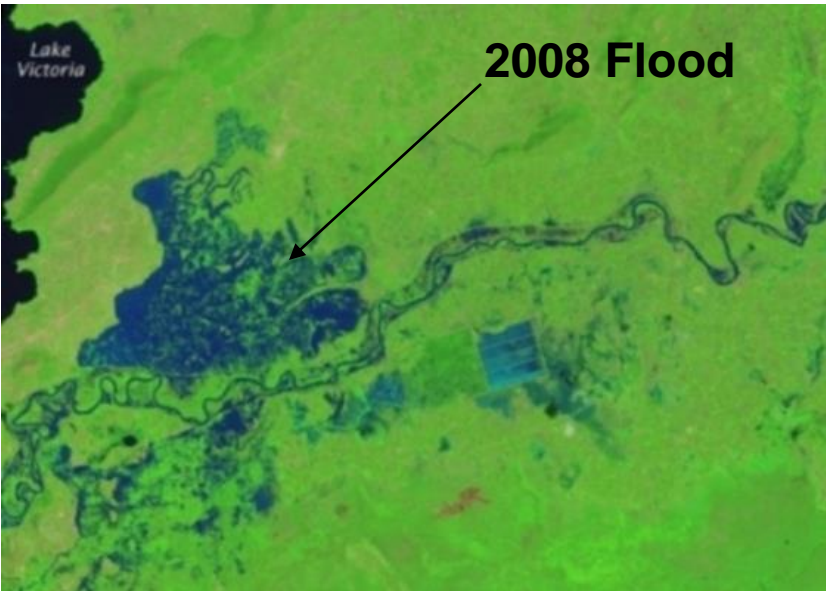
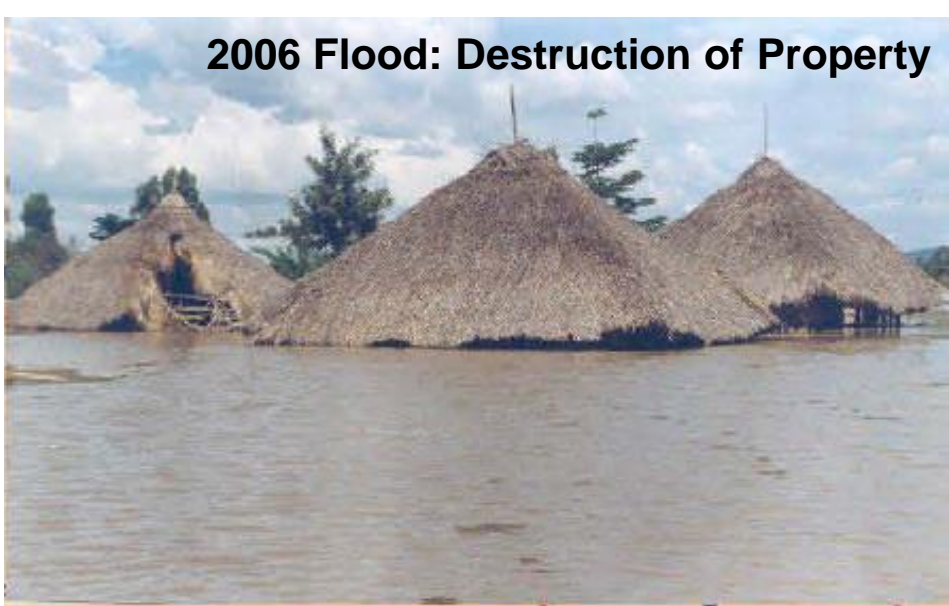


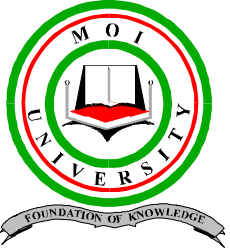
Fig.: Flooding at the Lower Reaches of Nzoia



Repair of the broken dyke in Budalang'i

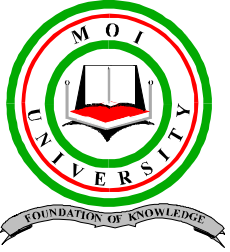


During a Survey to a breached dyke in Jan 2012



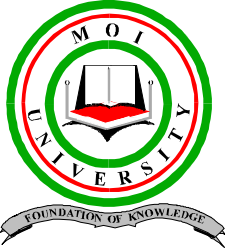
Background Information...

- Weak disaster management capacity
 - Facilities
 - Information
 - Manpower
 - Funding
- Lack of sufficient data
- Aim: To develop a **calibration technique for satellite-based weather data.**



Methodology

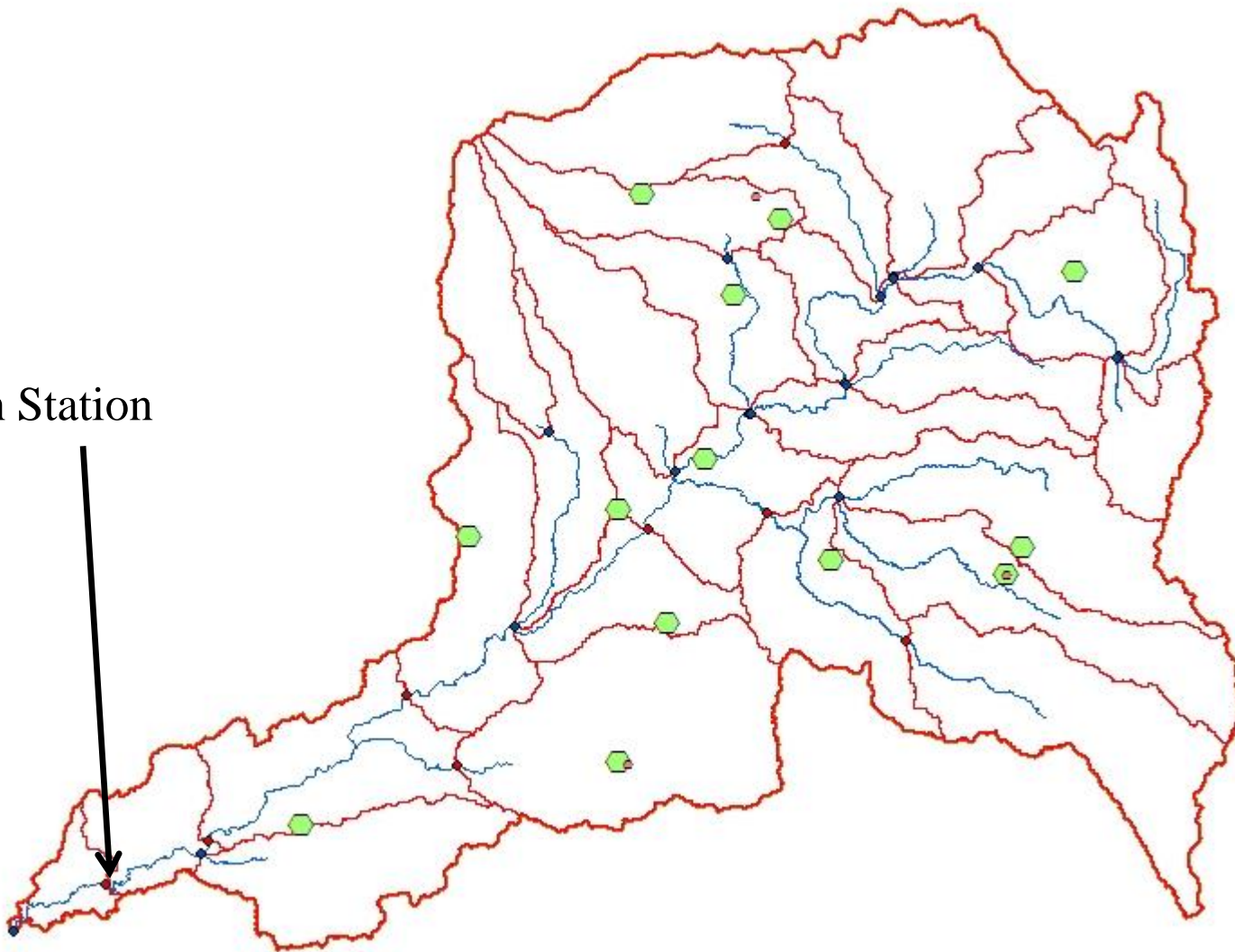
- Development of Rainfall-Runoff model-SWAT model for Nzoia basin.
- Model sensitivity analyses and calibration
- Calibration of satellite weather data



Development of Nzoia SWAT Model

- Watershed: 12, 800 sq.km.
- 27 Subbasins.
- 211 HRUs- Landuse, soil and slope
- 13 Rainfall stations
- Simulation: 1974-1984

Calibration Station



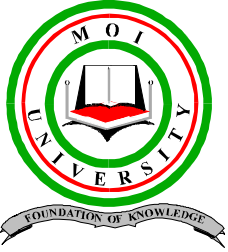
Sensitivity analysis

- Most sensitive parameters for calibration
- LH procedure, sensitivity of parameters dependent on interval used
- Rank....groups (sensitive and non-sensitive)
- Some parameters low in ranking....crucial (GW_DELAY)...judgement needed!
- Sensitive parameters: CN2, ESCO, Sol_AWC, Surlag, GWQMN, GW_REVAP, ALPHA_BF... and GW_DELAY

- Based on observed discharge at downstream station.
- Models runs for the period 1974-1984.
 - Warm-up: 1974-1975
 - Calibration: 1980-1984
 - Validation: 1976-1979
- The models performance assessed through:
 - NSE
 - Validation of Maxima and Minima (Box-Cox transformations)...

$$BC(q) = \frac{q^\lambda - 1}{\lambda}$$

[Box and Cox, 1964]

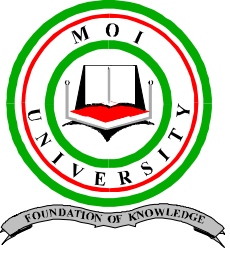


Model Calibration

- Water Engineering Time Series PROcessing tool (WETSPRO) for calibration (Willems, 2008).
- Multi-criteria objective employed.

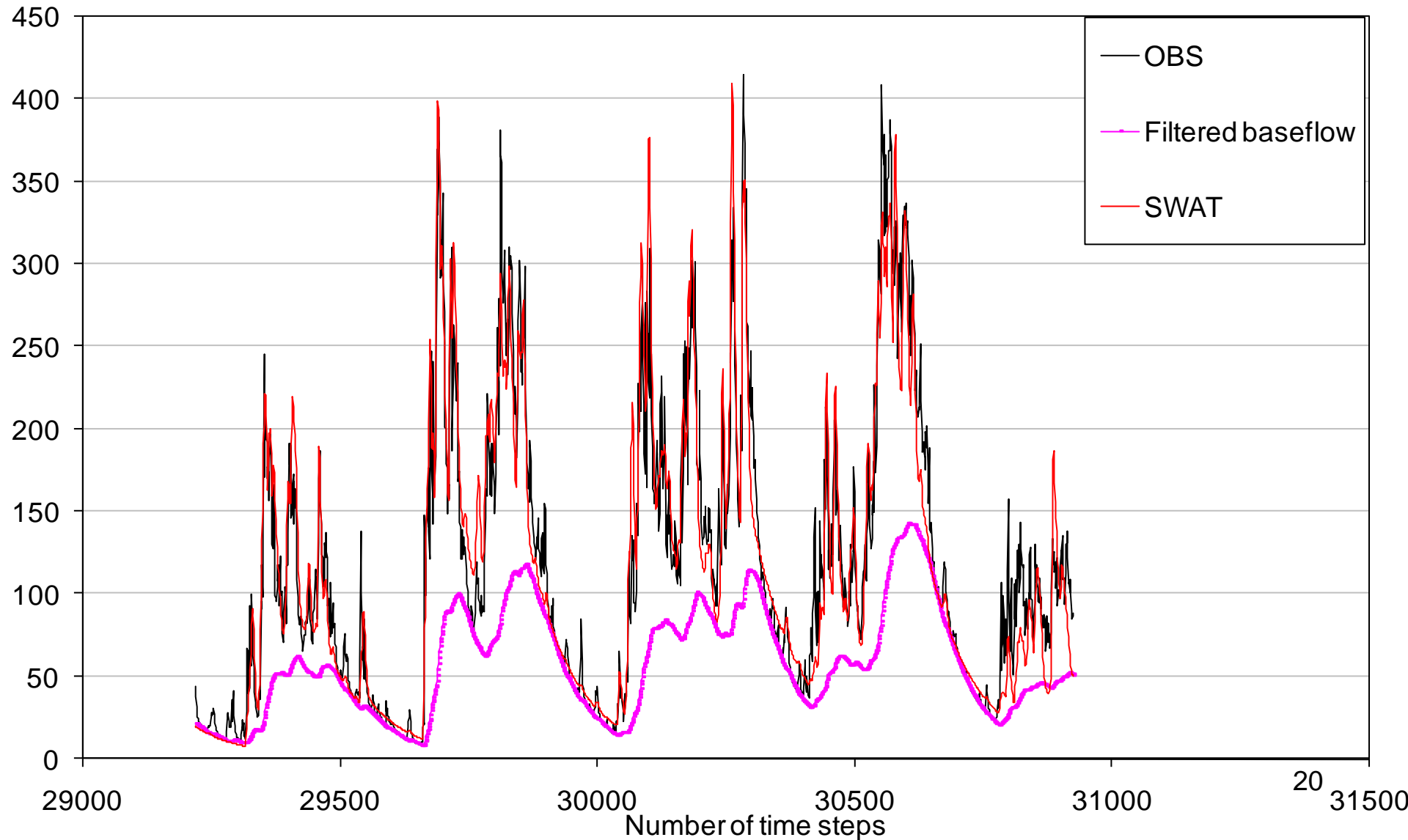
NSE

- NSE: 0.89 Calibration; 0.81 Validation



Model Calibration...

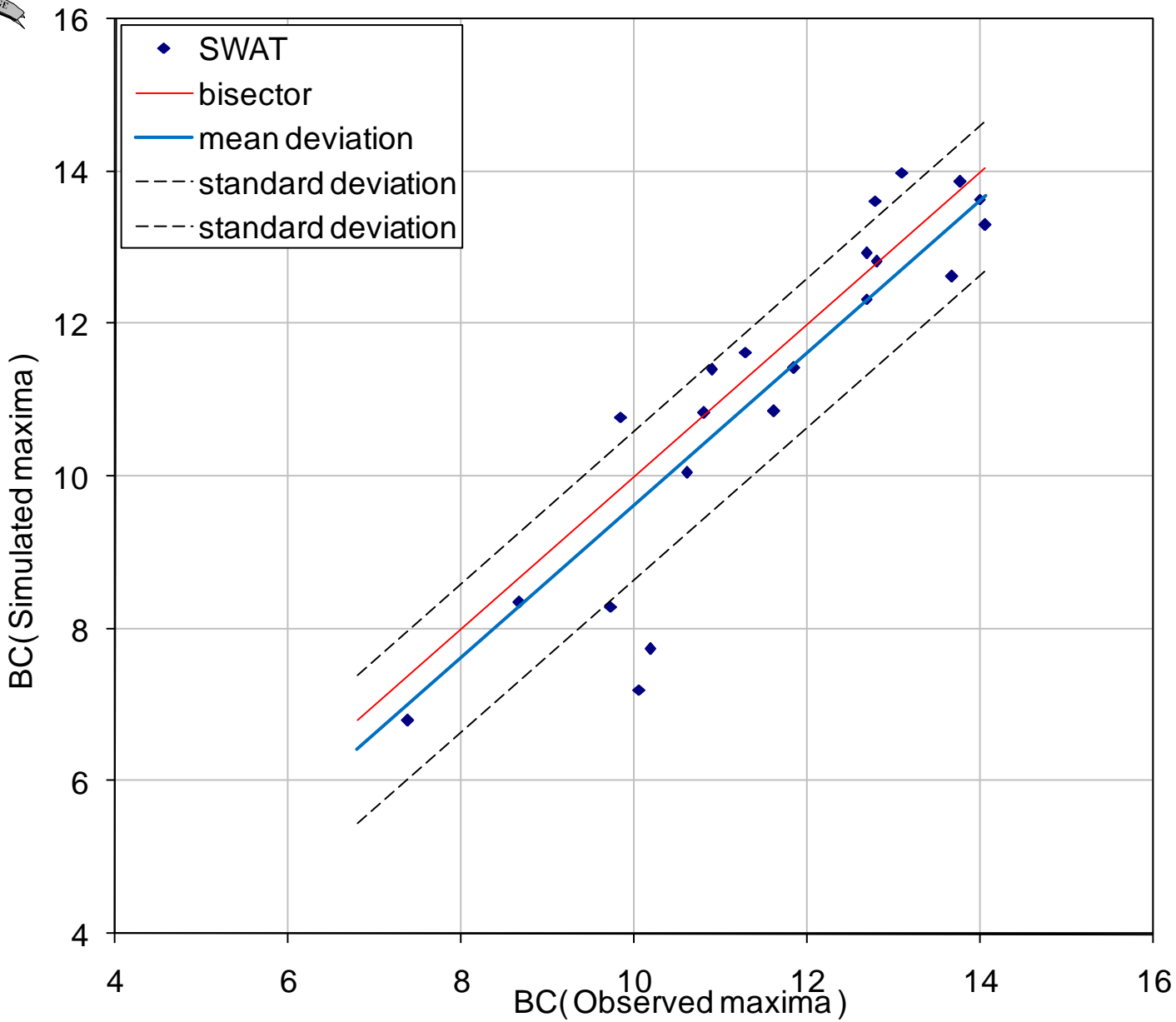
General agreement:





Model Calibration...

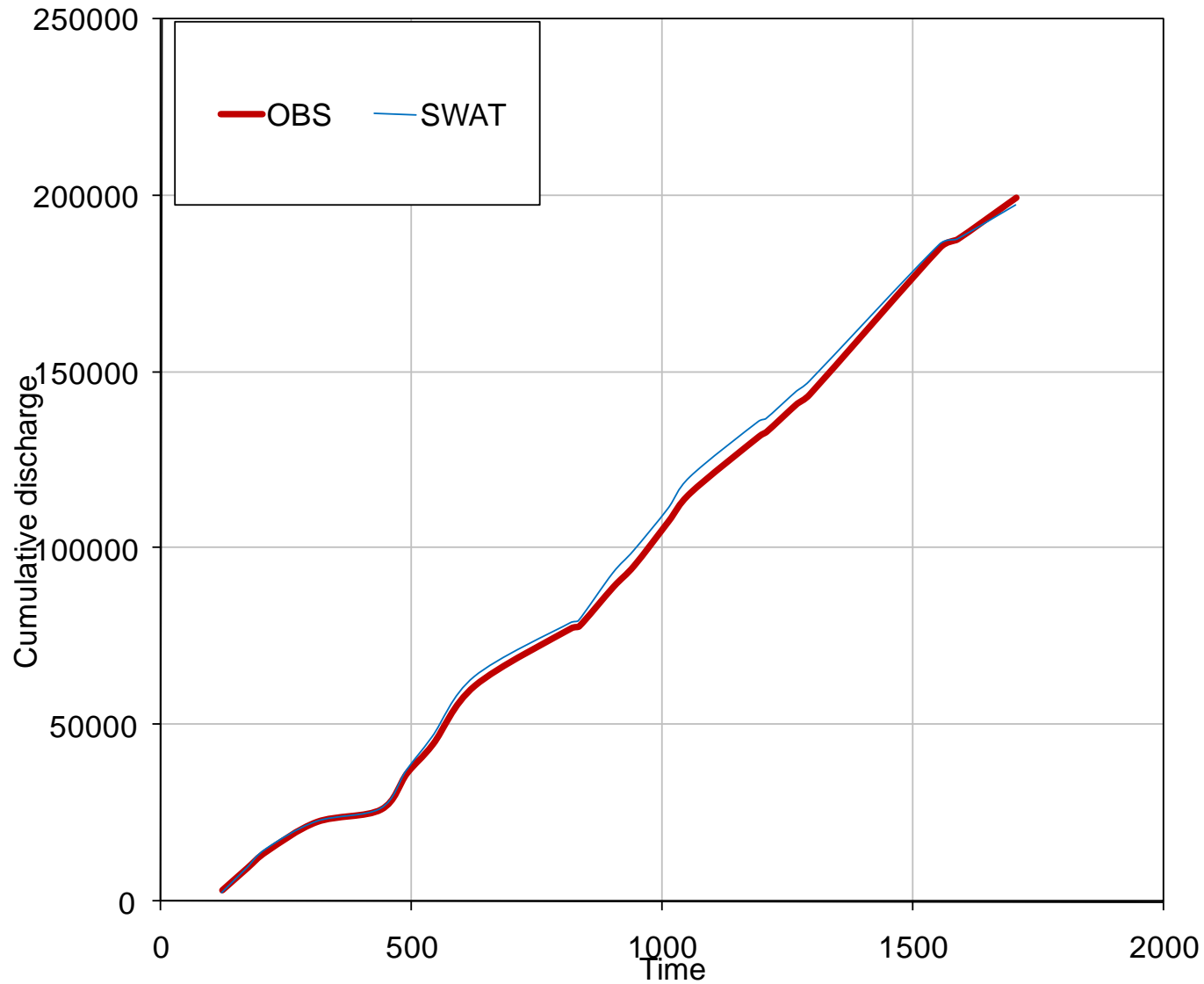
Maxima (peaks):





Model Calibration...

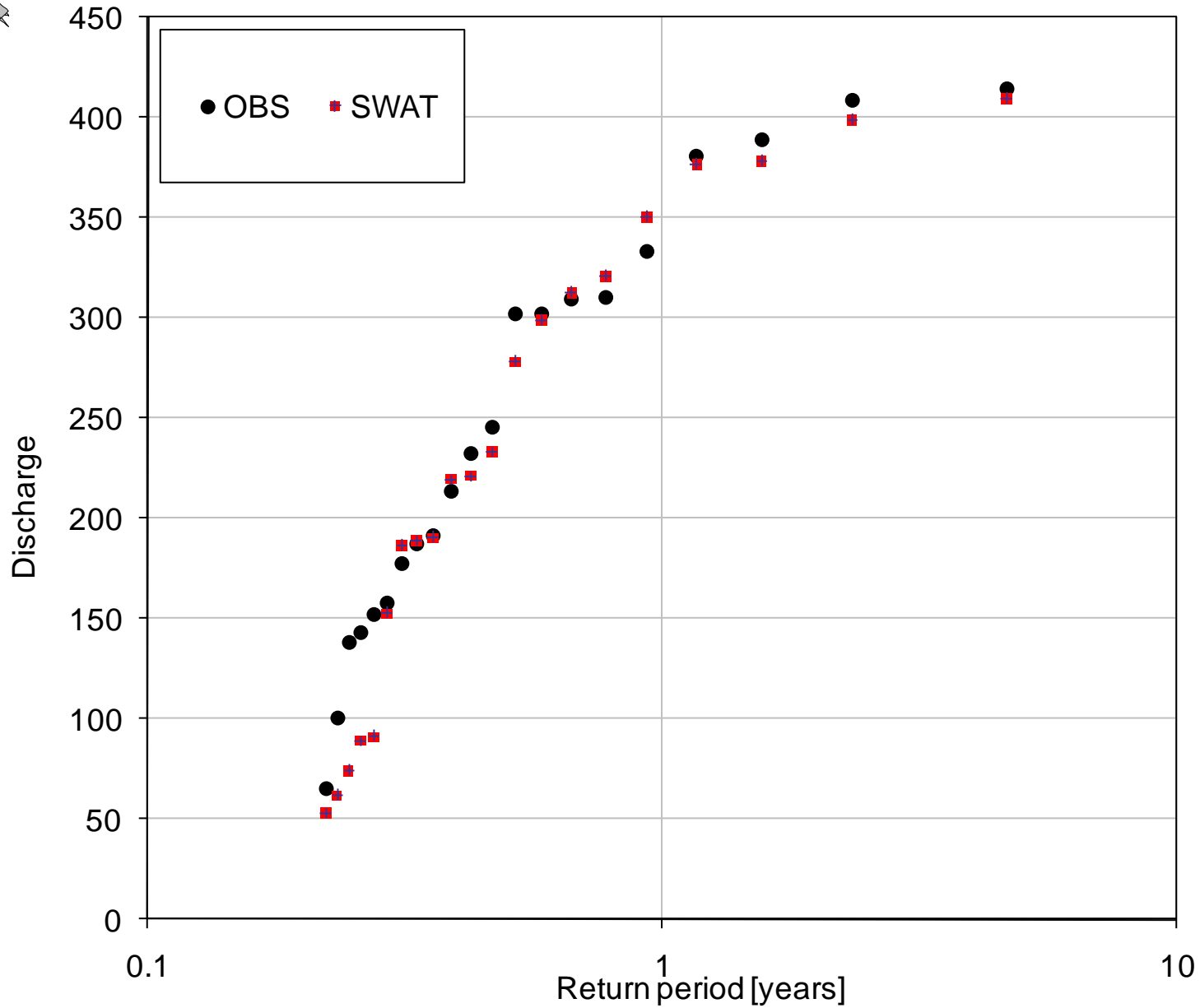
Cumulative Vol:

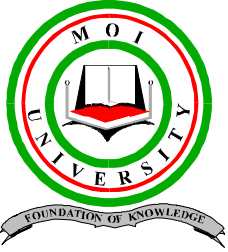




Model Calibration...

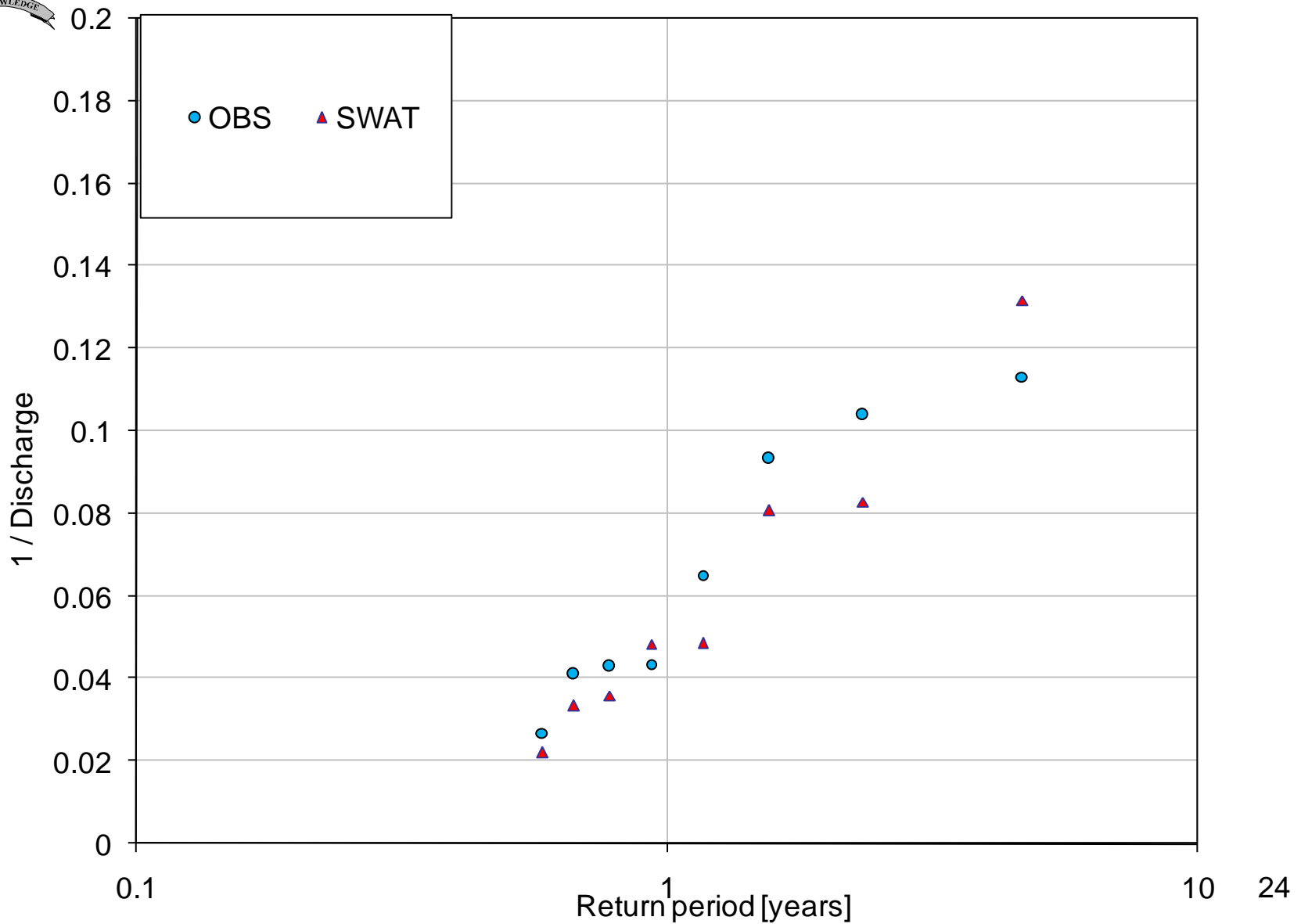
Extreme maxima:

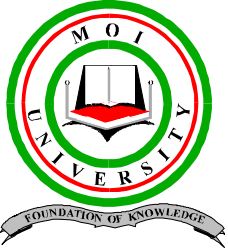




Model Calibration...

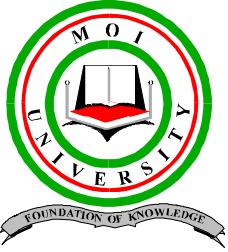
Extreme minima:





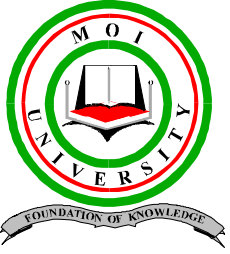
Calibration of satellite data

- USGS RFE Satellite rainfall estimates for calibration against raingause data.
- Resolution: 8km
- Satellite data extracted at 13 points (at raingauge stations)
- Calibration: Quartile-pertubation approach at individual stations
- Period: 2001-2008
 - 2001-2004: Calibration of Satellite data
 - 2005-2008: Validation
- Analysis: Mass curves Runoff extremes.

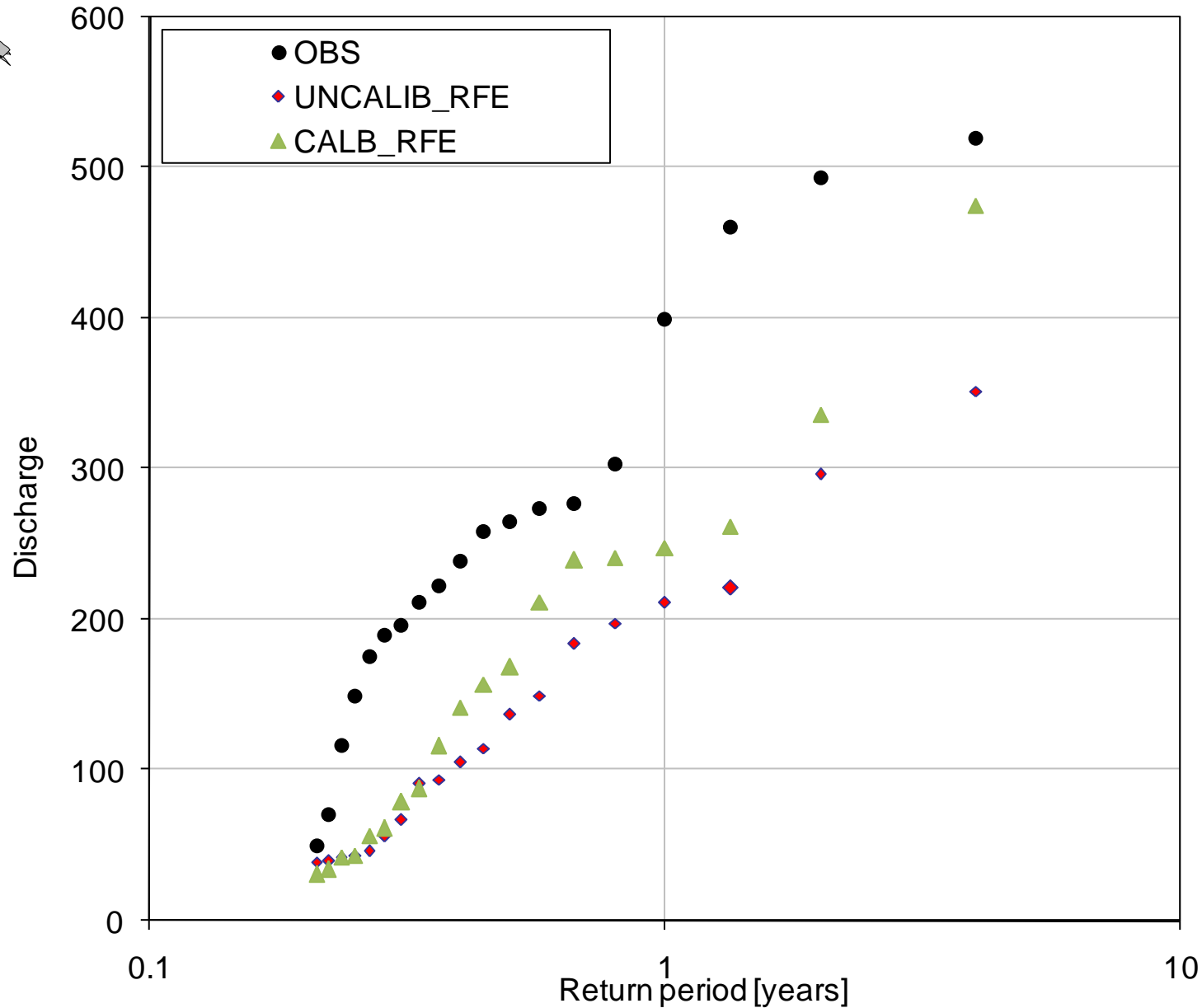


Calibration of satellite data

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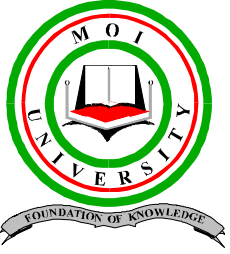
Calibration of satellite data...





Calibration of satellite data

- Satellite data can be valuable where observed data is insufficient
- Calibration to local scale can better improve runoff estimation with satellite data
- Effect of using both satellite rainfall and pet data to be studied



THANK YOU

Suggestions and Questions