
POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

# Obstacles and Pitfalls

## Simulating the **Water Balance** of **Lake Victoria** Catchment

**stefan.liersch@pik-potsdam.de**

**Fred F. Hattermann, Hagen Koch**

Leibniz Gemeinschaft

Potsdam Institute for Climate Impact Research
RD2 Climate Impacts & Vulnerability

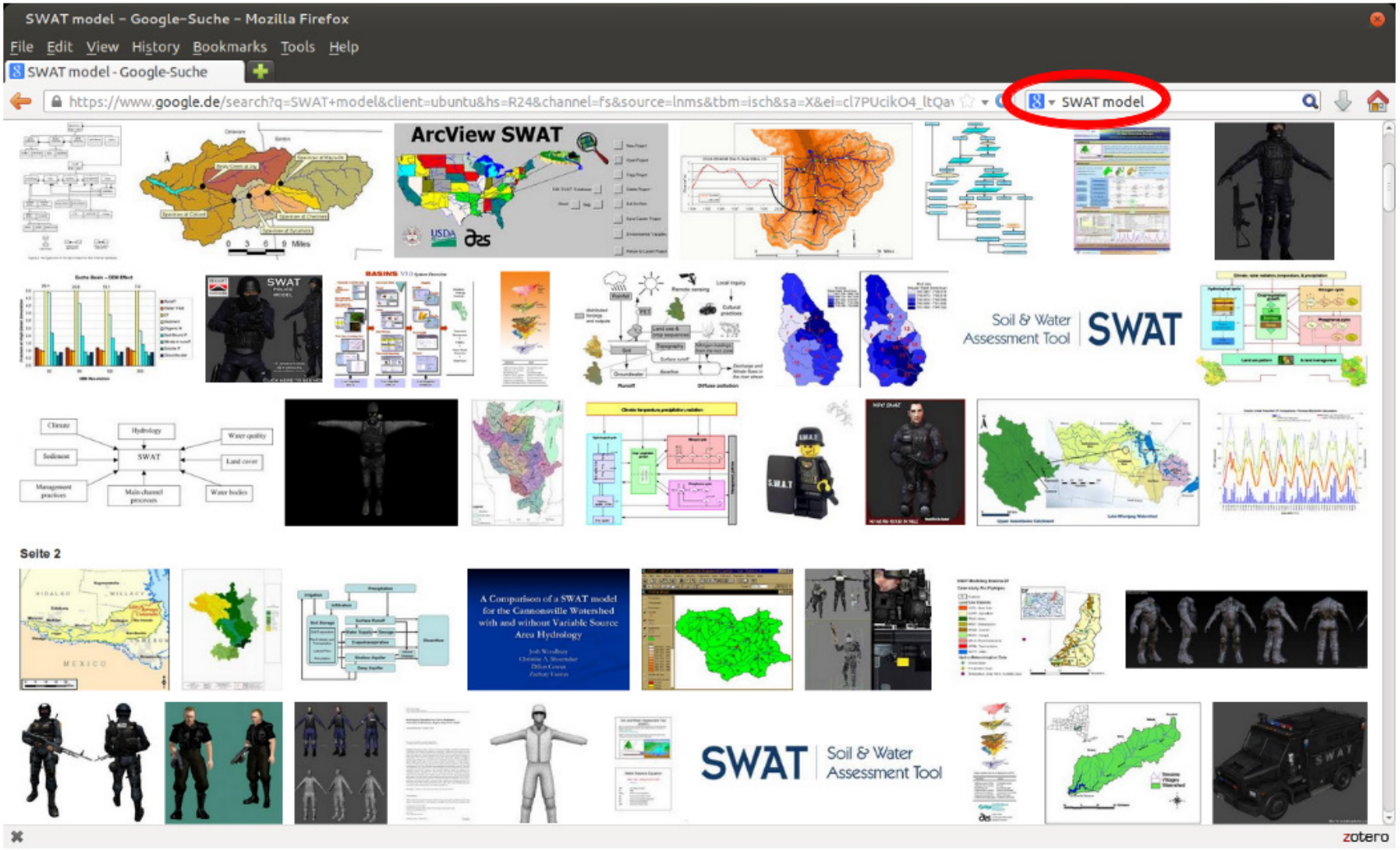
# Overview

- **SWIM vs. SWAT**
- **Lake Victoria basin characteristics**
- **Effects of papyrus swamps, lakes and wetlands**
- **Model calibration** (with and without considering papyrus swamps)
- **Do parameter settings matter?**
  - **Why, when and in how far?**
  - **Depending on research question?**
- **What are the implications for impact studies?**

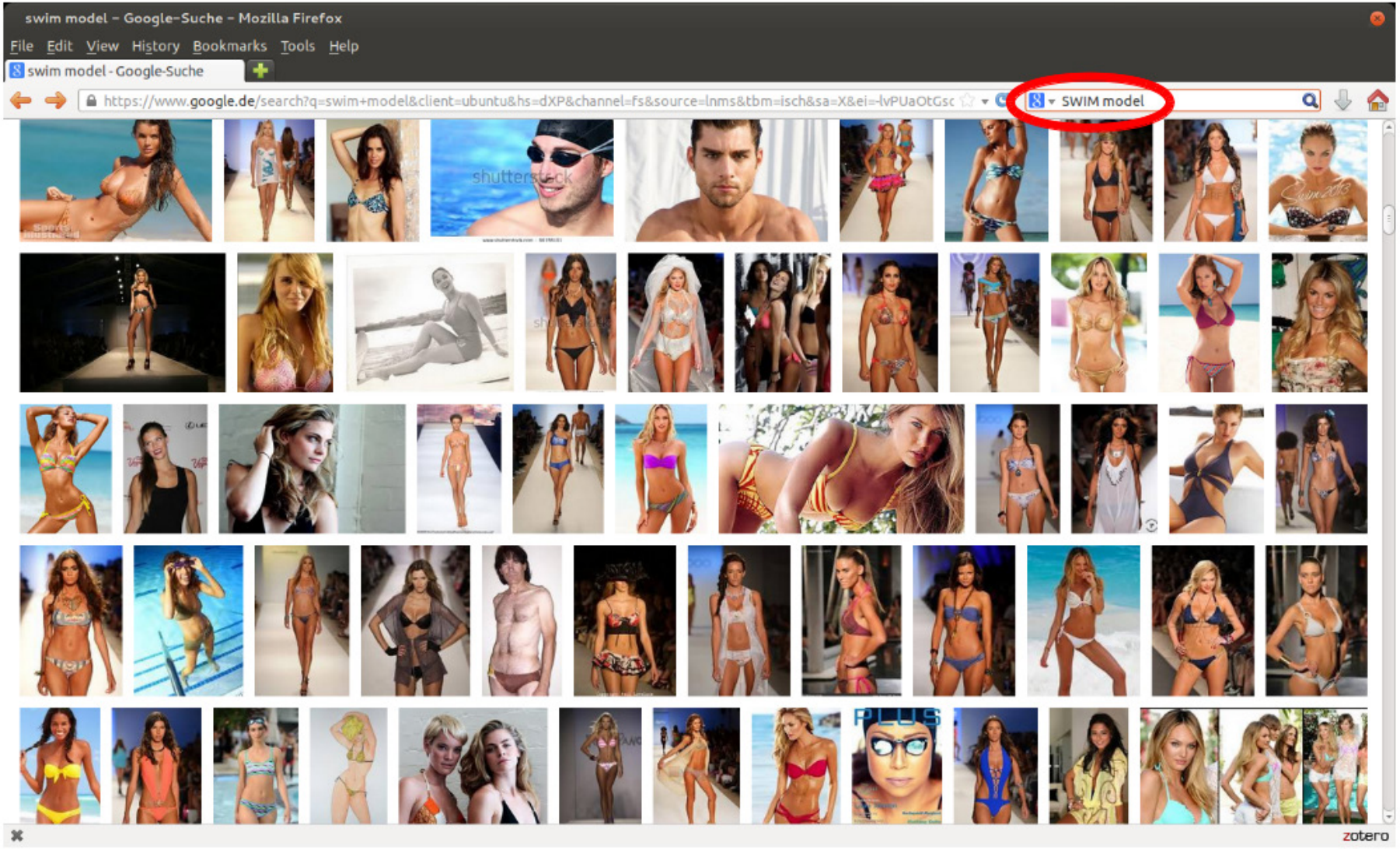
# SWIM vs. SWAT

- **Are there any differences?**
  - **No, not significantly**
  - **Same model structure**
  - **Similar basic assumptions and equations**
  - **Some specific functionalities**
    - **Irrigation**
    - **Dams and reservoirs**
    - **…**

# SWIM vs. SWAT


SWAT model – Google-Suche – Mozilla Firefox
File Edit View History Bookmarks Tools Help
SWAT model - Google-Suche
https://www.google.de/search?q=SWAT+model&client=ubuntu&hs=R24&channel=fs&source=lnms&tbm=isch&sa=X&ei=cl7PUcikO4_ltQav
SWAT model
ArcView SWAT
Soil & Water Assessment Tool SWAT
Seite 2
A Comparison of a SWAT model for the Cannonsville Watershed with and without Variable Source Area Hydrology
SWAT Soil & Water Assessment Tool
zotero

# SWIM vs. SWAT


swim model – Google-Suche – Mozilla Firefox
File Edit View History Bookmarks Tools Help
swim model - Google-Suche
https://www.google.de/search?q=swim+model&client=ubuntu&hs=dXP&channel=fs&source=lnms&tbm=isch&sa=X&ei=-lvPUaOtGsc
SWIM model
zotero

# SWIM & SWAT combined

# SWIM & SWAT combined

SWAT

# SWIM & SWAT combined

SWAT


+

SWIM

# SWIM & SWAT combined

SWAT

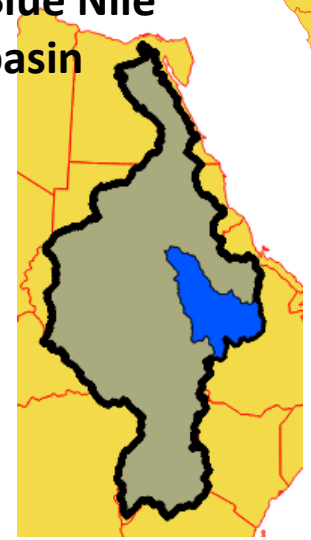

+

SWIM

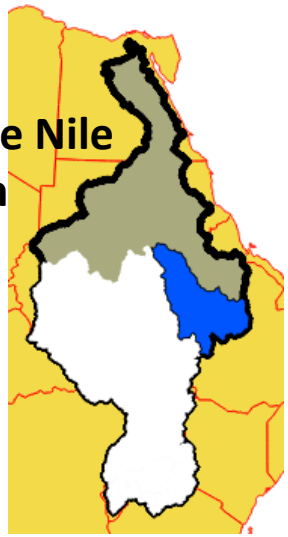
=

# Study Area


Blue Nile basin



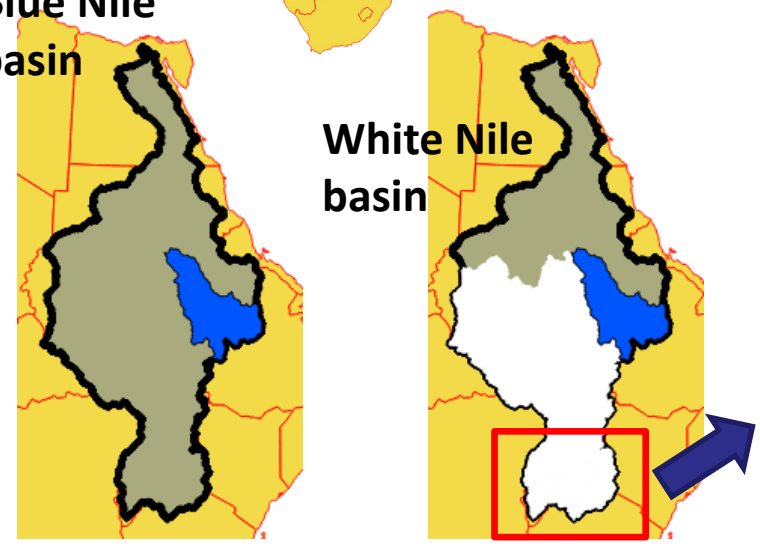
White Nile basin



# Study Area

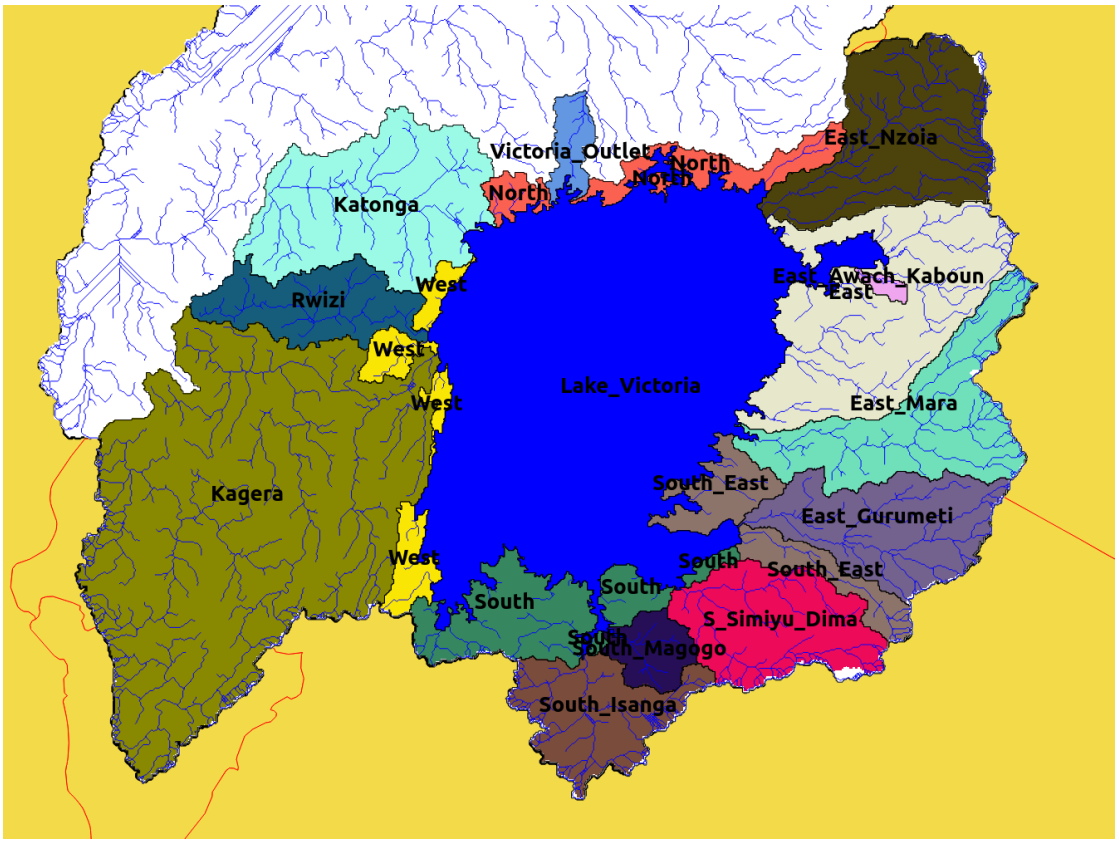

Blue Nile basin

White Nile basin



Lake Victoria Catchment

~ 260,000 km²

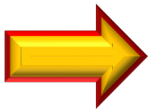


# Challenges

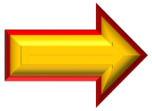
- Catchment size ~260,000 km$^2$
- The Lake Victoria itself ~67,000 km$^2$ (Reservoir)
- Heterogeneity of the catchment
- Lakes and swamps
- Data quality and uncertainties
  - Rainfall over the lake
  - Evaporation over the lake
  - …

# Water Balance of Lake Victoria

- Lake rainfall ~1850 mm
- Tributary inflow ~340 mm
- Lake evaporation ~1590 mm
- Lake outflow ~520 mm



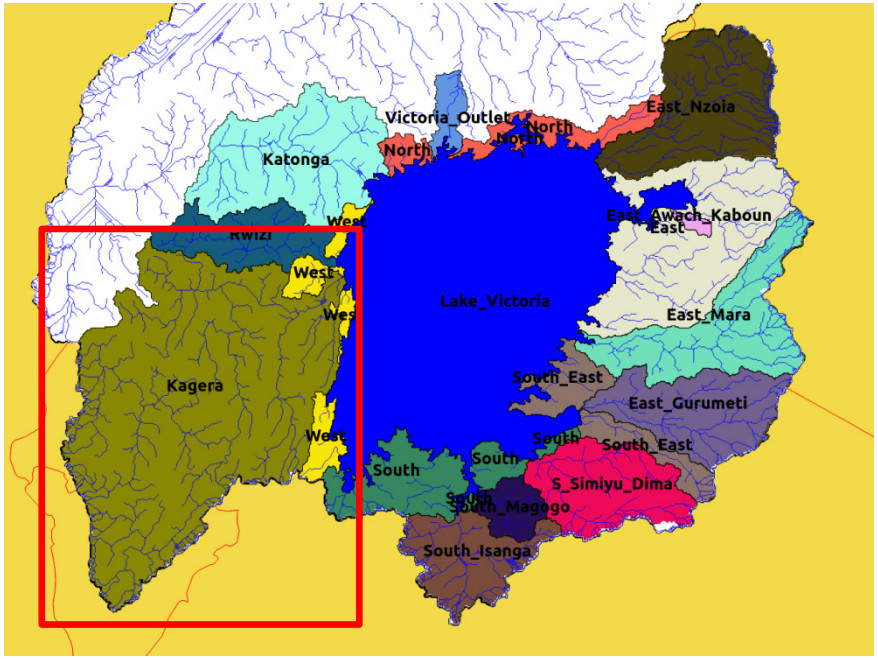
Lake rainfall is ~85% of total input



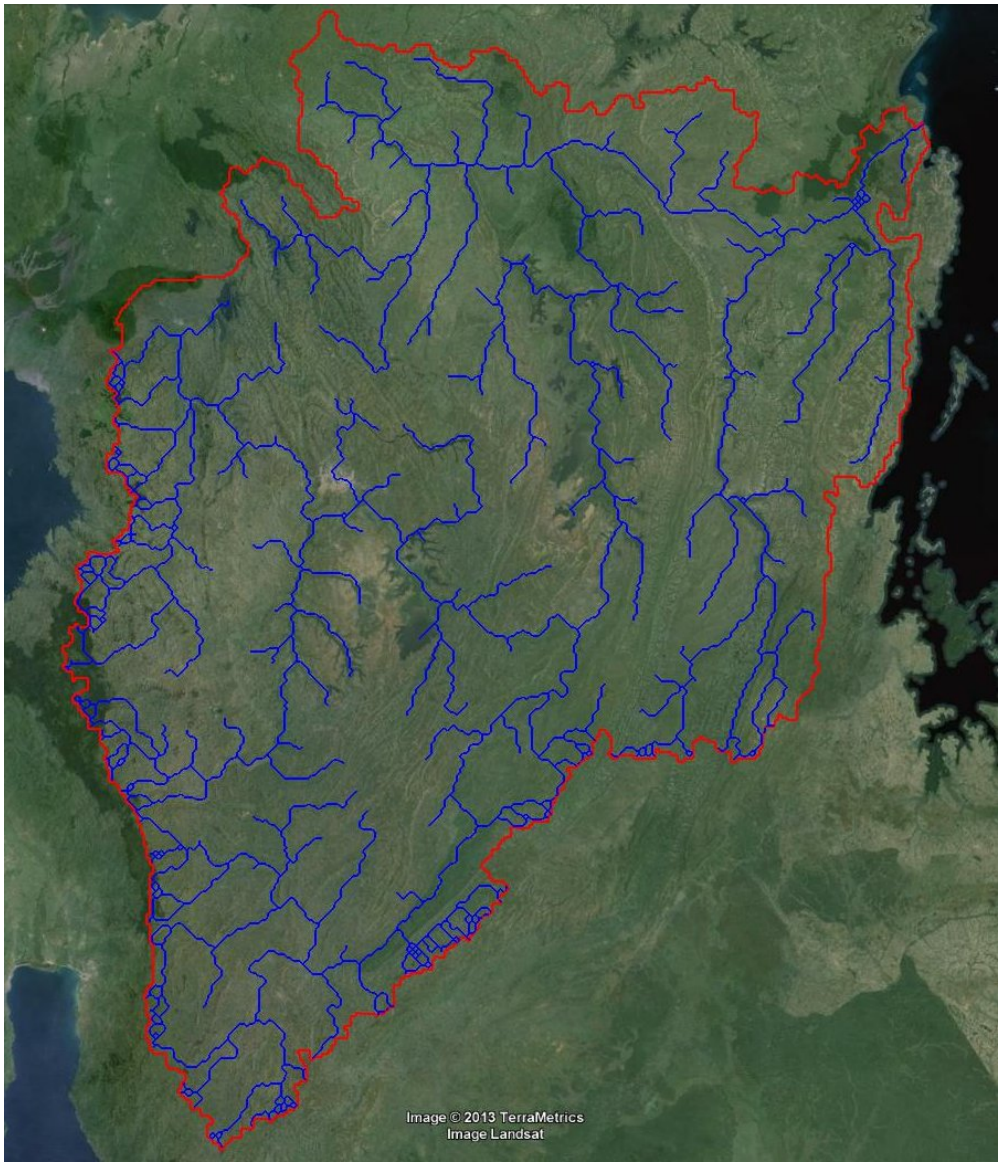
Data quality!!!

# Study Area

## Lake Victoria Catchment



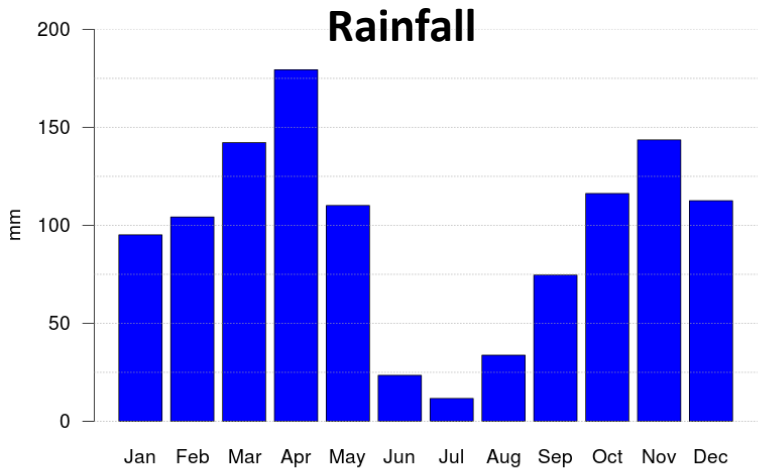

## Kagera River Catchment

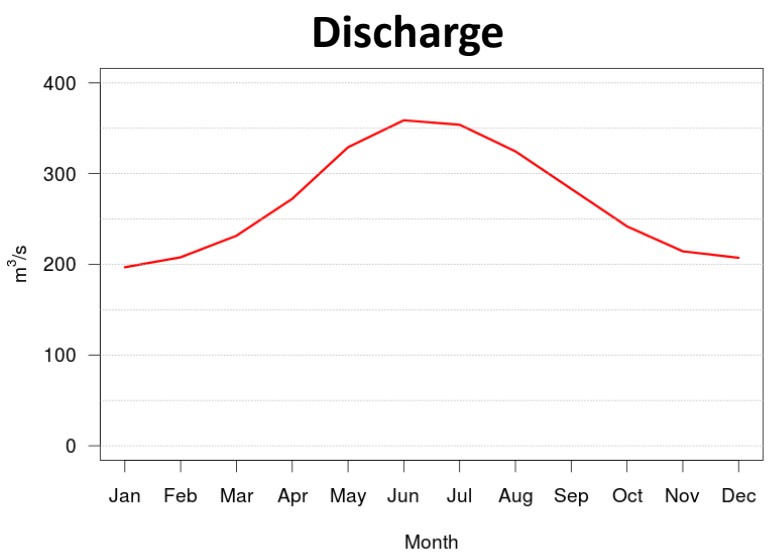


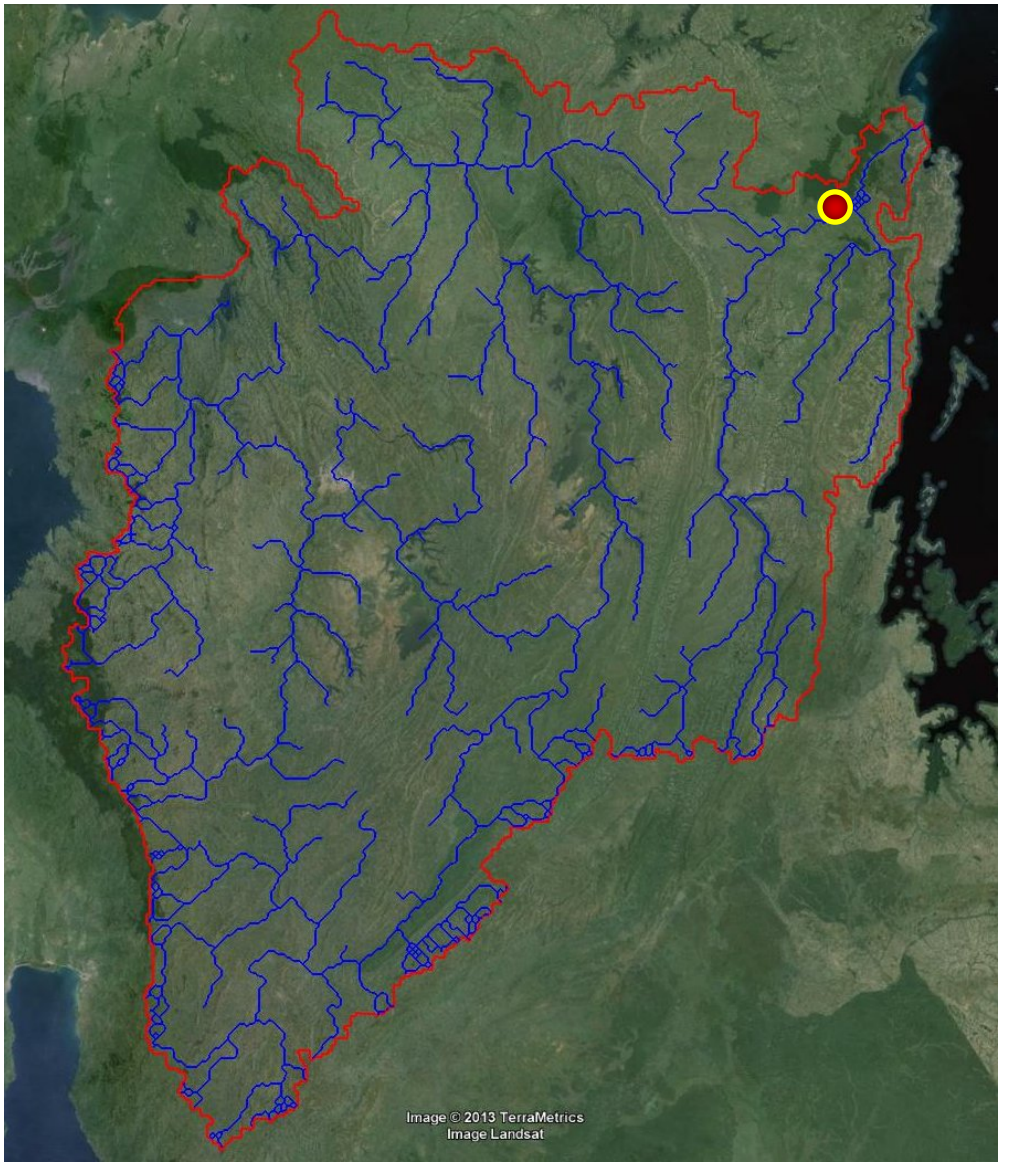
# Kagera Catchment

~60,000 km$^2$

## 1/3 of tributary inflow



# Lakes and Swamps


# Processes

- **Storage effect**
  - **Riverine wetlands (HRUs) considered as storage**
  - **Release as percentage of actual storage volume**
- **Lag in river runoff**
  - **Every drop of water from upstream and the subbasin itself are routed through the wetland storage**
- **„Losses“**
  - **Increased evapotranspiration in wetlands ($ET_{act} > ET_{pot}$)**
  - **Seepage → ground water recharge**

# Calbration

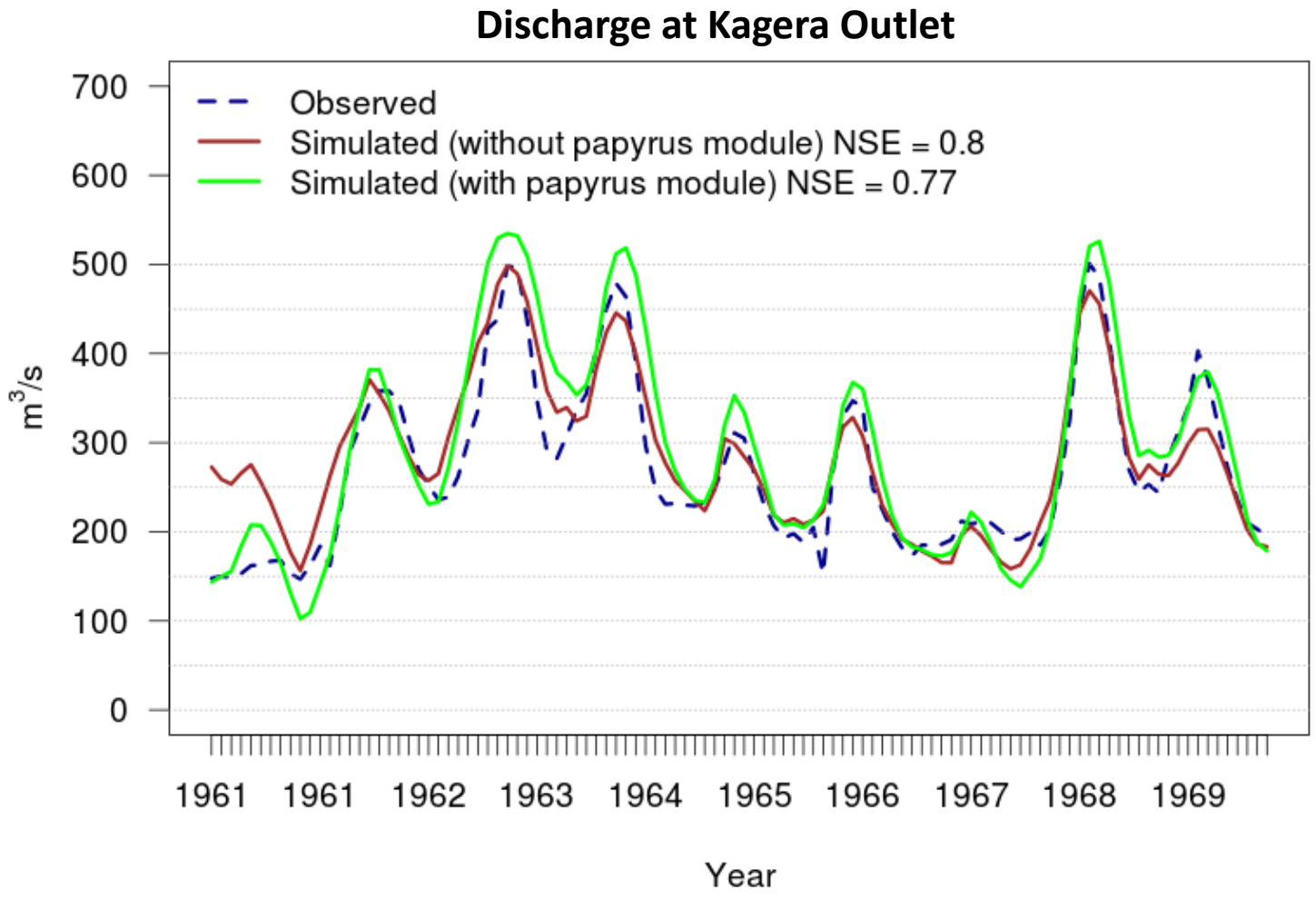
- *Is it possible to calibrate the SWIM model to the catchment without considering these „special features“?*
- **Yes, it is!**
  - **Increase $ET_{pot}$ correction factor *5**
  - **Muskingum routing parameter settings to smooth discharge curve**

- *What are the implications for impact studies assuming changing boundary conditions? Are there any at all?*
- **Yes, there are!**

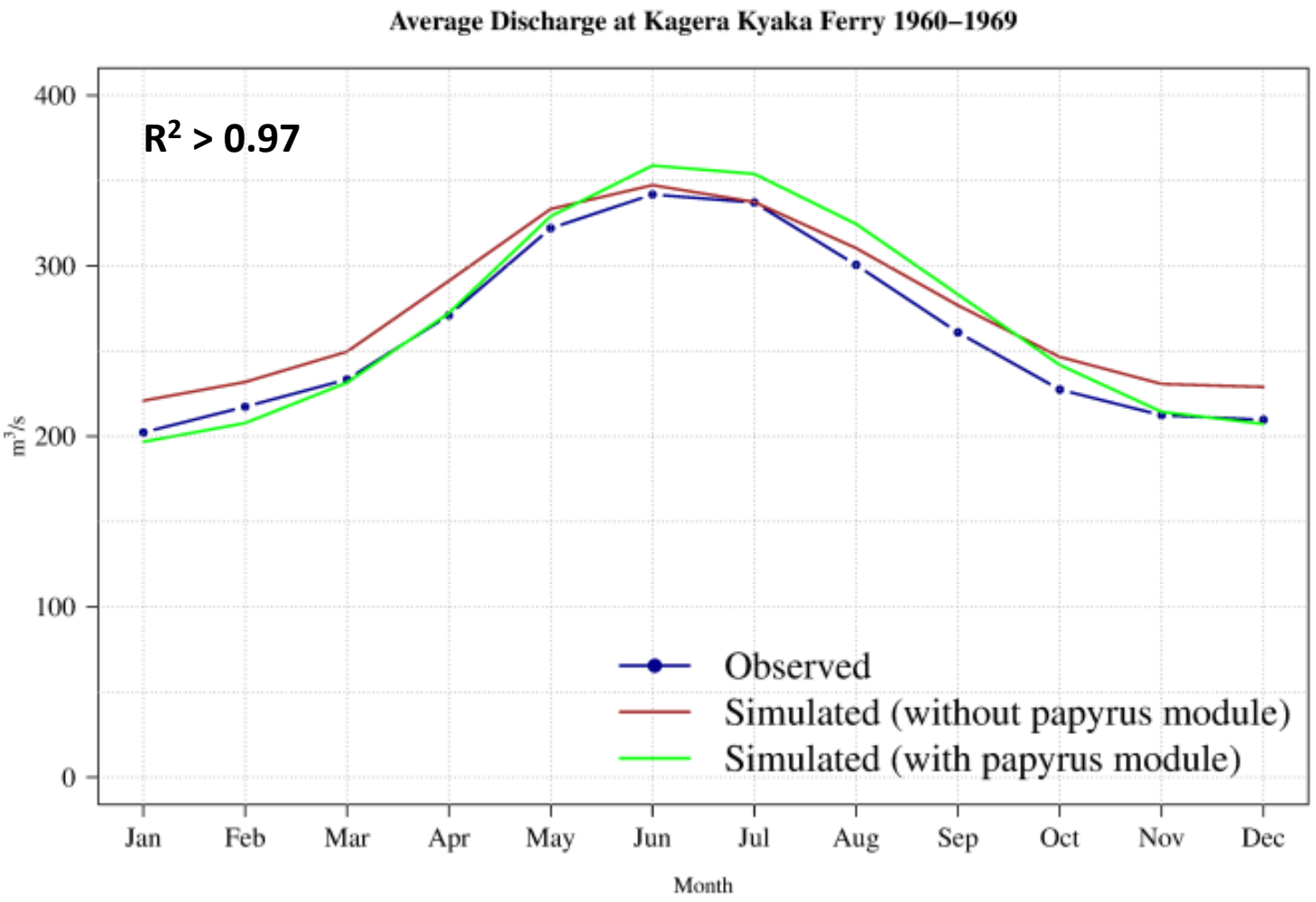
# Input Data

- **SRTM DEM 90m**
- **Soil: HWSD (FAO74) for Africa**
- **Land use: GLC2000**
- **Climate: Watch Forcing Data (WFD)**
- **Discharge: GRDC**

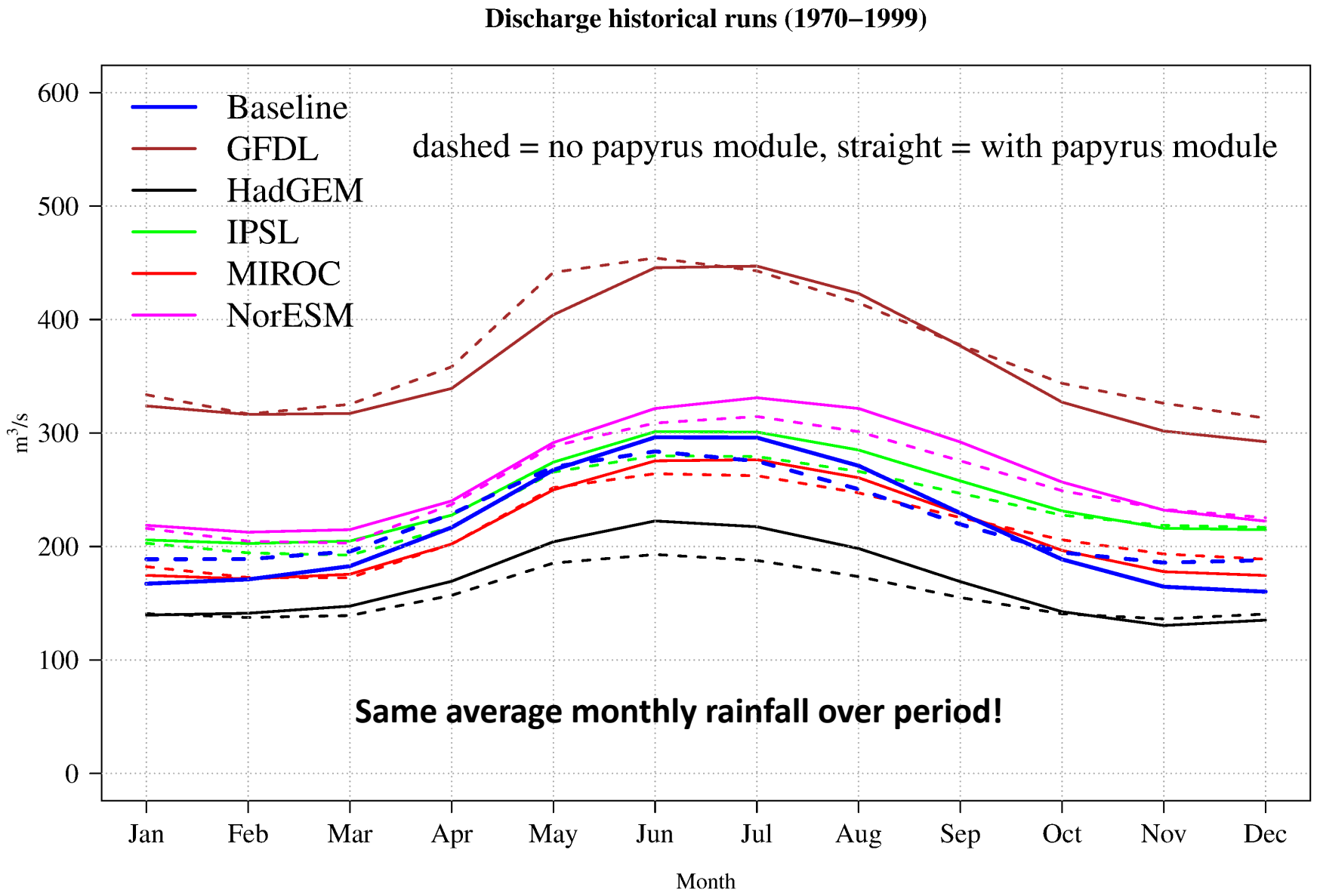
# Model Calibration



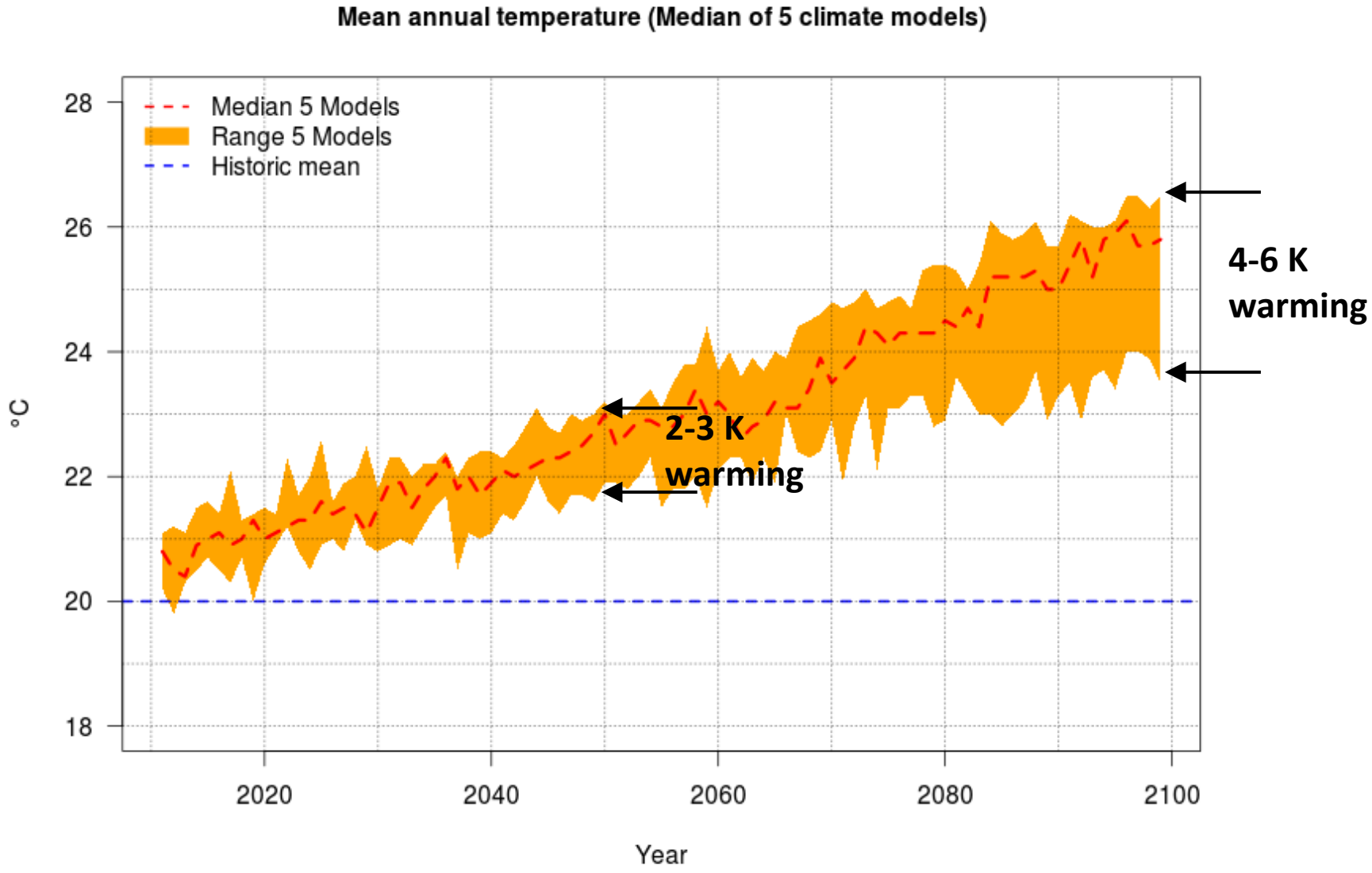
# Model Calibration



# Climate Sensitivity

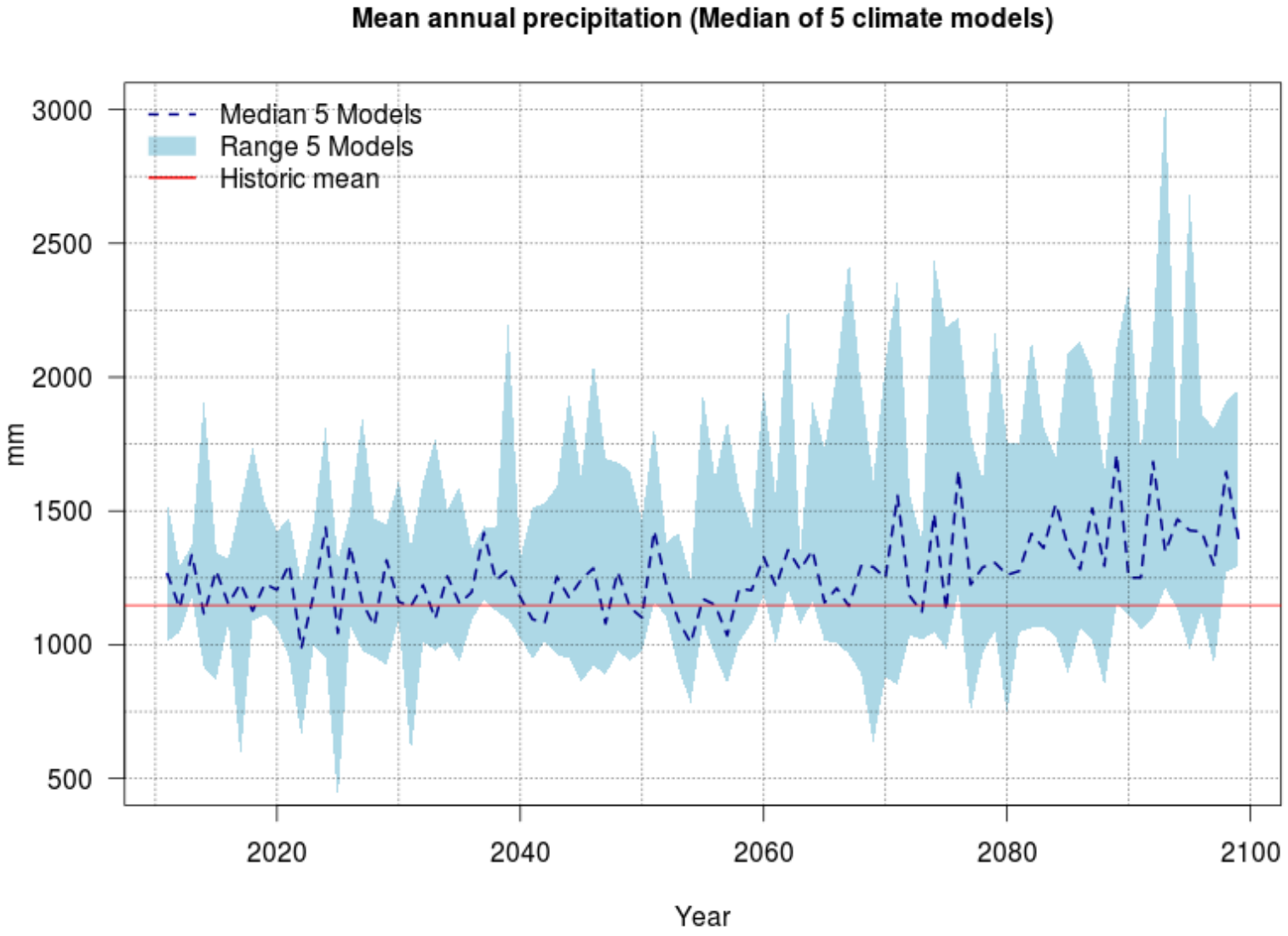


Temperature Projection

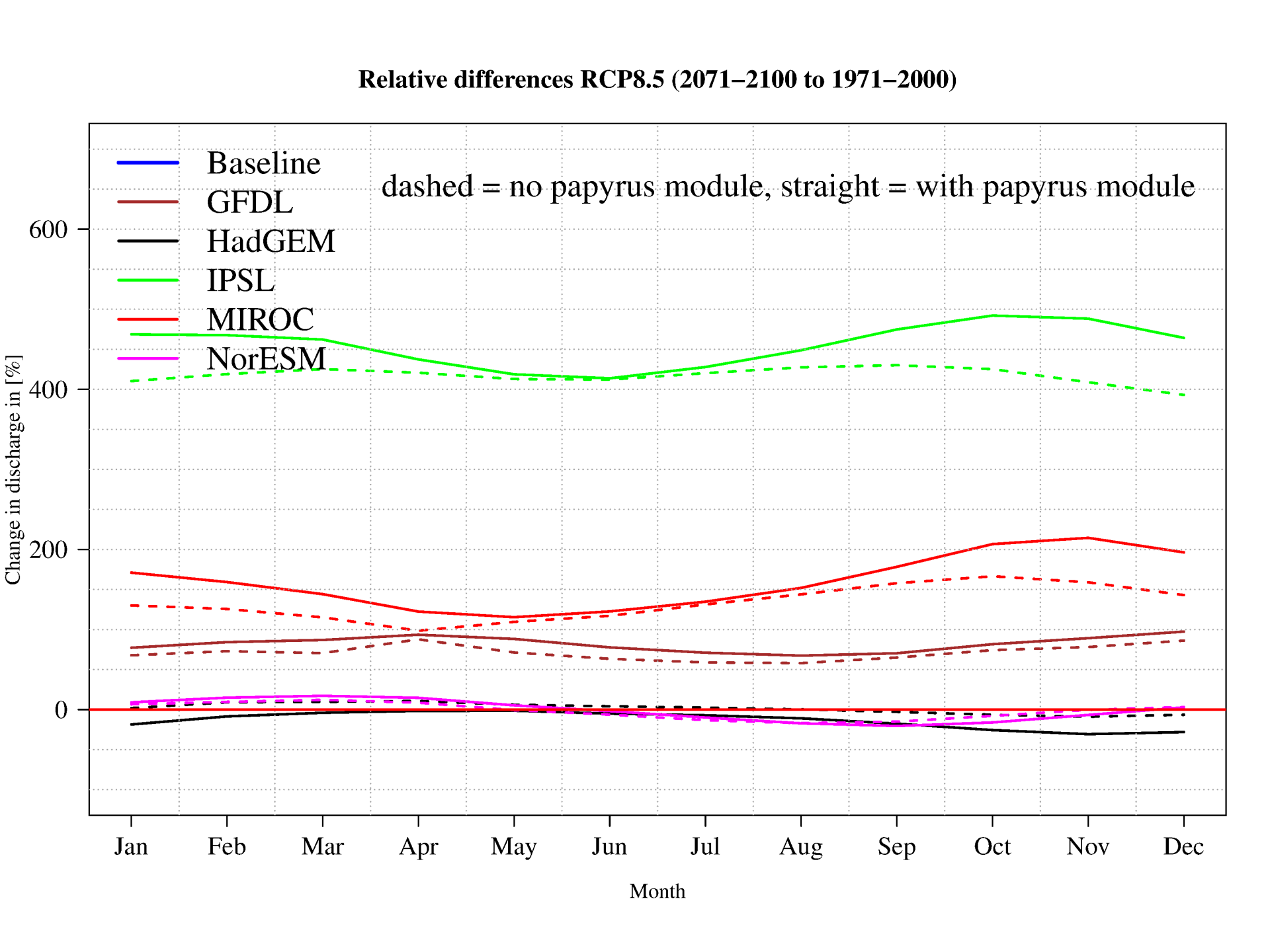


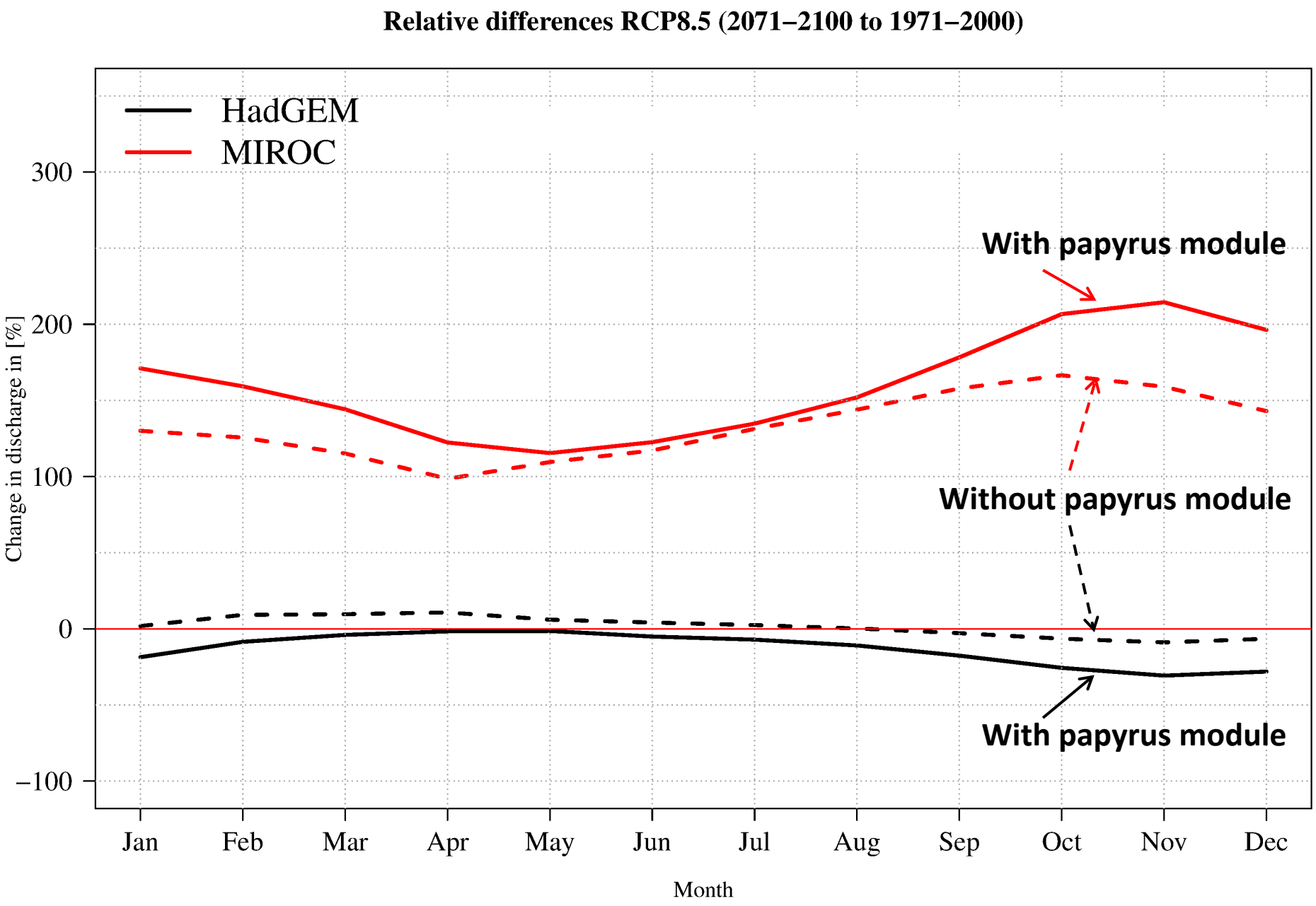

**5 ESMs, RCP8.5**

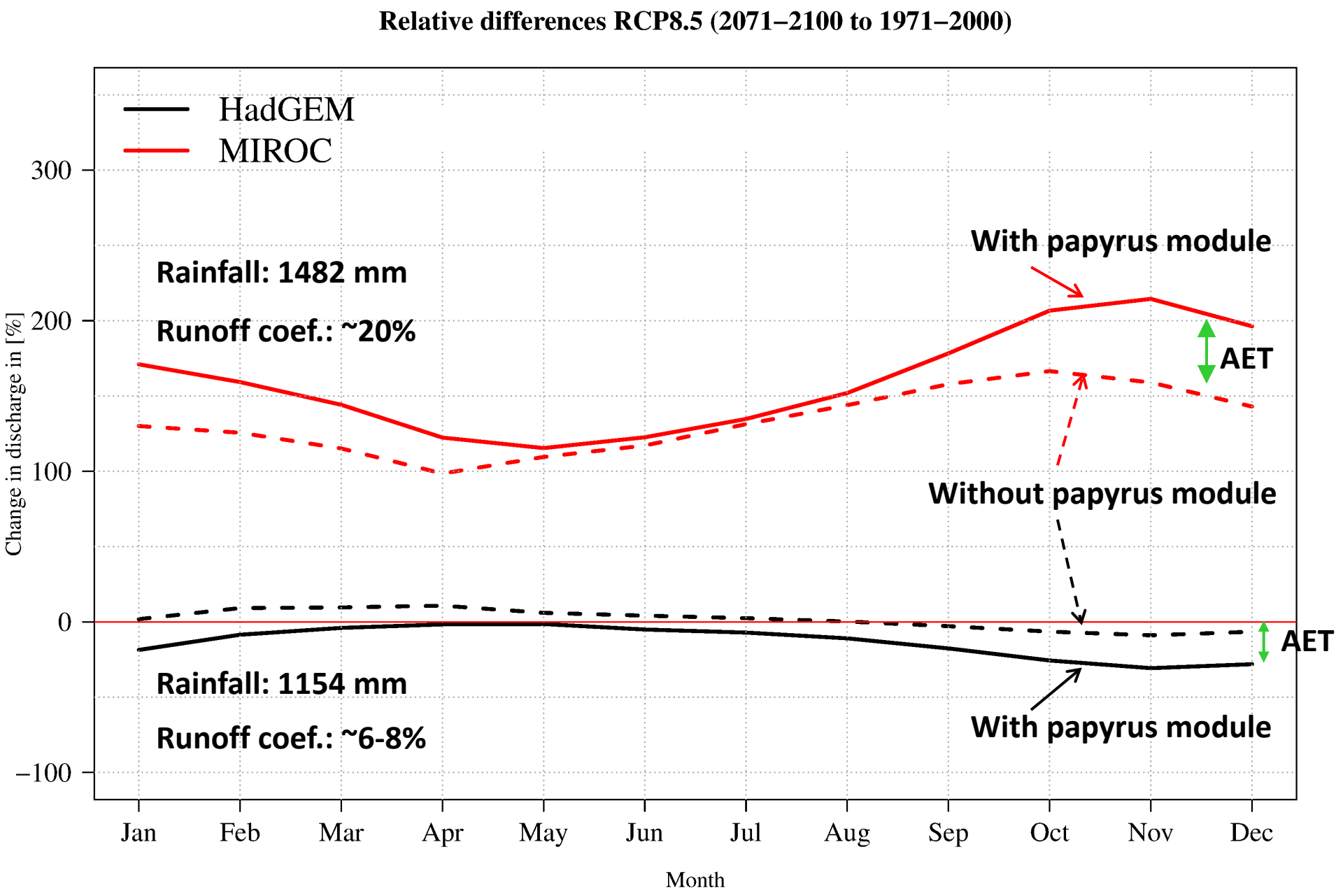
Rainfall Projection




**5 ESMs, RCP8.5**


Relative differences RCP8.5 (2071–2100 to 1971–2000)
Baseline
GFDL
HadGEM
IPSL
MIROC
NorESM
dashed = no papyrus module, straight = with papyrus module
600
400
200
0
Change in discharge in [%]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Relative differences RCP8.5 (2071–2100 to 1971–2000)
HadGEM
MIROC
With papyrus module
Without papyrus module
With papyrus module
300
200
100
0
−100
Change in discharge in [%]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Relative differences RCP8.5 (2071–2100 to 1971–2000)
HadGEM
MIROC
300
200
100
0
−100
Change in discharge in [%]
Rainfall: 1482 mm
Runoff coef.: ~20%
With papyrus module
AET
Without papyrus module
AET
Rainfall: 1154 mm
Runoff coef.: ~6-8%
With papyrus module
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

# Conclusions

- **The catchment is very sensitive to climate (rainfall)**
  - **Data quality**
  - **Uncertainties in applying climate projections**
- **Parameterisation matters!**
  - **Implications under different boundary conditions are likely!**
  - **Reverse trends are possible!**
- **Are processes represented adequately?**
- **Large scale applications**
  - **What level of detail is required?**
- **Communicate the weaknesses of your study**

# Which type of modeller are you?