



UNIVERSITY OF
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Cooperative operation of the Grand Ethiopian Renaissance Dam reduces Nile riverine floods

Mohammed Basheer

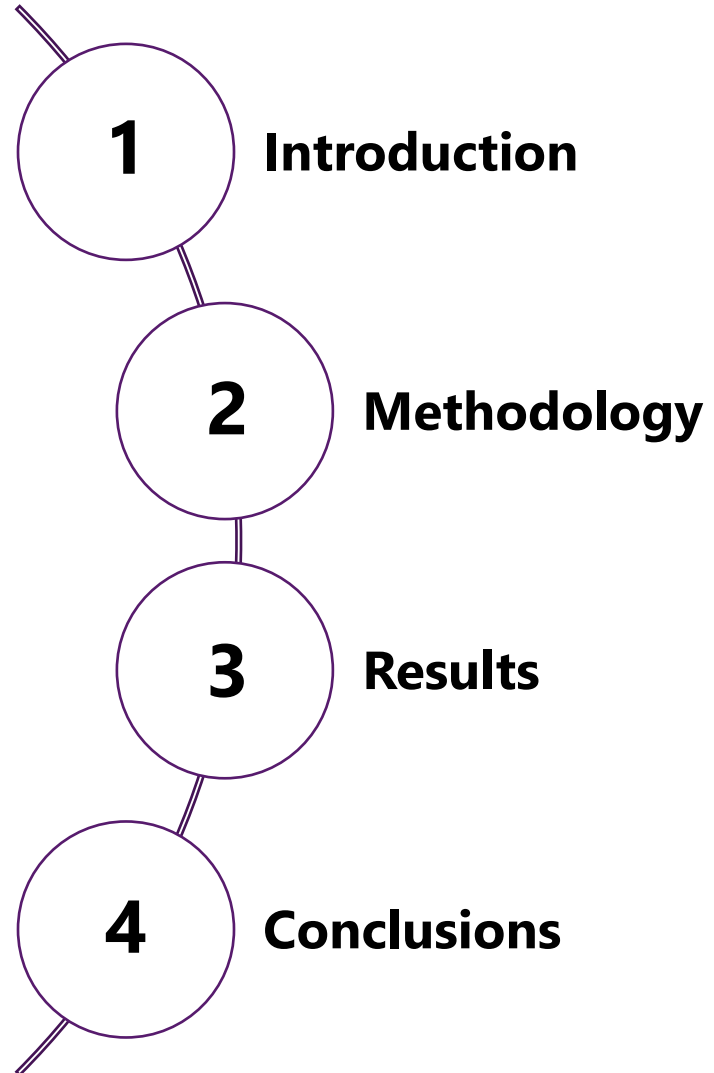
Assistant Professor
University of Toronto, Canada

Alexander von Humboldt Research Fellow
Humboldt University of Berlin, Germany

30 August, 2023



Presentation outline



1- Introduction

Length

- Around 6,700 km long

Area

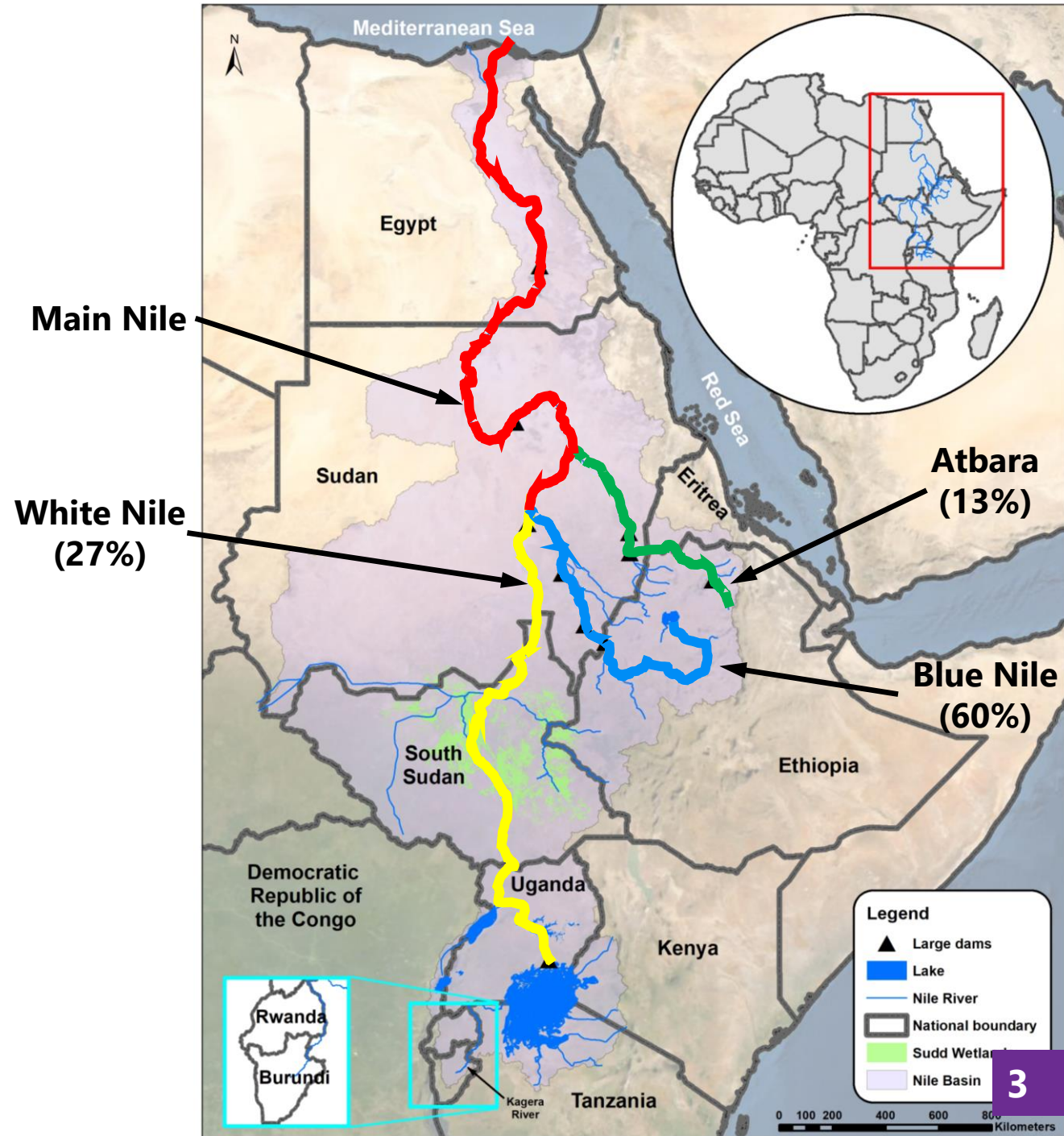
- Covers around 10% of Africa

Countries

- 11 riparian countries

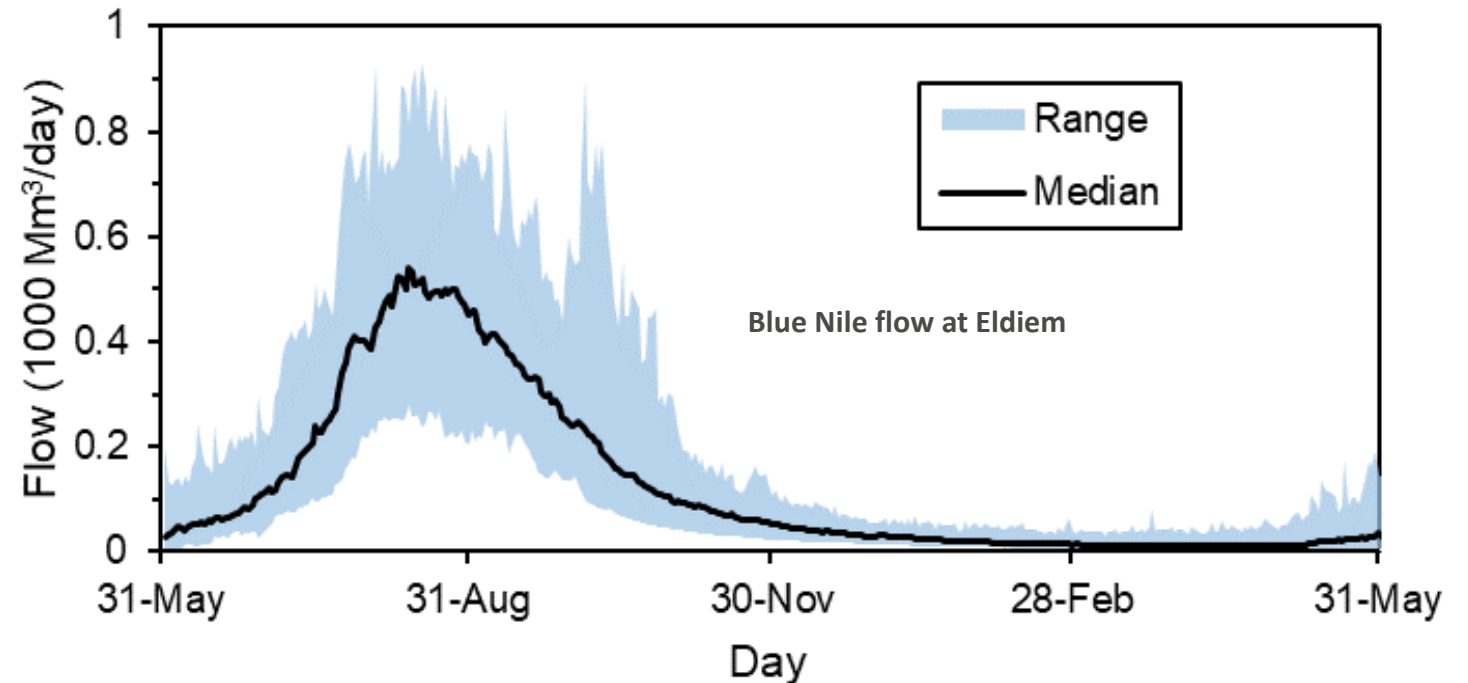
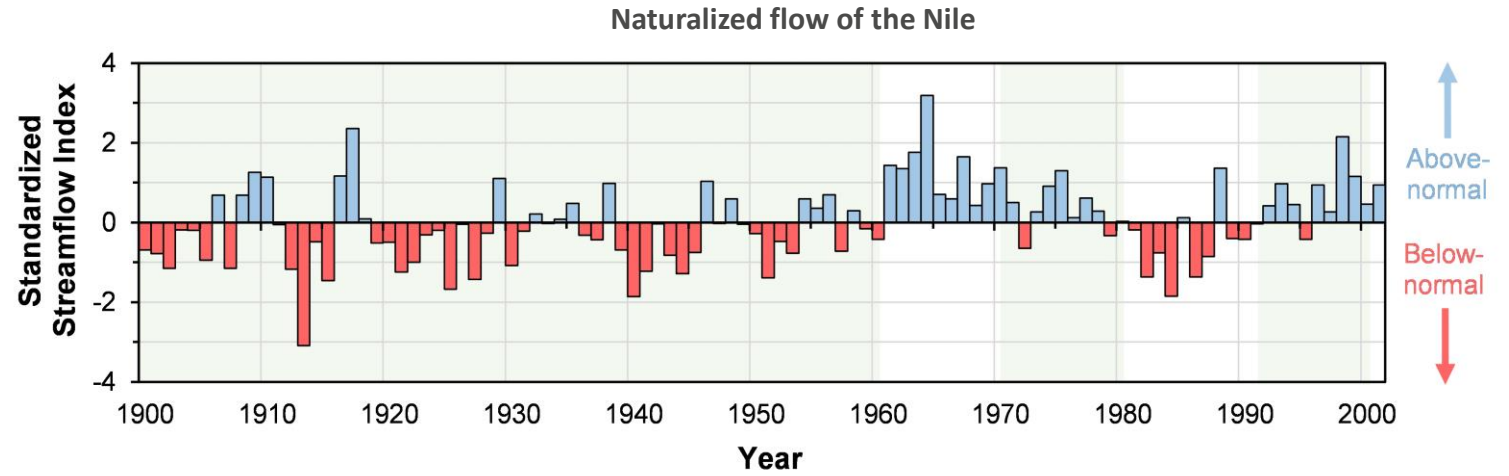
Population

- 505 million



1- Introduction

- ❑ The Nile flow has high inter-annual variability.
- ❑ The Blue Nile flow is highly seasonal with around 80% of the flow occurring from July to October.



1- Introduction

Types of floods in Sudan

- ❑ Riverine floods
 - Occurs due to river overflow outside the river channel to the floodplains.

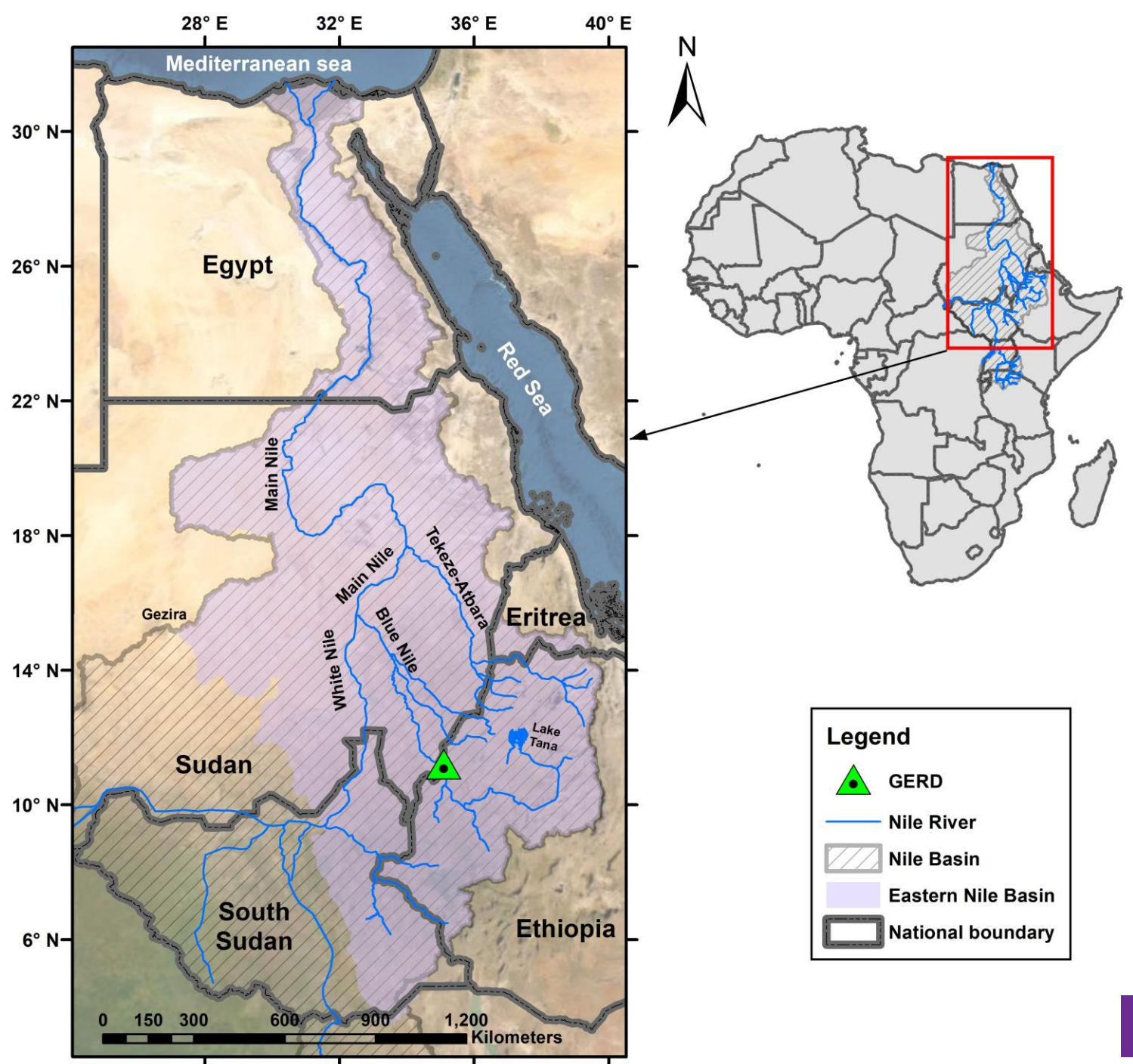
- ❑ Flash floods
 - Caused by intense local rain.
 - Occurs in most parts of Sudan.



1- Introduction

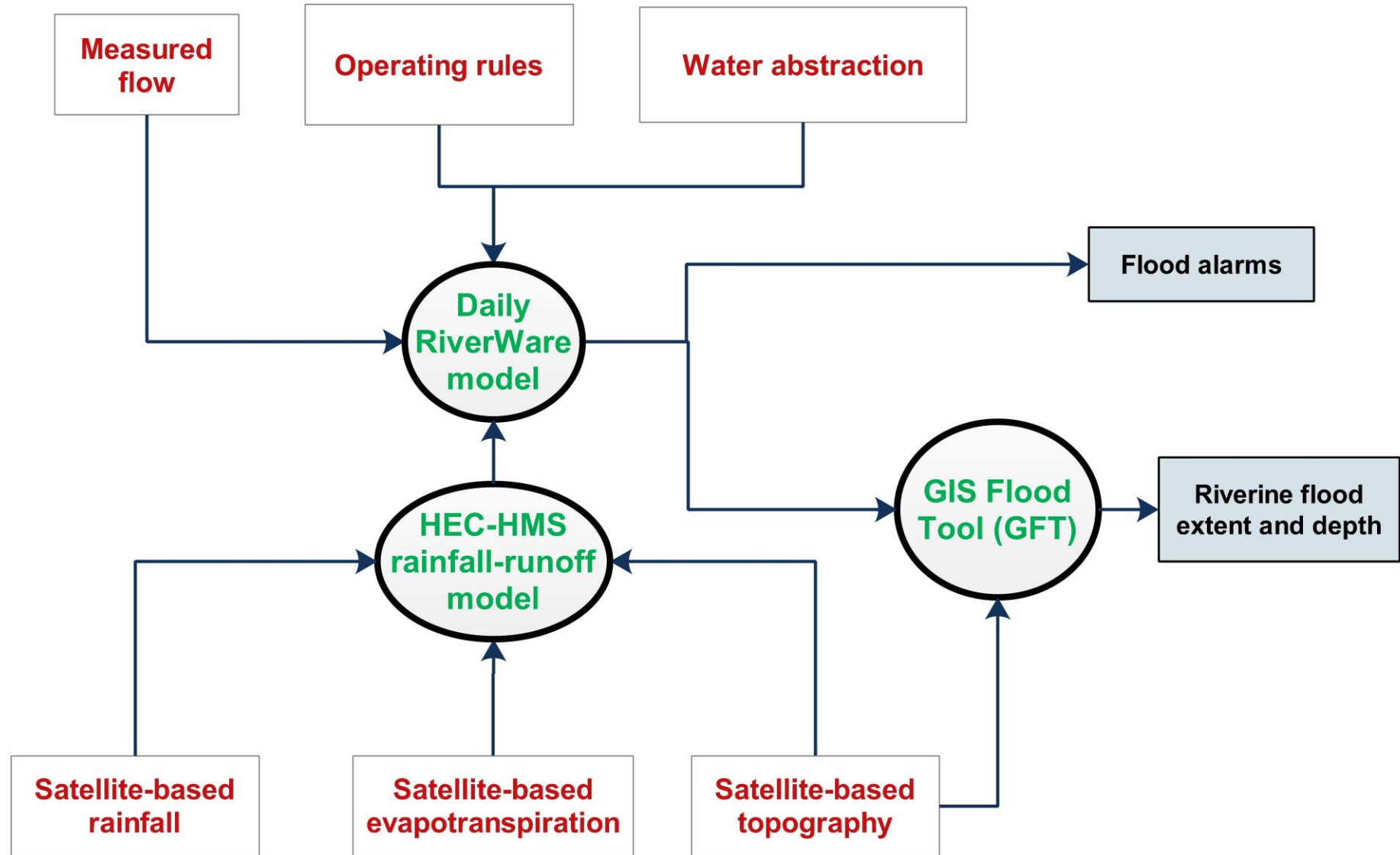
Grand Ethiopia Renaissance Dam (GERD)

- ❑ GERD has a hydropower capacity of 5,150 MW.
- ❑ Mean annual energy generation of around 15,000 GWh.
- ❑ Will increase Ethiopia's electricity generation twofold.

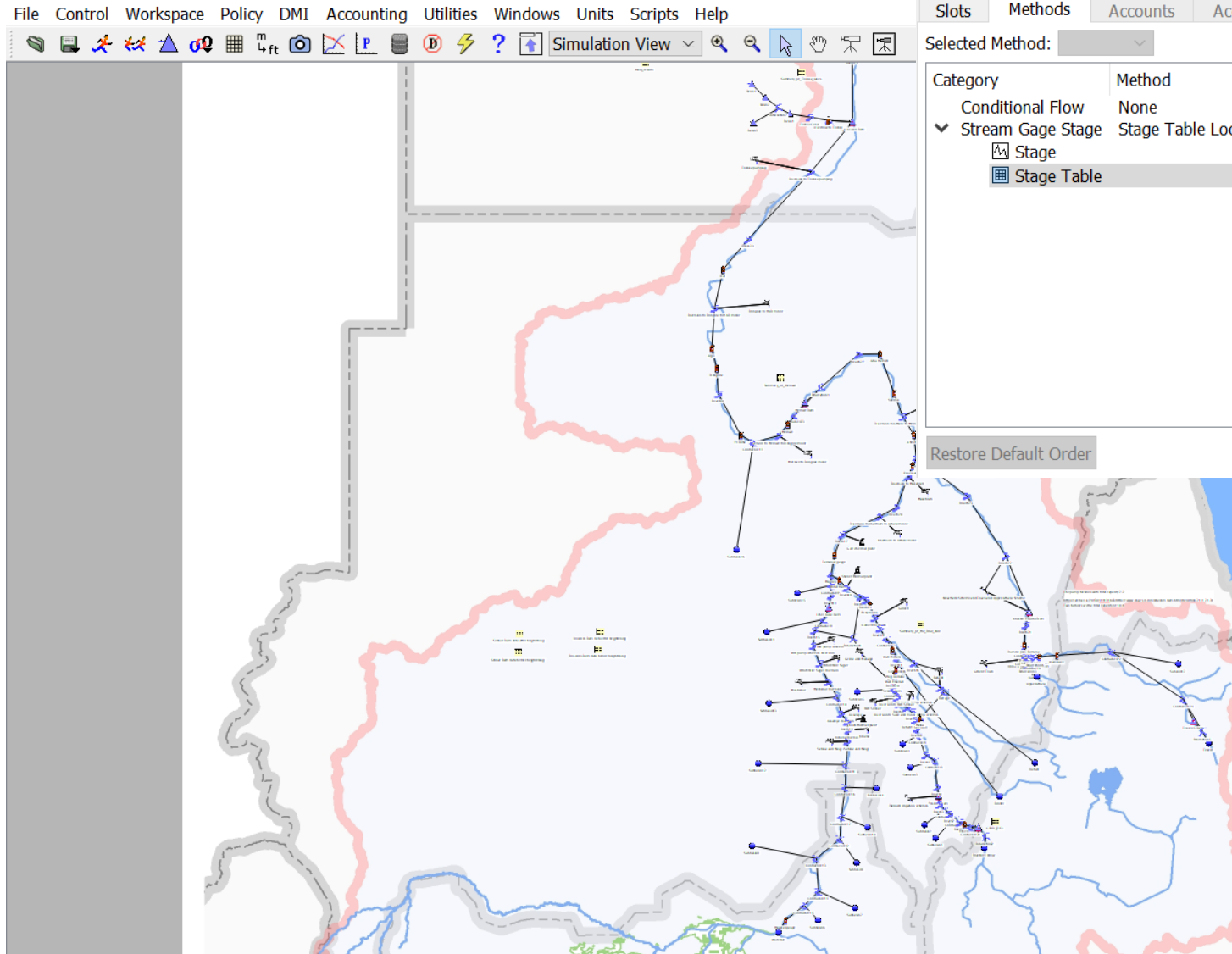


2- Methodology

Modelling framework:



2- Methodology



Object Viewer

File Edit View Slot Account Group Object Tabs

Khartoum

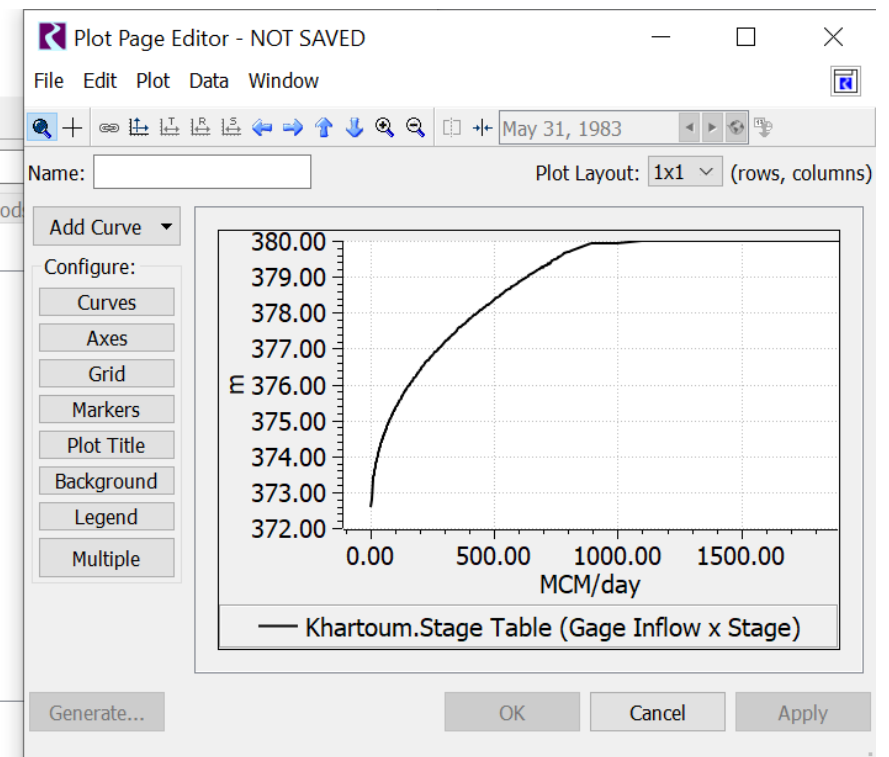
Object: Khartoum

Slots Methods Accounts Accounting Method

Selected Method:

Category	Method
Conditional Flow	None
Stream Gage Stage	Stage Table Lookup
Stage	
Stage Table	

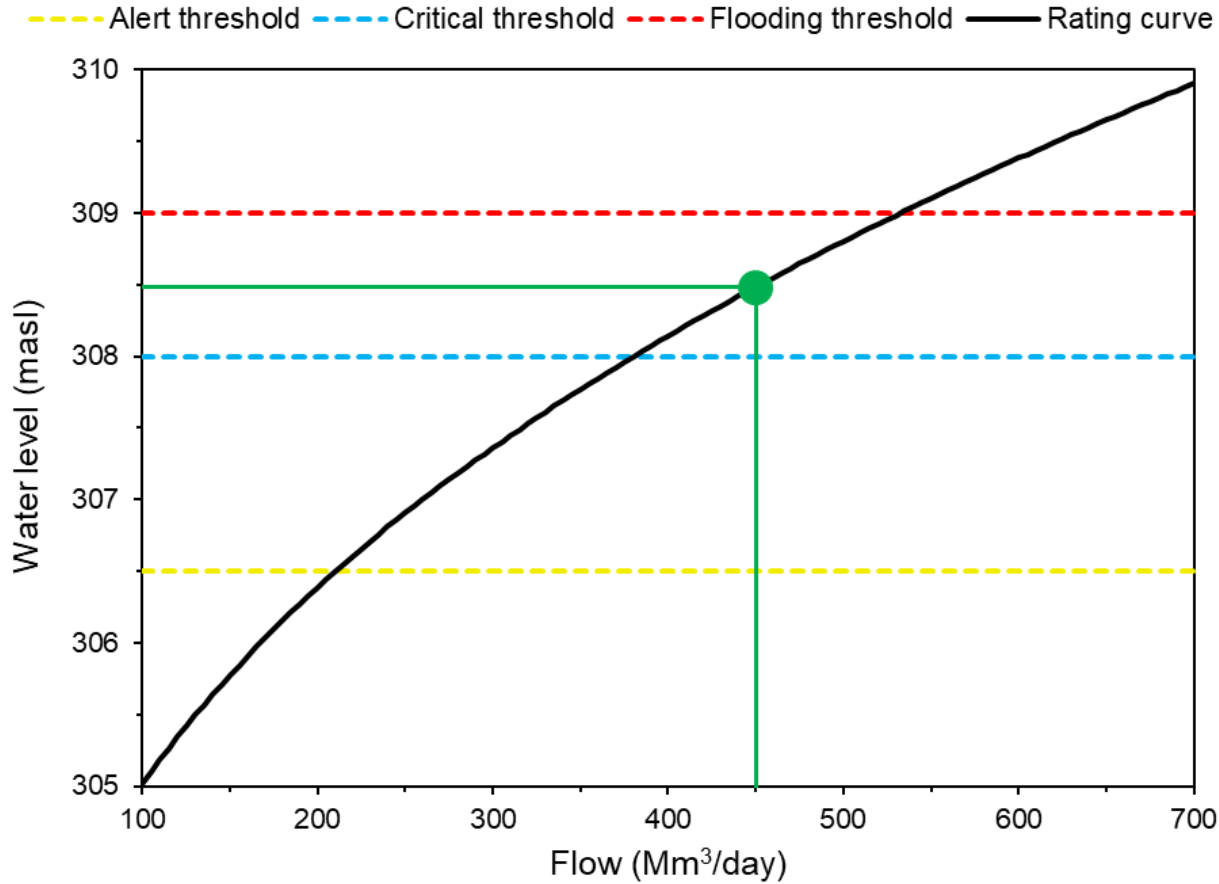
Restore Default Order



- ❑ 27 inflow nodes
- ❑ 9 storage dams
- ❑ 21 water withdrawal locations
- ❑ 13 stage-discharge gages
- ❑ 252 operating rules

2- Methodology

General illustration



Khartoum.Flooding... K...

File Edit View Expression Adjust File Edit View

Flooding_days Annual_Flooding_days

Value: NONE Value: 0 NONE

Evaluation Time: End of timestep, current timestep only

Evaluation Range: Run start to run finish (Step: 1 DAY)

```
IF (Khartoum.Stage []  
    >= Khartoum.Flooding_level []) THEN  
    1.00000000  
ELSE  
    0.00000000  
END IF
```

Show: Comments

Jun 1, 1983

	NONE
06-01-1983 Wed	NaN O
06-02-1983 Thu	NaN O
06-03-1983 Fri	NaN O
06-04-1983 Sat	NaN O
06-05-1983 Sun	0.00 O 0
06-06-1983 Mon	0.00 O 0
06-07-1983 Tue	0.00 O 0
06-08-1983 Wed	0.00 O 0

Show: Description

Khartoum.Flooding_days [@ 24:00 June 1, 1983]
0 values:

Show: Description

1983 C.E.

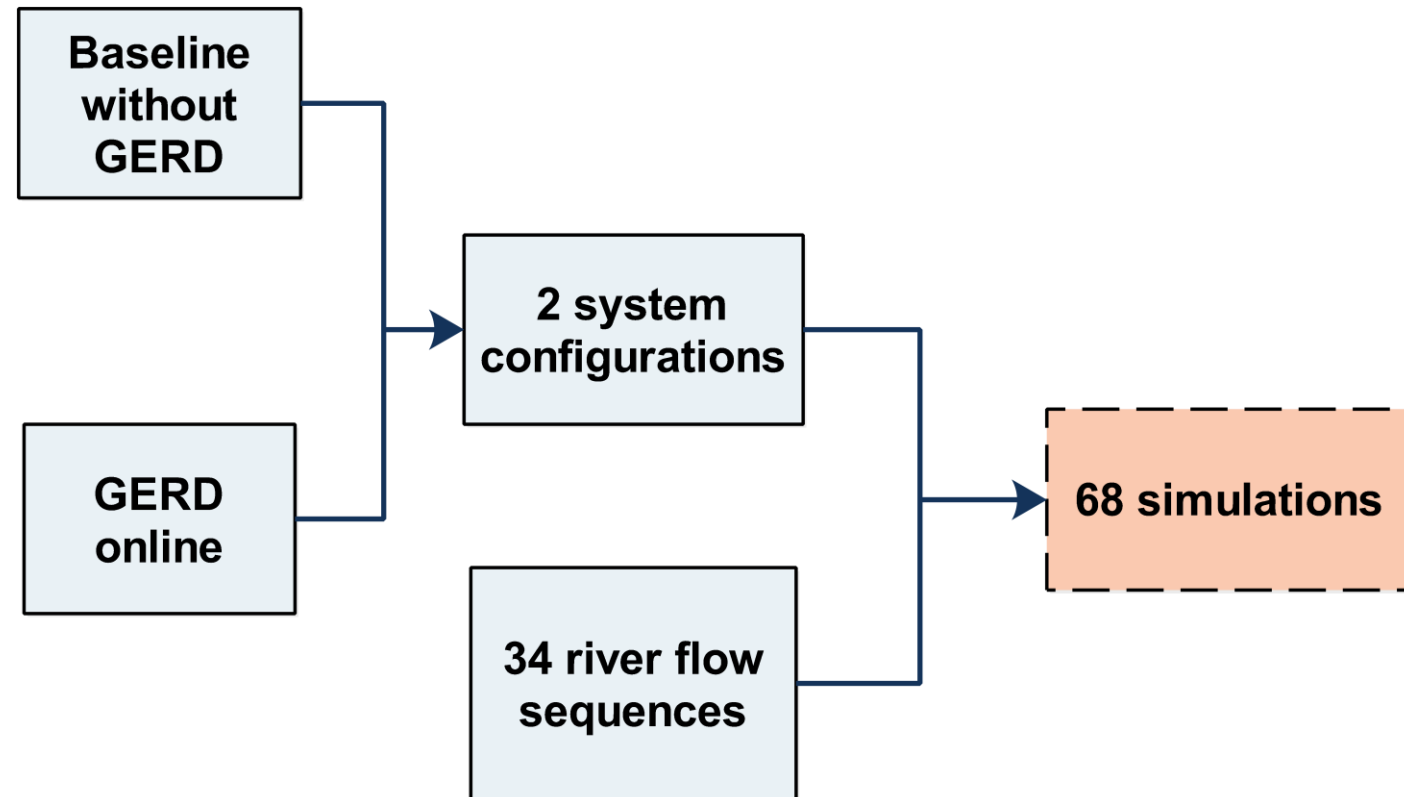
	NONE
1983	0.00 O 0
1984	0.00 O 0
1985	0.00 O 0
1986	0.00 O 0
1987	1.00 O 0
1988	0.00 O 0
1989	2.00 O 0
1990	0.00 O 0
1991	0.00 O 0
1992	0.00 O 0
1993	0.00 O 0
1994	0.00 O 0
1995	2.00 O 0
1996	0.00 O 0
1997	0.00 O 0
1998	0.00 O 0

Show: Description

Khartoum.Annual_Flooding_days [@
1 value: 0.00 [NONE] (Priority 0)

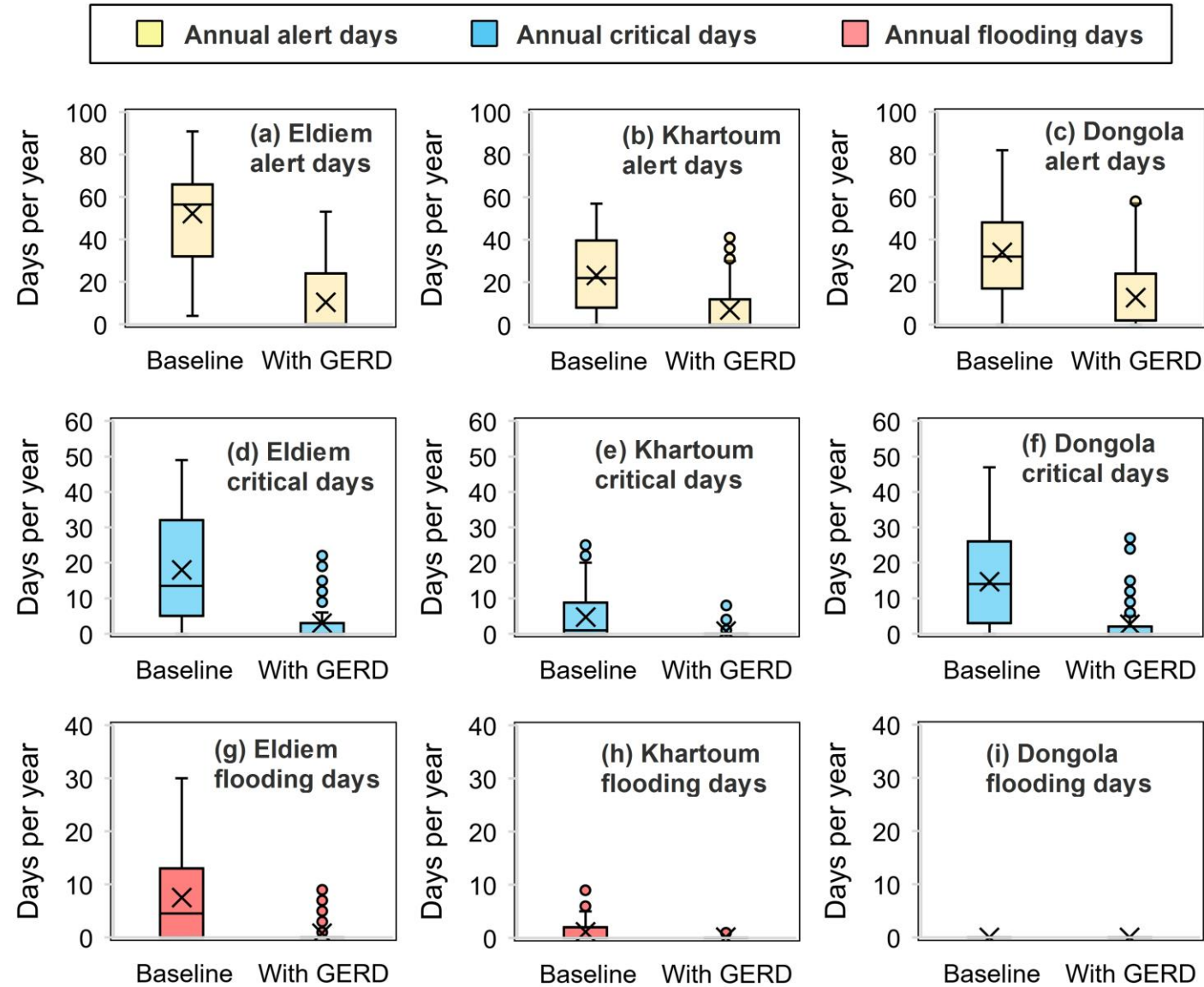
2- Methodology

- ❑ Index-sequential method used to generate 34 river flow sequences, each 34 years long
- ❑ The GERD is operated to target 38.4 GWh/day (Wheeler et al., 2018)
- ❑ Perfect downstream knowledge on GERD releases is assumed



3- Results

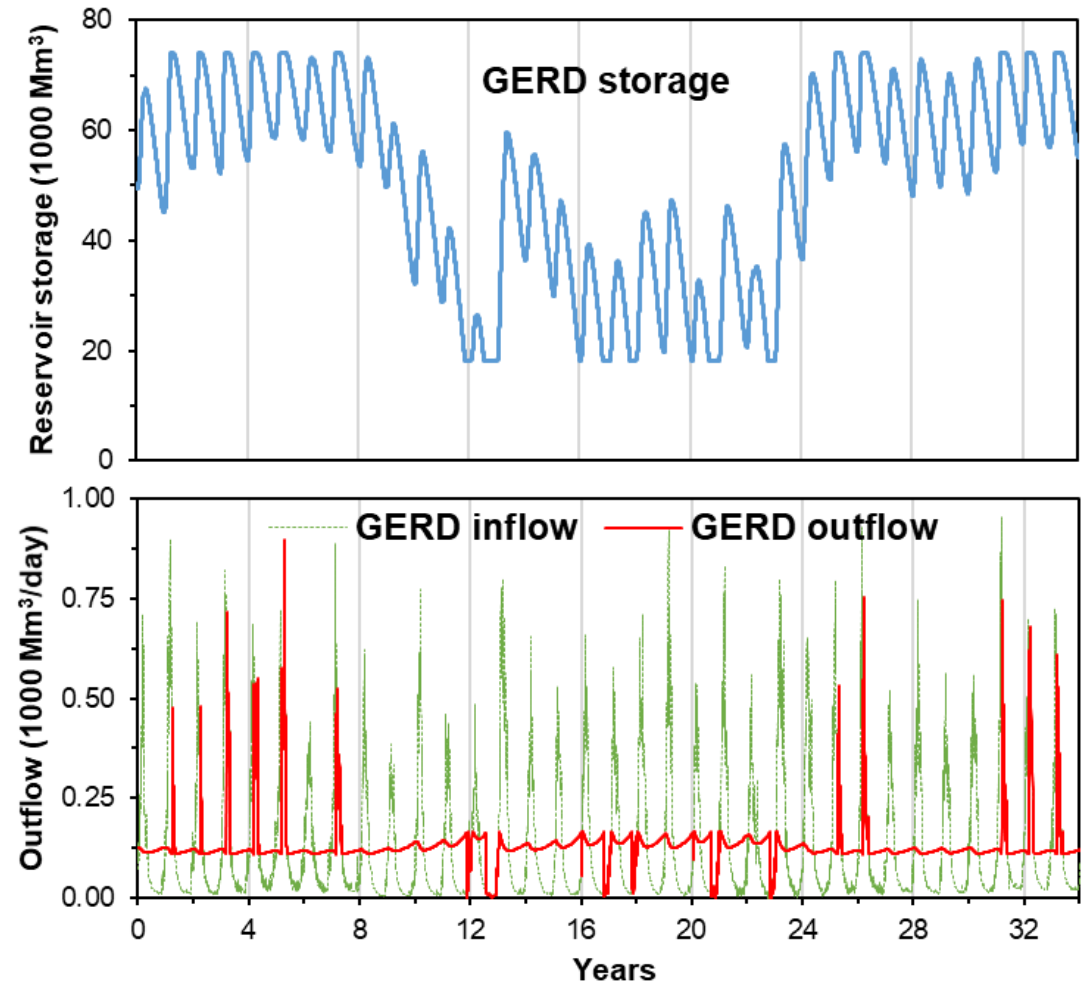
- ❑ GERD would reduce the annual number of days in each of the three flood alarm categories
- ❑ There remains a riverine flood hazard, especially at Khartoum



3- Results

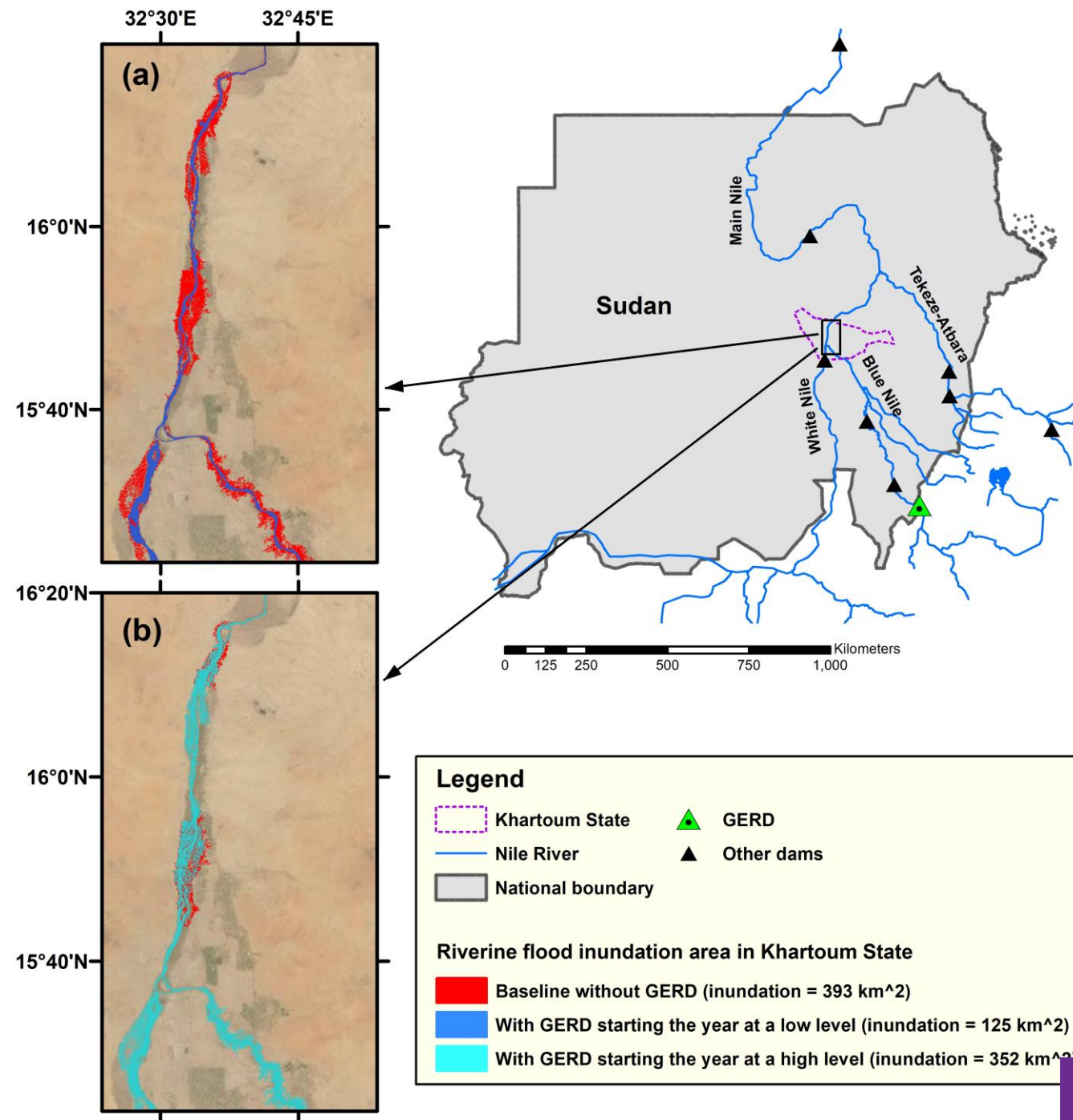
- ❑ Inter-annual variability of the Blue Nile flow results in fluctuation in GERD storage
- ❑ When the GERD level is close to the full supply level the likelihood of too intense downstream releases increase.

Results of one of the 34 simulated river flow sequences



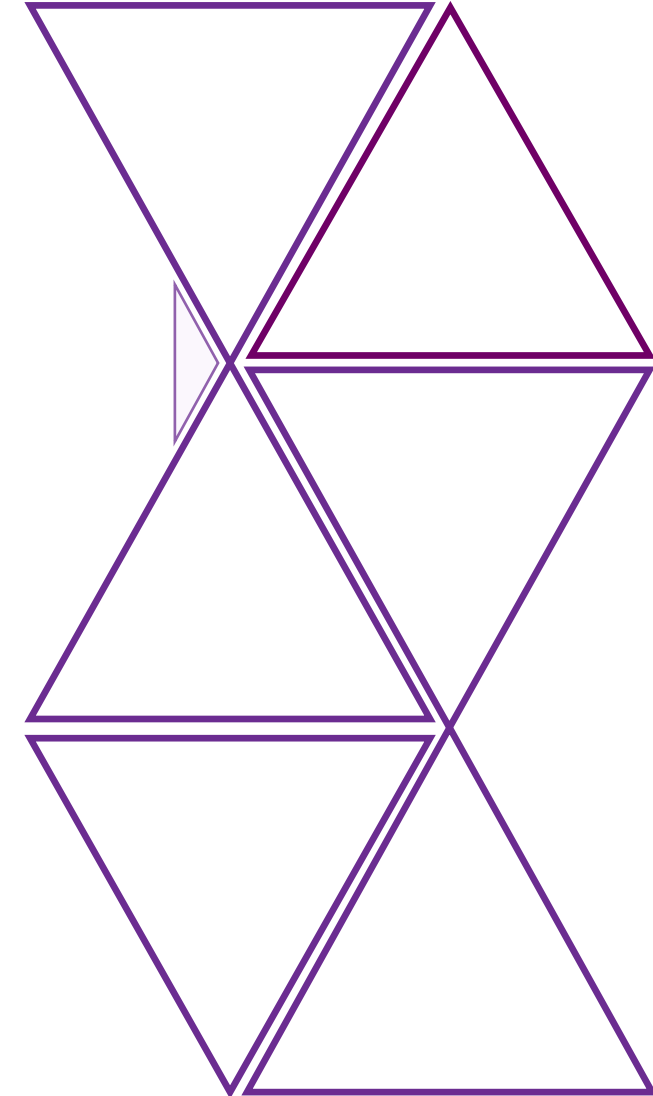
3- Results

- ❑ The inundated area in Khartoum State decline by 68% when the GERD reservoir starts the year at 595 masl
- ❑ The inundated area in Khartoum State decline by 10% when the GERD reservoir starts the year at 625 masl



4- Conclusions

- ❑ GERD operation aiming to achieve a 90% power reliability **reduces** the riverine flood **hazard** in Sudan.
- ❑ How to mitigate the remaining riverine flood **risk**?
 - Seasonal coordination and planning on GERD operation
 - Raising public awareness on the remaining riverine flood hazard



Thank you
for your attention!

Basheer, M. (2021). **Cooperative operation of the Grand Ethiopian Renaissance Dam reduces Nile riverine floods**. River Research and Applications, <https://doi.org/10.1002/rra.3799>