Understanding the potential impact of the Grand Ethiopian Renaissance Dam on floods in Sudan

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Presentation outline

1. Introduction
2. Assessment method
3. GERD role in 2020 Nile floods
4. GERD potential long-term impacts on riverine floods
5. GERD potential downstream environmental impacts
6. Conclusions
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.
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.
GERD’s long-term operation would reduce the risk of riverine flooding in 6 of the 18 states of Sudan.
1- Introduction

Sudan (18 states)

- 6 states affected by GERD
  - Flash floods
  - Riverine floods

- 12 states not affected by GERD
  - Flash floods
  - Riverine floods
2- Assessment method

Modelling framework:

- A daily suit of models for the Eastern Nile
- The model is calibrated and validated over the period 1983-2017
2- Assessment method

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

- Rating curves are used to translate river flows to river water levels.

- The generated water levels are used to calculate the number of days within each of three flood alarm categories.
2- Assessment method

Roseires Dam

Sennar Dam

Khartoum Gage

Tamaniat Gage

Hassanab Gage

Jebel Aulia Dam

Khashm Elgirba Dam

Dongola Gage

High Aswan Dam
2- Assessment method

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3- GERD role in 2020 Nile floods

13 April 2020 to 22 July 2020

Flow to Sudan

Day

1-Jan
12-Jul
22-Jul
31-Dec

Inflow

560 masl

Low block (560 masl)

Bottom outlets

Turbines

Diversion outlets

4 diversion outlets
4- GERD potential long-term impacts on riverine floods

- 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
4- GERD potential long-term impacts on riverine floods

- Simulation assumptions
  - GERD's long-term operation starts with reservoir storage of 49.3 bcm
  - Roseires, Sennar, and Merowe dams are operated at high levels and are allowed to drop only to meet the water or energy demands
4- GERD potential long-term impacts on riverine floods

- 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.
4- GERD potential long-term impacts on riverine floods

- 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.
4- GERD potential long-term impacts on riverine floods

- 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.

Legend:
- Khartoum State
- Nile River
- GERD
- Other dams
- National boundary

Riverine flood inundation area in Khartoum State:
- Baseline without GERD (inundation = 363 km\(^2\))
- With GERD starting the year at a low level (inundation = 125 km\(^2\))
- With GERD starting the year at a high level (inundation = 352 km\(^2\))
4- GERD potential long-term impacts on riverine floods

4- GERD potential long-term impacts on riverine floods

- Coordinated operation and planning are necessary to mitigate the remaining riverine flood hazard.

- Tough trade-offs on flood management lay ahead, requiring to in advance agreement.

- Raising public awareness on the remaining riverine flood hazard.
5- GERD potential downstream environmental impacts

- Floods provide social, economic, and environmental benefits.

- GERD-induced alterations would:
  - Reduction in oxygen content
  - Increase in water salinity
  - Alteration to water temperature
  - Loss of floodplains
6 - Conclusions

- GERD operation aiming to achieve a 90% power reliability reduces the riverine flood hazard in 6 states 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

- Floods provide social, economic, and environmental benefits.
Publications on GERD


Thank you for your attention!