Filling the Grand Ethiopian Renaissance Dam:
Implications for Riparian Countries

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What is the Effect of the Reservoir Filling Rate?

Ethiopia → Hydropower generation

Sudan → Irrigation water

Egypt → Inflow to Lake Nasser

Zhang and Block, 2015
Blue Nile River Characteristics


Monthly Streamflow at Roseires, Sudan (1951 - 1995)

King and Block, 2014
Blue Nile River Characteristics

King and Block, 2014
Relevant GERD Characteristics

Construction Plan
2011 – 2017/2018

Generating Capacity
6,000 MW (5,250 MW)

Reservoir Size
74 B m$^3$ (63 B m$^3$)

Minimum Operating Level
590 masl

http://seeker401.wordpress.com/2011/10/01/the-grand-ethiopian-renaissance-dam/
Hydrology Model

Transform meteorology data $\rightarrow$ streamflow data

- Daily Mean Temperature
- Monthly Precipitation
- Diurnal Temperature Range

Model

Streamflow

Climate $\rightarrow$ Hydrology Model $\rightarrow$ Reservoir Model $\rightarrow$ Nile Water Balance Model $\rightarrow$ D/S Flow Impacts
Water Balance Model

Major tributaries
Spatial/temporal coherence

Water Balance Model
Yates, 1996

Major tributaries:
- Atbara
- Dinder-Rahad
- Blue Nile (GERD)
- Nile Water Balance Model

Spatial/temporal coherence

Climate

Hydrology Model

Reservoir Model

Nile Water Balance Model

D/S Flow Impacts

Yates, 1996
Reservoir Model

Filling Policy

*Fraction of Monthly SF*
5%, 10%, 25%, etc

*Volume > Historical Average SF*
Hist Avg, 90% of Hist Avg, etc.

Climate

Hydrology Model

Reservoir Model

Nile Water Balance Model

D/S Flow Impacts
Time to Fill the Reservoir

Can vary options; 2014 start year

Median = 5.7 yrs post 2017

For Res Size = 74 B m³, 6.7 yrs post 2017
GERD Hydropower Generation

2014 – 2031

Cum Power Generation (GW)

10% 25% >HASF >0.9*HASF

Filling Policy
GERD Releases

Volume (Mm$^3$)

Month
Downstream Flows
Sudan (Gezira Irrigation Scheme, GERD = 74 B m$^3$)

- **10% FP**
  - Stable reduction (9%)

- **HASF FP**
  - Low average (6%)
  - High variance

- **25% FP**
  - Initially large (22%)
  - Evaporation losses
Downstream Flows

Egypt (Dongola, surrogate for Nasser inflow, GERD = 74 B m$^3$)

10% FP
stable reduction (5%)

HASF FP
low average (4%)
high variance

25% FP
initially large (12%)
evaporation losses
Trade-offs: GERD Release & HP
2017 - 2027
Trade-offs: GERD Release & HP
2017 - 2027
Climate Change – E. Africa

Giannini et al. 2008
Hydropower Generation with CC
2014 - 2031
SF Reduction at Nasser with CC

Median Streamflow at Lake Nasser by Filling Policy under No Precipitation Trend

Percent Change in Annual Average Streamflow at Lake Nasser (2017-2022)

Filling Policy

5% 10% 25% >HASF >0.9*HASF No Dam
Tool

Resulting GERD Performance

1. Time to FSL
   - FSL: $V = 63,350 \text{Mm}^3$
   - 206 Months

2. Retention of Flow >100% of Blue Nile SF
   - 224.5 Months

Anticipated Power Generation (2014-2031)

1. Cumulative Power Generation (GW)
   - 260 GW

Vol Discharged at GERD Sim. Hist. vs. Inputs

1. Volume Discharged (Mm$^3$)
   - 242.9 Mm$^3$

Results for Inputs of:
- Power Gen. Capacity = 6.0 GW
- Minimum Operating Level (MOL) = 590 masl
- No Climate Change Trend
- Filling Policy = Retain 10% of Blue Nile Inflow

Results for Inputs of:
- Power Gen. Capacity = 6.0 GW
- Minimum Operating Level (MOL) = 590 masl
- No Climate Change Trend
- Filling Policy = Retention of Monthly Flow >100% of Simulated Historical Blue Nile Stream Flow
Thank You

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Courtesy of Dorling Kindersley