Scientific Perspectives on the Grand Ethiopian Renaissance Dam:
An independent technical analysis

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Sharing Knowledge = Gain Knowledge
Outline

• Overview of the Eastern Nile Region
• Characteristics of the GERD
• Long-term impacts of the GERD
• Short-term impacts and approaches for filling the GERD
Hydrology of the Nile

100% - Inflow to Lake Nasser

13% - Atbara
57% - Blue Nile
30% - White Nile

(Blackmore and Whittington, 2008)

Aswan = 270 cm/year
GERD = 108 cm/year

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GERD = 108 cm/year

Net Evaporation Rates

Average annual flow

Inflow to Lake Nasser

53% above GERD
4% below GERD

14% - Sobat
16% - Sudd

(Blackmore and Whittington, 2008)
Modern Historical Development

Egypt
Aswan Dam (1902)
High Aswan Dam (1960-70)

Sudan
Sennar Dam (1925)
Jebel Aulia Dam (1937)
Khashm El Girba (1964)
Rosaries Dam (1967)
Merowe Dam (2009)

Ethiopia
Tekeze Dam (2009)
Tana Beles HP (2009)
GERD (2017)
Grand Ethiopian Renaissance Dam (GERD)

June 12, 2015
Increased in Ethiopian Hydropower Generation with the GERD

15,000 GWh energy

7,300 GWh
Historical Increase
Electricity production from hydroelectric sources

(WORLD BANK, 2016)
GERD Characteristics

- Turbine Test Elevation = 560 m
- Minimum Operating Level = 590 m
- Full Supply Level = 640 m
- Active Storage = 59 BCM
- Dead Storage = 15 BCM
Long-term Downstream Impacts

1. GERD will reduce downstream variability of flows
2. Reduce downstream sedimentation
3. Effects and opportunities for Sudan and Egypt
Long-term Downstream Impacts

1. GERD will reduce downstream variability of flows

2. Reduce downstream sedimentation

3. Effects and opportunities for Sudan and Egypt
Monthly Inflows near Ethiopia-Sudan Border
Monthly Inflows to GERD

Extreme variation of flows
Flooding in Khartoum, Sept 2014
Reduce Flow Variability

+ Reduction of flood damages
+ Impact on irrigated agriculture
+ Protection for uncertainties of climate change

- Impact on flood recession agriculture
-/+ Environmental impacts are unknown
Long-term Downstream Impacts

1. GERD will reduce downstream variability of flows

2. Reduce downstream sedimentation

3. Effects and opportunities for Sudan and Egypt
Sediment Impacts

• 130-167 million tons of sediment at El Diem (Ali et. al, 2014)

• Current Management
  – Rosaries Dredging:
    • 1.3 to 4.3 million USD/year
  – Canal Intakes at Sennar
    • 0.63 million USD/year
  – Gezira Canals
    • 10 million USD/year
  (Gismalla, 2009)
Sediment Impacts

• Reservoir storage volume reduction
  – 60% reduction in Sennar storage
  – 34% reduction in Rosaries storage

• GERD could may reduce 86% downstream sediment load (Tesfa 2013, not peer reviewed)

• Reduction of nutrient transport downstream
Long-term Downstream Impacts

1. GERD will reduce downstream variability of flows

2. Reduce downstream sedimentation

3. Effects and opportunities for Sudan and Egypt
Long-term Effects and Opportunities for Sudan

• Full reliability for Sudanese water users
  – Sudan must re-operate existing reservoirs
    • Rosaries, Sennar and Merowe

• Allows Sudan reservoirs to be operated with greater efficiency
  – Reduced need for flood releases (“spills”)
  – Hydropower ‘up-lift’ effect

• Allows expansion of Sudan uses
• Maximizing agricultural efficiency is important
Long-term Effects and Opportunities for Egypt
Likelihood of Shortages as a Result of Drought to Egypt

- Temporary increase from HAD
- Long-term benefit from HAD
- Temporary increase from GERD
- Long-term benefit from GERD

This is being studied by TNC to find a filling strategy to minimize this temporary increase.

* Figure is for illustrative purposes only. Dates or numbers are not exact or specified.
Long-term Effects and Opportunities for Egypt

• Additional storage allows for greater drought resilience
  – Requires a basin-wide drought management strategy
• More efficient flood planning for High Aswan Dam
  – Current August 1st elevation can potentially be modified
• Minimal Reservoir Evaporation Changes
Long-term basin-wide coordination

• Storage in GERD can provide a drought ‘safety net’ for Sudan and Egypt
  – Basin-wide drought management plan
  – Reliability of deliveries increases

• GERD can provide flood control space for downstream reservoirs
  – Requires coordination agreement
  – Requires real-time communication of data
  – Joint-seasonal planning
Short-term Impacts

- Filling period of GERD Reservoir
- First opportunity for tangible coordination
- Immediate need for planning and preparation
Many Possible Management Options

Ethiopia

Agreed Release

Sudan

Initial Elevation

Egypt

Basic Cooperation
Two Approaches to Fill Agreed Annual Release

- Dams provide downstream reliability
- Fill faster during wet years
- Fill slower during dry years

Target Elevation/Storage

- ‘Fill as you build’ approach
- Fill the same rate regardless of hydrology
- No guarantee for downstream
Explore Cooperation Parameters and Decisions During Filling

- Agreed annual releases from the GERD (0 to 50 BCM)
- Operations of the Sudanese reservoirs
- Operations of the High Aswan Dam
- Starting elevation of the High Aswan Dam (165 to 180m)
Analysis Assumptions

• Hydrology
  – 103 years of historical data (1900-2002)
  – Future can act like any point in history
  – Does not include climate change effects
Analysis Assumptions

• Water requirements during filling
  – Ethiopian withdraws are insignificant
  – Sudan withdraw 16 BCM per year
  – Egypt releases 55.5 BCM per year
  – Uses do not increase during filling period

* Values used are for the purposes of this study and do not reflect agreed reference baseline numbers
<table>
<thead>
<tr>
<th>GERD Agreed Annual Release</th>
<th>Ethiopia Short Term</th>
<th>Ethiopia Medium Term</th>
<th>Sudan Short Term</th>
<th>Sudan Medium Term</th>
<th>Egypt Short Term</th>
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Short Term = Average of initial 10 years after filling begins
Medium Term = Average of 11-30 years after filling begins
Units are TWH

*Losses to Egypt above is less than 1% of Egyptian Energy Production (170 TWH in 2013)
Many Possible Decisions

Ethiopia
Agreed Annual Release

Sudan
Possible basinwide agreement on safeguard Elevation

Egypt
Initial Elevation

Continuous Cooperation

150 m
Probability of High Aswan Dam reaching Minimum Power Elevation

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<th>180m</th>
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Currently under negotiation

BASIC COOPERATION
With GERD + Current High Aswan Dam Drought Operations

CONTINUOUS COOPERATION
With GERD + High Aswan Dam Drought Operations + GERD Safeguard of 150 m HAD Elevation
Conclusions

• Strong argument for cooperative agreements
  – Significant basin-wide long-term benefits
  – Short-term impacts are manageable

• Information sharing arrangements are critical
  – Requires sufficient time to plan and prepare
  – Real-time data sharing
    • Reservoir levels and releases
  – Common analytical platform
  – Quality assurance protocols