Cooperative Filling Approaches for the Grand Ethiopian Renaissance Dam


Water International
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Outline

I. Rationale
II. Methods
III. Key Results
IV. Way Forward
Hydrology of the Nile

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

100% - Inflow to Lake Nasser
13% - Atbara
57% - Blue Nile
30% - White Nile

53% above GERD
4% below GERD

(Inflow to Lake Nasser)

(Blackmore and Whittington, 2008)
Rationale for Study

• Independent
• Collaborative
• Unofficial

• Understand Probabilistic Impacts
  – “Risk-Based” Analysis
• Explore Creative Solutions
  – Maximize Benefits
  – Minimize Risk
Explore Strategies

• Increasing degrees of cooperation/coordination

(Sadoff and Grey, 2005)

Risks always exist
Non-cooperation increases risk
Risks are best be managed together
Methods
Building a Model

3 Countries + ~ 20 Visits + 7 Training Sessions
Stakeholder Participation + Data Collection + Field Visits
Hydro-Policy Model Building

• ACCURACY:
  – Capture all the ‘major’ processes

• TRANSPARANCY:
  – Design the model to be easily understood by trained stakeholders

• FLEXIBILITY:
  – Allow the model to be highly adaptable to meet proposed policy changes

Well Designed Models can Support Negotiations
Eastern Nile RiverWare Model Schematic

Does not dynamically model Equatorial Lakes
Hydrology Scenario Analysis

• Traditional Methods
  – Wet, average, dry scenarios
  – Consider the “Drought of record”
  – Insufficient: Subject to selection bias

• Multiple Scenarios > risk-based analysis
  – Index Sequential Method (ISM)
    • All starting points in history are possible
  – Synthetically generated hydrology (climate change?)
    • auto-regressive models, k-nn bootstrapping, simulated annealing
    • see Zhang, Erkyihum & Block, 2016 – this issue

Demand Scenario Analysis

Assumed demand request:
- Ethiopia: Essentially 0 BCM
- Sudan: 16.0 BCM
- Egypt: 55.5 BCM

Remains unchanged throughout filling period
El. 640 Full Supply Level

El. 624.9 Gated Spillway

Min. Operating Level: 590

Intake to Turbine: 560

Bottom Outlet (2 No)
Capacity:
2 x 886 m$^3$/s @ El. 640
2 x 386 m$^3$/s @ El. 565

Penstocks

Diversion Outlets
4 No 8m DIA.

Power Station

Turbine (15 No)

Active Storage = 59 BCM

Dead Storage = 15 BCM

(Adapted from Massachusetts Institute of Technology, 2014)
Reservoir Management Scenario Analysis

Ethiopia

Agreed Annual Release

Sudan

Basic Coordination

Initial Elevation

Egypt
Dimensions To Evaluate

• Agreed annual releases from the GERD
• Starting elevation of the High Aswan Dam
• Operations of the High Aswan Dam
• Operations of the Sudanese reservoirs
  – Rosaries, Sennar, Merowe
Key Result:
How Long to Fill the Reservoir?

Note: Time to fill with the 50 BCM scenario exceeds the model run period and therefore is excluded.
## Average Energy Generation Impacts

<table>
<thead>
<tr>
<th>GERD Agreed Annual Release</th>
<th>Ethiopia</th>
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<th>Sudan</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 1000 GWH
“Averaged” Shortages to Egypt

* Assuming no HAD Drought Management Plan
Example: Starting HAD Elev = 175 m
Probabilistic Risks to Egypt (2016-2025)

- Average Hydrology = No Shortage
- Low Probability of a Large Shortage

What is an acceptable risk?
HAD Pool Elevation

Full Supply Level = 182 m

Annual Flood Protection Limit = 175 m

Minimum Operating Level = 147 m

HAD DROUGHT MANAGEMENT

5% Reduction
10% Reduction
15% Reduction

TURBINES SHUT DOWN or UNPLANNED REDUCTIONS
Probability of HAD reaching minimum power elevation

<table>
<thead>
<tr>
<th>GERD Agreed Annual Release</th>
<th>Basic Coordination</th>
<th>Basic Coordination + HAD Drought Management Plan</th>
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Increase Cooperation

**USE THE GERD TO BACK UP THE HAD**

Ethiopia

Sudan

Egypt

Agreed Annual Release

Initial Elevation

Continuous Coordination
CONTINUOUS COORDINATION

• Agreed Annual Release
• Use the GERD to back-up the HAD
  – Requires open data sharing
  – Agreement from all 3 countries
### Probability of HAD reaching minimum power elevation

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### Continuous Coordination

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Probabilistic Risk to Egypt (2016-2025)
Summary and Way Forward

• Shift from binary (harm/no harm) to risk-based thinking
  – Low risk on ‘average’
  – Some probability of significant impacts
  – Critical question: What is a tolerable risk?

• Strong argument for cooperative agreements
  – Impacts are highly dependent on agreements
  – Significant basin-wide long-term benefits
  – Risk exist, but impacts are manageable

• Information sharing arrangements are critical
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Recent Publication

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