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

Main Nile

White Nile

Victoria/Albert Nile

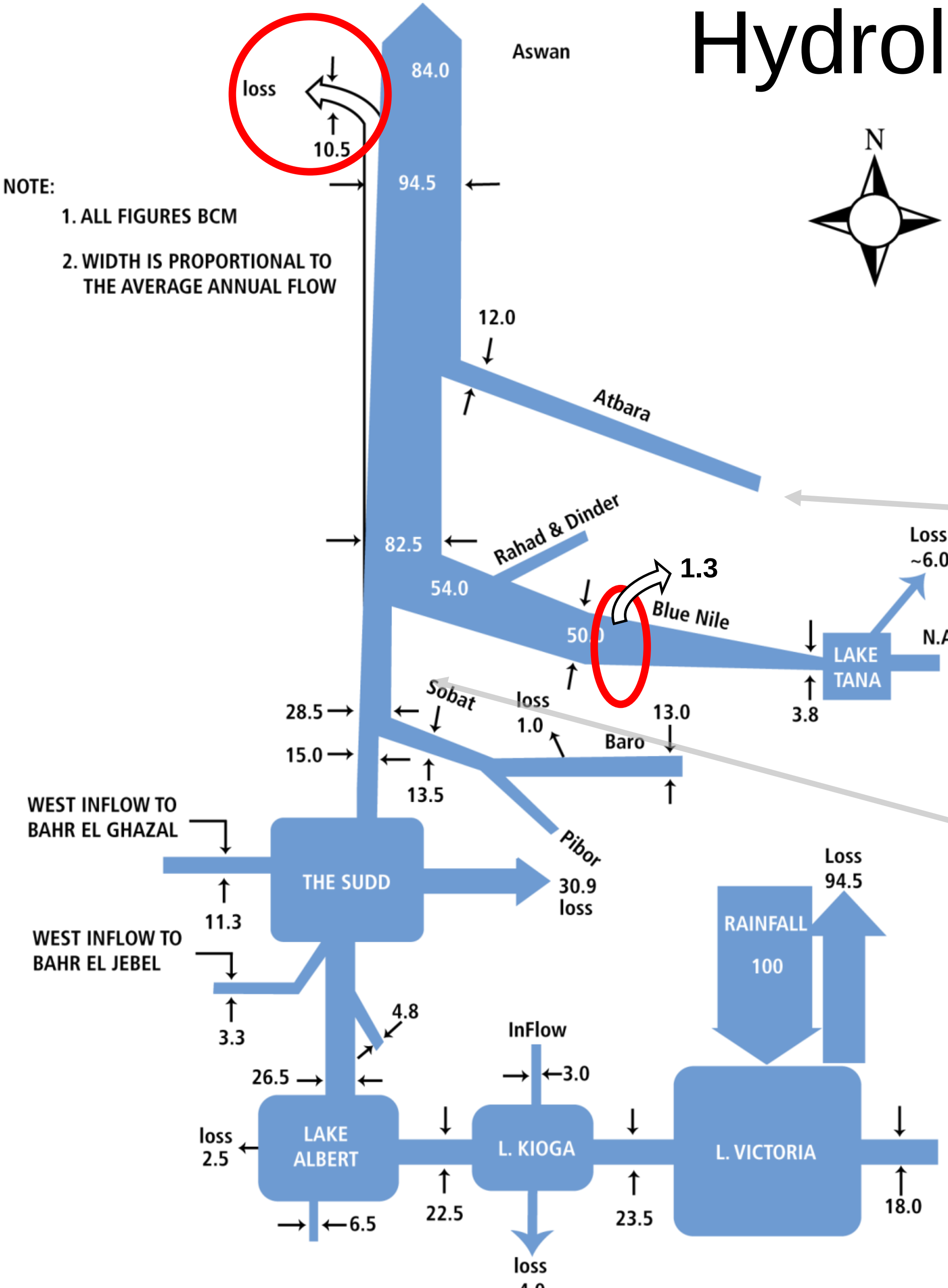
Lake Victoria

Blue Nile

Lake Tana

Sudd Wetland

Hydrology of the Nile

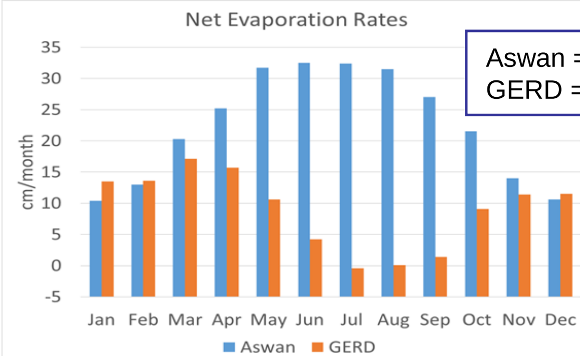


100% - Inflow to Lake Nasser

13% - Atbara

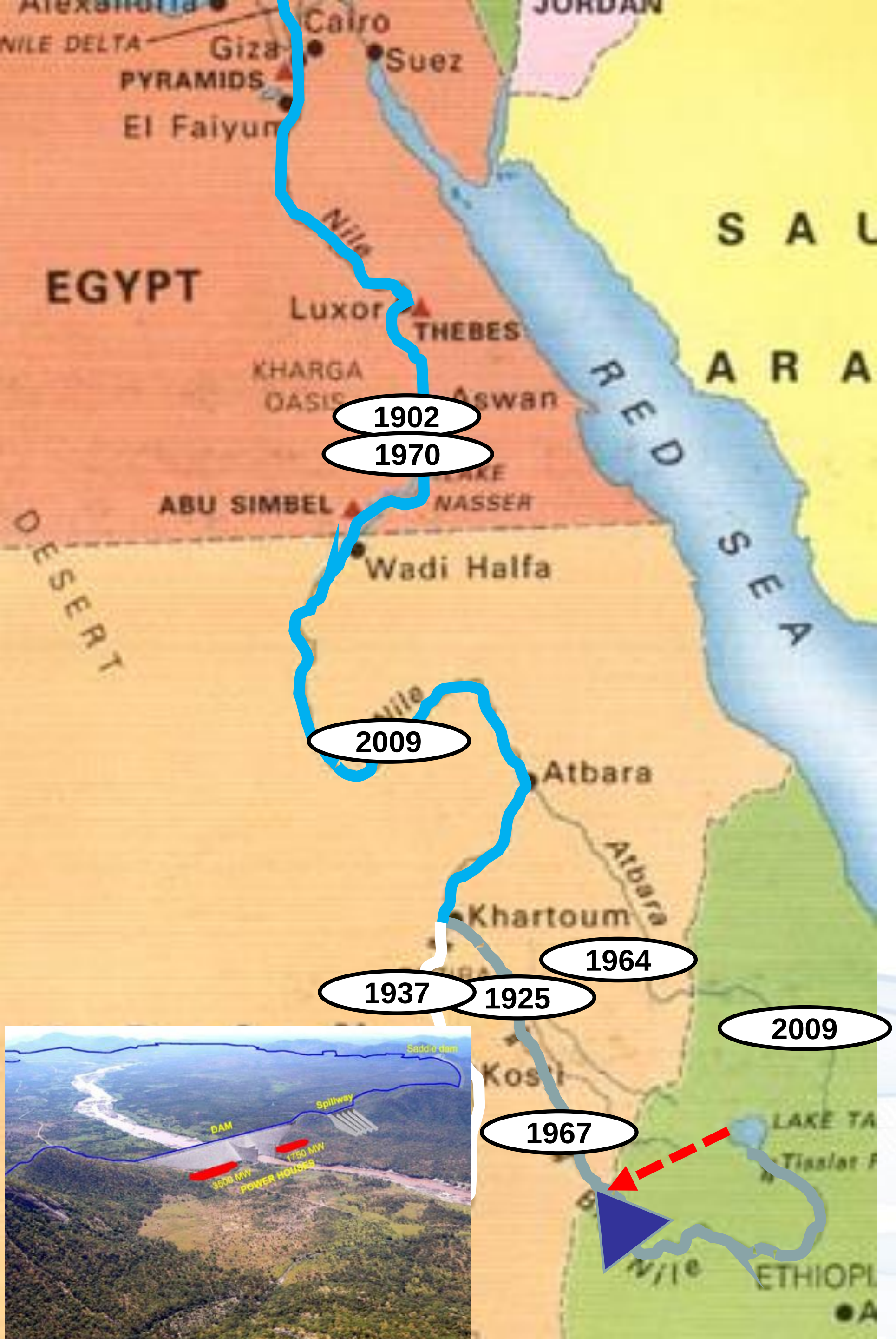
57% - Blue Nile
- 53% above GERD
- 4% below GERD

30% - White Nile
- 14% - Sobat
- 16% - Sudd



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

(Blackmore and Whittington, 2008)



Modern Historical Development

<u>Egypt</u>

Aswan Dam (1902)

High Aswan Dam (1960-70)

<u>Sudan</u>

Sennar Dam (1925)

Jebel Aulia Dam (1937)

Khashm El Girba (1964)

Rosaries Dam (1967)

Merowe Dam (2009)

<u>Ethiopia</u>

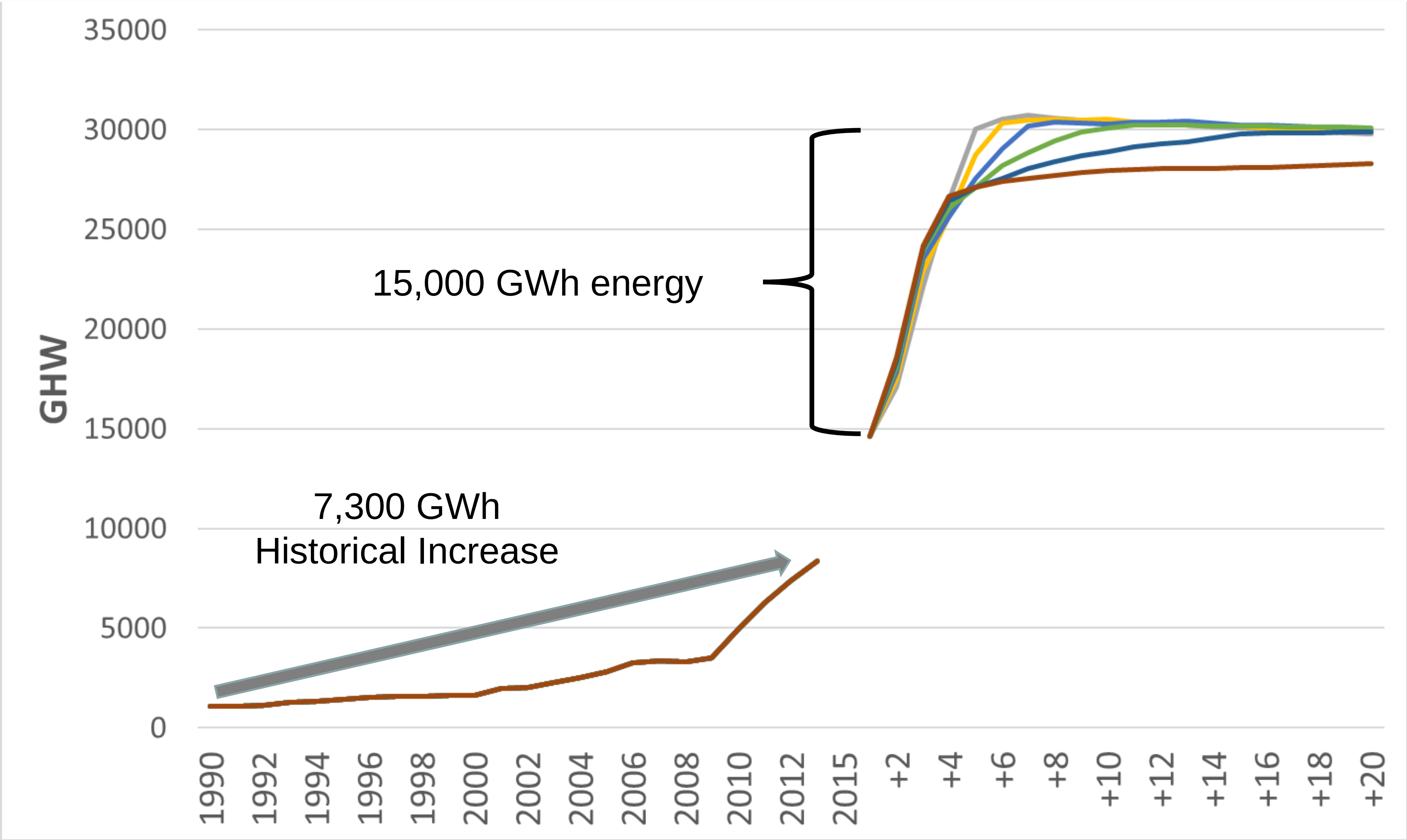
Tekeze Dam (2009)

Tana Beles HP (2009)

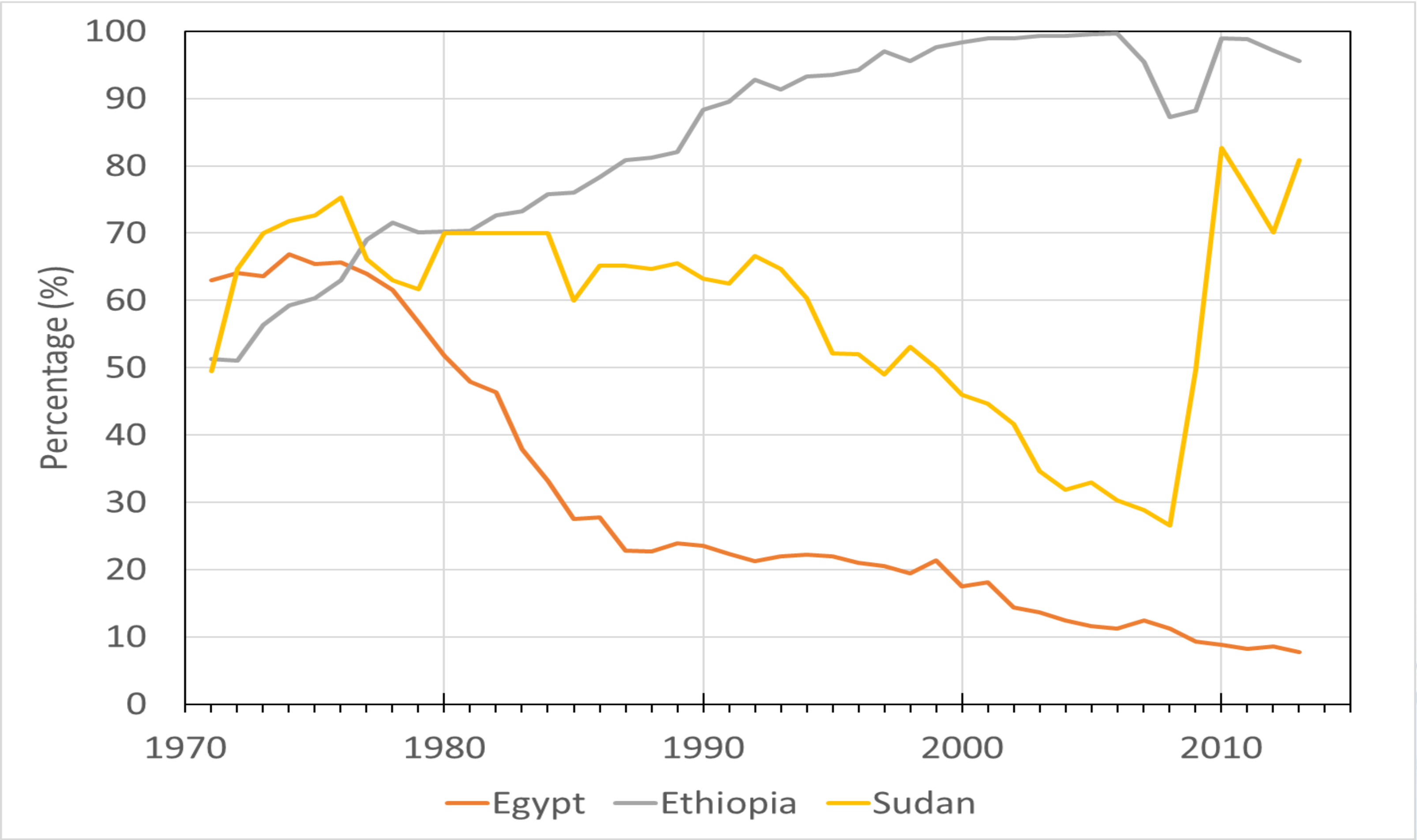
GERD (2017)

Grand Ethiopian Renaissance Dam (GERD)

Increased in Ethiopian Hydropower Generation with the GERD

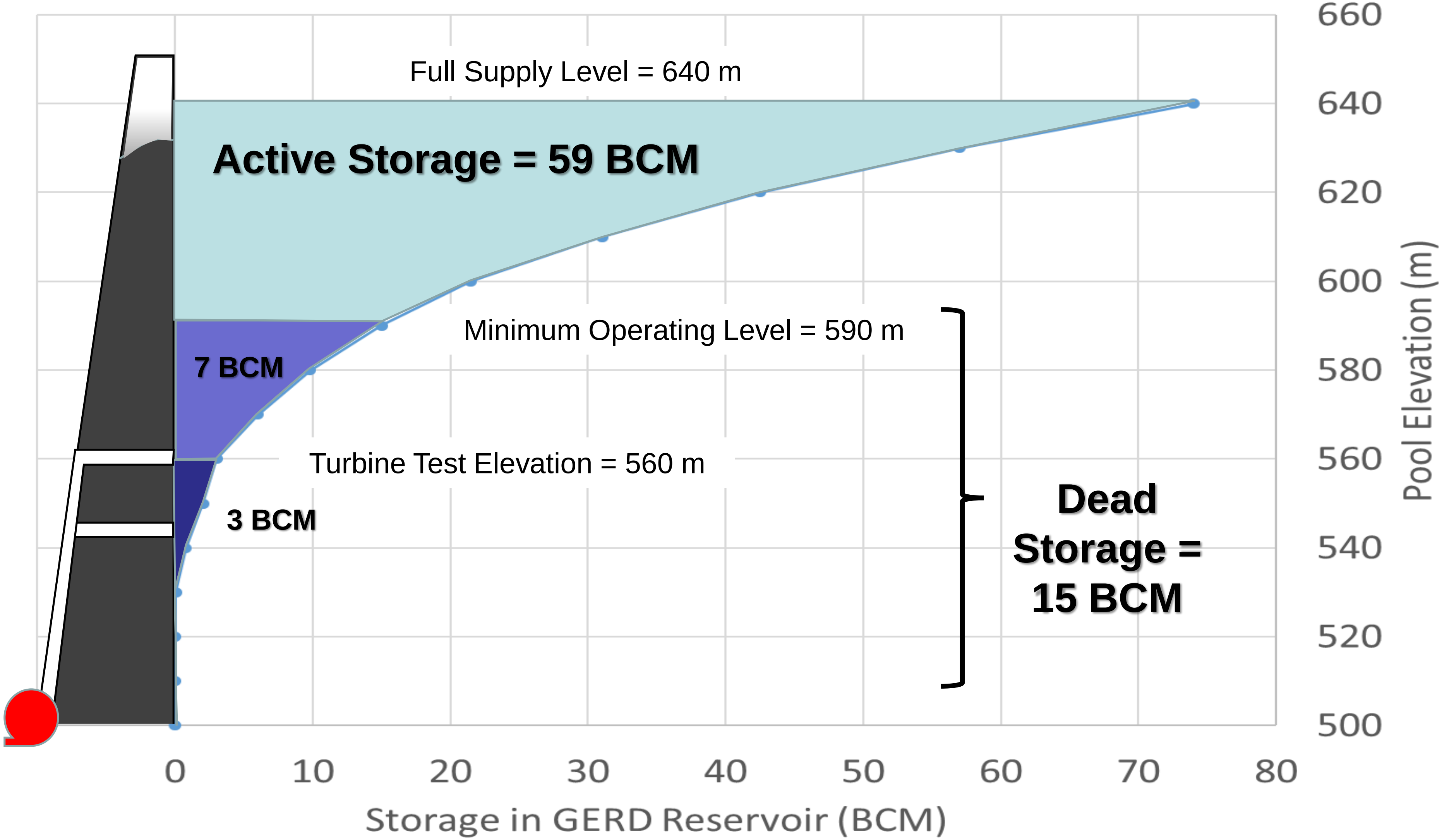


Electricity production from hydroelectric sources



(World Bank, 2016)

GERD Characteristics



Long-term Downstream Impacts

1. GERD will reduce downstream variability of flows
2. Reduce downstream sedimentation
3. Effects and opportunities for Sudan and Egypt

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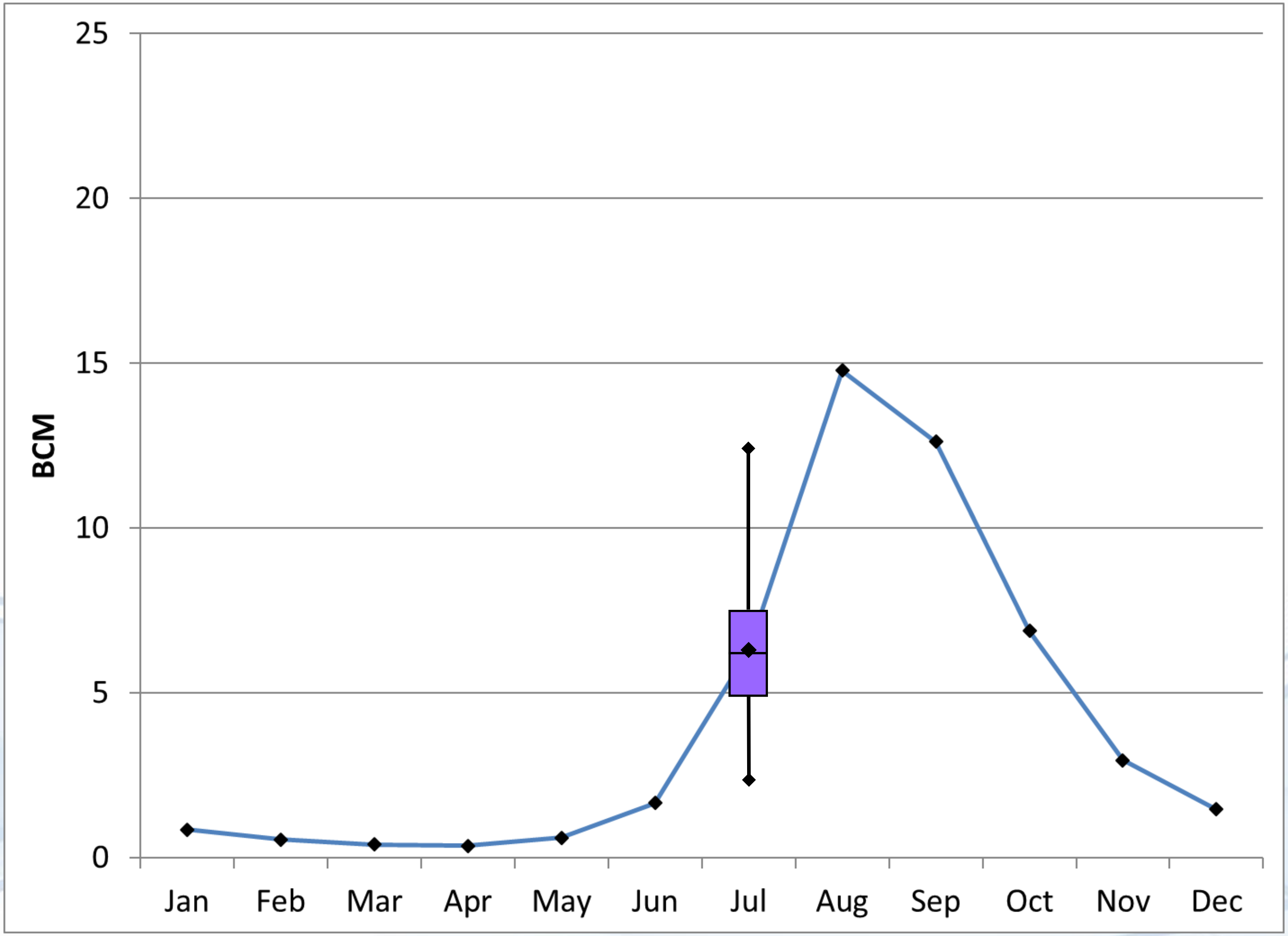
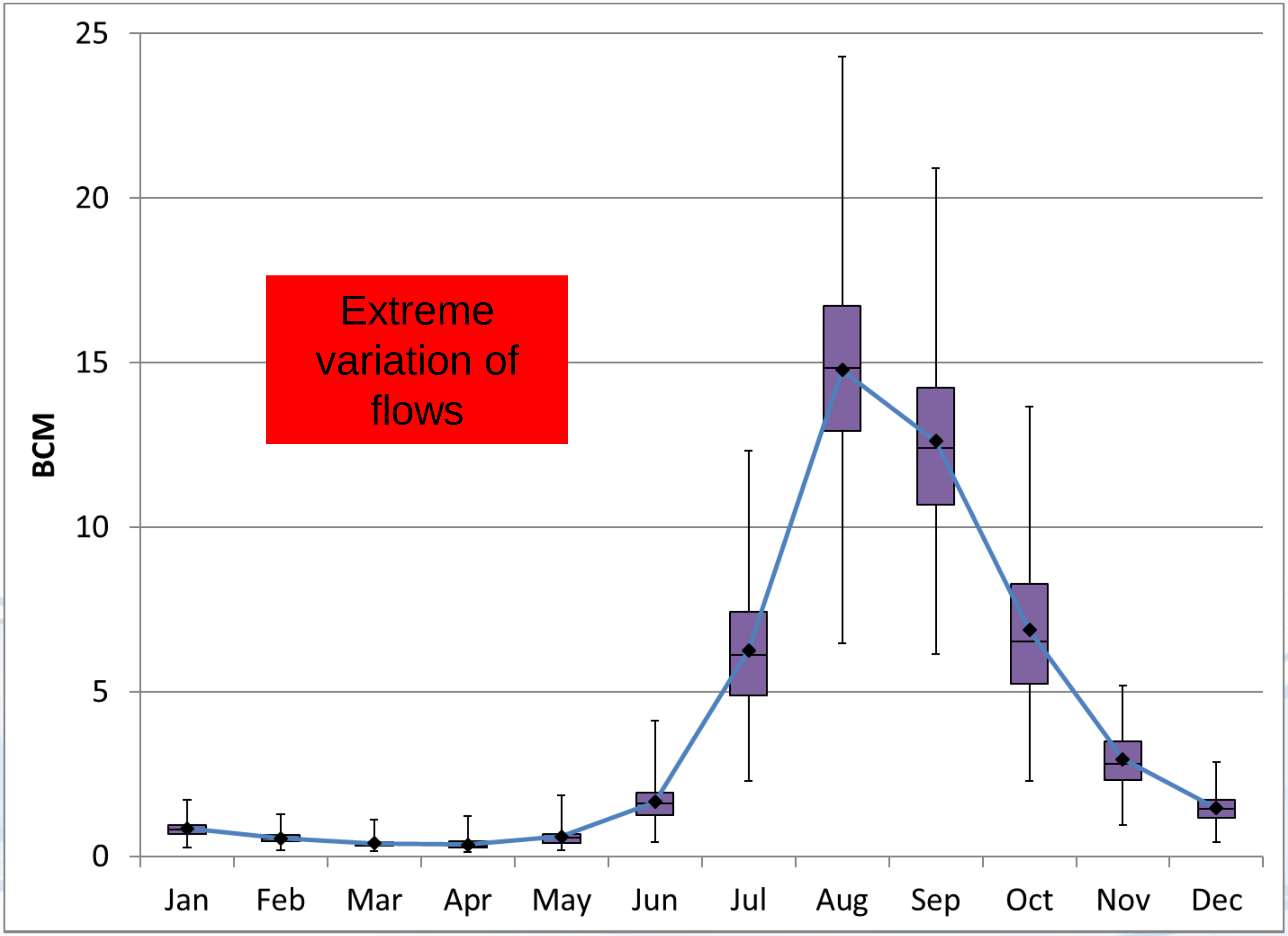
Monthly Inflows near Ethiopia-Sudan Border

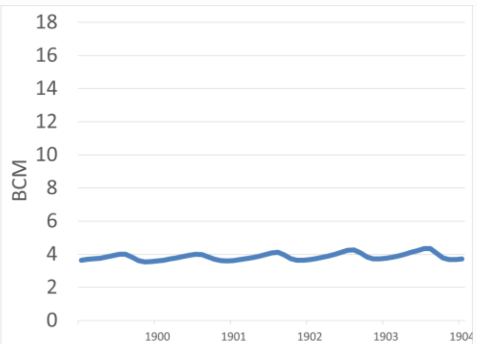


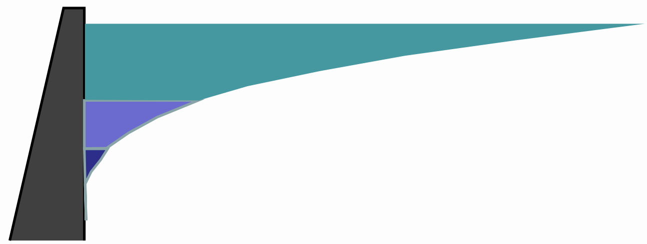
Monthly Inflows to GERD

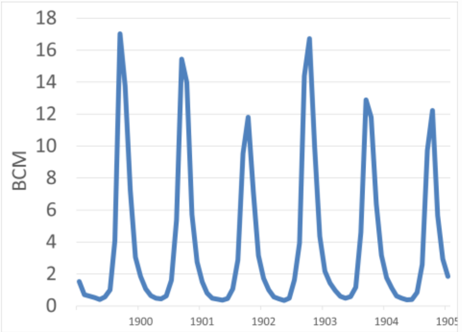


Flooding in Khartoum, Sept 2014

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

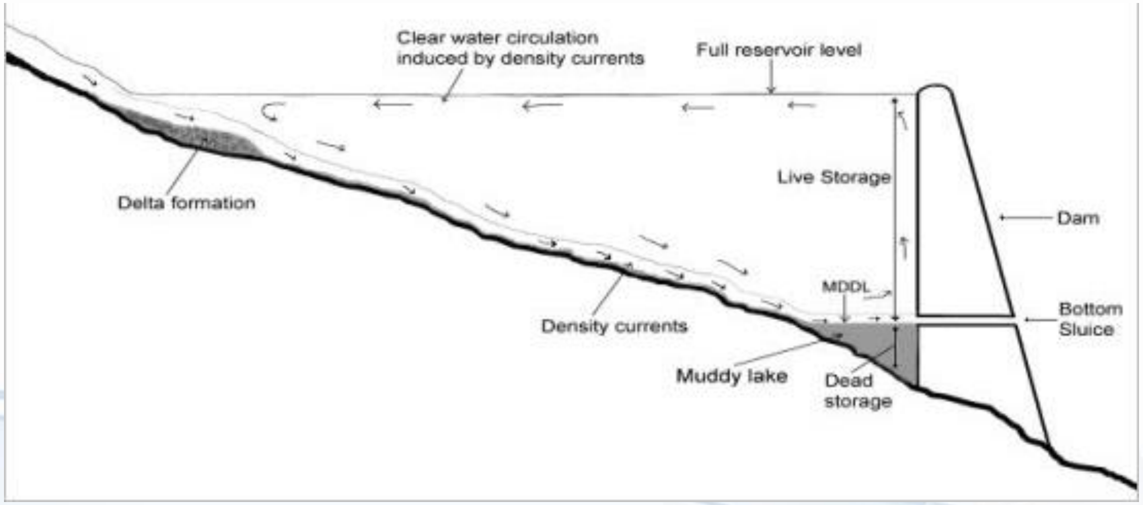
Sediment Impacts

- 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
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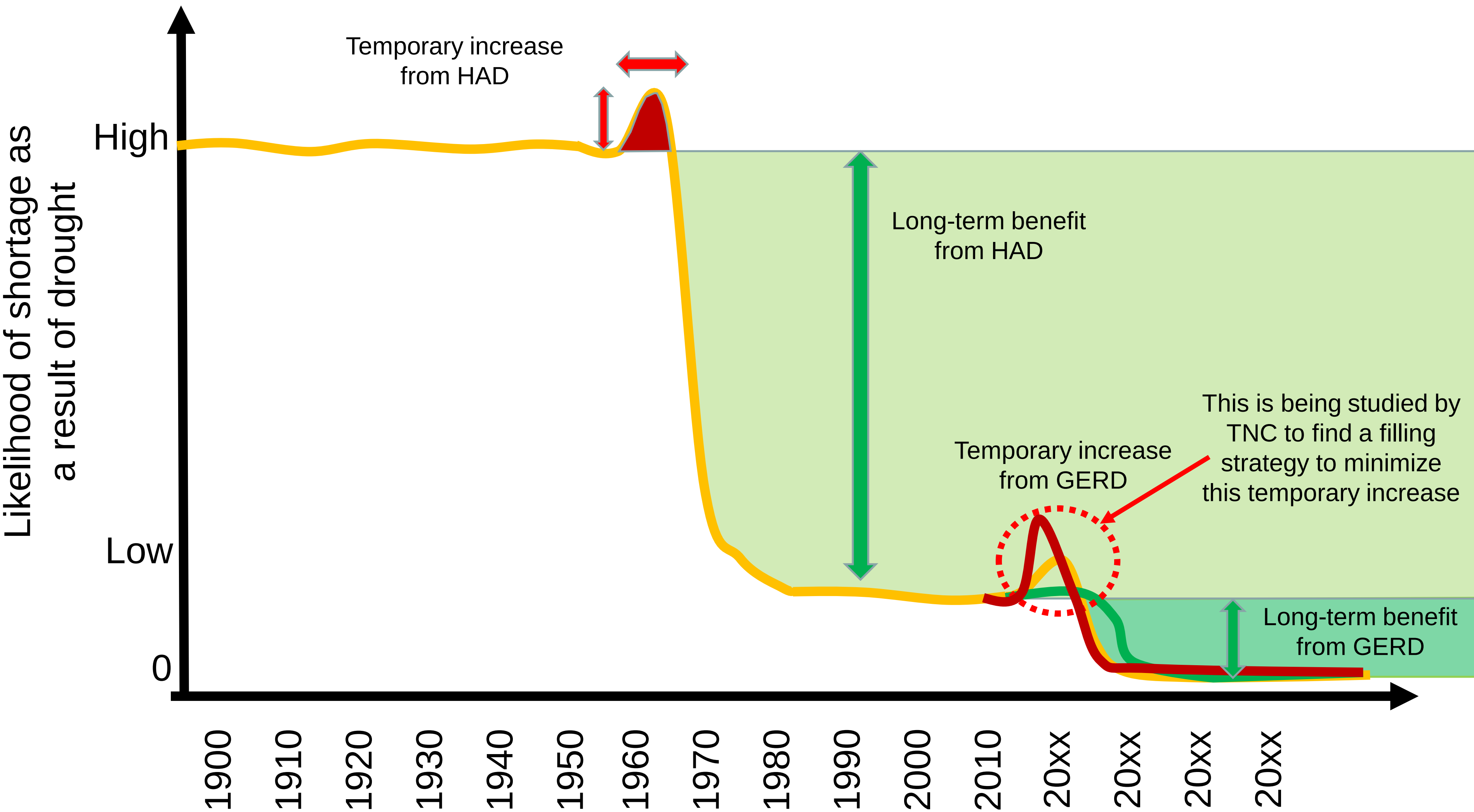
Long-term Effects and Opportunities for Sudan

- 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

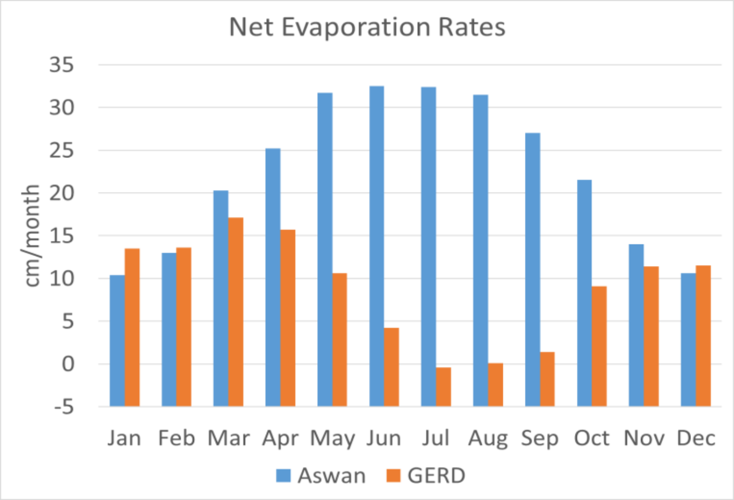
Likelihood of Shortages as a Result of Drought to Egypt



* 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



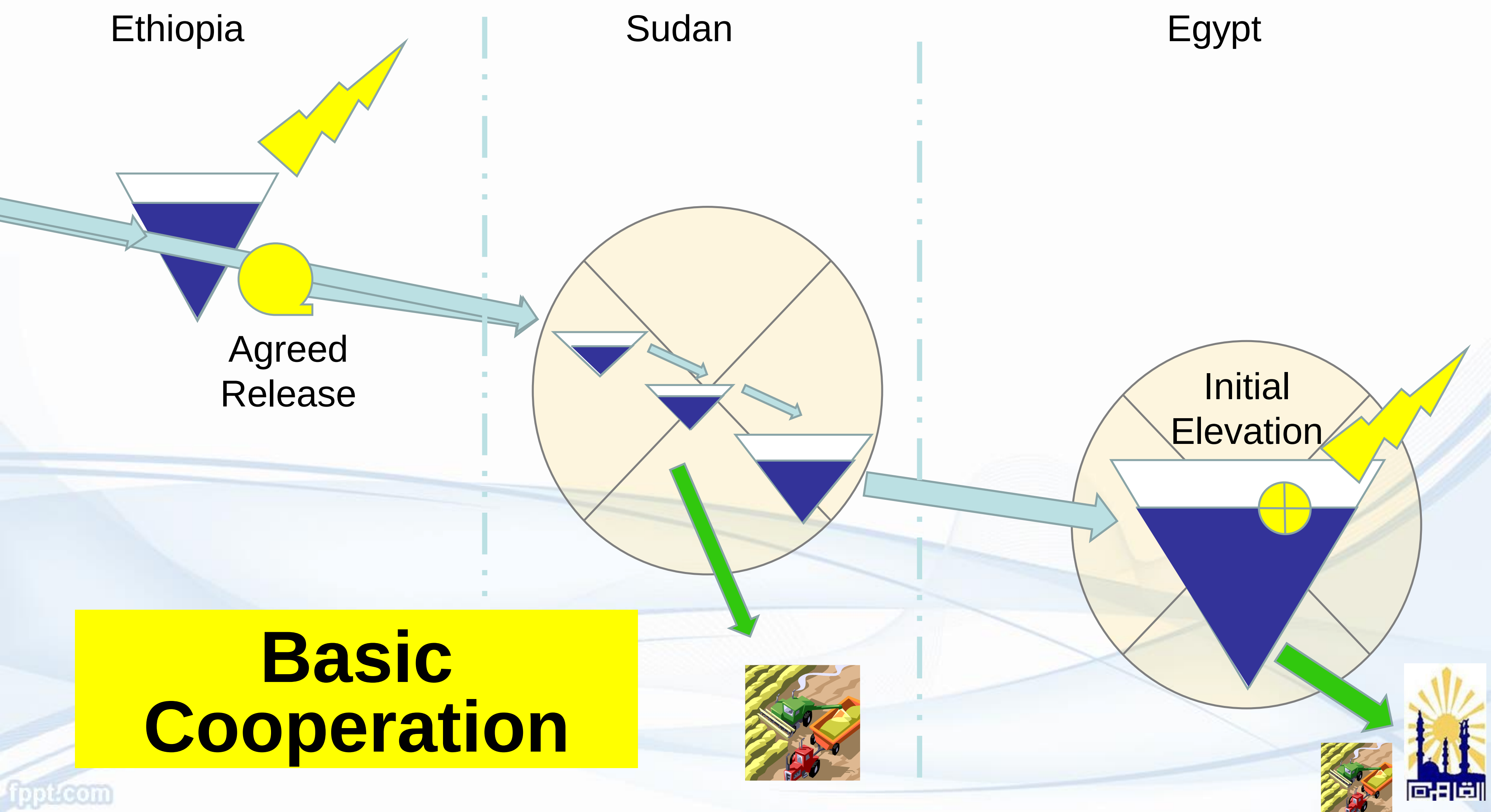
Long-term basin-wide coordination

- 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

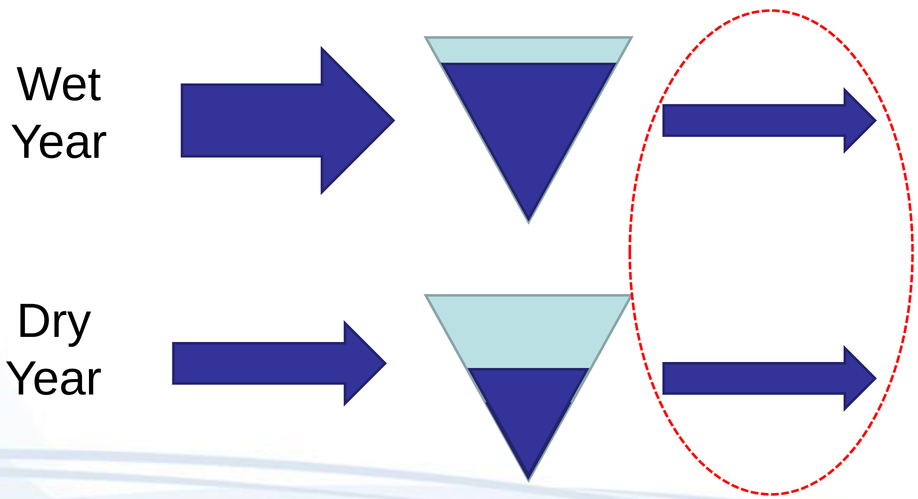
Many Possible Management Options



Basic Cooperation

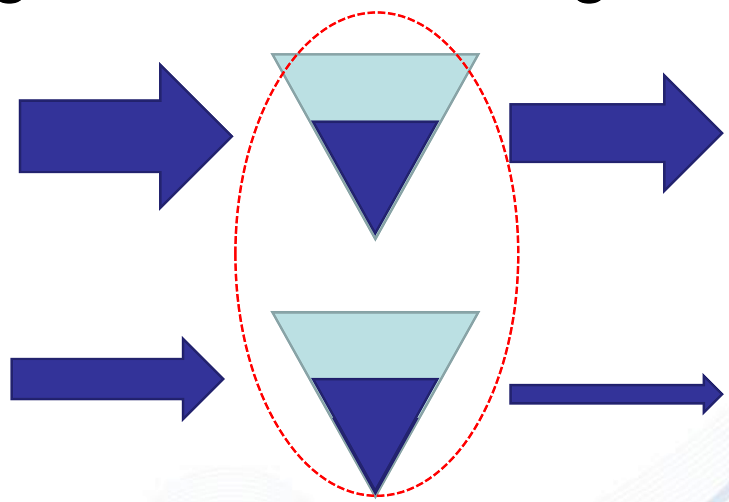
Two Approaches to Fill

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

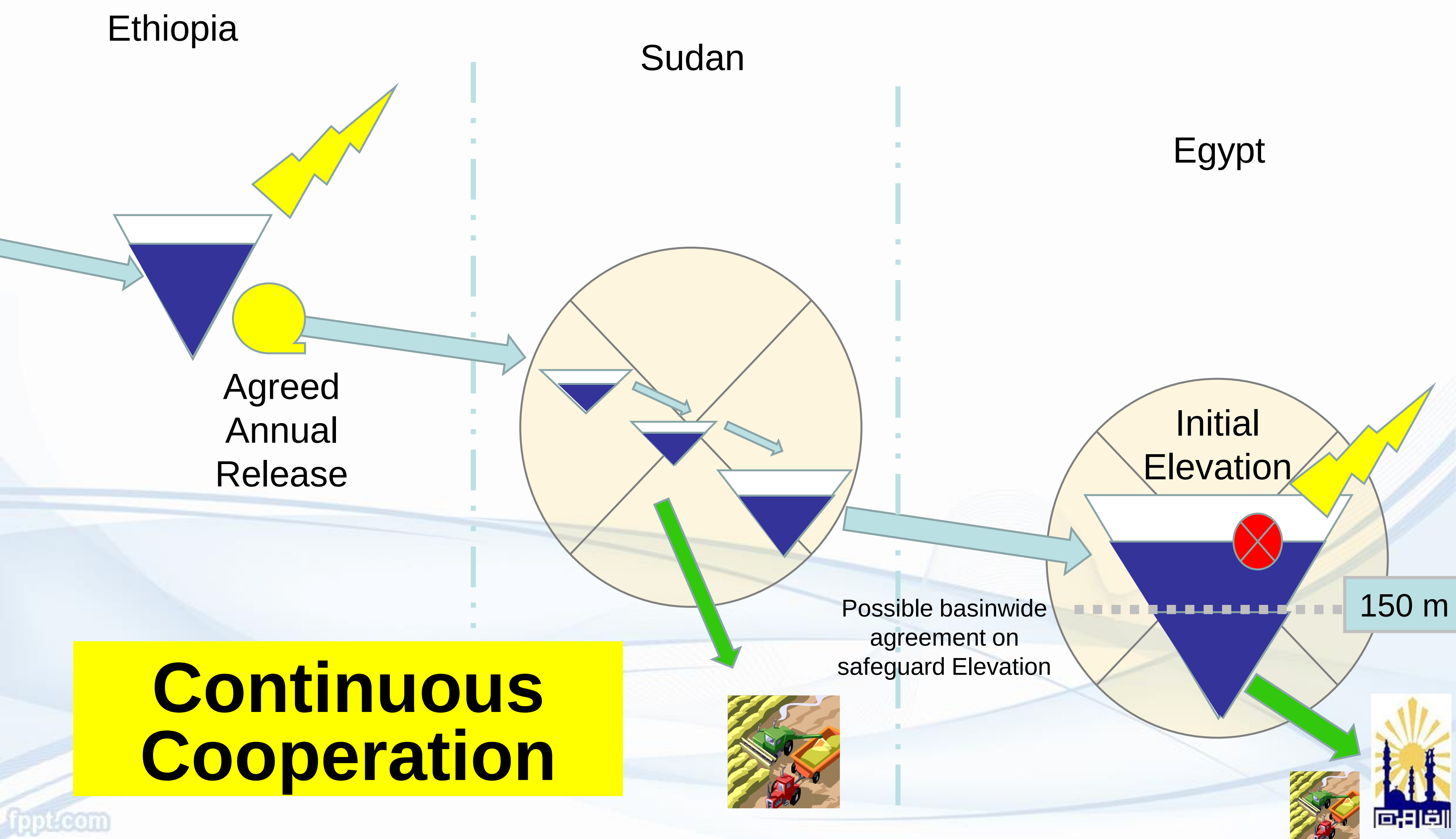
Energy Generation Impacts

		Ethiopia		Sudan		Egypt	
		Short Term	Medium Term	Short Term	Medium Term	Short Term	Medium Term
GERD Agreed Annual Release	50 BCM	10.3	13.5	1.5	2.3	-0.9	-0.3
	45 BCM	10.7	14.0	1.4	2.2	-1.2	-0.3
	40 BCM	11.1	14.0	1.2	2.2	-1.4	-0.2
	35 BCM	11.4	13.8	1.2	2.2	-1.5	-0.2
	30 BCM	11.7	13.6	1.1	2.2	-1.4	-0.1
	25 BCM	11.8	13.5	1.0	2.2	-1.4	-0.1
	0 BCM	11.9	13.3	0.9	2.2	-1.2	-0.1

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

Short Term = Average of initial10 years after filling begins
Medium Term = Average of 11-30 years after filling begins
Units are TWH

Many Possible Decisions



Probability of High Aswan Dam reaching Minimum Power Elevation

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			
		Initial HAD Elevations				Initial HAD Elevations			
		180m	175m	170m	165m	180m	175m	170m	165m
Baseline - No GERD		0%	0%	0%	0%	0%	0%	0%	1%
GERD Agreed Annual Release	50 BCM	0%	0%	0%	2%	0%	0%	0%	1%
	45 BCM	0%	0%	0%	3%	0%	0%	0%	2%
	40 BCM	0%	0%	0%	5%	0%	0%	0%	1%
	35 BCM	1%	1%	3%	6%	0%	0%	0%	2%
	30 BCM	4%	5%	6%	11%	0%	0%	1%	1%
	25 BCM	6%	7%	9%	18%	0%	0%	2%	2%
	0 BCM	1%	3%	10%	20%	0%	0%	0%	1%

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

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Recent Publication

Cooperative filling approaches for the Grand Ethiopian Renaissance Dam
Kevin G. Wheeler, Mohammed Basheer, Zelalem T. Mekonnen, Sami O. Eltoum, Azeb Mersha, Gamal M. Abdo, Edith A. Zagona, Jim W. Hall, Simon J. Dadson
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