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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Outline

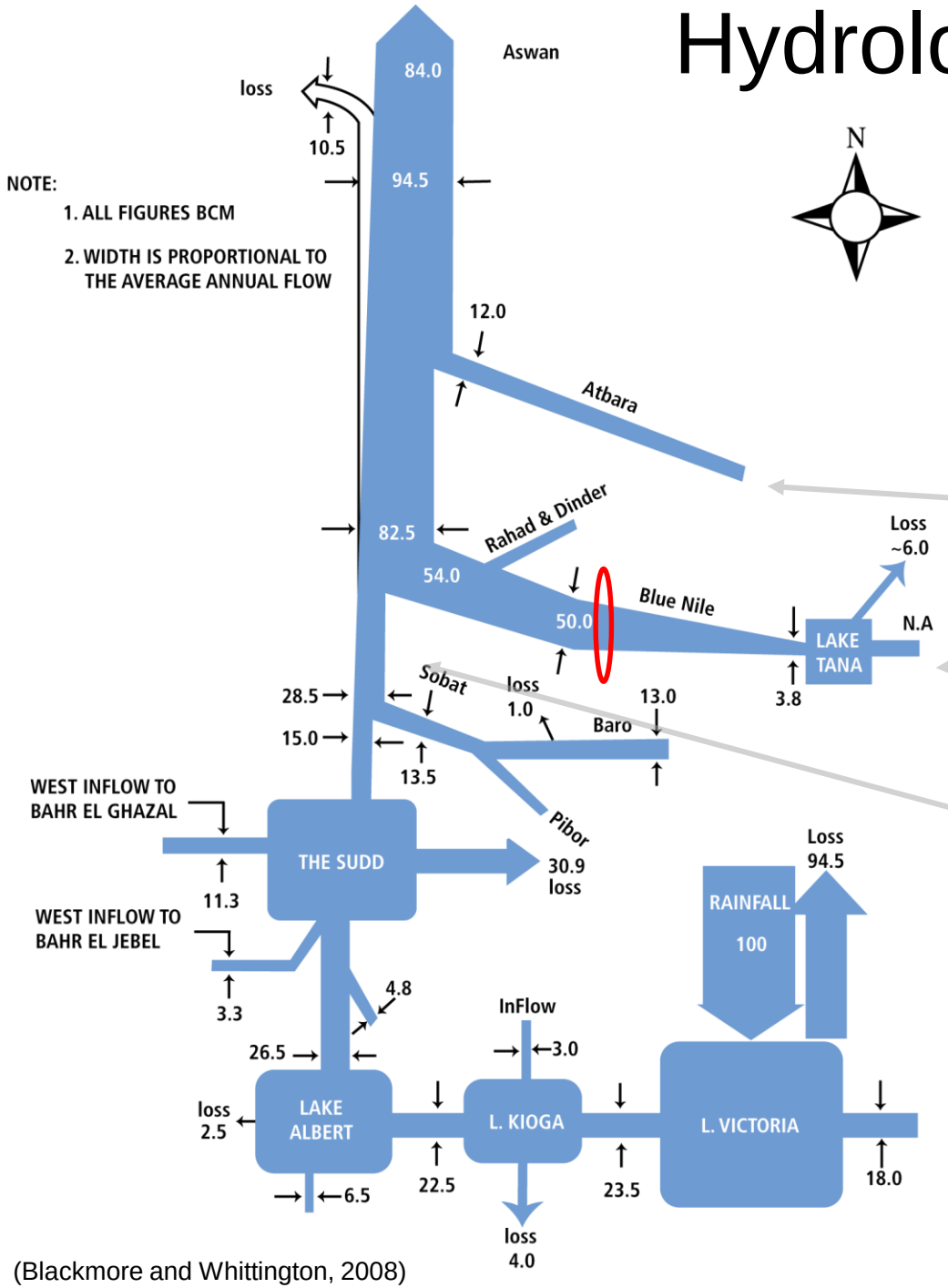
I. Rationale

II. Methods

III. Key Results

IV. Way Forward

Hydrology of the Nile



N

100% - Inflow to Lake Nasser

13% - Atbara

57% - Blue Nile

- 53% above GERD
- 4% below GERD

30% - White Nile

(Blackmore and Whittington, 2008)

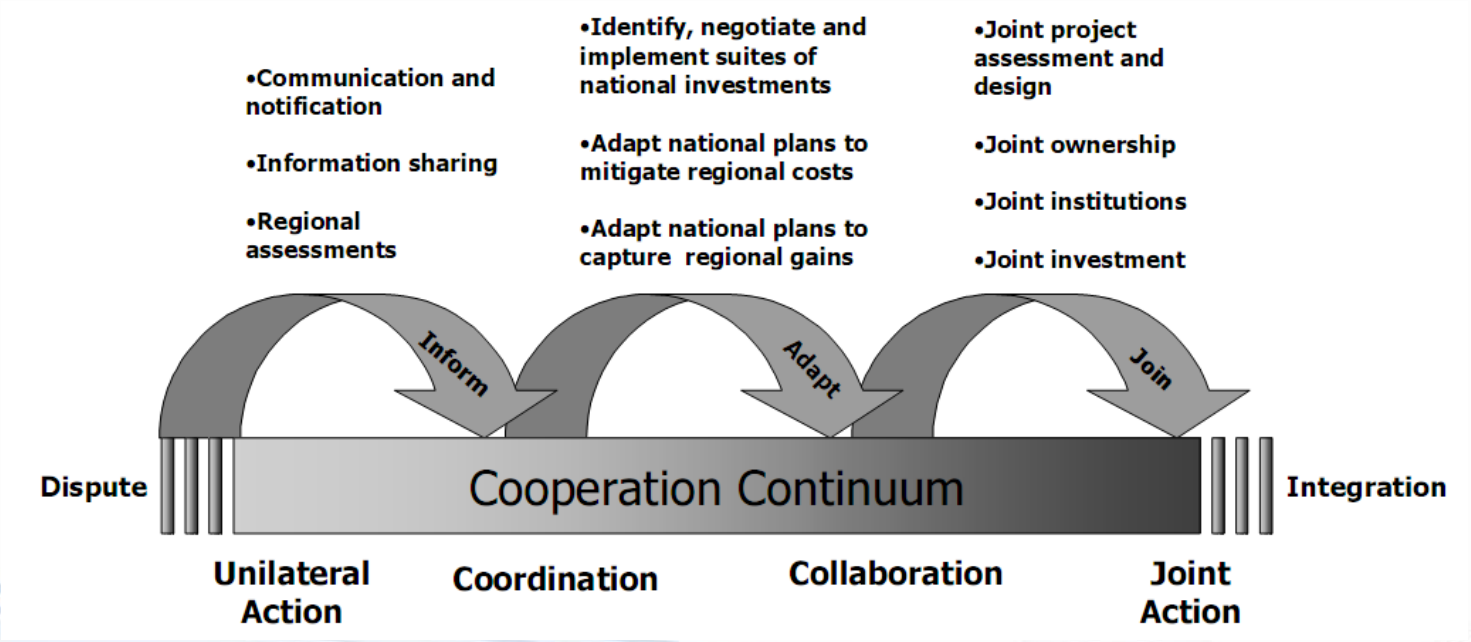
Rationale for Study

- 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

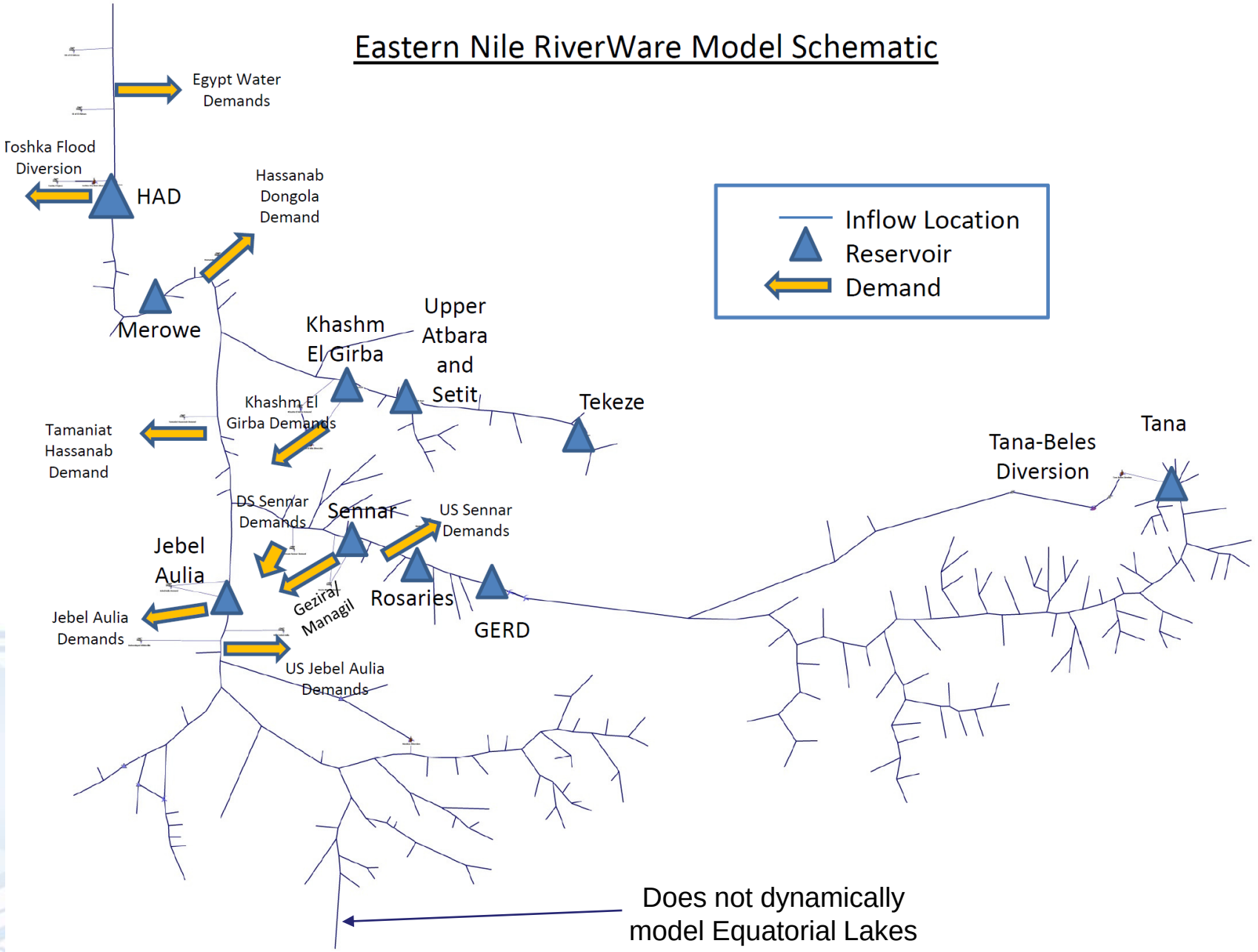
Stakeholder Participation + Data Collection + Field Visits

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



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

Hydrology Basis: Monthly Reconstructed Flows 1900-2002 (Deltares 2012)

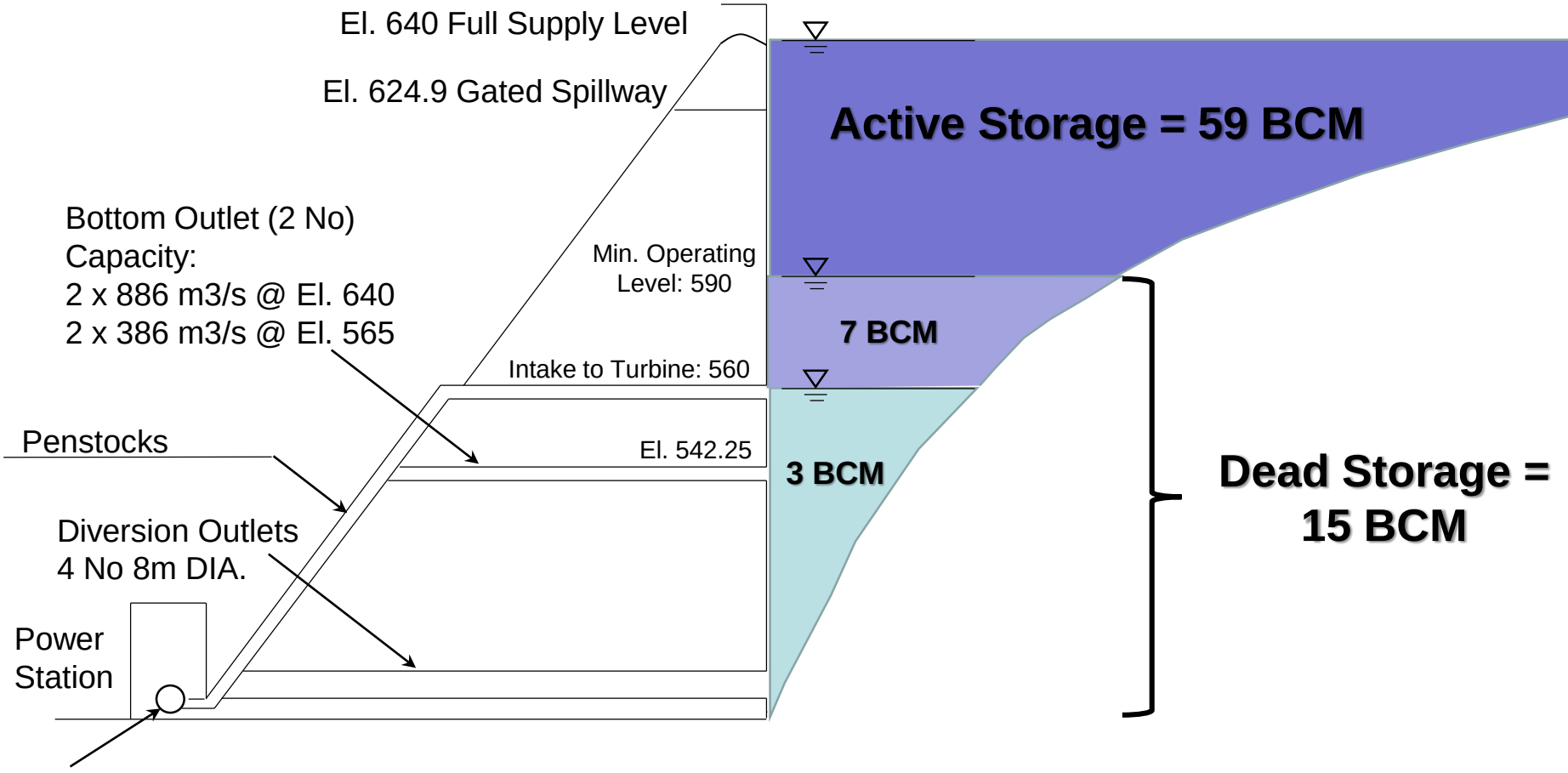
Demand Scenario Analysis

Assumed demand request:

- Ethiopia: Essentially 0 BCM
- Sudan: 16.0 BCM
- Egypt: 55.5 BCM

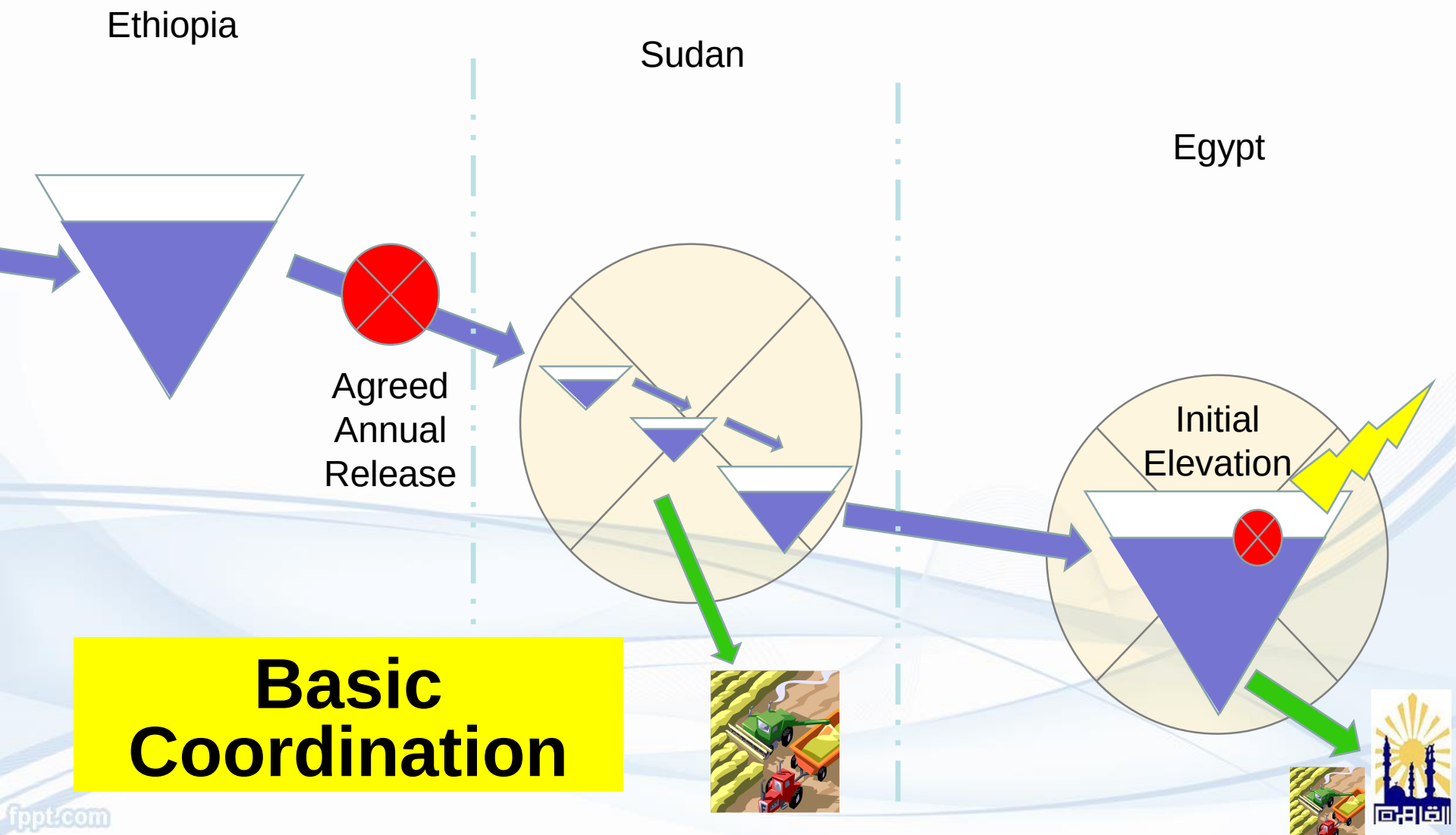
Remains unchanged throughout filling period

GERD Schematic Diagram



(Adapted from Massachusetts Institute of Technology, 2014)

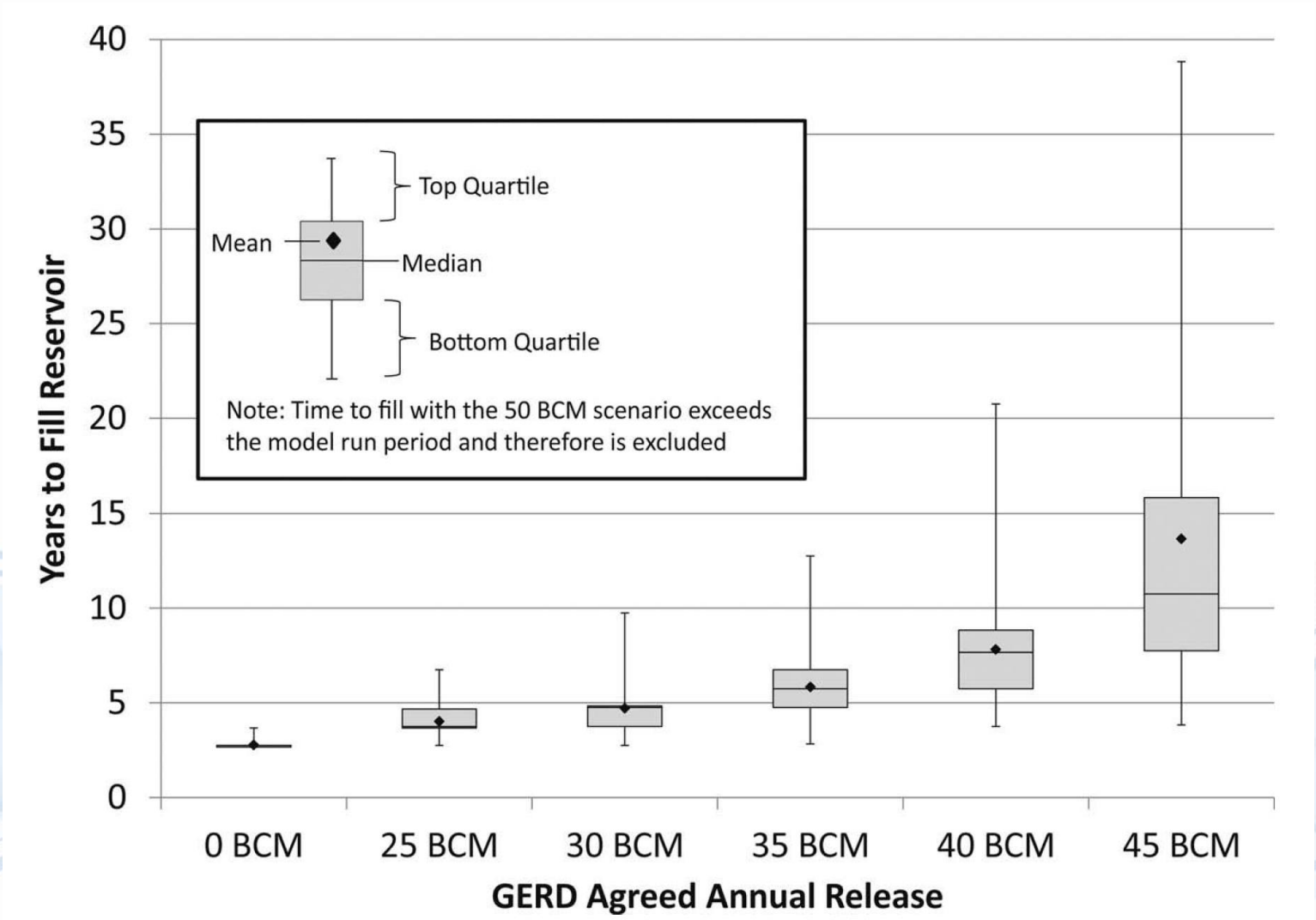
Reservoir Management Scenario Analysis



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?

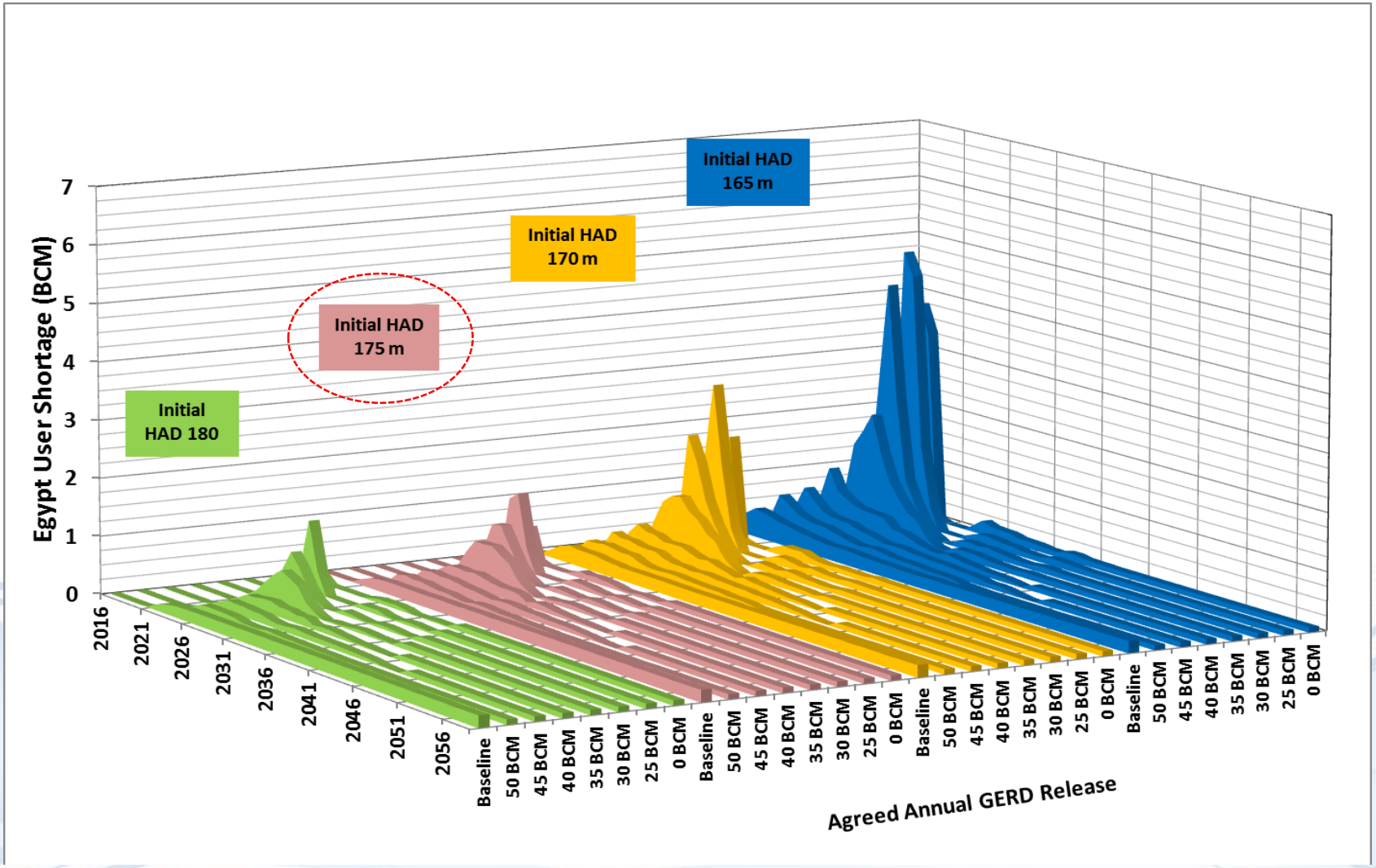


Average Energy Generation Impacts

		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

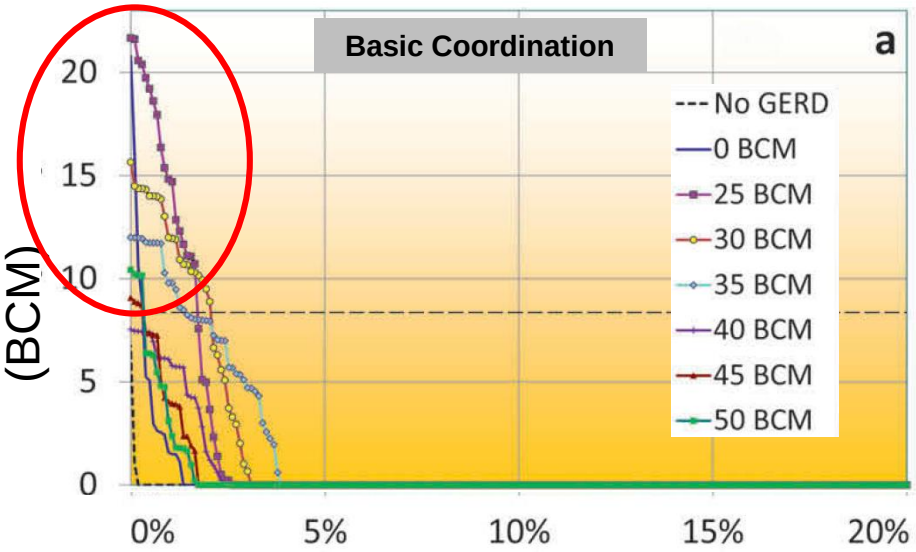
Short Term = Average of initial 10 years after filling begins
Medium Term = Average of 11-30 years after filling begins
Units are 1000 GWH

“Averaged” Shortages to Egypt



* Assuming no HAD Drought Management Plan

Example: Starting HAD Elev = 175 m
Probabilistic Risks to Egypt
(2016-2025)

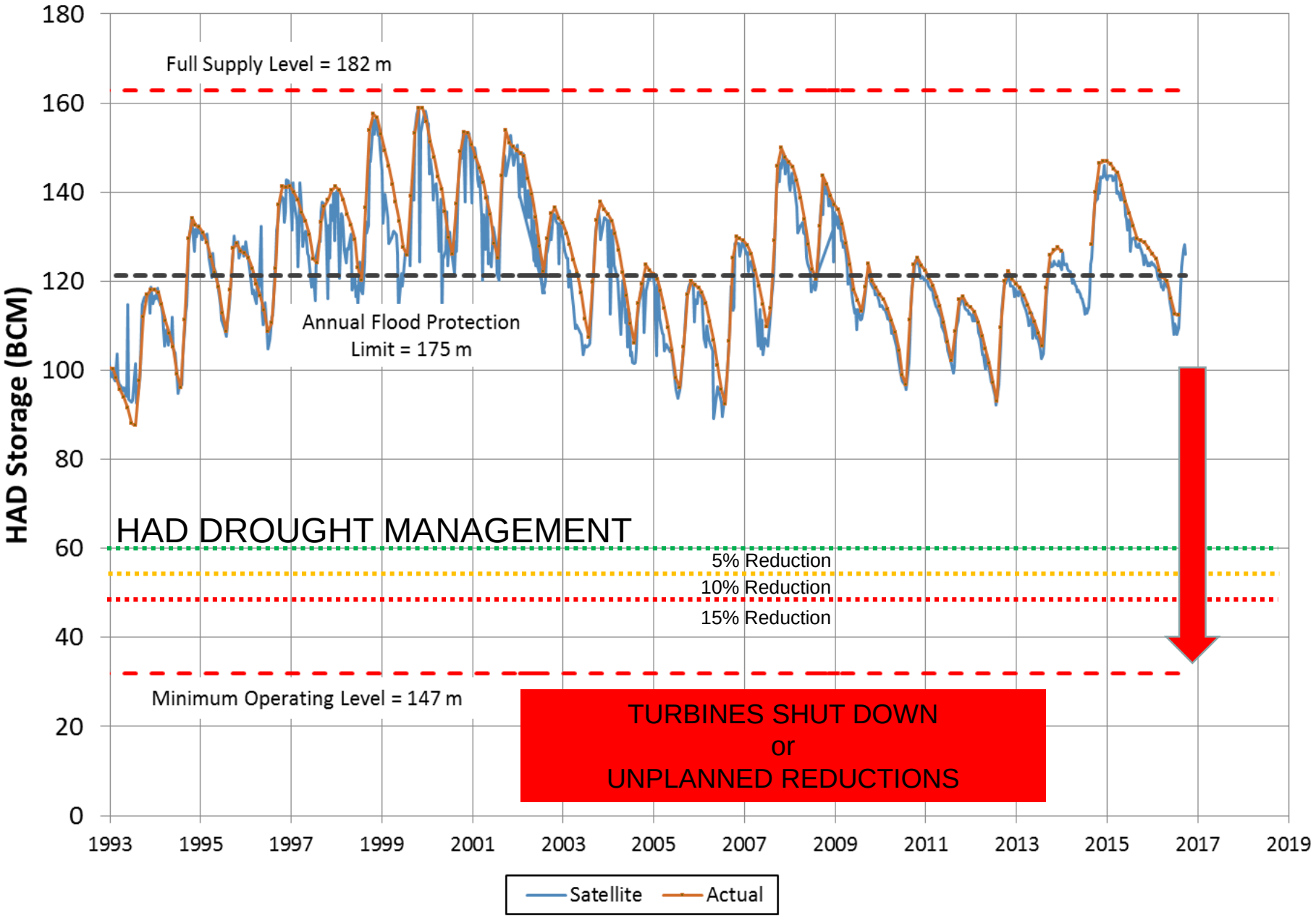


- ✓ Average Hydrology = No Shortage
- ✓ Low Probability of a Large Shortage

(Not equal to maximum annual risk)

What is an acceptable risk?

HAD Pool Elevation

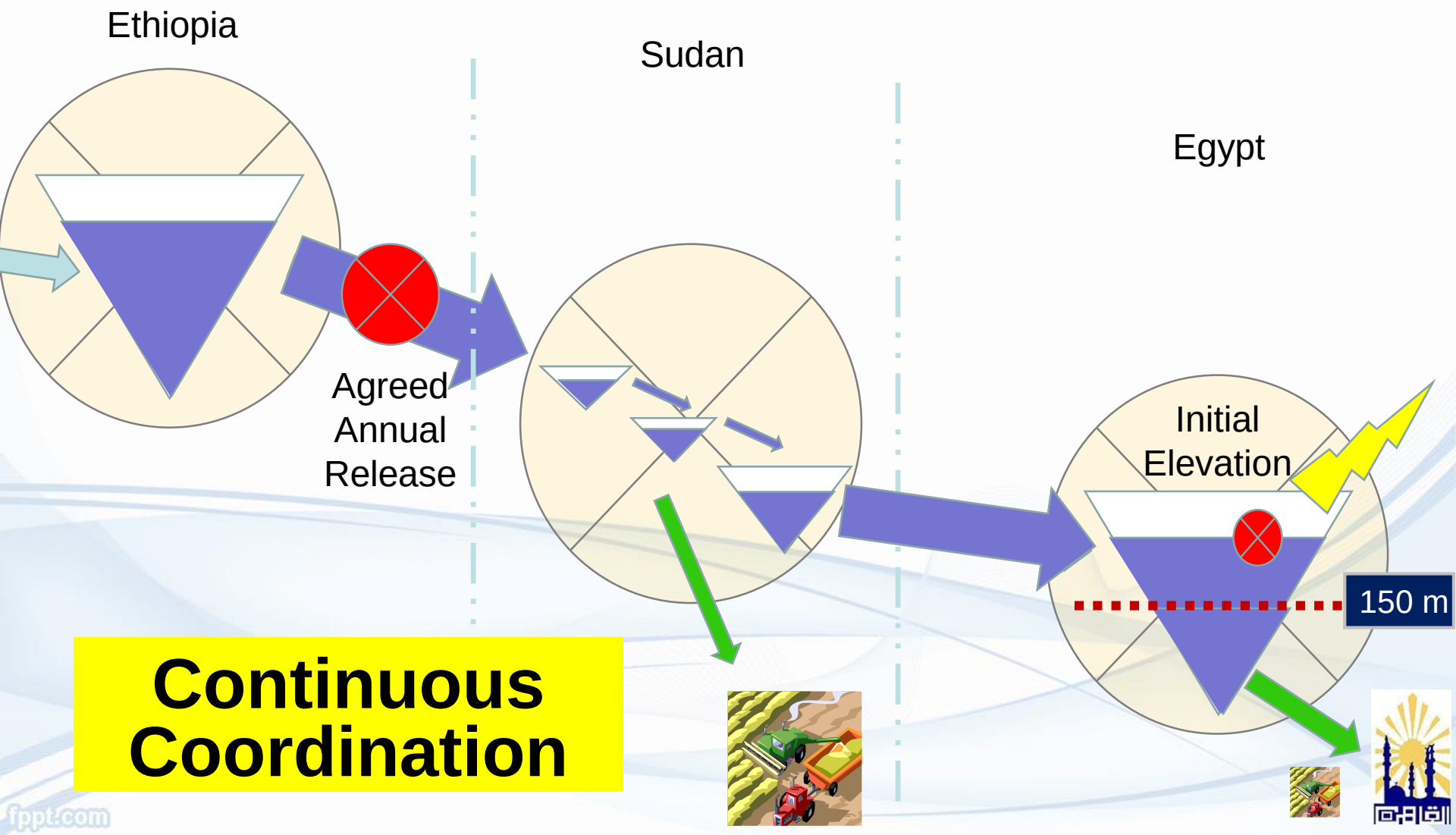


Probability of HAD reaching minimum power elevation

		Basic Coordination					Basic Coordination + HAD Drought Management Plan			
		Initial HAD Elevations					Initial HAD Elevations			
		180m	175m	170m	165m		180m	175m	170m	165m
No GERD		0%	0%	0%	0%		0%	0%	0%	0%
GERD Agreed Annual Release	50 BCM	3%	4%	6%	10%		0%	0%	0%	2%
	45 BCM	3%	4%	6%	11%		0%	0%	0%	3%
	40 BCM	5%	6%	7%	13%		0%	0%	0%	5%
	35 BCM	7%	9%	15%	31%		1%	1%	3%	6%
	30 BCM	7%	9%	21%	45%		4%	5%	6%	11%
	25 BCM	8%	9%	27%	47%		6%	7%	9%	18%
	0 BCM	2%	7%	17%	37%		1%	3%	10%	20%

Increase Cooperation

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



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

		Basic Coordination				Basic Coordination + HAD Drought Management Plan			
		Initial HAD Elevations				Initial HAD Elevations			
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	35 BCM	7%	9%	15%	31%	1%	1%	3%	6%
	30 BCM	7%	9%	21%	45%	4%	5%	6%	11%
	25 BCM	8%	9%	27%	47%	6%	7%	9%	18%
	0 BCM	2%	7%	17%	37%	1%	3%	10%	20%

		Continuous Coordination				Continuous Coordination + HAD Drought Management Plan			
		Initial HAD Elevations				Initial HAD Elevations			
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	45 BCM	2%	3%	3%	7%	0%	0%	0%	2%
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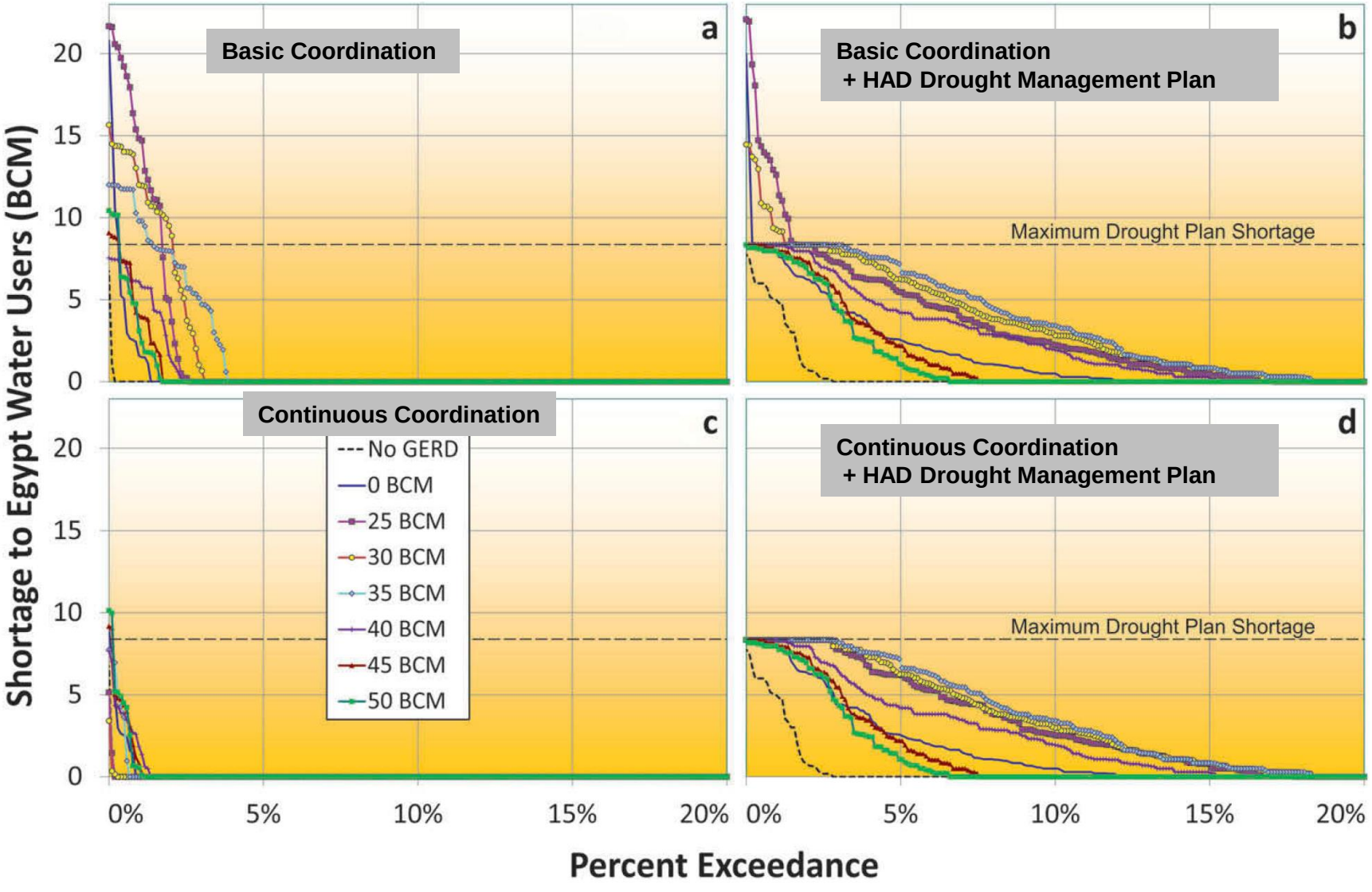
	35 BCM	2%	2%	3%	5%	0%	0%	0%	2%
	30 BCM	2%	3%	4%	7%	0%	0%	1%	1%
	25 BCM	2%	3%	5%	21%	0%	0%	2%	2%
	0 BCM	2%	4%	5%	8%	0%	0%	0%	1%

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

Kevin Wheeler

Kevin.wheeler@ouce.ox.ac.uk
kgw@waterbalance.org

Recent Publication

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