

Water Resources account of Egypt vs Ethiopia's Nile Sub-Basins: The Utility of the Water Budget Model

By

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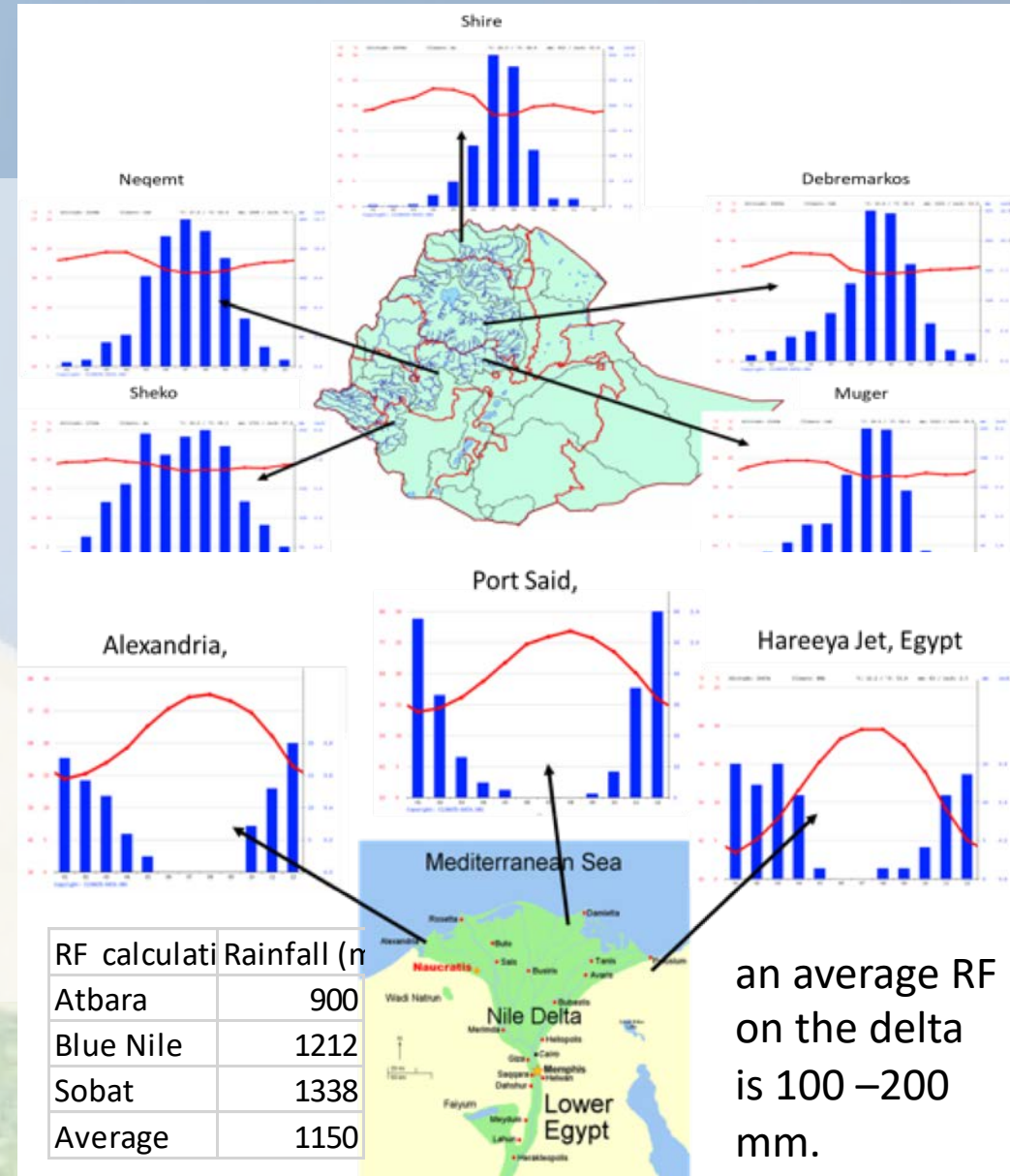
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Ethiopia: Water Tower of Africa

- There is an overwhelming perception of Ethiopia's plentiful water resources.
- Ethiopian highlands obtain rainfall as high as 2000 mm per annum, in comparison to Egypt annual average rainfall, which is in the order 200mm.

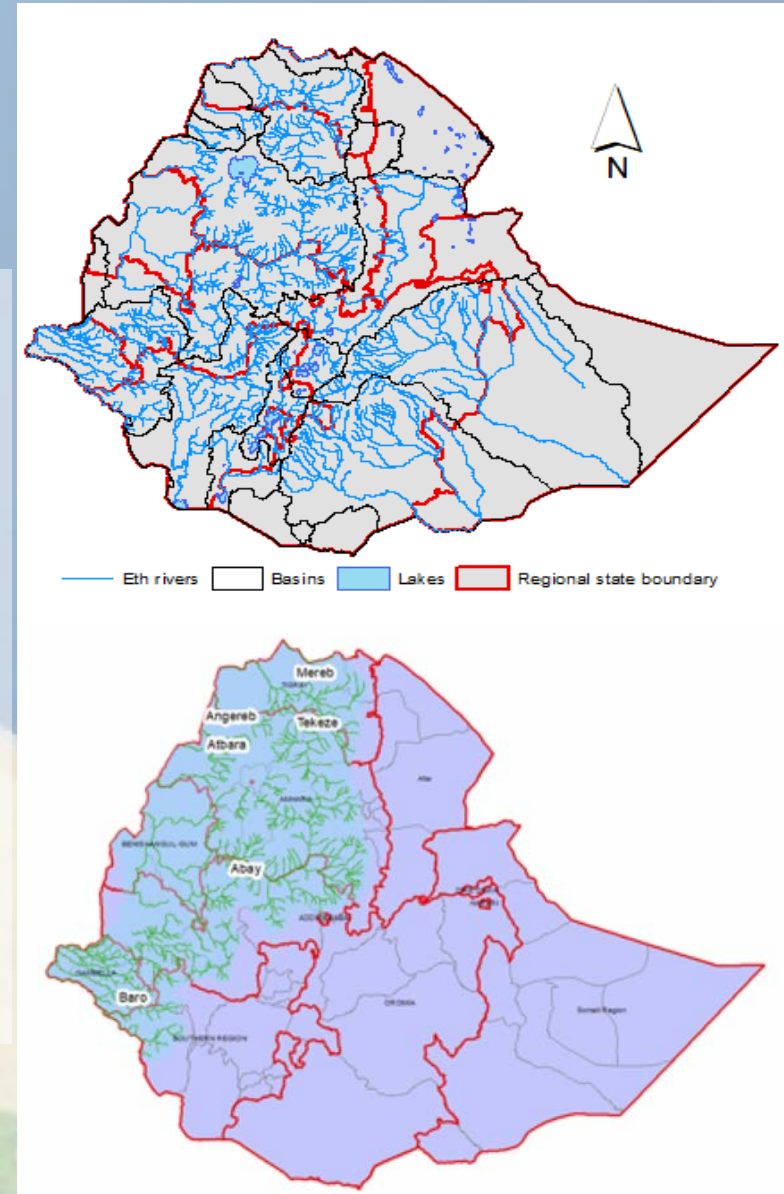


Rainfall is not the only sources

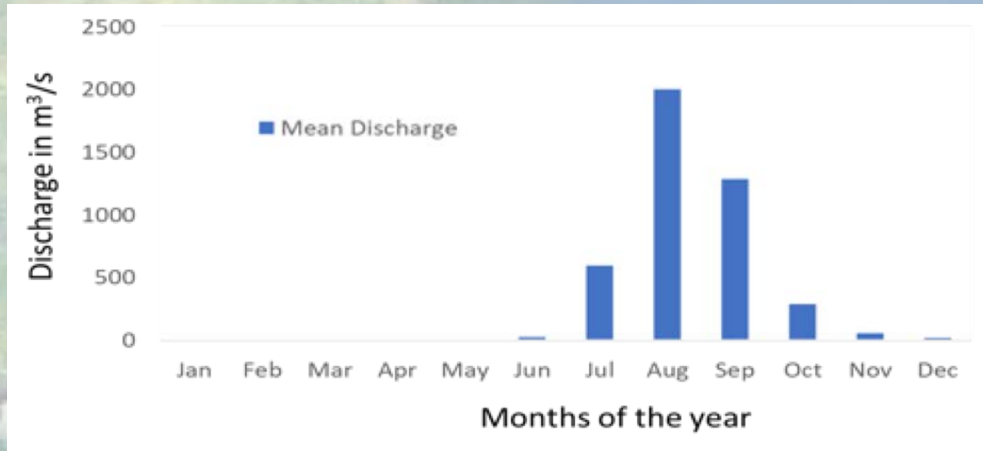
- Several hydrologic inputs are available for a watershed or country to gain water resource. These are:
 - Surface water Inflow
 - Extraction of Groundwater
 - Applied water reuse
 - Return (recycled) water flow
 - Imported water
 - Subsurface water inflow and
 - Desalinization
- The fates of inputs can be run-off, evaporation, and infiltration into soils

Stream outflows

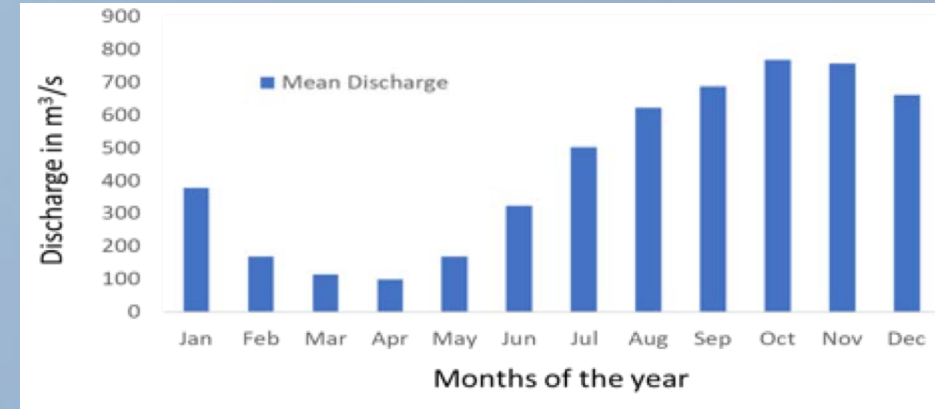
- 97% of these streams/ rivers are transboundary, and only 3% remains within the country
- The western Ethiopian highlands, source of Nile river accounts for 70% of the overall stream water resources of the country.



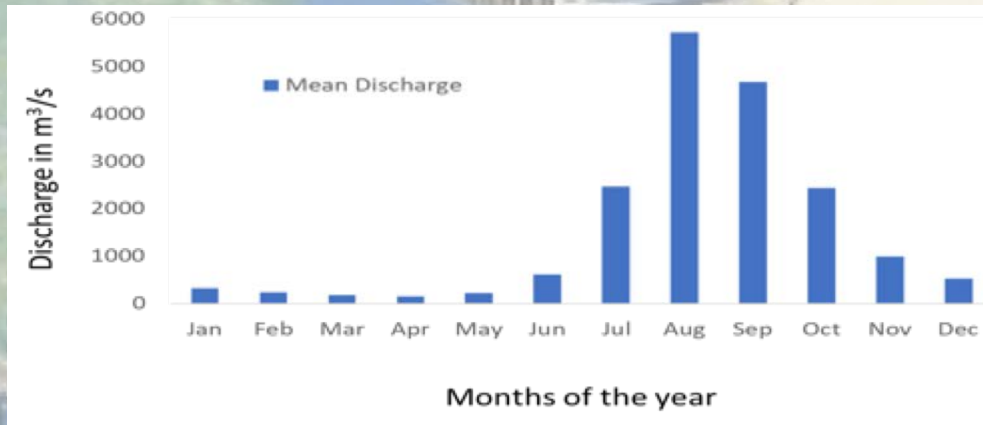
Hydrographs Showing Stream Discharge



Tekeze-Atbara



Baro-Akobo-Sobat

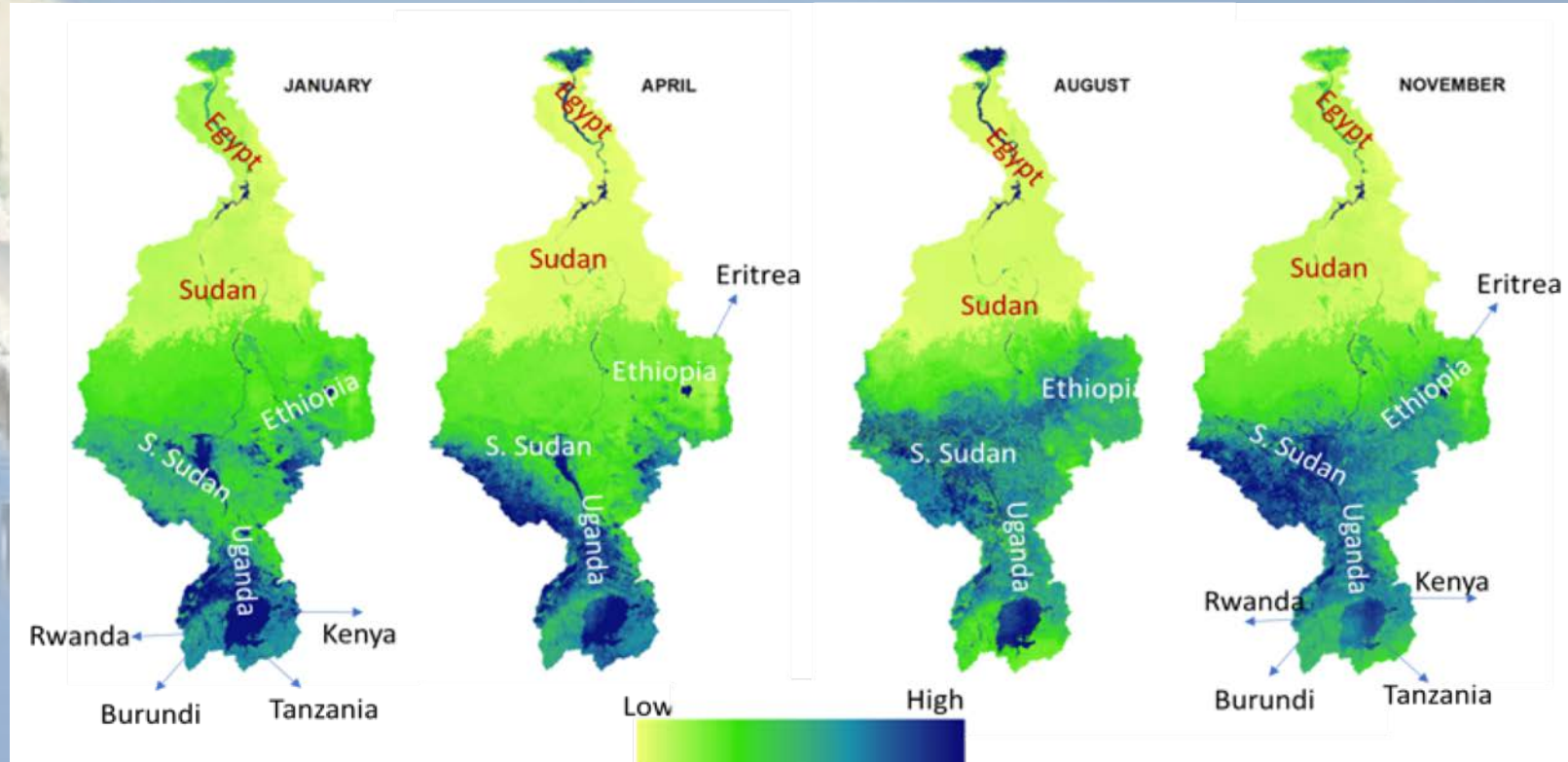


Blue Nile

Sub-basins' calculation	Mean Discharge (m³/s)
Atbara	437.6
Blue Nile	1548.4
Sobat	358.7

(Source: University of New Hampshire - Global Runoff Data Centre)

Evapotranspiration



Direct evaporation and evapotranspiration (ET) of January, April, August, and November from the Nile river basin (Source; Nile basin water resource Atlas).

Objectives

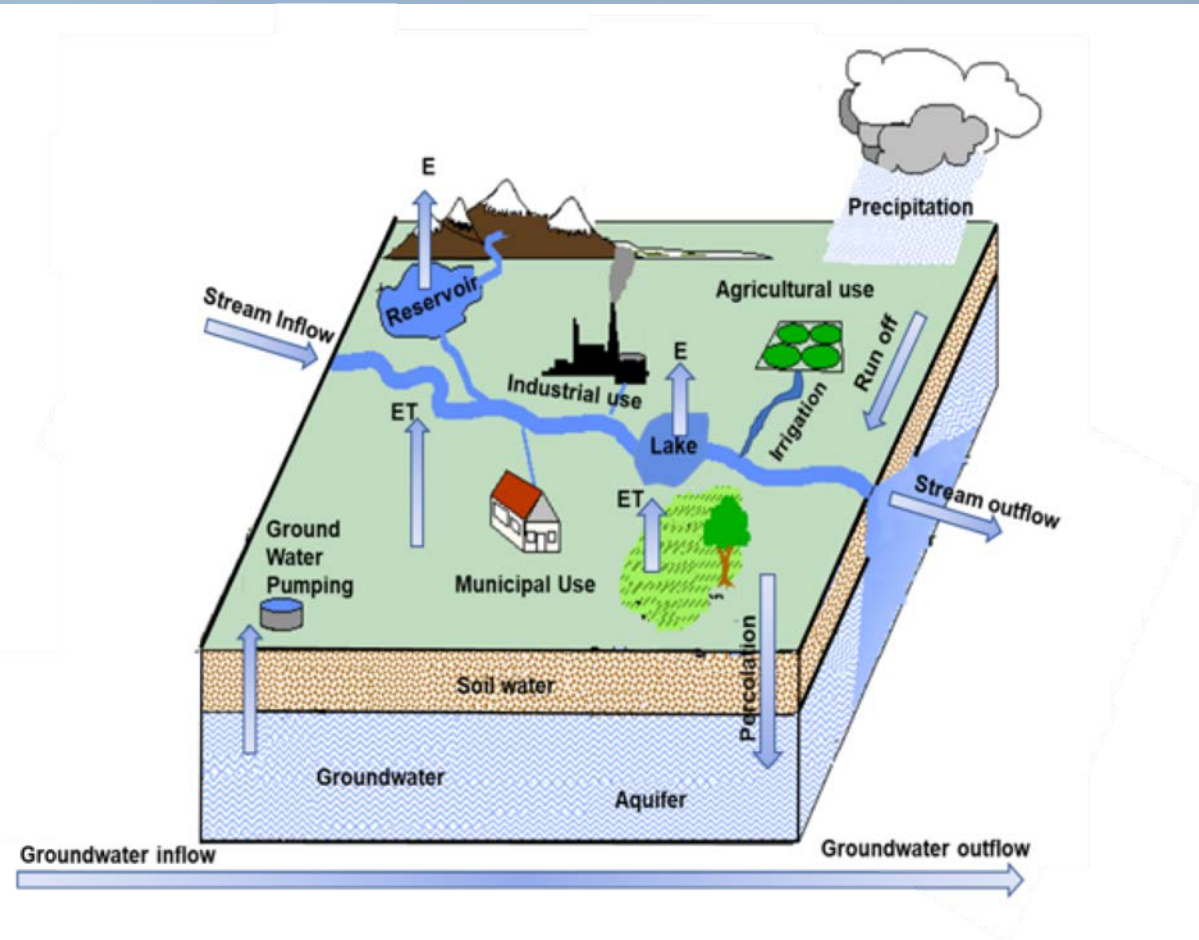
- Therefore, given these prevailing hydrologic processes, there is a need:
 - a) to conduct detailed and dynamic water resources inventories in the Nile basin in these two countries.
 - b) to verify if indeed Ethiopia has plentiful alternative freshwater resources, and Nile water is the Egypt's sole freshwater source and the dam is an existential threat.

Water Budget Concept

- This study uses the concept of water budget, a hydrologic tool used for measuring water movement in between hydrologic regimes (atmosphere, surface and the subsurface).
- It also involves measurement of the quantities of water storages in each component, particularly, the surface and subsurface.
- Watershed managers use this tool for evaluating sustainable qualities and quantities of water supplies; watershed best practices, and watershed planning and management thereof.

Water Budget Concept

- The water budget concept applies the law of conservation of mass/matter.
- The law states that matter or mass can't be created or destroyed but can change from one form to another,
- such that the total mass of the matter on the reactant is equal to the total mass of the matter on the product side.



Sub-basins



According to FAO report 1997, out of the total inhabited area of 77,041 km²; cultivated area is 46200 km².

Result: Sources of Water Resources

Table 1 Ethiopian vs Egypt rivers of Nile Sub-basins and their Hydrologic inputs

Role No.	Country	Types of Hydrologic Inputs	Volume in BCM	Total in BCM
1	Ethiopia	Precipitation	456.0	456.6 BCM
		Groundwater extraction	0.6	
1 2 3 4	Egypt	Precipitation	12.0	106.0 BCM
		Stream Inflow	84.0	
		Groundwater extraction	9.0	
		Desalinization	1.0	

Result: Stream outflow

Table 2 Ethiopian vs Egypt rivers of Nile Sub-basins and their outflows

Role No.	Country	River system	Major tributaries	Average Surface Water loss	Total
1 2 3	Ethiopia	Atbara	Tekeze, Angereb, Ataba and Mereb	12.0 BCM	81.0 BCM
		Blue Nile	Abbay, Jamma, Muger, Guder, Didessa, Beles, and Dabus	54.4 BCM	
		Sobat river	Boro, Bako and Akobo	13.6 BCM	
1	Egypt	Nile river	Nile River	13 BCM	13 BCM

Result: Evapotranspiration

Table 3 Ethiopian vs Egypt Nile Sub-basins and their total ET loses

Role No.	Surface	Mechanism of loses	Amount of ET losses	Total Loss
Ethiopia				
1	Crops/Vegetation	ET loses	357 BCM	362.3 BCM
2	Lake Tana	Evaporation	5.3 BCM	
Egypt				
1	Irrigated agriculture	ET loses	39 BCM	51 BCM
2	Lake Nassir	Evaporation	12 BCM	

Result: Net Change in storage

Table 4: Change in water storage of Ethiopian vs Egypt Nile Sub-basins

Ethiopia's Nile sub-basin	Egypt's sub-basin
$\Delta S = (P) - (E + ET + OF)$ <p>Where:</p> <p>ΔS = Net storage P = Precipitation (i.e., Rainfalls) E = Evaporation ET = Evapotranspiration OF = Outflow</p>	$\Delta S = (P + IF + GWE + Dsal) - (E + ET)$ <p>Where:</p> <p>ΔS = Net storage P = Precipitation (i.e., Rainfalls) IF = Inflow GWE = Groundwater extraction $Dsal$ = Desalinized water E = Evaporation ET = Evapotranspiration</p>

Result: Net Change in storage

Table 4: Change in water storage of Ethiopian vs Egypt Nile Sub-basins, cont..

Ethiopia's Nile sub-basin	Egypt's sub-basin
ΔS $= (456.0 \text{ BCM}) - (5.3 \text{ BCM} + 357.0 \text{ BCM} + 81.0 \text{ BCM})$	ΔS $= (12.0 \text{ BCM} + 84.0 \text{ BCM} + 9.0 \text{ BCM} + 1.0 \text{ BCM}) - (12.0 \text{ BCM} + 39.0 \text{ BCM})$
ΔS $= (456.0 \text{ BCM}) - (5.3 \text{ BCM} + 357.0 \text{ BCM} + 81.0 \text{ BCM})$	ΔS $= (12.0 \text{ BCM} + 84.0 \text{ BCM} + 9.0 \text{ BCM} + 1.0 \text{ BCM}) - (12.0 \text{ BCM} + 13.0 \text{ BCM} + 39.0 \text{ BCM})$
$\Delta S = (456.0 \text{ BCM}) - (442.0 \text{ BCM})$ $\Delta S = 14 \text{ BCM}$	$\Delta S = (106.0 \text{ BCM}) - (64.0 \text{ BCM})$ $\Delta S = 42 \text{ BCM}$

Result: Surface Water

Table 5: Water stored on the surfaces of Egypt's and Ethiopia's Nile river basin

Lakes	Elevation	Surface area (km ²)	Average depth (m)	Volume of water (BCM)	Total (BCM)
Egypt					~138
Lake Nassir	183	5370	25	132	
Lake Idku	5	63	79	5.5	
Ethiopia					~30
Lake Tana	1788	3047	9	28.2	
Lake Fincha	2,302	239	2	0.7	

Groundwater Reserve

- Egypt is among the African countries' that has a huge groundwater reserve. It ranks 4th among the African countries; only Libya, Algeria, and Sudan have more groundwater reserve than Egypt.
- There are three major aquifers for storing the groundwater in Egypt, namely: the Nubians sandstone aquifer, the Moghara aquifer, and the Nile aquifer storing an estimated total groundwater storage of 63,200 BCM.
- On contrary Ethiopia ranking 14th, among the African countries, 9 ranks below Egypt and has an estimated groundwater reserve is in the order of 12,700 BCM of water.

Coastline water

An aerial photograph of a large dam or barrage structure spanning a wide river. The dam is a long, light-colored concrete wall with several spillways. The river flows from the top left towards the bottom right. The surrounding landscape is green and hilly. The sky is a clear, pale blue.

- A direct interface between Egypt's Nile sub-basin and Mediterranean coastal water is about 300km.
- This is a gateway for access to coastal water reserve, from which infinite freshwater can be harvested, through desalinization

Conclusion

- The water budget concept has assessed a comprehensive analysis and assessment water resources and water movements in the Nile river sub-basins of two countries.
- The net annual water storage for Egypt is, therefore, 42 BCM, indicating a clear water resource advantage over Ethiopia's 14 BCM.
- Secondly, there is 108 BCM more surface water reserve in Egypt's sub-basin compared to Ethiopia.
- Thirdly, Egypt's groundwater reserve is approximately, 400% higher than Ethiopia's.
- Lastly, Egypt has an infinite access to coastal water, which up on desalination can provide unlimited domestic water supply, compared to landlocked Ethiopia
- Therefore, it is verified that Egypt has an overwhelming water resource advantage, and that Nile water is not the only freshwater source, and so the dam is not remotely Egypt's existential threat.
- The perception pushed by Egypt that Ethiopia has a plentiful water to share Nile and/or Egypt would cease to exist with Ethiopia's dam, is mendacious.