



Enumerating the principle of equitable and reasonable water utilization of international rivers: Application to the Nile River basin

Yared G., Paul B, Getachew A, Muluneh M, Seifu A.(2020)

Key Findings

- The broad factors in the UN water convention for assigning equitable apportionment of states have been defined and applied on the Nile river.
- Priority of these defined factors were determined based on multi-disciplinary experts judgment
- Equitable and reasonable water share of riparian countries have been quantified based on Article 5 and 6 of the convention.

OUTLINES



Introduction.



Study Objective



Method



Findings

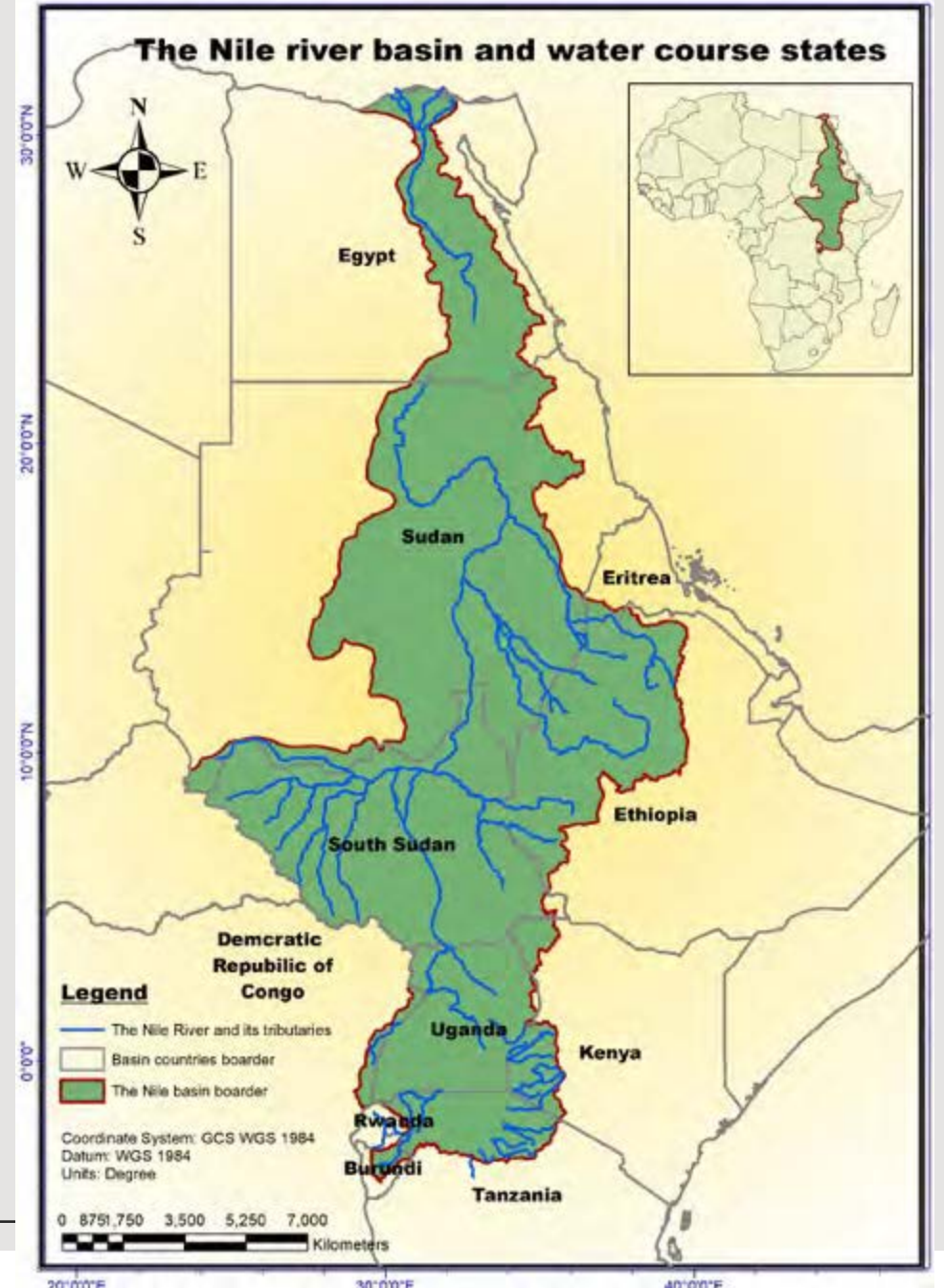


Conclusion and
recommendation



Introduction

- The Nile basin is one of longest river in the world traversing 6800km S-N.
- Originates from Ethiopian highlands and equatorial African countries.
- From 4 main sub-basins: Blue Nile, White Nile, Tekeze-Atbara and Baro-Sobat.
- Consists of 11 riparian countries.



Historic cooperation of riparian countries on Nile water

Pre-colonial

era
quantitative water
share treaty
Hydro-hegemony of u/s
states



1929

Anglo-
Egyptian

Out of 84bcm, 48bcm
allotted for Egypt, 4bcm
for Sudan & 32bcm left
without allocation



2011

GERD
Started



1959

Egypt Vs
Sudan

Out of 84bcm, 55.5bcm for
Egypt and 18.5bcm for Sudan
and 10bcm.



2015

DoP

Ethiopia, Sudan & Egypt
agreed to utilize the water
particularly in relation to
GERD based on equitable
and reasonable sharing.

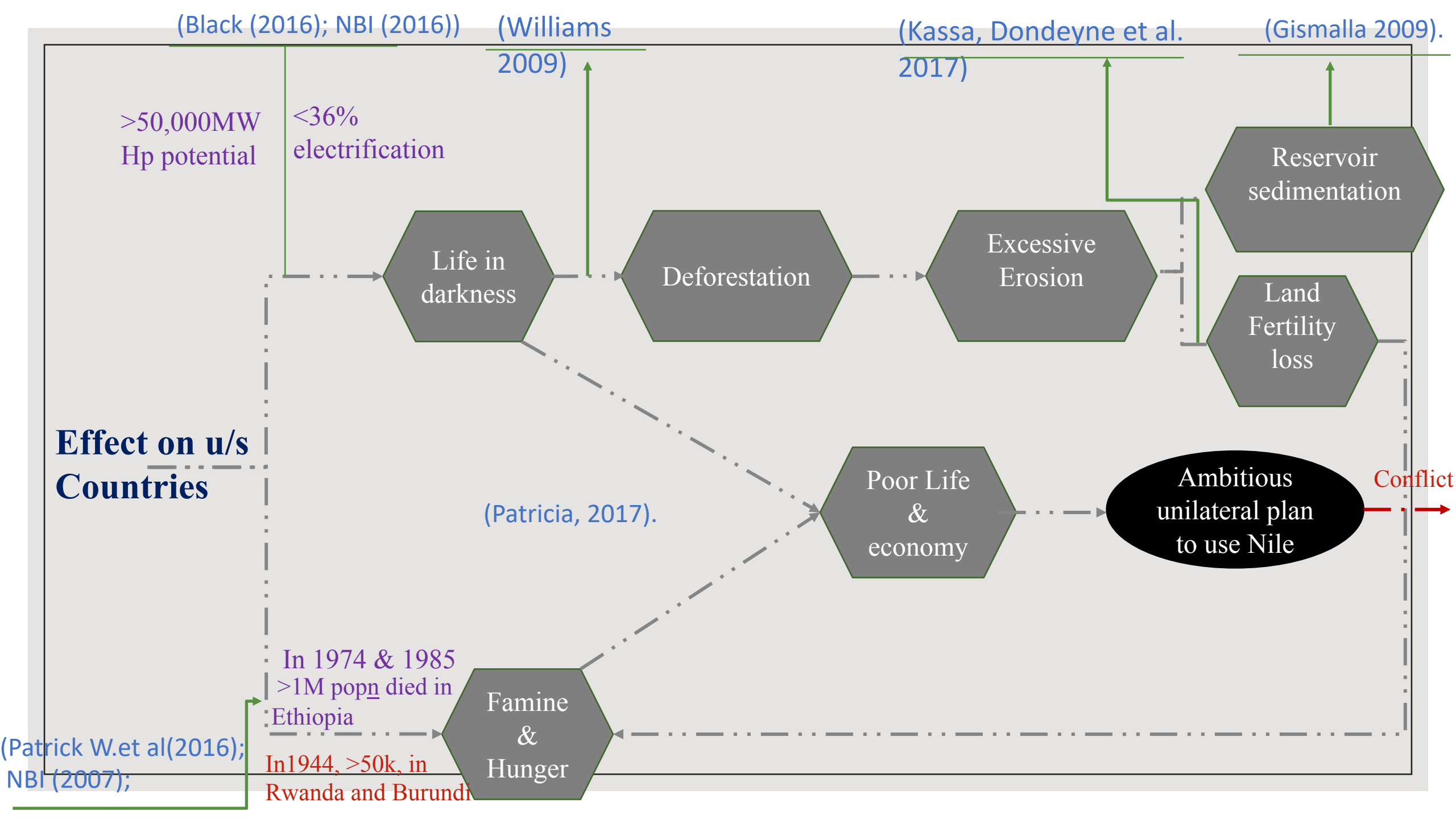


2010

CFA

Principle of
equitable
sharing agreed
by 6 u/s
countries.





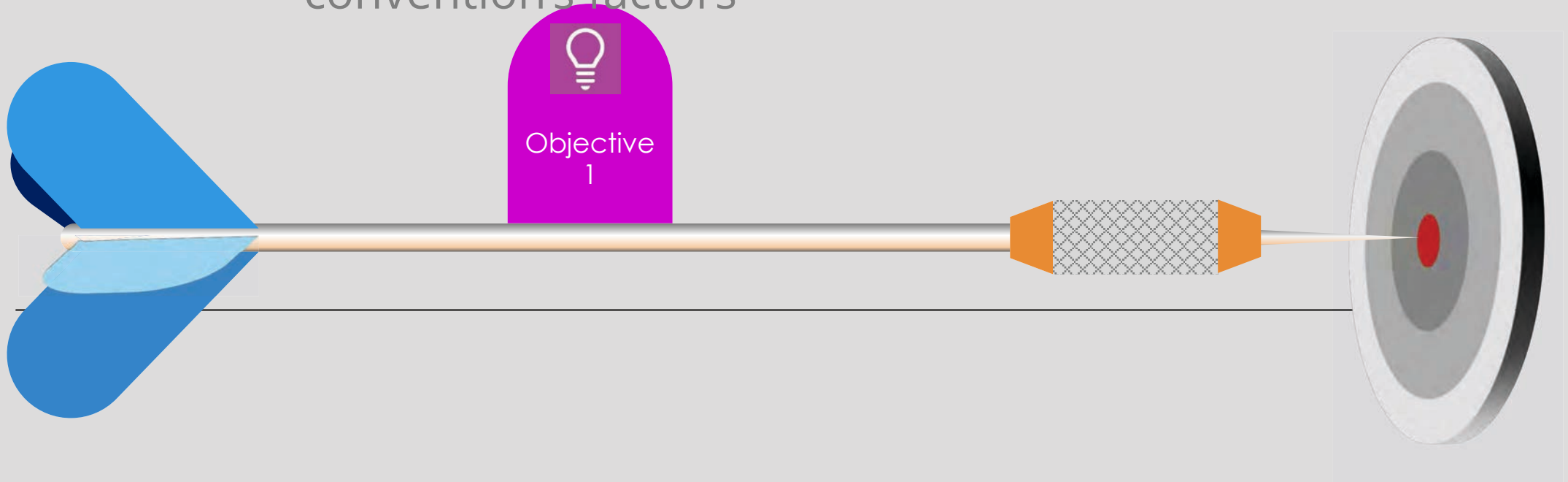
What has been done so far and gaps

- A lot of multi-objective simulation and optimization models have been employed to inform how the Nile water can be utilized and benefit can be shared among states (**technical solutions**)
- However, since a small amount of water allocation for upstream states contradicts with the colonial treaty, it is challenging to implement them.
- Moreover, even to **distribute the benefits** optimized water allocation among countries there a need to **know who owns what/how much quota** from the Nile river.
- No research attempts done to quantify the fair apportionment of states based on International laws (beyond explaining the principle of equitable and reasonable sharing).
- This is also mainly due to i)The **immeasurability broad factors** stated under international laws to implement the principle of equitable and reasonable share (*T. M. Franck, 1995*).

ii) As per art 6(2) the absence of **priority(weight)** of these factors has not been

The main objectives

- To quantify equitable & reasonable water share of riparian countries using appropriate indicators that best describes the UN convention's factors



Methodology

- The [UN water convention](#) that came into force in [2014](#) is used as a legal instrument.
 - In its part II: art- 5&6 although the convention states the principle and detail factors, however factors are immeasurable.
 - DoP and CFA are also fully adopted this principle and factors.
- These immeasurable factors under (art-6) are;
 - Natural features
 - Socio-economic need of states
 - Population dependent on watercourse
 - Effect of water use of one state on the other
 - Existing and future uses
 - Conservation, protection, devt, & economy of uses
 - Availability of alternative uses

Methodology

- For this purpose, we compiled 75 indicators which are applied in different previous studies and used by international organizations as a measure of these factors.
- Since the level of consensus among experts on these indicators were not evaluated till now, we also attempted to consult multidisciplinary experts in 5 profession living in 5 continents through survey.
- So that a cross-sectional analytical research design is employed.

Steps of the study

Designed & distributed a pairwise comparison of factors to determine their weight.

Equitable and reasonable water sharing model is developed.

step1

Step2

Step3

step4

Step5

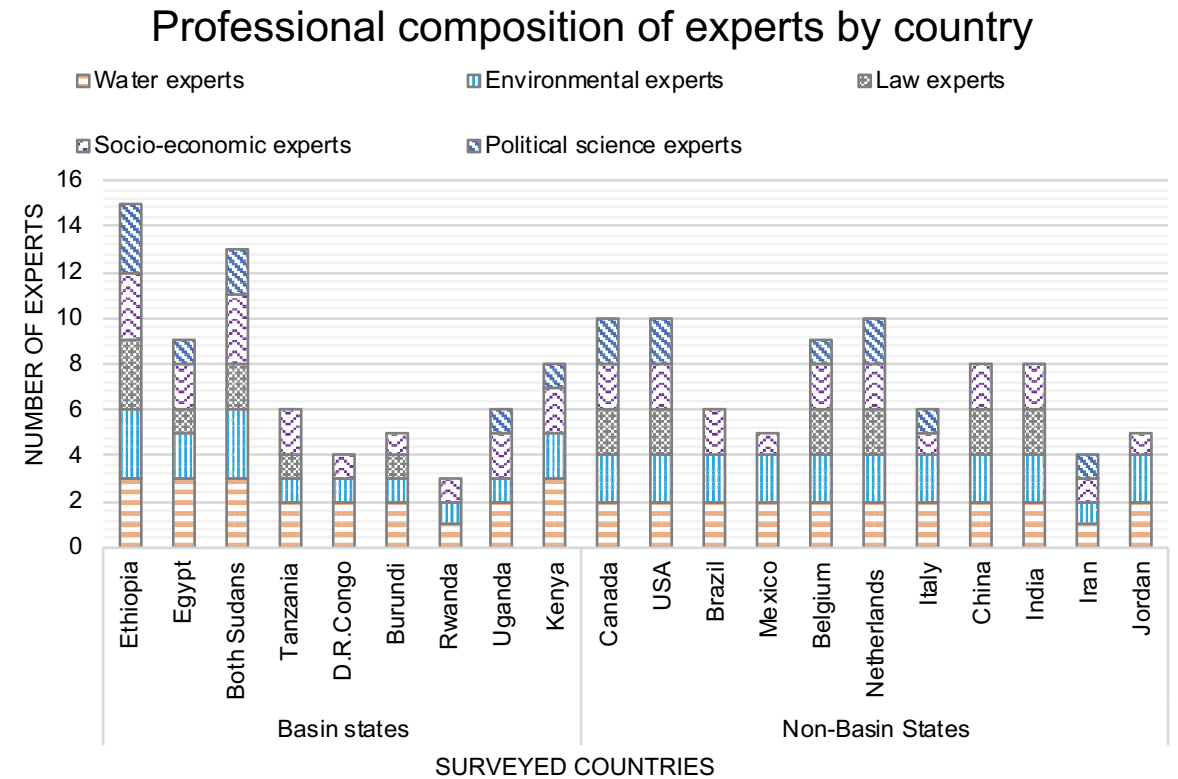
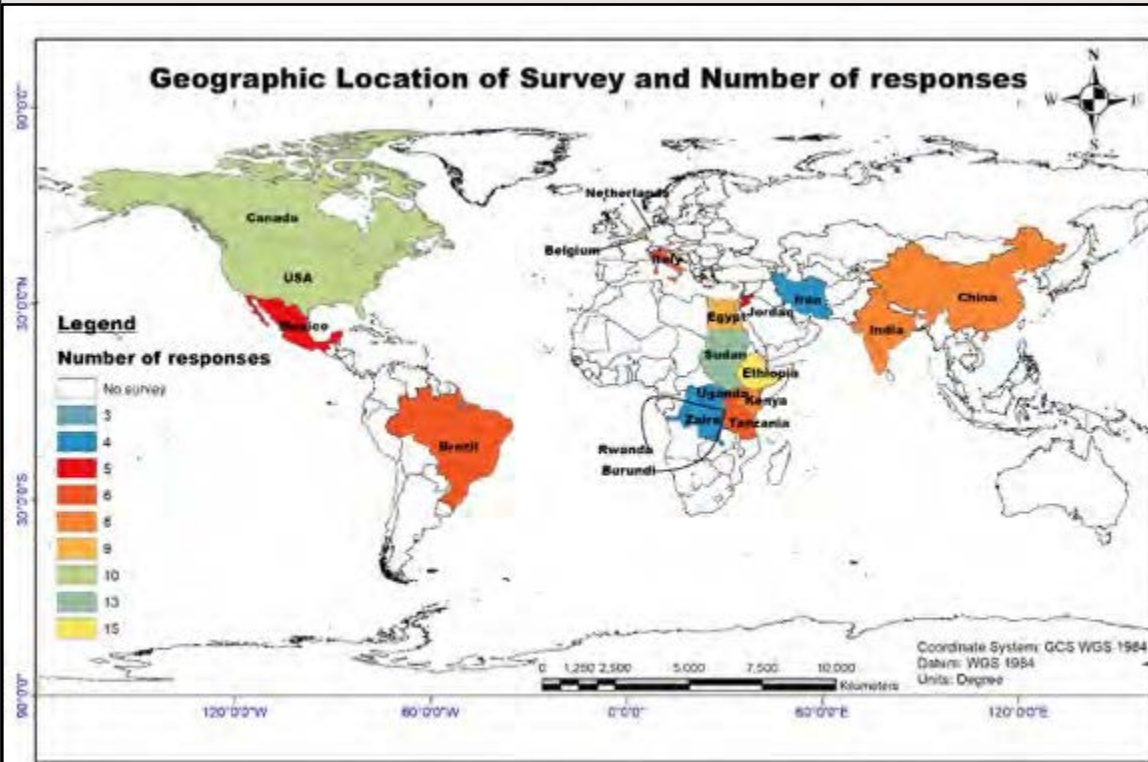
A Likert scale questionnaire was designed & distributed for 215 multi-disciplinary experts

Relevant indicators on which experts agreed and factors weight have been determined (FAHP).

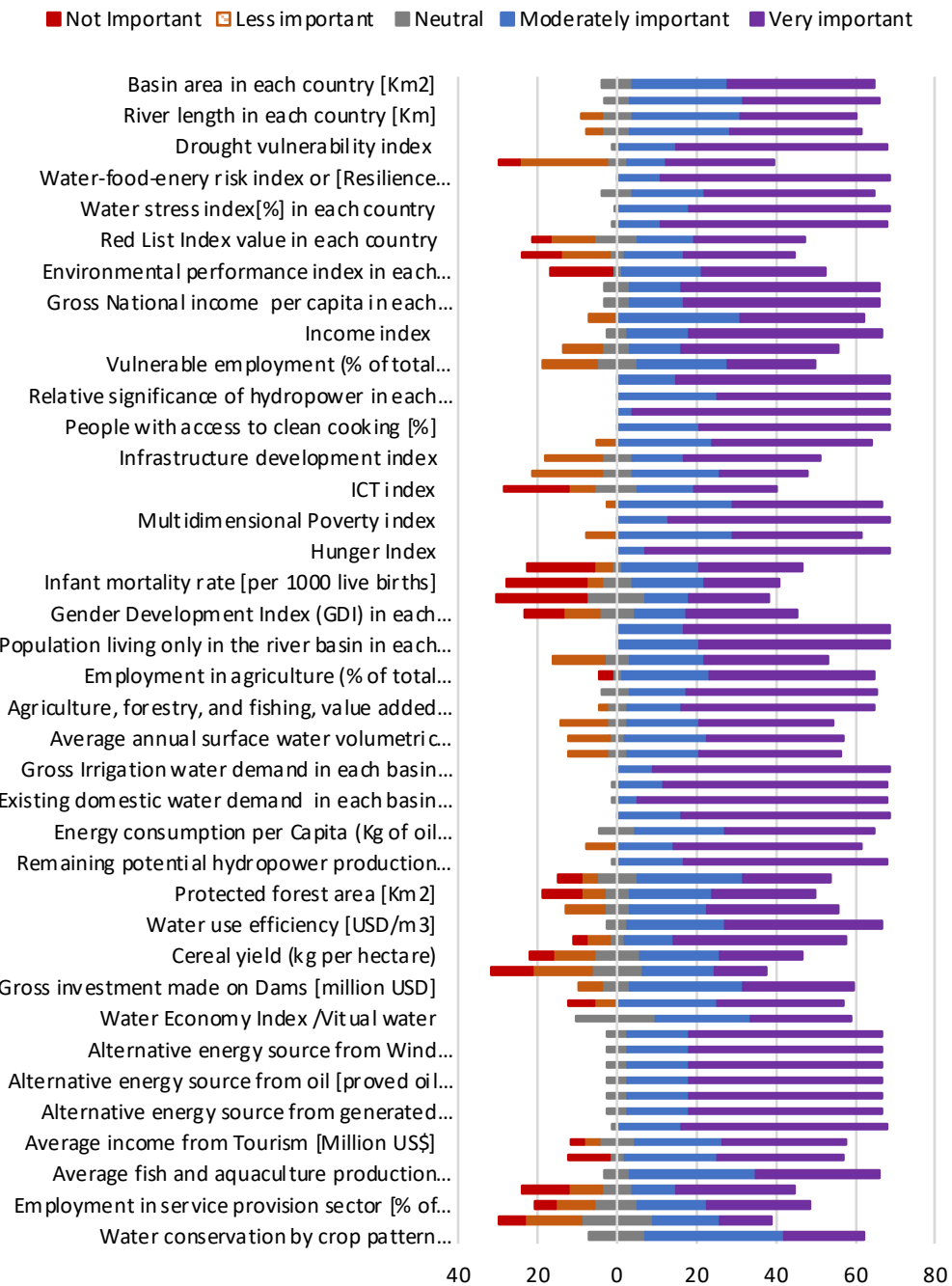
States water apportionment from the 4 sub-basin have been computed

Findings

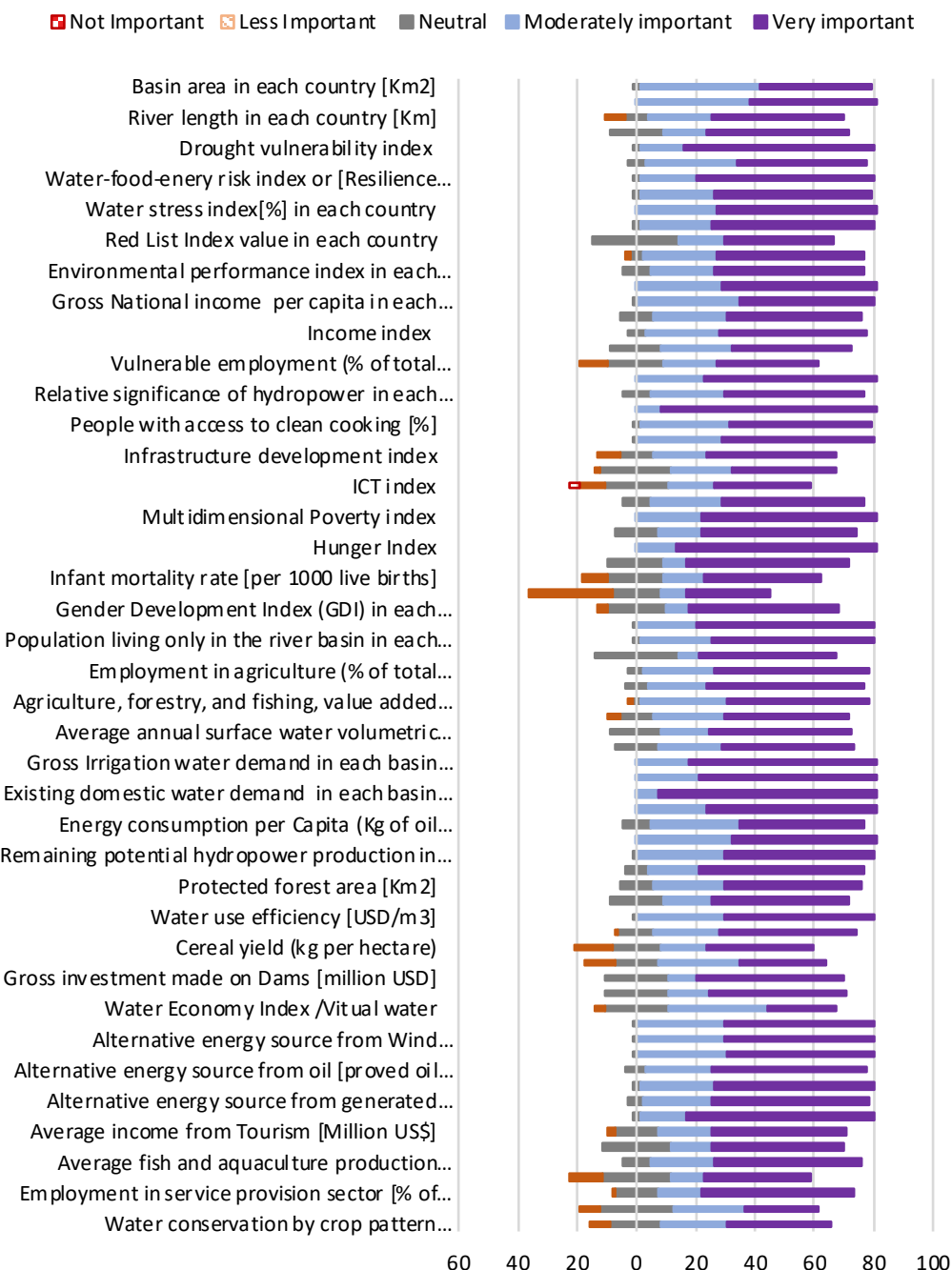
- Survey result = 151/215 response was collected.



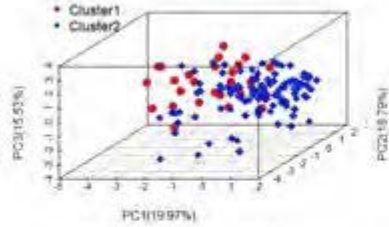
Response of Experts from the Basin Countries



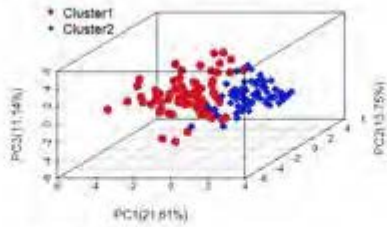
Response of Experts from the Non-Basin Countries



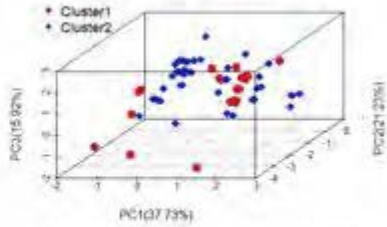
Cluster of principal components for Factor #1



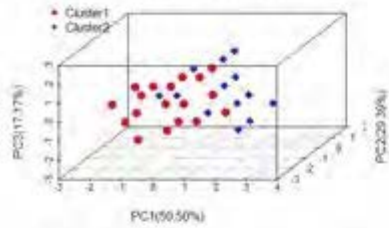
Cluster of principal components for Factor #2



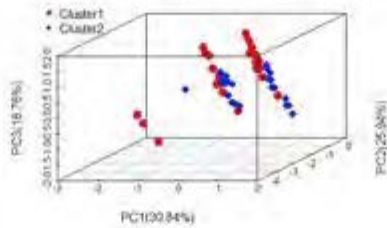
Cluster of principal components for Factor #3



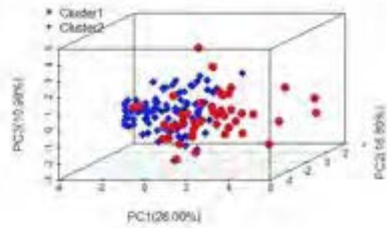
Cluster of principal components for Factor #4



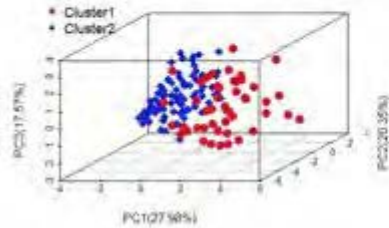
Cluster of principal components for Factor #5



Cluster of principal components for Factor #6

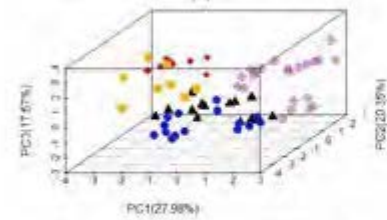


Cluster of principal components for Factor #7

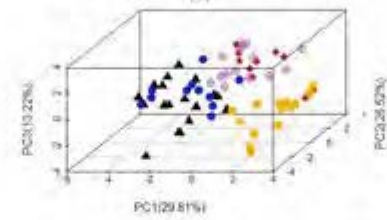


A Cluster Based on basin vs non-basin

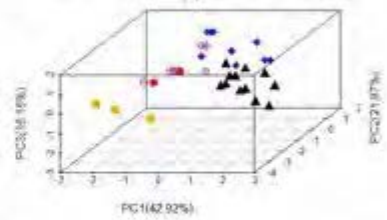
Cluster of principal components for Factor #1 (a)



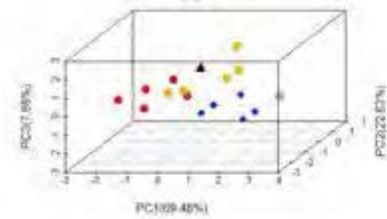
Cluster of principal components for Factor #2 (b)



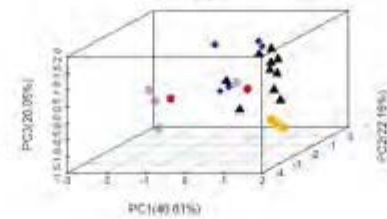
Cluster of principal components for Factor #3 (c)



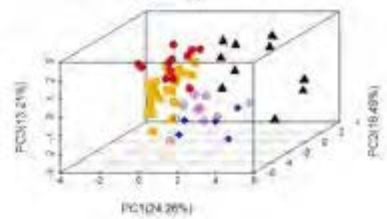
Cluster of principal components for Factor #4 (d)



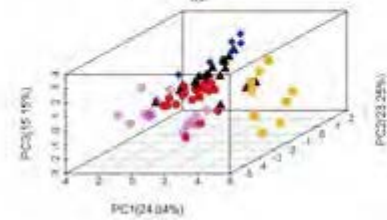
Cluster of principal components for Factor #5 (e)



Cluster of principal components for Factor #6 (f)

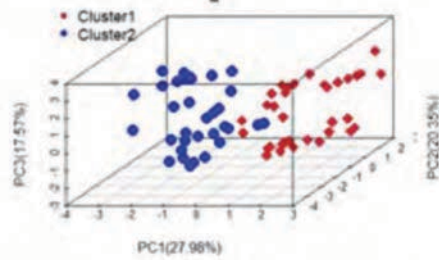


Cluster of principal components for Factor #7 (g)

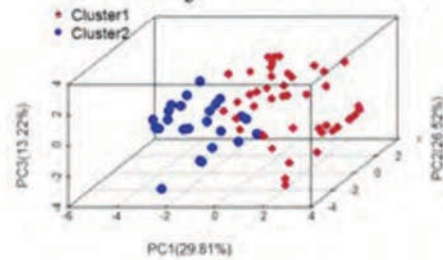


A Cluster Based on profession

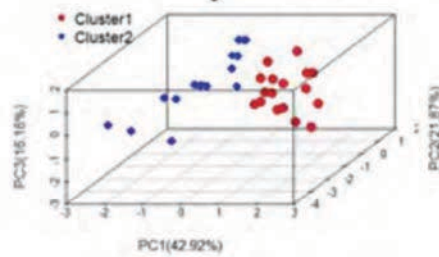
Cluster of principal components for Factor #1



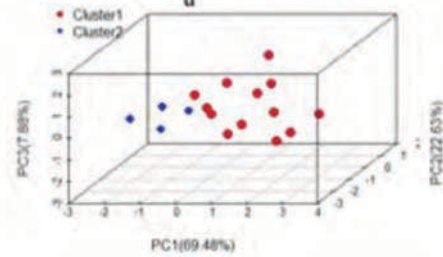
Cluster of principal components for Factor #2



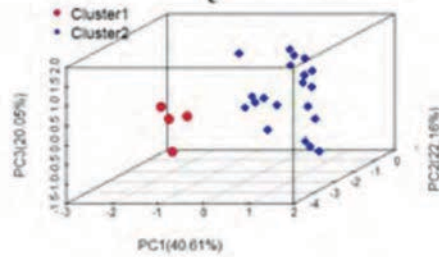
Cluster of principal components for Factor #3



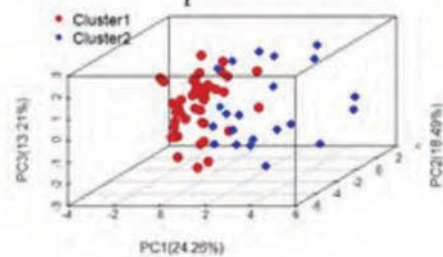
Cluster of principal components for Factor #4



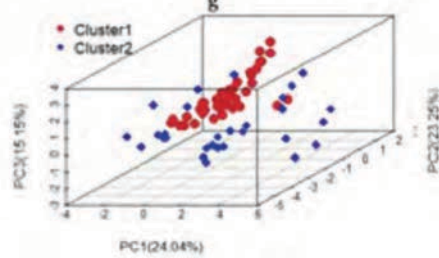
Cluster of principal components for Factor #5



Cluster of principal components for Factor #6

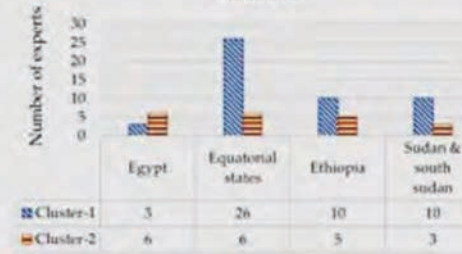


Cluster of principal components for Factor #7



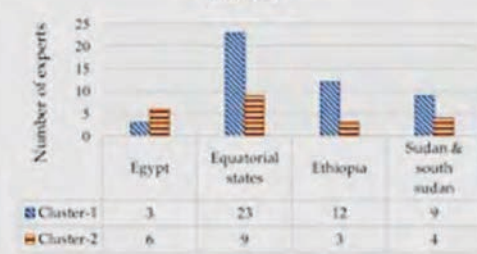
A Cluster Based on hydrologic position

Factor-#1



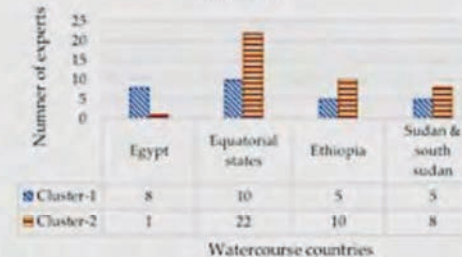
Watercourse Countries

Factor-#2



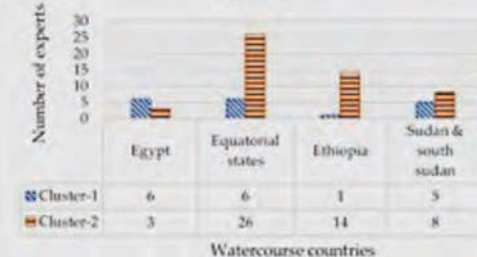
Watercourse countries

Factor-#3



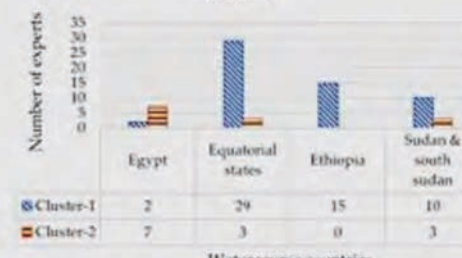
Watercourse countries

Factor-#4



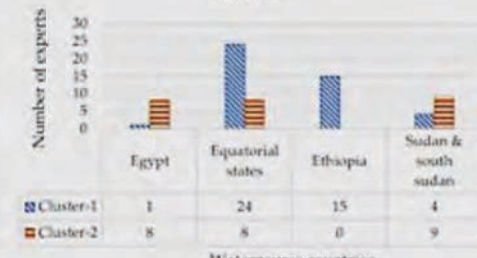
Watercourse countries

Factor-#5



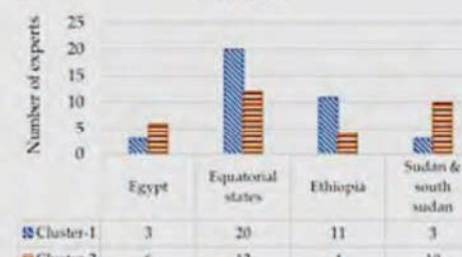
Watercourse countries

Factor-#6



Watercourse countries

Factor-#7



Watercourse countries

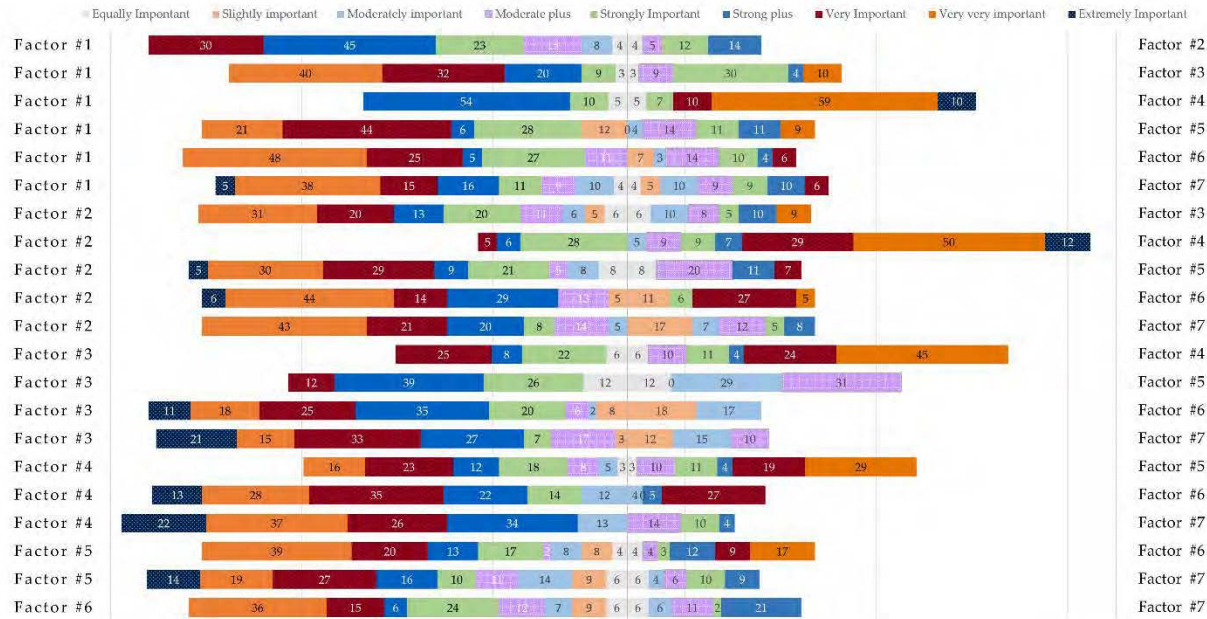
Number of experts grouped in each cluster

Findings....

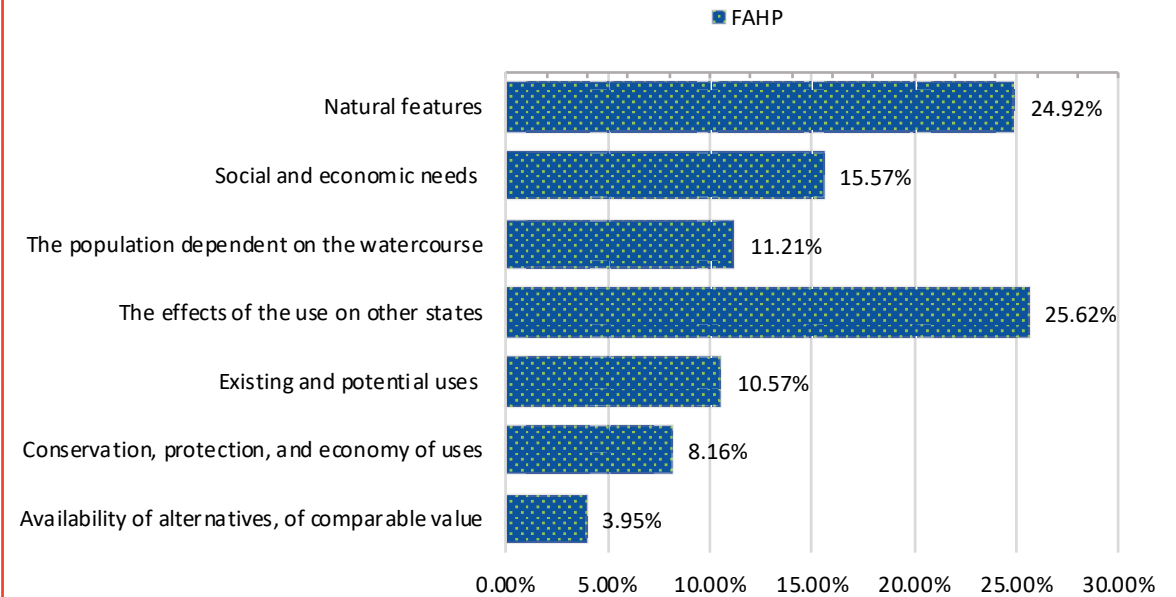
- Therefore, based on ANOVA and t-test, experts had no significant difference on 56 of 75 indicators within, between and among basin and non basin states.
- So that 56 indicators were labeled as very important indicators.
- 9 indicators was labeled as moderately important and
- 10 indicators was categorized as less important.

Results of the pairwise comparison survey

Summary of experts judgment on the pairwise comparison of relevant factors



Weight of Relevant factors



Sample Analysis

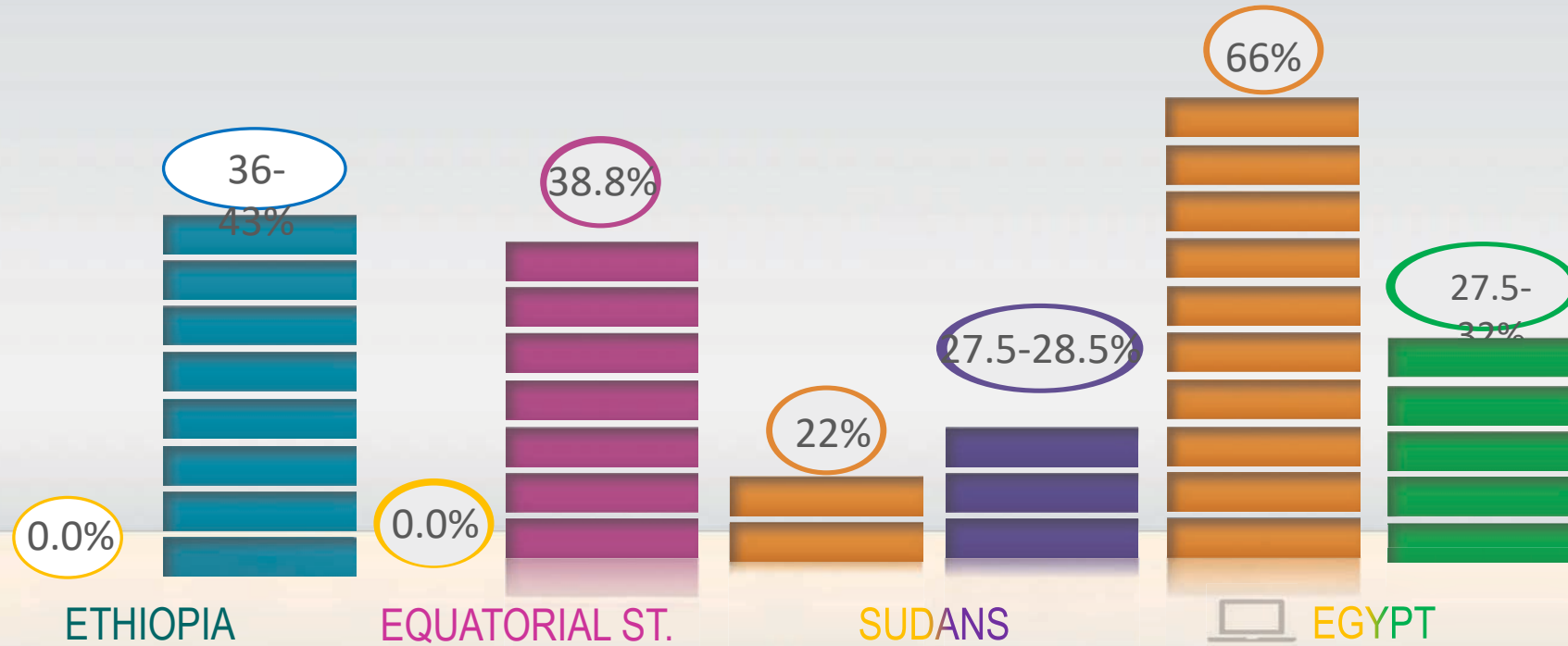
$$P_{cj} = \sum_1^n \left(W_{ij} \left(\frac{S_{ci}}{\sum S_{Ti}} \right)^{\pm 1} \right)$$

Assigned Letter	Description of Major and Sub-Factors	Indicators/Proxy/ of factors	Indicator relations hip with score	Weights by AHP	SCORE OF EACH STATES IN DIFFERENT TIME SCALE				Weighted average share of White Nile for each basin countries			
					EGYPT	ETHIOPIA	SUDAN	TOTAL	EGYPT	ETHIOPIA	SUDAN	Sum
A	Natural features			24.92%								
A1	Geography	Basin area in each country [Km2]	Direct	2.27%	302,452	365,318	1,396,230	2,064,000	0.003	0.004	0.015	0.023
-	-	The whole area in each country [Km2]	Direct	2.27%	996,960	1,144,035	1,864,049	4,005,044	0.006	0.006	0.011	0.023
A2	Hydrography	River length in each country [Km]	Direct	2.27%	1,747	1,321	2,827	5,895	0.007	0.005	0.011	0.023
A3	Climate conditions	Köppen Aridity Index (Precipitation/Temperature+33) in each country	Reverse	2.27%	0	21	4	26	0.020	0.000	0.002	0.023
-	-	Median Drought vulnerability index	Direct	2.27%	0	1	1	2	0.003	0.011	0.009	0.023
-	-	Water-food-energy risk index or [Resilience Index]	Reverse	2.27%	2	3	2	7	0.010	0.005	0.007	0.023
A4	Hydrology	Annual surface water contribution of each countries [Bm3/year]	Direct	2.27%	0	53	0	53	0.000	0.023	0.000	0.023
-	-	Water stress index[%] in each country	Direct	2.27%	117	32	119	268	0.010	0.003	0.010	0.023
A5	Ecology and Environment	95% time flow exceeded minimum environmental flow with moderate mana	Direct	2.27%	1,233	652	989	2,874	0.010	0.005	0.008	0.023
-	-	Total greenhouse gas emissions (kt of CO2 equivalent) in each country	Reverse	2.27%	295,500	185,292	491,982	972,774	0.007	0.011	0.004	0.023
-	-	Envirnomenta performance index in each country	Direct	2.27%	43	34	35	113	0.009	0.007	0.007	0.023
B	Social and economic needs of the watercourse States concerned			15.57%								
B1	Economic and trade Status	GDP per capita in each country [Current \$]	Reverse	0.82%	3,020	858	781	4,658	0.001	0.003	0.004	0.008
-	-	Gross National income per capita in each country [\$]	Reverse	0.82%	11,350	2,140	4,430	17,920	0.001	0.005	0.002	0.008
-	-	Exports and imports trade (% of GDP)	Reverse	0.82%	48	31	23	102	0.002	0.003	0.004	0.008
-	-	Income index	Reverse	0.82%	1	0	1	2	0.002	0.003	0.003	0.008
B2	Work employment and vurnerability	Unemployment in the basin in each country [%]	Direct	0.82%	11	2	17	29	0.003	0.001	0.005	0.008
-	-	Vulnerable employment (% of total employment)	Direct	0.82%	21	86	50	157	0.001	0.004	0.003	0.008
B3	Social and economic sustainability	Population with access to electricity [%]	Reverse	0.82%	100	45	60	205	0.002	0.004	0.003	0.008
-	-	Relative significance of hydropower in each Nile basin countries[%]	Direct	0.82%	12	95	49	156	0.001	0.005	0.003	0.008
-	-	Population using basic drinking-water supply [%]	Reverse	0.82%	99	41	60	200	0.002	0.004	0.003	0.008
-	-	People with access to clean cooking [%]	Reverse	0.82%	98	4	41	143	0.000	0.007	0.001	0.008
-	-	Water supply and sanitation index	Reverse	0.82%	99	40	67	205	0.002	0.004	0.002	0.008
					100%				0.295	0.430	0.270	1.00

~~The outcomes of water apportionment~~



Comparison with colonial treaty



Colonial treaty
apportionment

Conclusion

- From the above analysis two challenges were observed,

1. The existing water allocation (colonial treaty) is definitely unfair to upstream countries,

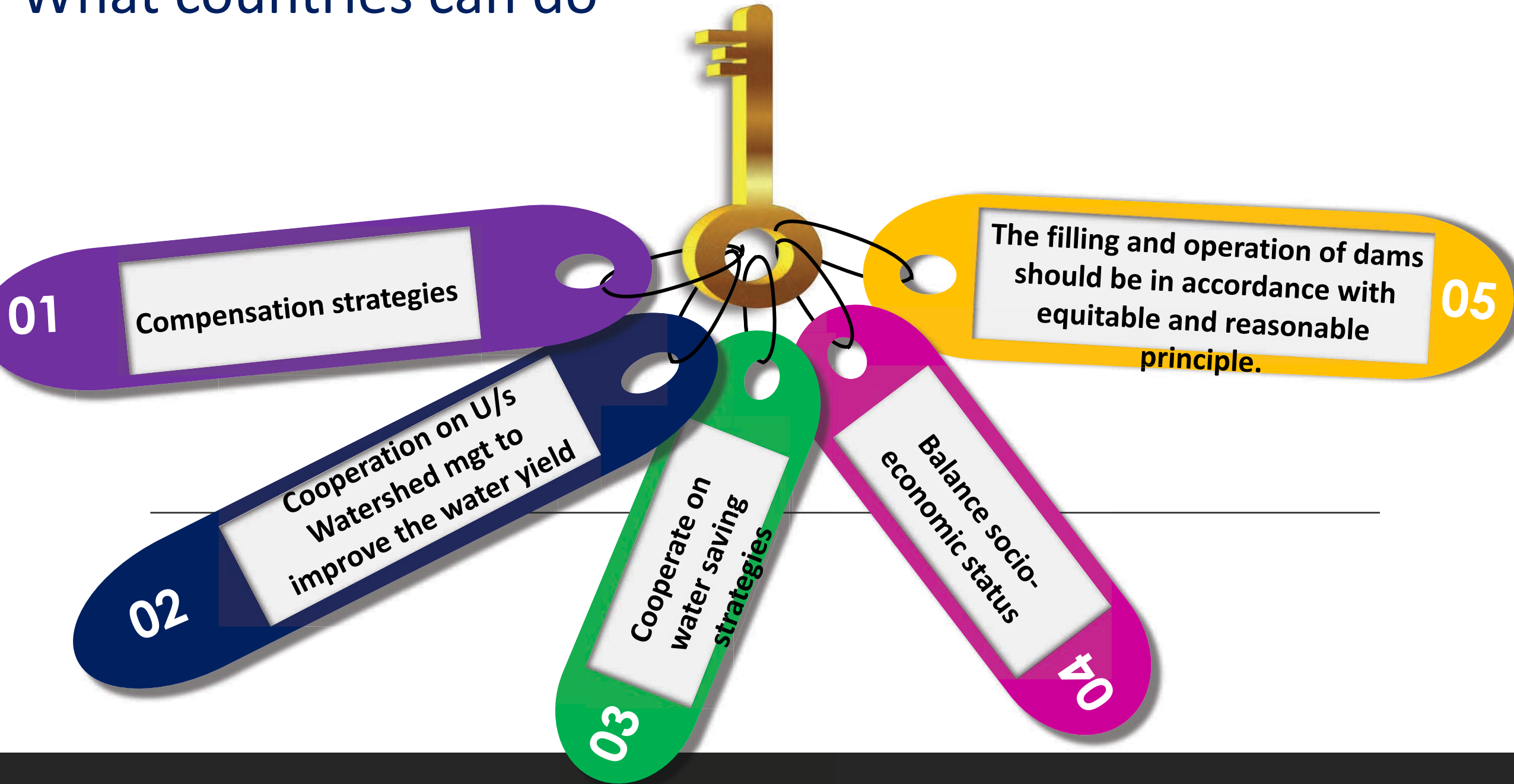
“The refusal or unwillingness either to amend (i.e. reduce) the existing use or to enter into negotiations with a genuine view to achieve an equitable result may be interpreted as a breach of its international legal obligations”(UNWC guide, pp115)

Conclusion

2. Although the principle of equitable & reasonable water sharing is expected to redistribute the monopolized water quota to all states, however, as compared to a 55 bcm irrigation plus 10cm for Industrial and municipal use, cutting the Nile water by more than half of its previous share can cause an of extreme water stress.

For this reason, since it is illegal to ban upstream countries for the benefit of one country, and it also not acceptable to significantly cut the river flow that goes to downstream, states should enter into negotiation in the following way;

What countries can do



The end

*Thank
You*