Water Resources Data for Nile Basin

By Dr. R.J. Mngodo,
Water Resources Division,
Ministry of Water & Livestock Development
Tanzania

1.0 BACKGROUND

The Nile Basin countries have been able to assemble together historical data into a single database in a bid to come up with a tool for multi objective water resources allocation decision-making, Decision Support System (DSS). This tool was developed to support water resources planning and management in a river basin.

This is considered as a major achievement for 9 countries (Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda) to be able to put their data in one database (see Figure 1). Sharing transboundary waters require a transparent system for enabling sustainable use of the resource. It is with the use of such a tool as the DSS that the response of the basin can be processed and quantified for alternative weather, demand and management scenarios. Water uses in a basin include domestic water supply, abstraction for irrigation, flood and drought protection; energy generation; environmental and ecosystem management; recreation; and navigation.

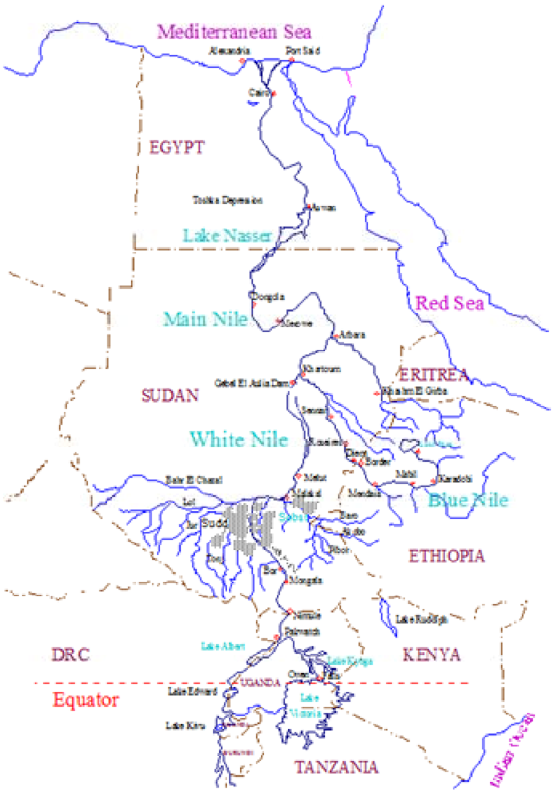

Figure 1. The Nile River Basin States

The Decision Support System is useful for planning and operational purposes: Planning level and Operational level. At planning level impacts of various river/reservoir regulation policies may be derived. In the operational level, tradeoffs between water withdrawal for irrigation and other uses and hydropower generation may be assessed. The impact of these tradeoffs between competing users may provide information that can assist decision makers to formulate better water management strategies for a river basin (Mngodo and Sadiki, 2001).

It is important to note that for one to be able to decide on riparian rights, water markets and social and environmental responsibilities, it is necessary to accurately monitor the behaviour of the hydrological cycle so that decision makers can appreciate the hydrological context of their economies from both the national and international perspectives. This is particularly important for those that share river basins and aquifers. It is important that decision makers understand that when the limits of water resources are being reached it is necessary to begin thinking in terms of "what can we do with what we have", rather than " what would we like to do". This is where the concept of the "economic value" of water becomes a key issue.

Planning authorities need to know when they are reaching the limits of water resource supply so that they can begin planning inter-basin water transfers, or implementing new financial and economic incentives to encourage industry to recycle water, and agriculture to use water more efficiently (Georgakakos *et al*., 2002). To be able to make all these decisions, those responsible for economic and financial analysis must be provided with scientifically accurate hydrological information whenever it is required. Therefore hydrological services and water management agencies must have the technical means and institutional capacity to monitor and assess water resources quantitatively and qualitatively in function of this new demand for market information, upon which billions of dollars of decision-making will rest. This is the challenge for the hydrologic and water resources management profession and the justification for developing the art of applied hydrology for water resources management.

2.0 METHODOLOGY

Water resources data from Nile Basin countries is used to demonstrate the available opportunities for socio-economic activities development in the Nile Basin that includes domestic water supply, agriculture, and hydropower. By using the Nile Decision Support Tool (Georgakakos and Yao, 2003), different scenarios of water development and management are examined. The scenarios include:

1. The effect of Water Withdrawal in Southern Nile on outflow of five nodes; Pakwatch, Torrents, Mongala, Sudd and Sobat. An amount of 2 billion cubic meters (BCM) is abstracted without and without the Jonglei canal. In another scenario, 14BCM is abstracted without and without the Jonglei canal. All these cases are compared with the default condition of natural flow. The results of this investigation are shown in Table 1 and on Figure 2.

2. The effect of water withdrawal from Lake Tana for power generation as well as the outflows from Lake Tana and other dams down stream along the Blue Nile is also investigated.

3. Investigation on agricultural productivity is done using the LVDSS. Yield of maize with respect to season and location in Lake Victoria Basin is determined for a number of sites and a spatial distribution of the yield was drawn using Arc View GIS.

3.0 RESULTS

The results of water withdrawal from Lake Victoria for irrigation considering the downstream water uses, with and without the Jonglei Canal, are presented in Table 1 and Figure 2. Withdrawal of water upstream of the nodes has reduction effect downstream, where significant withdrawal shows significant reduction of flow. Introduction of the canal allows water to flow faster as it bypasses the swamp at the Sudd.

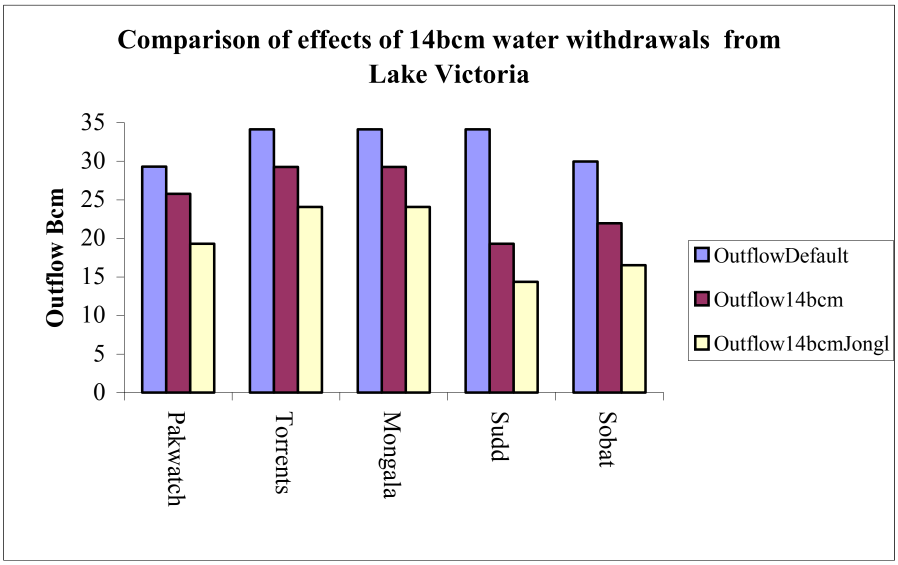

Figure 2. Comparison of effects of 14bcm water withdrawals from Lake

Table 1 Withdrawal in Southern Sudan

NodeName	Outflow Default	Outflow 2BCM	Outflow 2BCM+Jonglei	OutFlow 14BCM	Outflow 14BCM+Jonglei
Pakwatch	29.317	27.475	27.475	25.773	19.283
Torrents	34.128	32.286	32.126	29.283	24.101
Mongala	34.128	32.286	32.286	29.283	24.101
Sudd	34.128	32.286	31.922	19.292	14.378
Sobat	29.958	29. 668	29. 413	21.966	16.521

Eastern Nile case

The Eastern Nile Region has great potential for agriculture and hydropower development. The effect of water withdrawal for irrigation was investigated at two locations in the Eastern Nile region: Lake Tana as well as at Border Dam.

On applying different levels of withdrawals from Lake Tana (Table 2), power generation is reduced as well as the outflows from Lake Tana and other dams down stream along the Blue Nile are affected. The results are shown graphically in Figures 3-6. In the second case a number of water withdrawals (Table 3) that were applied from Border dam also have affected power generation as well as the outflows downstream along the Blue Nile. All scenarios of withdrawals were compared with the default scenario, which does not have any new withdrawals.

Table 2 Effect of different levels of withdrawal from lake Tana

Withdrawal (bcm)	Energy Reduction(%)	Total Energy Reduction(%)	Total outflow Reduction(%)	Withdrawal Deficit(%)
0	0	0	0	0
1	10.9	3.2	3.1	0
2	39.1	7.3	6.3	0
3	67.2	11.5	9.6	0
4	94.9	15.5	12.5	0.1
5	100	16.3	13	3.40

Table 3 Effect of different levels of withdrawal at Border Dam

Withdrawal (bcm)	Energy Reduction(%)	Total Energy Reduction(%)	Total outflow Reduction(%)	Withdrawal Deficit(%)
0	0	0	0	0
5	10.4	2.7	6.7	0
10	20.6	5.6	13.3	0
20	30.4	8.6	20.0	0.1
25	39	11.8	25.7	1.7
30	47.6	31.3	29.2	15.9
40	48.3	62.0	15	50.1
45	54.3	66.2	13.8	56.4

The graphical presentation of the effect of withdrawal of water at different locations is presented below.

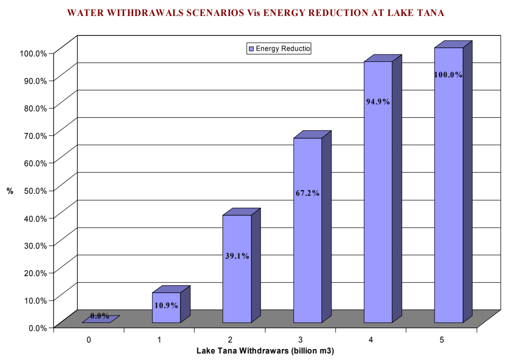

Figure 3 Water withdrawal vs energy reduction at Lake Tana

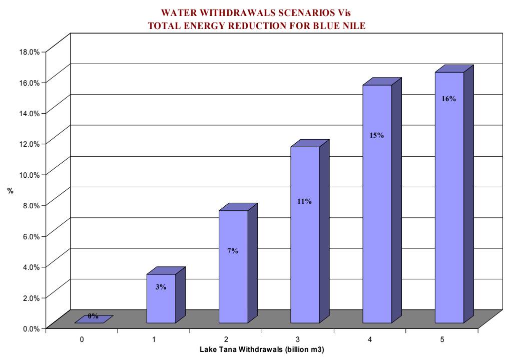

Figure 4 Water withdrawal vs total energy reduction for Blue Nile

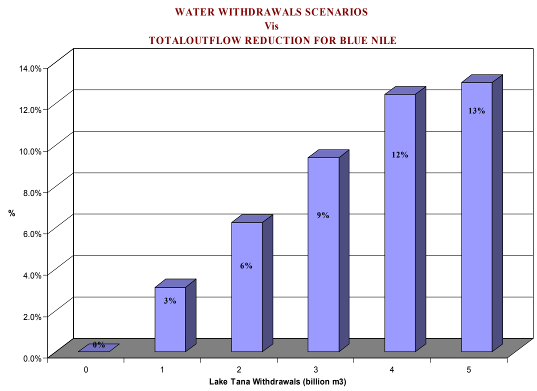

Figure 5 Water withdrawal vs energy reduction at Lake Tana

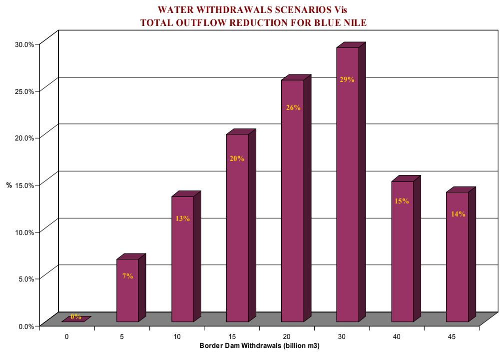

Figure 6 Water withdrawal vs energy reduction at Lake Tana

Crop yield in rainfed conditions

Maize yield in Lake Victoria Basin was investigated using two seasons and considering the wet and dry years. After exploring different locations by using the LVDSS, which considers the rainfall, soil type, elevation and moisture condition as part of the input parameters, spatial distribution of the yield plotted in Figure 7 reveals the suitability of planting maize in rainfed conditions; some parts have good yield during long rains and in both dry and wet years, but other areas as can be seen in Figure 7, respond well during short rains.

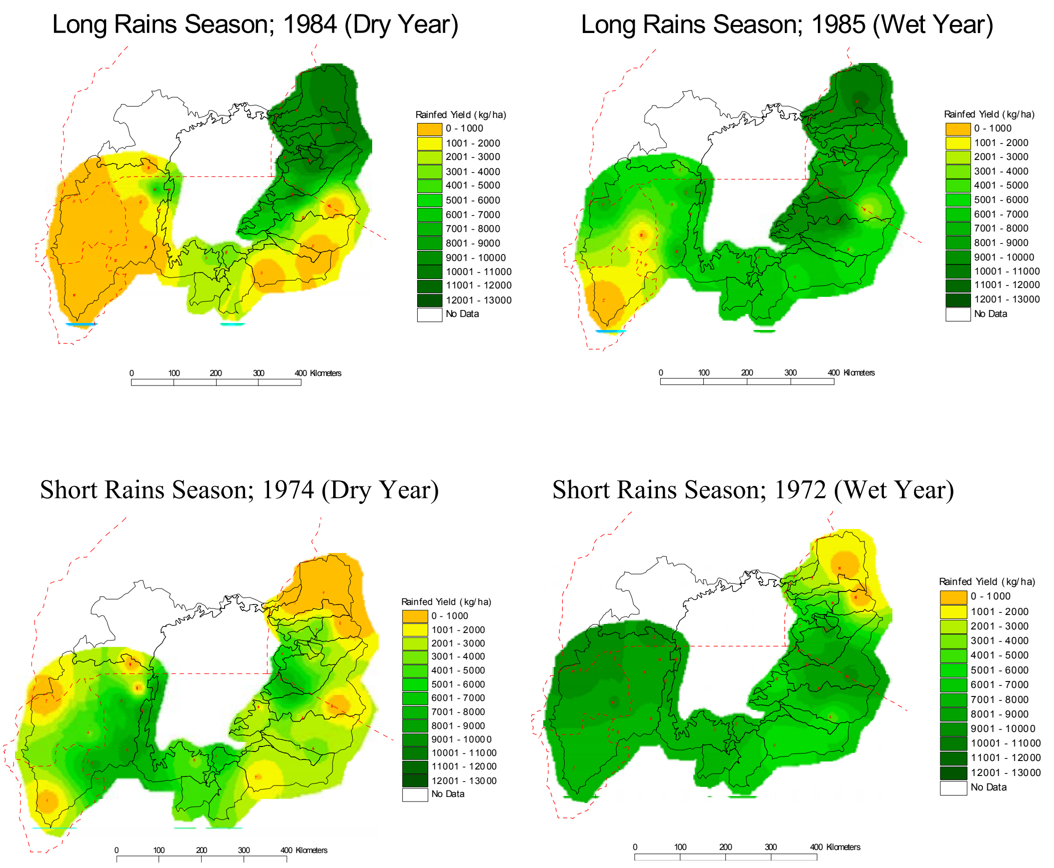

Figure 7 Rainfed maize yield for different seasons for Lake

4.0 DISCUSSION

The scenarios of water withdrawal from Lake Tana have shown that there is significant effect at Lake Tana when large quantity of water is withdrawn. Water withdrawal from Border dam beyond certain limit, which always have to be optimized, would have significant effect to all dams that are downstream of it. Such kind of analysis is necessary before any sizable project is to be implemented. Water withdrawal also affects power generation but cost benefit analysis can be done to assess the optimal decisions.

The investigation of agricultural productivity based on analysis of rainfed maize yield for different seasons around the Lake Basin shows the western part of the basin has poor yield of maize during long rain season on a dry year but high yield is achieved during short rain season on a wet year. The north eastern part of the basin always have high yield of maize during wet season while poor yield happens during short rain season. With such results, agricultural zones can be demarcated in order to know which crop is suitable for different areas. Also water requirements for irrigation can be determined for respective season for each part of the Lake Basin.

5.0 CONCLUSIONS

The availability of analysis tools where data is commonly stored and shared enables meaningful solutions to be obtained objectively among riparian countries in the basin. Irrigation requirements for different crops can be determined using the already developed tools such as LVDSS and DST. The availability of a well-defined cooperative framework within the Nile basin can be a good basis of using the available water resources in an equitable manner by using the already developed analysis tools and others that will be developed. Data sharing protocols is a good means of facilitating future use of water resources in an equitable and sustainable manner in this region.

6.0 ACKNOWLDEGEMENT

The author wishes to thank all modellers from Lake Victoria Basin States and the Nile Basin States and the Georgia Tech team who participated in the development and testing of LVDSS and Nile DST.

7.0 REFERENCES

Georgakakos A, Bourne S. Brumbelow K, De Marchi C and Yao H., 2002. Lake Victoria Decision Support System,Version 2.0, Georgia Water Resources Institute *Atlanta, Georgia 30332-0355, USA*

Georgakakos A and Yao H., 2003. Nile DST User Manual, River and Reservooir Simulation, Georgia Water Resources Institute *Atlanta, Georgia 30332-0355, USA*

Mngodo R.J. and Sadiki H, 2001. Multi-objective Water Resources Allocation Decision Making. *Paper presented at Working Meeting on Environmental Water Use*, Dar es Salaam, March 5, 2001