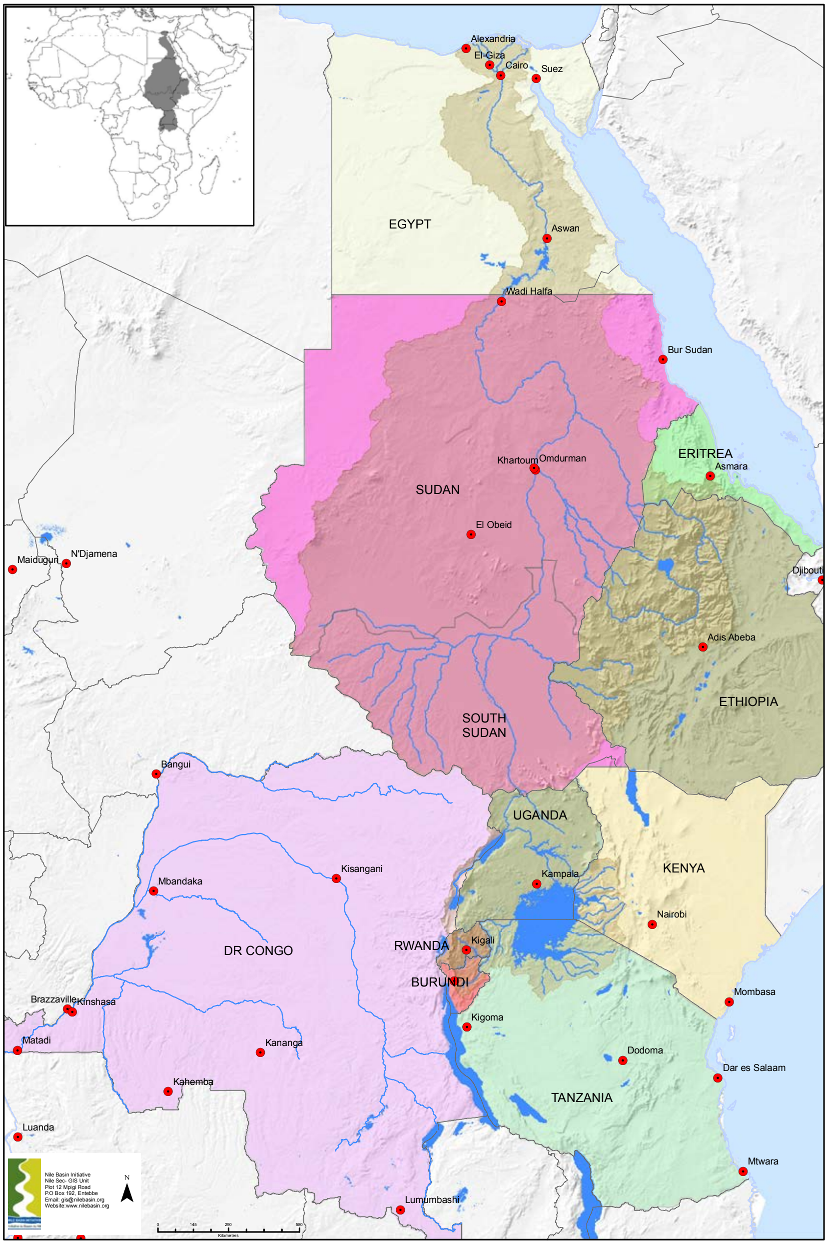
NILE BASIN INITIATIVE

THE NILE BASIN DECISION SUPPORT SYSTEM

BEST NATIONAL APPLICATION CASES 2015

THE NILE BASIN COUNTRIES



ABBREVIATIONS AND ACRONYMS

NB-DSS	Nile Basin Decision Support system
MCA	Multi criteria analysis
NBI	Nile Basin Initiative
RNRA	Natural resources Authority
GERD	Ethiopian Grand Renaissance Dam
IDB	Internal Drainage Basin
IDBWB	Internal Drainage Basin Water Board

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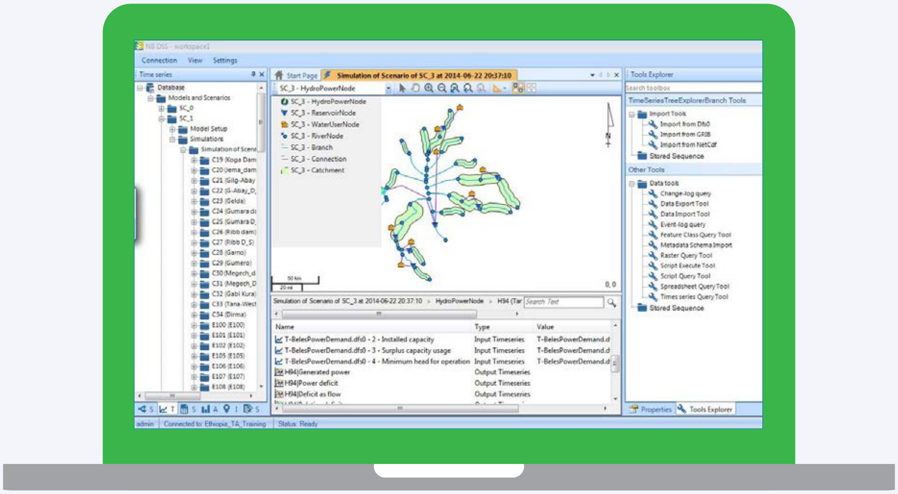

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Introduction

This booklet showcases winning NB-DSS National Application Cases for the year 2015.

In order to acknowledge, grant and support users of the NB-DSS for growing applications, informative case studies and profound contribution to the sustainable management of the Nile Basin Water resources, the NBI Secretariat organized the first ever NB-DSS Application Awards . The objective of the annual Award is also to document and promote the use and applicability of the NB-DSS as well as to strengthen its user community.

Habtam Achenef of Abby Basin Authority in Ethiopia won the top prize for his application of NB-DSS to support development of the Lake Tana Basin Integrated Water Resources Plan. The 1st runner-up prize went to both Omar Munyaneza from Rwanda and George Owiti from Kenya. Munyaneza used the tool to model the Sebeya dam for flood control in the Sebeya River Catchment, Rwanda while Owiti applied the tool to address water management issues in the Nyando catchment, Kenya. Bugingo Davis won the 2nd runner-up prize in recognition of his application of the NB-DSS for supporting water permit system in the Mukungwa catchment, Rwanda.

Members from the countries that participated in the user community workshop.

About Nile Basin Decision Support System

The NB-DSS was designed to meet the requirements of complex water resources planning. It provides diverse toolsets for data processing, modeling, scenario management, optimization and multi-criteria decision making.

If offers tools for integrating environmental, social and economic objectives thus greatly facilitating multi-sector water resources planning at river basin level.

The DSS is a generic system that can be applied at different scales both national and Transboundary levels. It can be installed both within an institutional setup, thereby allowing multiple access to its central database and toolset and also as a stand alone solution.

NBI has enhanced the DSS tool with additional features, acquired other 300 licenses, offered user training manuals and standardized training modules for the countries. The countries have used the tool to answer questions about expected benefits and potential impacts of the planned development interventions.

> ***"It provides diverse toolsets for data processing, modeling, scenario management, optimization and multi-criteria decision making."***

COUNTRY: ETHIOPIA

Title of Study: Integrated Water Resources Planning for Upper Blue Nile Basin, Tana Sub Basin using Nile Basin Decision Support System (NB-DSS)

Ministry/Agency directly benefiting from the case study: Abby Basin Authority

Introduction:

The Government of Ethiopia established the Abby Basin Authority to promote Water Resources Planning and Management at local level. As part of its key initial activities, the Authority is embarking on developing a multi-sector water resources plan for the Tana Sub Basin. The Authority carried out a study using the Nile Basin Decision Support System (NB-DSS) to provide the inputs needed for an integrated water resources management and development plan for the Tana Sub Basin.

Key economic, social and ecological issues and challenges were addressed; including agriculture and livestock, hydropower, tourism, fisheries, natural Habitats and Navigation. Emerging conflicts in resource use and threats to Lake Tana Sub Basin resources such as water balance, impacts on navigation, tourism and fisheries, watershed degradation and sedimentation, eutrophication, lake water quality, wetlands/biodiversity, and flooding have been adequately considered.

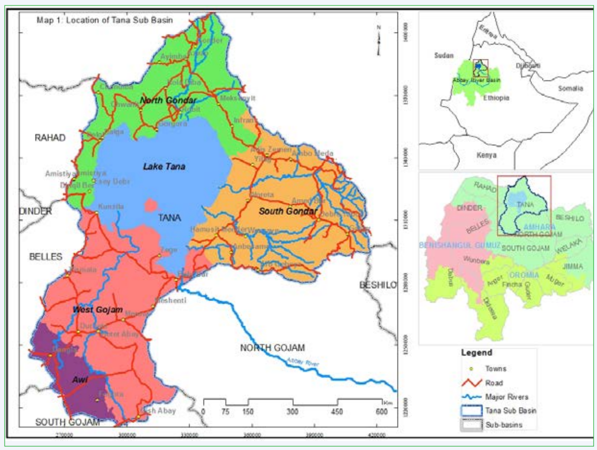


Figure 1: Tana Sub Basin administrative and geographical location

Objective of the study:

The objective of the study was to evaluate the impact of irrigation developments of Tana Sub Basin on Tana Beles Hydropower Production, Lake Tana Navigation, Lake Tana Fish Production and System Evaporation. Intensive trainings and multi-level stakeholder consultations were under taken in a participatory manner involving all stakeholders in the whole process.

NB-DSS Applications:

The modeling system of the DSS hydrology of the Sub Basin tool was used to collect data from 1960 to 2005 and future scenarios were set based on the Government development interventions plan. Considering the large number of potential development projects, a different combination of scenarios could be developed in order to assess the impact of individual projects on the downstream projects. NB-DSS Multi-Criteria analysis (MCA) tolls were used to evaluate and thus compare the set of scenarios based on defined economic, environmental and social evaluation indicators. Comparative evaluations were made regarding economic, social and environmental aspects of the Sub Basin. Analysis as well as setting weight/ranks were done together with the stakeholders in line with the government policy and strategy frame work.

Koga large scale modern irrigation dam

Conclusion:

Comparing the best case and the worst case scenarios the Tana Beles hydropower product decreases by 16% annually. There is an insignificant loss in the fish production sector because it is declining annually by 1% only. The pump irrigation development in the future will have a greater influence on the Lake navigation. This is shown by an increase in the number of days per year where the lake level decreases below 1785 (MSL), when navigation will not be possible for a duration of 35 to 141 days/year. Evaporation is increasing in all scenarios. It was therefore concluded that in the context of water resource planning and management, application at Basin and Sub Basin level is very useful and informative.

> ***"The pump irrigation development in the future will have a greater influence on the Lake navigation"***

Figure 2: Tana Beles Hydropower Production

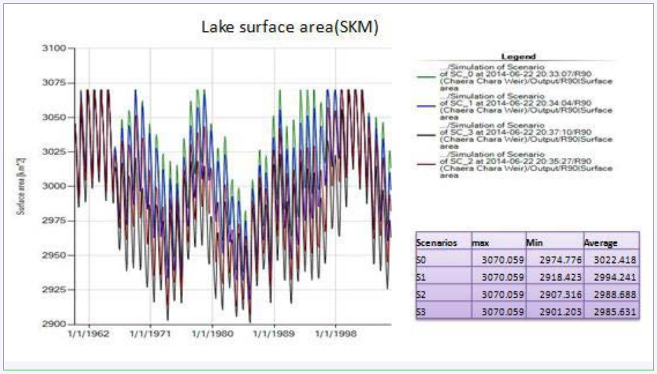


Figure 3: Lake Tana Surface area

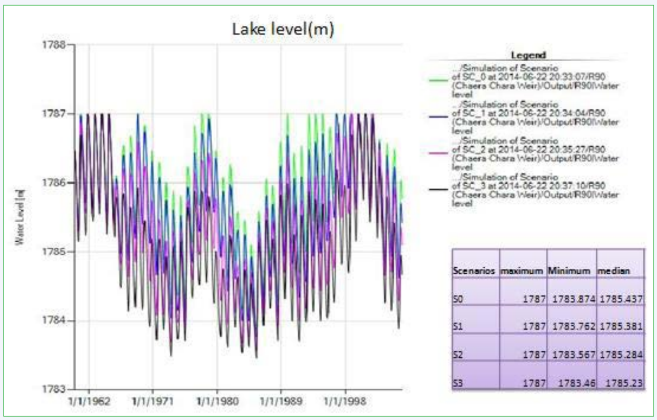
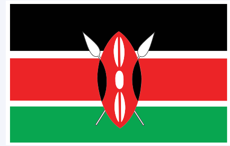


Figure 4: Lake Tana Water Level fluctuation

COUNTRY: KENYA



Title of Study: NBI-DSS Case Study On the highly populated and complex Nyando River Basin

Ministry/Agency directly benefiting from the case study: Ministry of Water, Environment & Natural Resources

Introduction:

The Nyando River Basin is highly populated and complex river system that involves many competing users/stakeholders. It joins the stream flows from the Nandi escarpment, the two regional Counties and the City of Kisumu; it floods during rainy season hence creating a disaster throughout Kano planes.

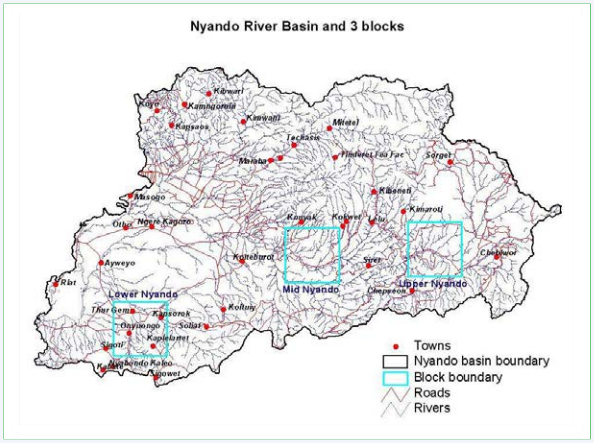


Figure 5: Nyando River Basin Area.

Objective of the study:

The main objective of this study was to investigate the impacts of floods downstream and what other uses can be invented as the government struggles with containing the negative effects of floods downstream.

The NB-DSS was therefore used to answer key questions such as:

- How can the negative impacts of floods downstream be contained?
- Rather than leaving this water to go to the lake, what other uses can it be subjected to in improving the economic status of the residents and the county?

NB-DSS Applications:

Effects of floods downstream for residents here, life must continue

In the NB-DSS application, Mike Hydro rainfall module was selected and the Irrigation parameters for rice growing scheme were adapted from available studies. The impact of a wide range of possible interventions on the flow of Nyando River at Ahero station was analyzed using the following Indicators; Flow Variability, Dry Low Flow, and Wet Low Flow. The model was further tested to examine the possibility of having sufficient water for both hydropower generation and irrigation of the two Schemes.

The results of the scenarios and the analyses by the NB-DSS showed that it is possible to improve the interventions of the calamity in the Nyando Sub Basin due to shortage and inefficient use can be avoided. The management scenario formulated using the NB-DSS for the case study indicated how the deficit and the downstream flow decreases,

“ ***In the NB-DSS application, Mike Hydro rainfall module was selected and the Irrigation parameters for rice growing scheme were adapted from available studies.*** ”

and consequently the decrease in water availability for irrigation and the correlated social dissatisfactions can be improved. Even without any additional water resources development, the Multi- criteria Analysis (MCA) of the NB-DSS clearly explains that the modified management can transform existing semi-traditional handling and management of the system by using a decision support tool. The same is true for other Basins like Lake Victoria, therefore the need to use NB-DSS in Nyando Basin for better management of the water resources was demonstrated.

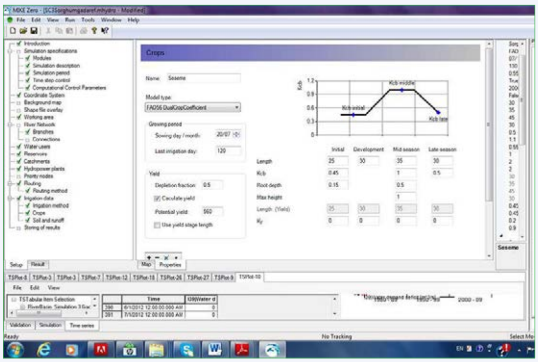


Figure 6: Data input for rice

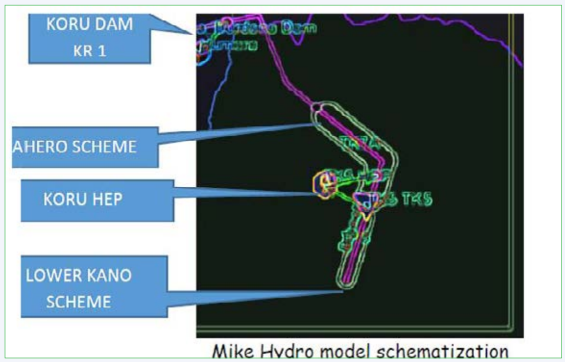


Figure 7: Schematization of the Mike Hydro Model

The selection of this particular area has a target of attracting the attention of the stakeholders and decision makers, who have also a large stake in the Lake Basin flows on the NB DSS tool and potential capacities to address the key water resources management issues of any Basin.

COUNTRY: RWANDA

Title of Study: Modeling the Sebeya dam using Nile Basin DSS for Flood control in the Sebeya River catchment

Ministry/Agency directly benefiting from the case study: Ministry of Natural Resources (MINIRENA)/ Natural Resources Authority (RNRA).

Introduction:

Since 2010, Sebeya River with catchment area of 365 km² is causing frequent and serious destructive floods that are affecting mainly its downstream part causing severe damages. With the changes of occupation and utilization of land use in the Basin between 1988 and 2009, the Sebeya regime has been changed and the minimum rates dropped in favor of the maximum flow. This is remarkable from floods observed more frequent in surrounding villages of Mahoko center, heading towards the upstream of the river with negative impact to the life and properties of surrounding people.

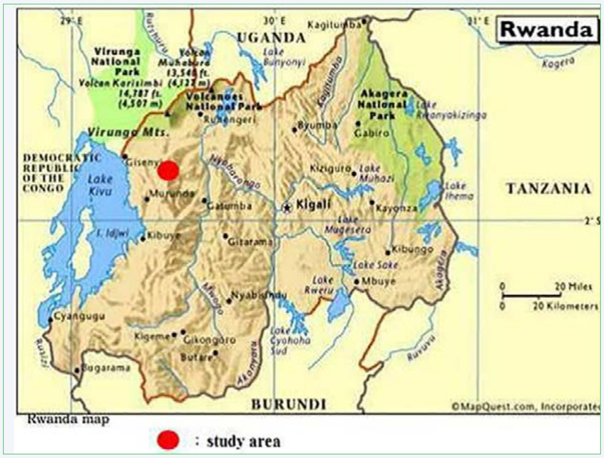


Figure 8. Hydrological network of Sebeya catchment

Study Objectives:

- To determine the main morphological and hydrological characteristics of the catchment area. (Field characteristics, area, rainfall runoff, precipitation rate, runoff coefficient)

- To delay flow in dams and release it once flood events finish
- To determine the annual input of the retaining basin, accounting for evaporation; Helping to understand the 3 Design retentions ponds for controlling Floods at Sebeya River network through the calculation and description of different catchments parameters for all Sebeya river branches existing upstream Mahoko Center.

The NB-DSS enabled the following;

- The ND-DSS tool helped to address the problem of flooding that was affecting the livelihoods of people downstream.
- To assess the impact of dam constructions on flood control along the catchment areas.
- The outcomes of this study has helped other organizations in Rwanda (RNRA and REMA) appreciate the ND-DSS tool and will soon be using it in addressing key concerns in water resources management.

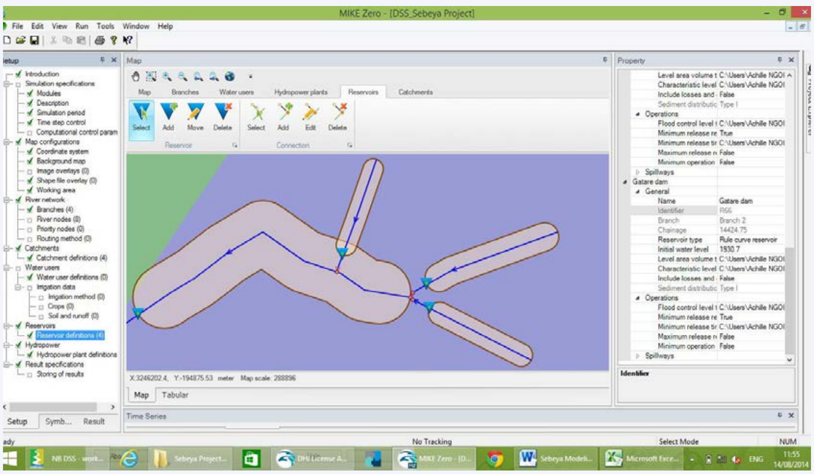


Figure 9: The NB-DSS Sebeya workspace Model

The results show that the 3 small dams upstream have greater impact because the initial peak discharge was 16.73m3/s and the inflow to Sebeya main dam is 14.55 m3/s which corresponds to the reduction of 2.19m3/s. This implies that the outflow of Sebeya main dam is 8.66m3/s.

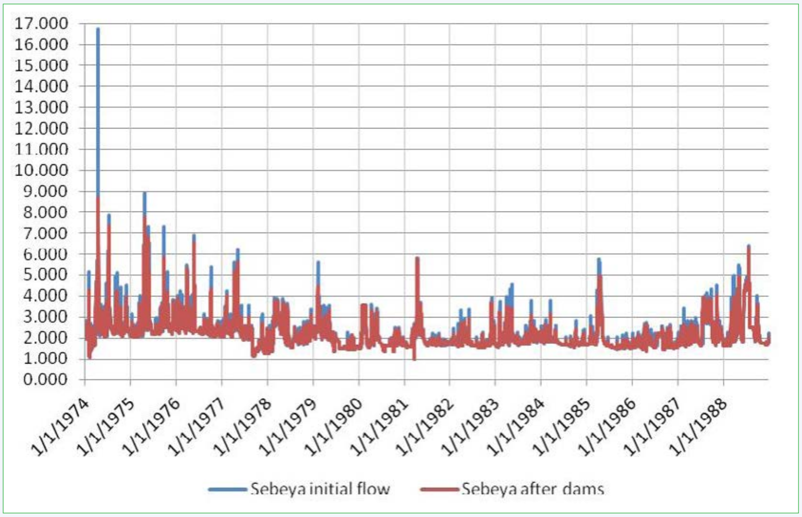


Figure 10: Daily Discharge for each scenario

DAM	PEAKS FLOW (M3/S)		PEAK FLOW REDUCED BY EACH DAM(M3/S)	TOTAL FLOW REDUCED BY ALL DAMS (M3/S)
Sebeya	Inflow	14.55	5.88	8.07
Main dam	Outflow	8.66		
Karambo	Inflow	3.42	0.60	
	Outflow	2.82		
Bihongora	Inflow	2.50	0.44	
	Outflow	2.06		
Gatare	Inflow	6.52	1.15	
	Outflow	5.38		

Table 1: Daily inflow and outflow of each dam

Based on the above results, the study suggests an additional Sebeya storage pond at the outlet of the catchment and also another at the outlet of each of the tributaries, with special focus on delaying flows in dams and releasing it once flood events finish for avoiding negative impact to the life and properties of surrounding people (releases will have a max of $8m^3/s$).

COUNTRY: SUDAN

Title of Study: The Impacts of the Ethiopian Renaissance dam on the Blue Nile reservoir system in Sudan

Ministry/Agency directly benefiting from the case study: Ministry of Water Resources, Irrigation and Electricity

Introduction

Using the Nile Basin Decision Support System (NB-DSS), the study investigated the impacts of Ethiopian Grand Renaissance Dam (GERD) and other planned dams across the Blue Nile, on the existing Blue Nile reservoir systems in Sudan.

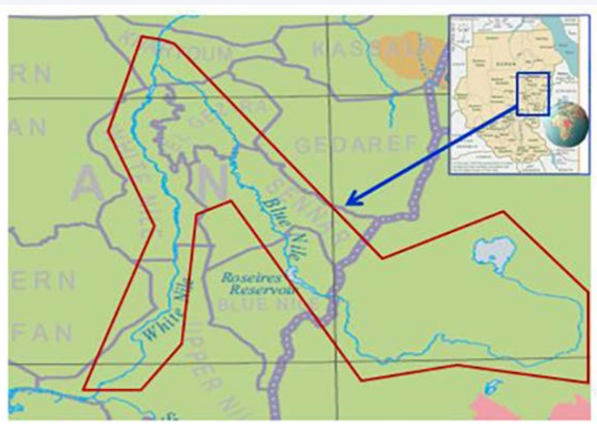


Figure 11: Study Area.

NB-DSS was used to answer critical questions such as:

- ***What are the impacts on the power generated in both countries (Ethiopia and Sudan)?***
- ***What will be the possible increase in the irrigated area in Ethiopia?***
- ***To what extent the recurrent floods will be alleviated?***
- ***To what extent the low flows will be augmented in Sudan?***

Study Objective:

The main objective of the study was to investigate the impacts of upstream Ethiopian dams including the Renaissance dam on the existing Blue Nile reservoir systems in Sudan.

Results of the NB-DSS:

The main results of the study showed the percentage reduction in peak flood values and the augmentation in low flow with respect to the baseline scenario (current state). The total reduction in the annual Blue Nile flows at Khartoum-Soba was estimated. It should be noted that the peaks and minimum flows depend largely on the operation policies of the different reservoirs along the Blue Nile.

Criteria used in scenario comparison

The table below shows the values of the criteria adopted to compare the scenarios in this study and the final ranking of the studies.

Criteria	EnvHotSpots	CarbonEmmission	AvgBankInundated Area	InundatedArea RosDam	EcoStress DS Sen	AvgWetDur DS Ros_Sen	WetShift DS Ros_Sen	MxFlowRatio MN	MnFlowRatio MN	MxFlowRatio BNKRT
Group	ENV	ENV	ENV	ENV	ENV	ENV	ENV	ENV	ENV	ENV
Unit	idx	M Tons	Perc B	Perc B	idx	Wks	Wks	Perc B	Perc B	Perc B
Scenario of SC_1_RenRosH	0	0	4	91	-3	-30	0.3	100.0	151.2	100.0
Scenario of SC_2_RenDam	0	0	-68	76	-5	-41	3.3	88.3	242.4	86.2
Scenario of SC_3_RenDam	0	0	-68	84	-5	-43	3.5	93.1	292.9	93.1
Scenario of SC_4_RenDam	0	0	-70	100	-5	-47	3.5	92.0	202.5	89.1
Scenario of SC_5_AllDams	0	0	-62	-50	-5	-54	3.6	100.5	295.3	98.1

Criteria	MnFlowRatio BNKRT	Water Avail DS Sen	FloodPlain AgroRecess DS Sen	FishProduction SD	FoodProduction SD	HP SD	Navigation	Evap SD	BCR
Group	ENV	SOC	SOC	SOC	SOC	ECO	ECO	ECO	ECO
Unit	Perc B	Perc B	Perc B	Ton	M Ton	KWh	Wks	BCM	Ratio
Scenario of SC_1_RenRosH	111.6	-46.1	3.9	7,395	8.16	1818	-72	2.92	2.52
Scenario of SC_2_RenDam	504.3	430.3	-66.3	7,439	8.16	2939	90	2.90	3.18
Scenario of SC_3_RenDam	762.3	508.9	-66.4	7,542	8.16	2978	90	2.93	3.66
Scenario of SC_4_RenDam	420.6	513.5	-68.3	8,051	8.16	2763	90	3.82	3.40
Scenario of SC_5_AllDams	584.5	351.4	-61.2	6,520	8.16	2724	90	3.16	3.20

Table 2: Criteria calculated values

Scenario/Group	Economic Session	Environmental Session	Social Session
Scenario of SC_1_RenRosH	5	1	5
Scenario of SC_2_RenDam	2	3	2
Scenario of SC_3_RenDam	1	2	1
Scenario of SC_4_RenDam	3	4	3
Scenario of SC_5_AllDams	4	5	4

Table 3: Final Ranking of the scenarios

Currently 80% of the Blue Nile flow comes during the three months of the flood. The two Ethiopian storage facilities will redistribute the flood water over the months of the year, thus availing water for the relatively small reservoirs in Sudan that are mainly used for irrigation purposes.

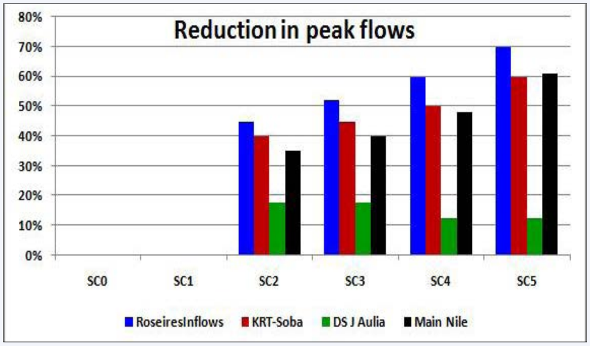


Figure 12: Reduction in Peak Flows

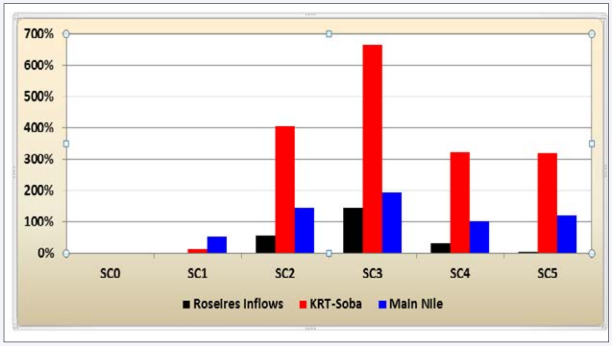


Figure 13: Percentage increase in minimum inflows to Roseires reservoir

The social and environmental impacts of the GERD are not fully studied yet. Therefore, this study may contribute to that on-going debate by shading the light on some hydrological and economic impacts on the Sudanese side.

COUNTRY: TANZANIA

Title of Study: Integrated Water Resources Management and Development Plan using Nile Basin Decision Support System

Ministry/Agency directly benefiting from the case study: Ministry of Water and Irrigation

Introduction:

Internal Drainage Basin (IDB) comprises of nine main Sub Basins and encompasses a large number of segregated river networks with several separate aquifers. This Basin faces a number of water related challenges including; Increasing water scarcity and competition for water between different water users; On the other hand, some areas are often perceived as having annually ‘surplus’ water and encounter recurrent floods during wet seasons. The combination of this widespread water resources system with scattered water demands, accompanied by several water resources development plans has provided a very complex and complicated Basin to be analyzed.

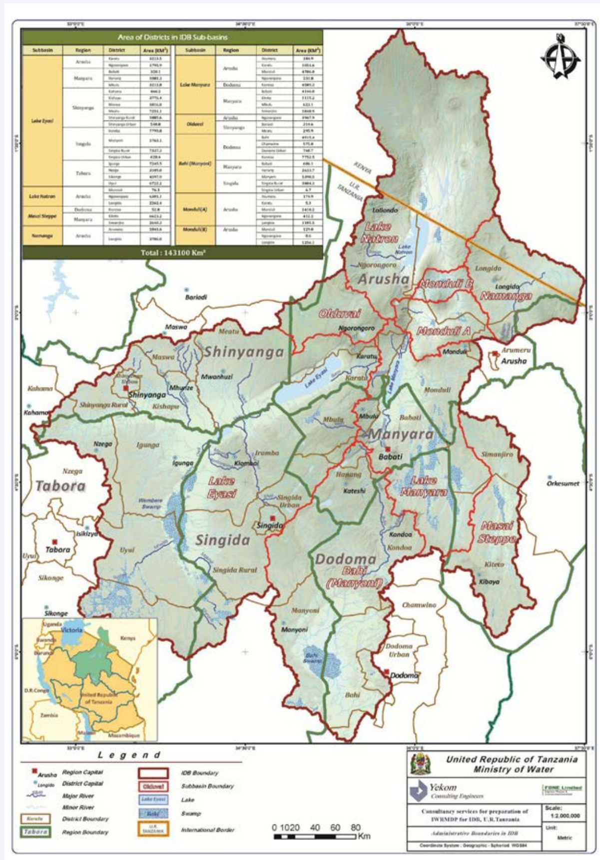


Figure 14: Map of the study area describing salient features

Study Objectives:

The Internal Drainage Basin Decision support system was developed to provide a comprehensive decision making platform for major decision makers of IDB with the aim of evaluation, analysis, and contrast the whole social, economic, and environmental impacts of their possible decisions in the Basin. The objectives of this study were;

- To allow for planning of the allocation of water resources over the Basin
- To monitor current conditions and alert decision makers what are the main water related insufficiencies of the Basin
- To provide water related data bank of the Basin
- To find tout he best economically, socially, and environmentally sustainable solutions of water conflicts
- To enhance water resources management capacities of IDBWB.

The NB-DSS enabled the following;

- Sound planning of the allocation of water resources over the Basin;
- Monitoring current conditions and alerting the decision makers what are the main water related insufficiencies of the Basin;
- Providing a water related data bank of the Basin;
- Identifying the best economically, socially, and environmentally sustainable solutions of water conflicts; and enhancing water resources management capacities of IDBWB

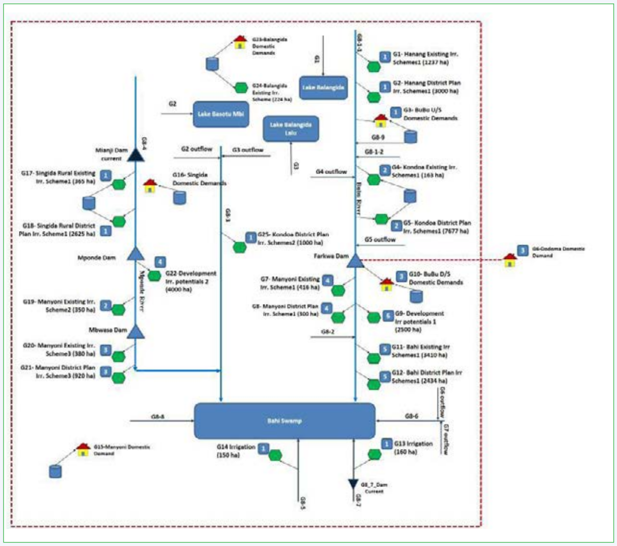


Figure 15: Schematization of IDB DSS in Bubu Sub Basin

Below are the results of the different scenarios that were run using Multi Criteria Decision Making analysis;

SCENARIOS	SOC.	ENV.	ECO.
SC0 - Baseline	0.079	0.153	0.490
SC1 - District Plans	0.119	0.148	0.103
SC2 - Fully Structural Development	0.164	0.113	0.173
SC3 - Fully Structural Development and Environmental Conservation	0.162	0.147	0.173
SC4 - Wise Structural Development and Demand Management	0.167	0.147	0.175
SC5 - Impacts of Climate Change	0.157	0.146	0.164
SC6 - Climate Change Adaptation Measures and Practices	0.152	0.145	0.164

Table 4: Final Scores of scenarios based on MCDM analysis using expert choice

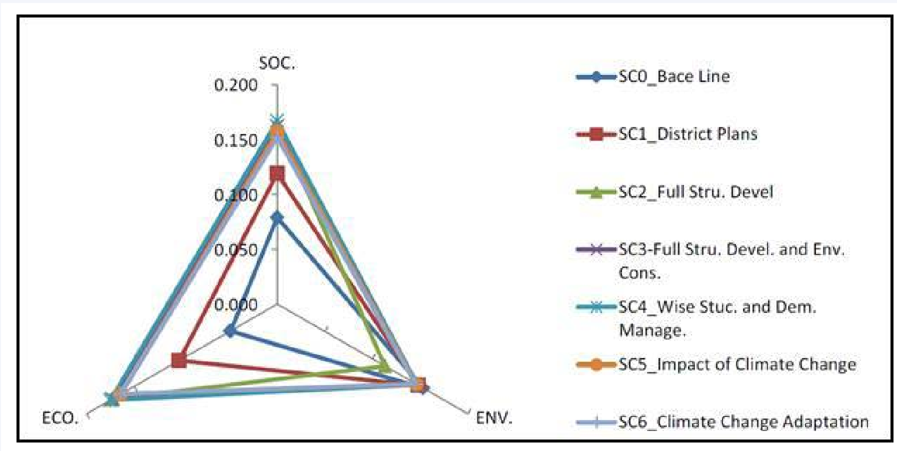


Figure 16: Pyramidal shape of scenario scores based om MCDM analysis

The NB-DSS application tool was much appreciated because it led to a common understanding of the implications, complexities and the best alternatives with their advantages and disadvantages in water allocation among competing water uses in the Basin.

Development Partners

Buitenlandse Zaken

Canadian International Development Agency

Agence canadienne de développement international

Ministry of Foreign Affairs of Denmark

DFID Department for International Development

SWEDEN

german cooperation DEUTSCHE ZUSAMMENARBEIT

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