MULTIPURPOSE WATER RESOURCE PLANNING AND MANAGEMENT USING NILE BASIN DSS IN THE TANA SUB BASIN, ETHIOPIA

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Abstract: The DSS is considered to comprise (i) a knowledge base, and (ii) modeling tools. These two elements are to have in-built internal interfaces, and the DSS as a whole, through input and output systems, is to have strong linkages with the separately developed BIS and WIS and The Authority is carrying out a study using the Nile Basin Decision Support System (NB-DSS) to providing the inputs needed for a water resources management and development plan for the Tana Sub-Basin.

Key Words: Nile Basin DSS, Tana Sub Basin, Scenarios, Indicators, Melt-criteria Analysis

Introduction

Background:

The Lake Tana Sub Basin has a drainage area of 15083 sq. Km, including lake surface area of 3000 sq. km. The lake is the source of Blue Nile River and total storage capacity of 32,000mcm with a useful storage capacity of 8,500mcm. Water resources planning for the Tana Sub-Basin need to take into account the various, often conflicting, water needs of the economic sectors and the environment. The Government of Ethiopia established the Abay Basin Authority to promote water resources planning and management at local level; the Authority was established in (Reg. 151/2008). 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 is carrying out a study using the Nile Basin Decision Support System (NB-DSS) to providing the inputs needed for a water resources management and development plan for the Tana Sub-Basin.

Objective:

- ☞ To evaluate the impact of large scale irrigations development on:
  - Tana Beles Hydropower productions
  - Lake Tana Fish Productions
  - Lake Tana Navigations
  - Evaporations, System Wise

Methodology and Approach

Methodology:

Mike Hydro Model (See Figure 1) was selected from Mike Zero for simulation of data from 1960 to 2005 and scenarios for development interventions. Within this context, the objective of this pilot case application for the Tana Sub-Basin was to undertake scenario evaluation using the NB-DSS.

Development	S0	SI	S2	S3
Chaera Chara 32BCM	X	X	X	X
TB HP, 460MW	X	X	X	X
Koga, 7000ha	X	X	X	X
Megech, 7311ha		X	X	X
Ribb, 18700ha		X	X	X
G.Abay, 14552ha			X	X
Jemma, 7786ha			X	X
Gumara, 14000ha			X	X
Pump, 44650ha				X

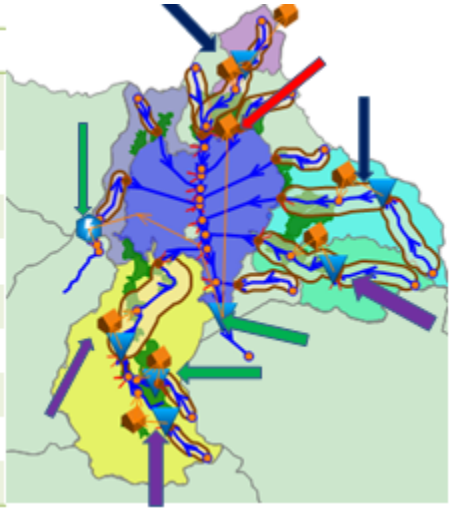


Figure1: Scenario Development using Mike Hydro Model

This involved the configuration, calibration and validation of a relevant baseline model for representing the present state of water resource development for the pilot application case, defining scenarios and a set of economic, environmental and social evaluation criteria (indicators), using the configured model implemented scenarios in the NB-DSS and employed the MCA tools and associated functionalities embedded in the NB-DSS evaluated scenarios based on the quantification of economic, environmental and social indicators. However indicators like Hydropower Generation with flow, Navigation with Lake water level, and Fish Production with lake water surface area and Evaporation with the system were used.

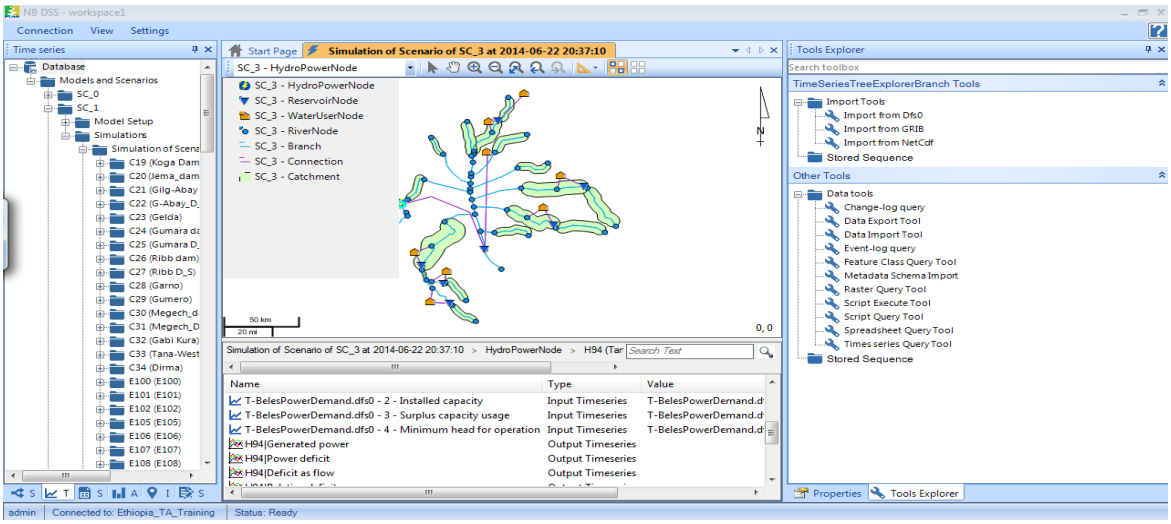


Figure2: Nile DSS Set Up

Approach:

- ☞ The following six steps have been under taken:
    1. Definitions of problems/Key Water Management Issues
    2. Clarifications of Objectives
    3. Development of scenarios
    4. Definitions of Indicators and Evaluation of Criterion
    5. Simulation and Quantification of Indicators
    6. Evaluation/Interpretations of Results and Trade offs

Source: NB-DSS, Guideline for the evaluation of water management interventions

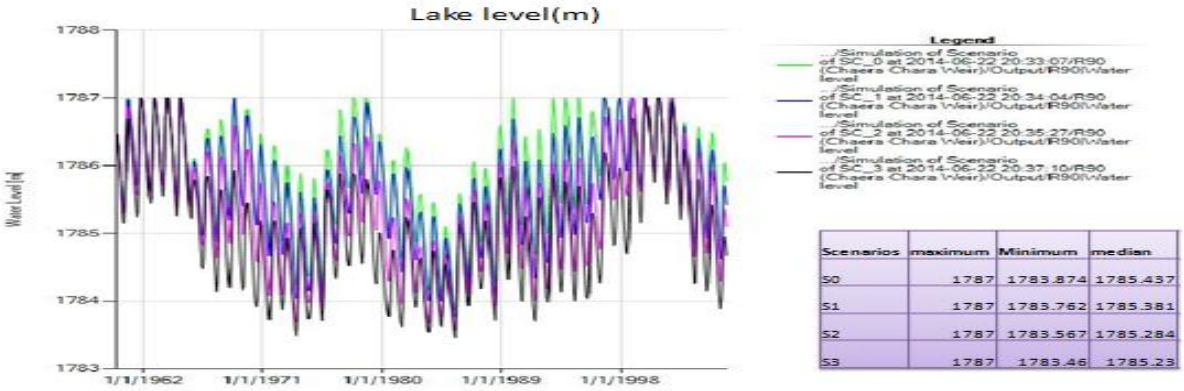
Findings and Arguments

Findings:

Comparing the base case and the worst case scenarios the Tana Beles hydropower product decreases by 16% annually, this indicates that the impact of irrigation development have little impact on the power generation but the study indicates that, this amount of power production have been incorporated in the design of upstream dams of the sub basin.

As seen from the result of indictor regarding fish production in the Lake, Comparing the base case and the worst case scenarios of fish production, there is an insignificant loss in the sector because it is declining annually by 1% only.

But the irrigation development in the future will have a greater influence on the Lake navigation; this can be shown by an increase in the number of days per year where the lake level decreases below 1785 masl where navigations blocked from (35 to 141) days/year. Though this values do not shows how many consecutive non-navigable days are present, it is a reasonable assumption to take most of this decrease in lake level happens in the dry seasons of the year. 141 non-navigable days have a greater socio-economical impact.



Scenarios	maximum	Minimum	median
S0	1787	1783.874	1785.437
S1	1787	1783.762	1785.381
S2	1787	1783.567	1785.284
S3	1787	1783.46	1785.23

Figure 3: Lake Level Fluctuations

The increase in the reservoir development on the total water surface evaporation of the system is insignificant, the result shows that development in the sub-basin have a smaller impact by increasing the amount of water surface evaporation from the sub-basin, the reason can be explained by the fact that the

evaporation & rainfall of the u/s dams are almost balanced and the development also increase the surface area that is exposed to evaporation at the lake body but at scenario three utilizations of water resource using pump irrigation from the lake makes it decrease due to minimizing of open surface water area of the lake.
During Stakeholder consultations and melt-criteria analysis, scenario two has been selected.

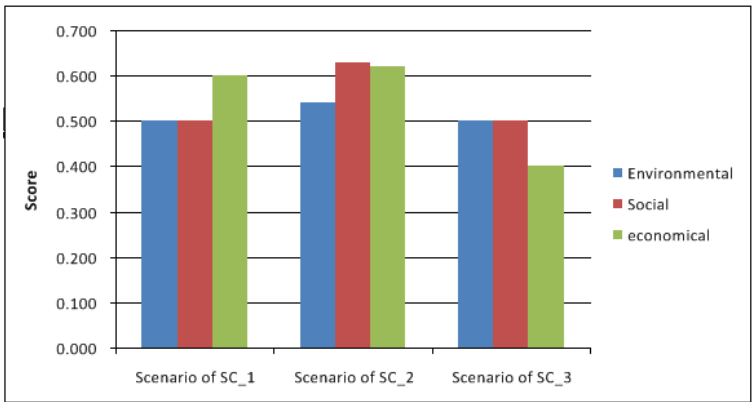


Figure 3 Multi criteria Comparison

Conclusions and Recommendations

Conclusions

Based on the findings, the development of large scale irrigation projects of koga, Ribb, Megech, Gilgel Abay, Jemma, Gumara and lake Tana Pump have no significant effect on evaporations, fish productions and hydropower power generations and also studies show that, some of the dams will have power as well as fish production plan equivalent to the decline amount to be able to compensate the productions. But for navigation it needs some amount of water during dryer period because due to those development interventions the lake level can lower below the average up to 5 months/year of the dryer period. Based on the MCA all irrigation projects are preferred except pump irrigation.

Recommendations

Operation rules of the dams should consider navigation during the dry period, with this result; it has to be able to do further with more indicators and even by CBA method of analysis by considering other sub basin water resource actors. All levels of stakeholders should participate all the way, starting from the early beginning to the implementation process. For further work a lot of data are collected and are organizing, and also scripts are developing. Experience sharing and training with Nile Basin Initiative and ENTRO.

Reference

Aurecon (2012), Guideline for Evaluation of Water Management Interventions

Bouwer, H. (2000), Integrated Water Management: Emerging Issues and Challenges, Agricultural Water Management, 45, 217-228.

Carron et al. (2011), NBI Water Resources Planning and Management Project Nile Basin Decision Support System (DSS) Data Processing and Quality Assurance, Pilot Application of the Nile Basin Decision Support System: Stage 1 Report on Development of Pilot Case Models, November 2011. Authors: J.Carron, G.Parkin, GM O'Donnell, P.E O'Connell

Eastern Nile Technical Regional Office (2006), Water Atlas of the Tekeze-Atbara-Setit Subbasin

ENTRO (2008), Eastern Nile Irrigation and Drainage Study – Component 1: Phase 1: Diagnostic and Planning Phase, Report by BRL, MCE and Shoraconsult Co. Ltd

European Commission (2003), Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document no 11, "Planning Process".

FAO (2011), Good Practice Principles Water Development in the Drylands of the Horn of Africa

Abbay River Basin Integrated Development Master Study; BCEOM 1998

Hydrological Study of Tana-Beles Sub-Basins, SMEC, 2008

Lake Tana Sub-Basin, Four Dams Project; Gilgel Abbay Dam Project; WWDSE, Tahl, 2010

Megetch Feasibility and Design Report, WWDSE, Tahl, 2009

Jema Feasibility and Design Report, WWDSE, Tahl, 2009

Birr and Koga Irrigation Project, Feasibility study.Acres International, 1995

Impact Assessment of Irrigation Development in the Tana Basin on Beles Hydropower and Lake Navigation, Deksyos Tarekegn 2011

Tana sub basin planning processes reports, TaSBO 2014