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ORIGINAL ARTICLE

IMPLEMENTATION OF THE NILE BASIN DECISION SUPPORT SYSTEM FOR MPIOKA BASIN WATER RESOURCES MANAGEMENT IN THE DEMOCRATIC REPUBLIC OF CONGO

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ABSTRACT

Background: The current climate change has increased water scarcity at watershed scale. Interests' conflicts between riparian communities are becoming commonplace. **Objective**: To solve such problem in Mpioka basin, in the Democratic Republic of Congo, this study aims to set up an integrated water resources management (IWRM) tool in this basin. **Methods**: Four types of data were used in this study. Hydrological and hydro-meteorological data allowed water balance evaluation and available water resources calculation in terms of discharge. Sociodemographic data were used to estimate current and future water and electricity demand. Land use mapping led to cultured area calculation and crops classification. Economic data and hydraulic parameters of the Mpioka dam facilitated its calibration in the model. Finally, a water allocation model was developed using Mike Hydro and Nile Basin Decision Support System (NB-SS) softwares, while crops water needs were evaluated using CROPWAT software. This model included three development scenarios and one baseline scenario**. Results:** At environmental level, Mpioka dam (SC1) will lead to a regulation of downstream discharge with a flow rate ranging 2.5 to $4m^3/s$ irrespective to below $1m^3/s$, in the dry season, to $25m^3/s$, during the rainy season, in current situation. In addition of socio-economic standards and policies, nearly 150 jobs created, the hydropower plant will generate 76GWh/a. Thus, 50% of the basin population could gain access to electricity. **Conclusion:** The whole stakeholders' opinion groups agreed unanimously that the Mpioka dam construction (SC1) seems to be the first development priority in the Mpioka basin. Then, could follow, gradually: the construction of Pilgrimage Center (medium term) and the development of Nkamba agro-industrial irrigation scheme (long term). In view of the present study results strengthening, it would be desirable to carry more investigations out in order to complete the performed multicriteria analysis (MCA) by a costs and benefits one (BCA). The latter will allow to assess the contributions of each development scenario in terms of economic gain for best decision making.

***Key words**: Watershed, Interests conflict, IWRM, Allocation Model.*

1. INTRODUCTION

Water is a unique resource for competing uses. The past experience demonstrated its management is complex, encompasses several levels and requires a comprehensive framework. Most of countries do not have national water policies. That is a major handicap because policy is the foundation for legislation, strategic planning, and operational management. Knowledge of available resources, their quality and variation over time and the state of other physical and socio-economic conditions, is a fundamental prerequisite for rigorous planning and design of sustainable and economically efficient water projects. Pricing plays a key role in improving water resources management. Development of cost system and royalties structures is based on economic, ecological, financial and social considerations.

The social analysis carried out requires appropriate measures to be taken for integration of these issues into projects and mitigate undesirable impacts. In order to eradicate the perverse effects of environmental degradation on water resources, the African Development Bank (2000) reported that several actions should include specific environmental strategies and policies to enable the optimal and effective use of these resources [1].

Hydroeconomic concepts and models are developed to predict the actual behavior of hydrographic systems following an alteration of management policies. Authors such as Yeh (1985), Labadie (2004) and Loucks et al. (2005) have thoroughly reviewed modeling methods commonly used for water systems studies and their development [25-12, 13]. While Mujundar and Ramesh (1997) considered that a standard management policy does not exist and that the proper functioning of any system lies in the possibility of choosing the appropriate operating policy from among all the available methods [16].

Regarding complexity of the IWRM concept implementation, and in order to its approach, research into water resources management has focused on specific issues. However many authors such as Singh (2014), Fonseca et al. (2013), Hadded et al. (2013), IPCC (2013), Mongelli et al. (2013), De Fraiture et al. (2010), Gholami et al. (2010), Molden et al. (2010), Namara et al. (2010) and Bates et al. (2008) reported that most problems often emerging are: water demand satisfaction [4], efficient water use [17] and its productivity improvement [14], impacts of climate change on hydrological events [2-10], population growth impact and management options on aquifer behavior [8], increased energy consumption by pumping [6], degradation of water quality due to the problem of salinization as a result of excessive pumping [7-15] or seawater intrusion for coastal aquifers [24].
In this study a water resources allocation model is developed with scenarios integrating stakeholders concerns and environment protection, using Nile Basin Decision Support System (NB-DSS) software to promote integrated water resources management and to avoid conflicts in Mpioka basin. Within this catchment, there are many villages hosting 598,333 inhabitants split into shared out between 4 tribes. Globally, this population is poor and needs water, food and electricity. The most part of this population lives in Nkamba-Yelusalemi city which is the capital of Kimbangu Prophet's Church. Every day, this city receives many pilgrims from all over the world. This situation increase supplies problems which have led to difficulties in the cohabitation of indigenous populations with kimbanguist pilgrims and, in turn, with the church authorities.

2. MATERIALS AND METHODS

2.1. Study area: Mpioka River, a minor tributary of the Congo River, with 73.869km length against 7.839m^3/s mean discharge, is located between 5°22'24.98"S / 14°20'33.54E and 4°53'25.02"S / 14°45'11.02"E in Kongo Central Province in Democratic Republic of Congo (figure 1). Its Catchment area is about 806 km², entirely located on Bangu's massif with 530 meters mean altitude. Tropical rainy climate (Aw4 in Köppen's climatic classification) predominates in this area. The underground is chiefly made of sandy stones covered by sandy loam soils. Damp savanna is the main vegetation of the basin but damaged forest can also be observed along Mpioka river and its tributaries. Biodiversity in those ecosystems is very poor.

2.2. Materials: The Mpioka basin water allocation model was first designed and calibrated using Mike Hydro software under which results simulation were performed for each scenario. All scenarios were then registered in the NB-DSS for their analysis. It should be noted that NB-DSS software was designed to meet requirements of complex water resources planning. It provides diverse toolsets for data processing, modeling, scenario management, optimization and multi-criteria decision making. It offers tools for integrating environmental, social and economic objectives therefore greatly facilitating multi-sector water resources planning at river basin level.

2.3. METHODS

2.3.1. Stakeholders meeting facilitation: The first task consisted of the stakeholders' meeting organization. The debate focused on stakeholders unraveled concerns about the development of water resources in their basin. Many activities were listed by themselves. Our research team advised the coordinator to group stakeholders according to their area in order to stimulate them on balancing and matching their priorities. It was the occasion for the team to detect groups' opinion expressed in the model.

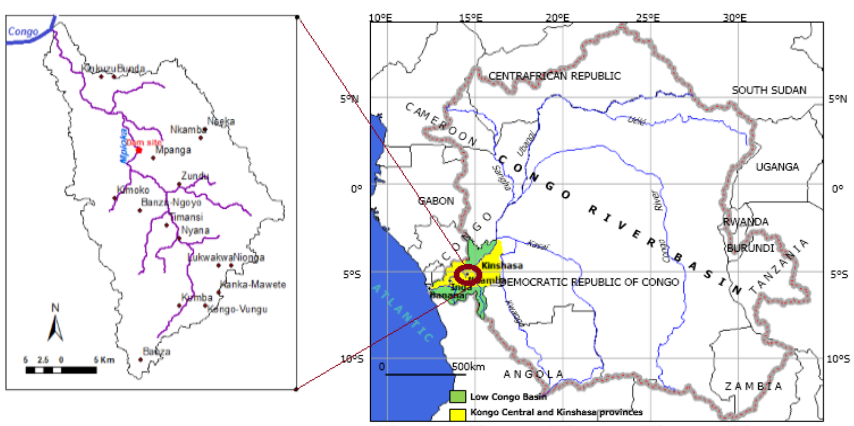

Figure 1: The figure presents the Mpioka catchment location in Congo River basin.

2.3.2. Data collection: Data used in the present study came from different sources. But it should be noted that lack of regular time series remains the major problem for such studies in water resources management. Within the pointed area, there is no station nowadays, hence the main task was focused on taking historical data. Consequently the simulations period was maintained in the past; reference is done on the period during which discharge and rainfall have been drastically observed in the basin. The major part of data used in this research was provided by the Kimbangu church Technical Holding. These data collection was mainly coordinated by Kalunga (2003) in collaboration with the researchers of the Regional Nuclear Studies Center of Kinshasa [11]. The main analyzes of these data are reported by Nlandu et al. (2004a, 2004b and 2008); they were collected within the framework of Nkamba dam pre-feasibility studies [18, 19, 20]. Those data concerned Dam characteristics, project discharge fixing, humidity, evaporation, and rainfall. It should be noted that data collection operations were stopped since 1998.

Democratic Republic of Congo's NB-DSS Office had already collected Mpioka basin's mean rainfall and discharge measured by the dam project manager office from 1991 to 1998. These data was completed by the processing of monthly rainfall maps available at Hydro-climatology laboratory, Geosciences Department, University of Kinshasa. The current situation of water use demand was collected in survey site with the implication of riparians and State's area administrators. However this information was used for the Baseline model calibration using Mike Hydro. The upcoming water utilization and demand was estimated in accordance with stakeholders' concerns based on the population rate growth. For illustration, the National Institute of Statistics (2010) published a population growth rate oscillating around 3.5% in the study area [9] while Ntombi et al. (2005) estimated a flat rate of domestic water use of 40 liters per capita per day [21]. These rates were used for both rural and urban areas water use calculation. This state of things lead to develop 3 additional Mike Hydro models so called scenarios.

Data collected, mainly:

- Rainfalls (Nkamba station: July 1991 to April 1995) _daily time series presented by Nlandu et al. (2008) [20];
- Monthly Rainfalls (Congo basin: 1141 stations located in DRC, RCA, CONGO, ANGOLA, CAMEROON, GABON, and TCHAD) _Previously criticized and discussed by Rouché (2013) [22];
- Rainfalls, Sunshine, Temperature (Min_Max_Mean), Atmospheric Pressure, Evaporation (ET and ETo), Wind speed. Tables and Maps elaborated by Bultot (1971) [3], homogenized and discussed by Nlandu and al. (2008) [20];
- Discharge measured by the Mpioka dam project hydrologist (Mpioka dam site: July 1991 to December 1998) _daily observations presented by Nlandu et al. (2004a and 2004b) [18, 19];
- Reservoir and Hydropower plant Characteristics computed by Kalunga (2003), available at Kimbangu's church Technical holding literature [11] and completed by the authors by hydroprocessing (Flooded area and water volume calculation) using a Digital Elevation Model processing;
- Population (1990-2014) _Mpioka Dam reviews and measurements computed by Kalunga (2003) using National Institute of Statistics (2010) population estimations (Annually observations) [11-9];
- Land cover map _Produced by FAO (2003) [5];
  All those data was stored in "MpiokaProject_DB", a PostgreSQL data base performed with NB-DSS Database Management utility.
- Catchments delineation, flooded area, and Water Volume calculation were carried out by using ILWIS Academic software.

2.3.2. Development of Mpioka water allocation model

2.3.2.1. Schematic design and description of the Mpioka water allocation model: Actually, in Mpioka basin there are not sustainable activities concerning water resources management. From this time, the baseline scenario should be developed delicately. The schematic design of the model was well out lighted by the stakeholder's challenge which revealed that there were 3 opinion groups living together in the basin. From the lonely river node (Dam site) of the June model which divided the Mpioka basin into two catchments, it was very difficult to represent the field reality. Because, noted the consultancy, People of Ntimansi so-called Nazareth (where was born the Prophet) representatives, took part for the Church solutions although living upstream bought with Boko People. They agreed the simulation time to remain in the past (1991-1998) in accordance with the project's surveys. This assumption seems comfortable because it allowed using field measures and literature considerations. Thus, a node for Boko People was so inserted upstream and Ntimansi was grouped with Nkamba. Inside the same area which is bearing Nkamba, the surrounding People of Gombe Matadi were strongly opposed to the idea of merging with Nkamba because they assumed that their interests were located downstream, a way for them to avoid impairments and troubles. A new node for them was finally created. NGOs representatives insisted for the preservation of the swamp area where everybody operate in fisheries and rodent hunting products. In addition of those concerns in the model, we got the first real scenario so called "Baseline Scenario" (figure 2A).
Accordingly, the baseline scenario (SC0) is made of:

- 5 River nodes: Boko, Mpioka dam site, Nkamba-Ntimansi, Gombe Matadi and the Outlet so-called Swamp Node;
- 6 Connexions: 2 connections for each user;
- 3 Regular Water users: Boko (Us), Nkamba_Ntimansi (Ds) and Gombe (Ds);
- 1 branch: Mpioka river;
- 5 Catchments: Boko (Us), Mpioka Dam site (middle but without users), Nkamba_Ntimansi (Middle), Gombe Matadi (Ds) and the Swamp (Ds).

A Mike Hydro Set up for Baseline scenario was developed (figure 2A) and populated with df0s files. After validation of the scenario, the Baseline Scenario was successfully run.

Considering the distribution of villages within the basin as shown in the map (figure 1), with all the data provided by Kalunga (2003) [10] and the conclusions of stakeholders meeting as inputs, to evaluate water and power demand deficit, the Scenario1 includes all objects of Baseline Scenario. Further sets have been indexed to the model as below:

- 2 Connexions;
- 1 Reservoir: Mpioka Reservoir;
- 1 Hydropower plant: Mpioka Dam.

The schematic Scenario1 is presented at (figure 2B). The same steps (as in the Baseline scenario) were followed before running the simulation of SC1.

The Scenario 2 includes all objects of both Baseline and Scenario1. In addition to the scenario:

- 2 Connexions;
- 1 User Node: Irrigation Scheme _Nkamba Farm Project.

The schematic Scenario 2 model is presented at (figure 2C). A simulation was run for this scenario. The irrigation scheme was computed as a regular user. For the purpose, we used CROPWAT 8.1 software to calculate Irrigation water demand. They allowed getting a monthly water demand for the Irrigation scheme. From this time, the type user: "Irrigation" was shifted to "Regular user" in the scenario 2. After validating this model the newer simulation went fine. After running all simulations in Mike Hydro, one by one, all of them was imported in NB-DSS software in the same way.
The Scenario 3 includes all objects of both Baseline and Scenario 2 except the hydropower plant; the electricity will be provided by Inga dam (electric line: 42km). This is at least, the proposition of the government. Further sets were indexed in the scenario as below:

- 2 Connexions
- 1 User node: Nkamba Pilgrimage Centre.

Figure 2: Schematic design of the Mpioka water allocation model set up; (A) Baseline scenario (SC0); (B) Scenario1; (C) Scenario2; (D) Scenario3.

2.3.2.2. Database creation: Before registering models into NB-DSS, a database called "MpiokaProject_DB" was created using the DHI Database Manager Utility under PostgreSQL server for data and results storage in NB-DSS software.

2.3.2.3. Registering Models and running scenarios into NB-DSS: After creation of an NB-DSS set up allowing login the Database, all those models have been registered in NB-DSS using Scenario Manager Tool. Scenarios were populated with inputs and outputs from the registered models before simulations were run for the second time in NB-DSS and generated suitable expected outputs.

2.3.2.4. Scenarios analysis: After scenarios registration, economic, social and environment indicators were defined and calculated using DSS Scripts. These indicators allowed for criteria calculation. The so-called criteria were used to generate decision matrix using NB-DSS Analysis Manager Tool. This tool allowed for scenarios multicriteria analysis.

3. RESULTS

Under the NB-DSS Time Series Manager, both inputs and new outputs can be visualized, compared and analyzed. Below, some outputs will be compared for a first results analysis.

3.1. Comparison of outputs (Scenario1 Vs Baseline Net flow to Nkamba node): Figure 3 shows in the baseline situation, the variation of water flow which was remarkably amplified compared to the situation after building the dam. The flow was rising during the wet season with peaks in December (25m^3/s). But during the dry season, the river leads very low threshold flow (≤ 1m^3/s). In SC1, the lowest level oscillates between 2.5 to 4m^3/s. This is due to the reservoir flow regulation for the preservation of a minimum flow of 12m^3/s needed by the Mpioka Dam.

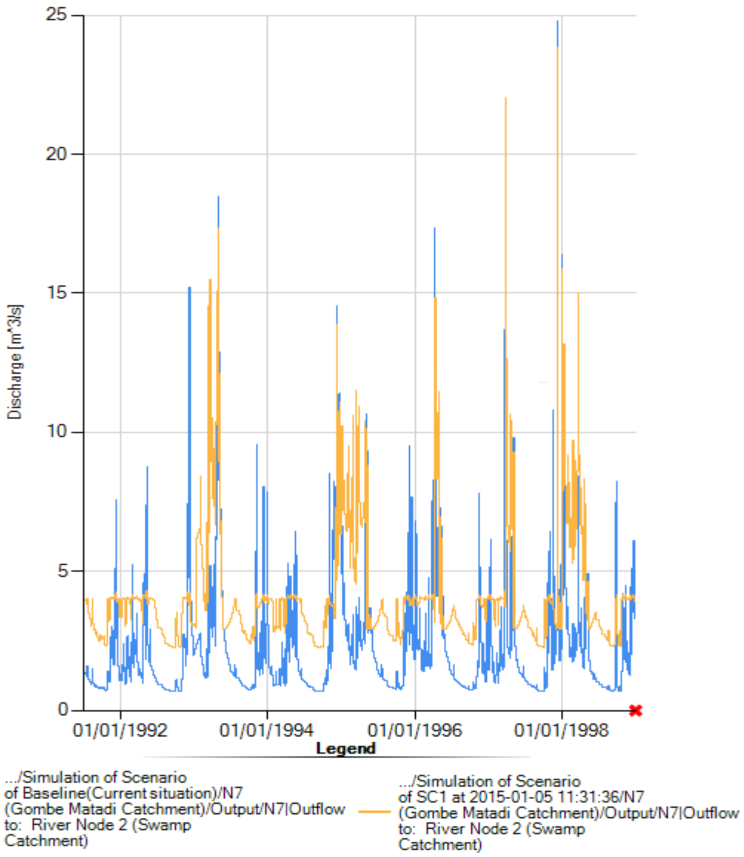

Figure 3: Comparison between Baseline scenario and SC1 using the Net flow to the river node Nkamba-Ntimansi.

3.2. Comparison of baseline situation with SC2 water demand deficit based: Figure 4 shows that there is not water demand deficit in the current situation at Nkamba river node. When Irrigation scheme upstream should generate at least, a deep deficit at Nkamba river node (0.045m^3/s).

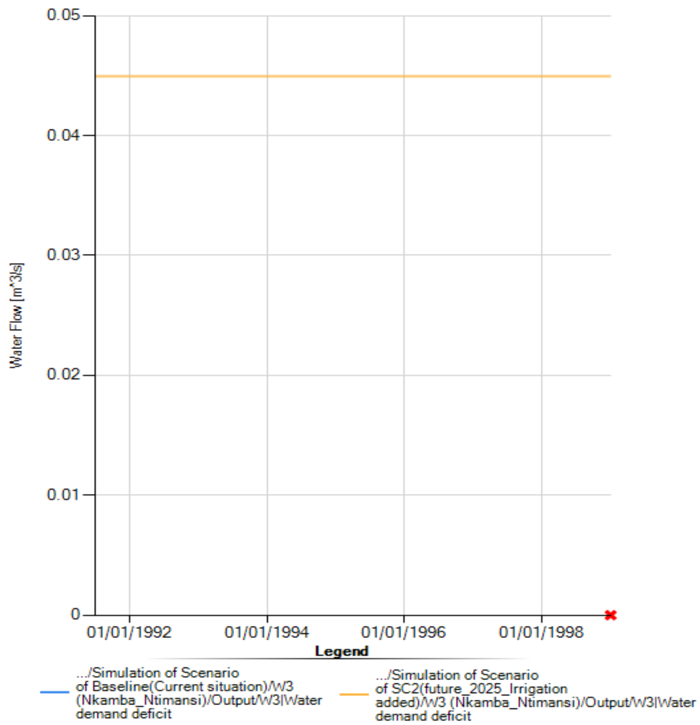

Figure 4: The figure presents the water demand deficit at the river node Nkamba (Baseline Vs SC2).

3.3. Comparison of the generated power with power demand deficit (figure 5):

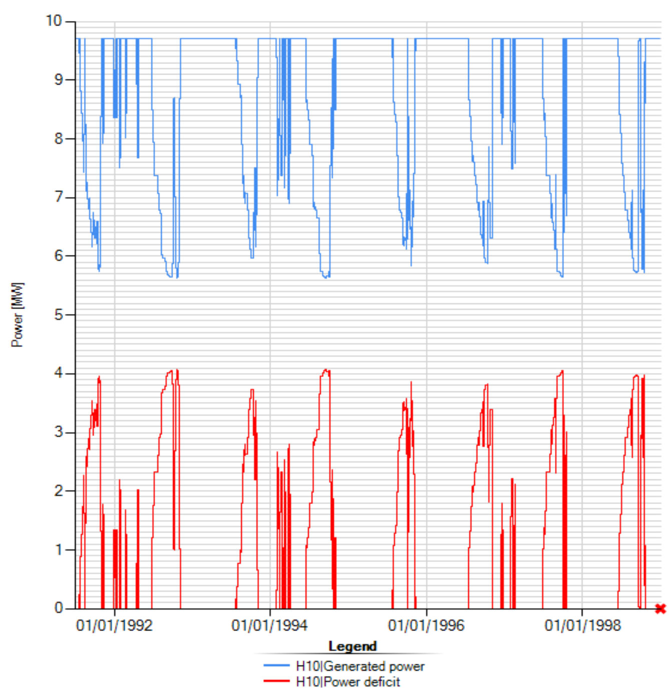

Figure 5: The figure presents the power generated by Mpioka Dam and power demand deficit from SC1.

Figure 5, shows that the generated power will never exceed 9.7 MW when the power demand of the project was evaluated to 11.4 MW. This is the consequence of water variation pointed at section 3.1. It means that water deficit will be permanent especially during the dry season. Thus, an additional amount of power should be found. Adding to this chart the power deficit from SC2, we have the confirmation that the irrigation scheme has no impact on the power deficit which is remaining the same with the SC1 one.

3.4. MCA set up development

3.4.1. Indicators definition and values calculation: The definition of indicators was essentially oriented by the stakeholder's priorities considering the Mpioka dam site as gravity point of the catchment. The tables 1 and 2 below give all characteristics of these indicators and their values.

Tableau 1: The table presents the indicators definition.

Category	ID	Name	Units	Script	Description
ECON	EC21	Average Energy generated	GWh/yr	*EC21_Average Energy*	Generated power at Mpioka Dam
ECON	EC31	Evaporation loss from reservoir	Mm^3/yr	*EC31_EvapLoss*	Evaporation Loss from Mpioka Reservoir
ENV	EN55	Flow variability	%Chang Vs Baseline	*EN55_Flow Variability*	Flow Variability D/s
ENV	EN10	Seasonal Shift	weeks	*EN10_Wetseason Shift*	Number of weeks delay in onset of wet season
SOC	SO1	Water Availability	%Change Vs Baseline	*SO1_Water Availability*	Water Availability D/s
SOC	SO81	Recession of Agriculture	%Change Vs Baseline	*SO81_RecessionAgriFloodPlain*	Agriculture recession due to Mpioka dam flooded area

Table 2: The table presents the indicators values comparison.

	Indicators					
Scenarios	**EC21**	**EC31**	**EN55**	**EN10**	**SO1**	**SO81**
SC 1	76.537	1.299	-10.5	42.3	175	-100
SC2	27.922	1.286	-100.0	1.1	-99.9	-13.4
SC3	76.537	1.299	-10.5	0	-100	-99.9

Scenarios comparison (table 2) shows that irrigation scheme added upstream will have a deep and strong impact on power production while Evaporation will remain nearly constant in all scenarios. Regarding environmental indicators, it seems that the irrigation scheme will have a deep impact on flow variability downstream while the season shift will be deeply improved. From social indicators, availability will be improved downstream at SC1 and SC3 due to flow regulation in Mpioka reservoir while the agriculture recession in Mpioka's valley will be more avoided at SC2. Those comparison results should be considered as the first conclusions deriving from a simple comparison of indicators.

3.4.2. Criteria definition: The stakeholders' meetings defined nine (9) criteria for an equitable evaluation of the three (3) selected scenarios. Among them, only six (6) criteria could be agreed by everyone. These criteria are Power production, Evaporation losses, Flow variability, Wet season shift, Water availability and Agriculture recession. Criteria values were calculated, indicators values based (table 3) and the software generated normalized criteria values (table 4).

Table 3: The table presents the Multicriteria Analysis criteria definition.

Define Criteria

	Power production	Evaporation Losses	Flow variability	Wet season shift	Water availability	Agriculture recession
Group	ECON	ECON	ENV	ENV	SOC	SOC
Unit	Gwh/yr	Mm^3/yr	%	weeks	%	%
Scenario of SC1	76.54	1.30	-10.50	42.30	-100.00	175.00
Scenario of SC2	27.92	1.29	-100.00	1.10	-13.40	-99.90
Scenario of SC3	76.54	1.30	-10.50	0.00	-100.00	-99.90

Table 4: The table presents the Multicriteria Analysis normalized criteria values.

Normalized Criteria Values	Power production	Evaporation Losses	Flow variability	Wet season shift	Water availability	Agriculture recession
Group	ECON	ECON	ENV	ENV	SOC	SOC
Unit	Gwh/yr	Mm^3/yr	%	weeks	%	%
Scenario of SC1	1.000	0.990	9.524	0.024	7.463	1.000
Scenario of SC2	0.365	1.000	1.000	0.909	1.000	-1.752
Scenario of SC3	1.000	0.990	9.524	1.000	7.463	-1.752

3.4.3. Scenarios and criteria pre-analysis: Performing a pre-analysis of scenarios allows identification of both dominating or not included scenarios as well as redundant criteria as shown by the legend of table 5. In that case, dominating scenarios are automatically selected for scenarios evaluation in future while not included scenarios are dropped and those redundant should be reconsidered. Among redundant criteria, some of them should be eliminated to avoid evaluation keys to be alike. In this study, there are no dominating scenarios while Power production, Flow variability, and Water availability are redundant criteria. Thus, Power production is selected while the two others are eliminated (table 6).

Table 5: The table presents the identification of dominating scenarios and redundant criteria.

Identify Dominating Scenarios And Redundant Criteria	Power production	Evaporation Losses	Flow variability	Wet season shift	Water availability	Agriculture recession
Scenarios	rank	rank	rank	rank	rank	rank
Scenario of SC1	1	2	1	3	1	1
Scenario of SC2	3	1	3	2	3	2
Scenario of SC3	1	2	1	1	1	2

dominating
redundant
not included
dominating and not included
dominating and redundant
redundant and not included
dominating, redundant and not included

Table 6: Selection of suitable criteria for scenarios evaluation.

Identify Dominating Scenarios And Redundant Criteria	Power production	Evaporation Losses	Wet season shift	Agriculture recession
Scenarios	rank	rank	rank	rank
Scenario of SC1	1	2	3	1
Scenario of SC2	3	1	2	2
Scenario of SC3	1	2	1	2

3.4.4. Objective analysis sessions: The so-called objective sessions are carried out, criteria based, by the NB-DSS specialist without consideration of stakeholders' criteria limits specification. Nevertheless, the traditional three (3) sessions (Economic, Environmental and Social) should be respectively done accordingly with criteria priorities as defined by each stakeholders group. These analysis sessions led to three (3) decision matrix. A comparison of the three decision matrix is synthesized in table 7 and figure 6.

Table 7 and figure 6 show that economic and social sessions declared scenario SC1 as optimal while the environment session preferred scenario SC3. On this level, even if scenario 2 was dropped at least by everyone, there is not yet a dominating scenario. That is the reason which militated for three concerted sessions. These new sessions were carried out according to criteria limits accepted by all stakeholders groups.

Table 7: The table presents the synthetic Decision matrix, sessions comparison based.

Scenario ranking matrix

	ECON	ENV	SOC
Scenario of SC1	1	2	1
Scenario of SC2	3	3	3
Scenario of SC3	2	1	2

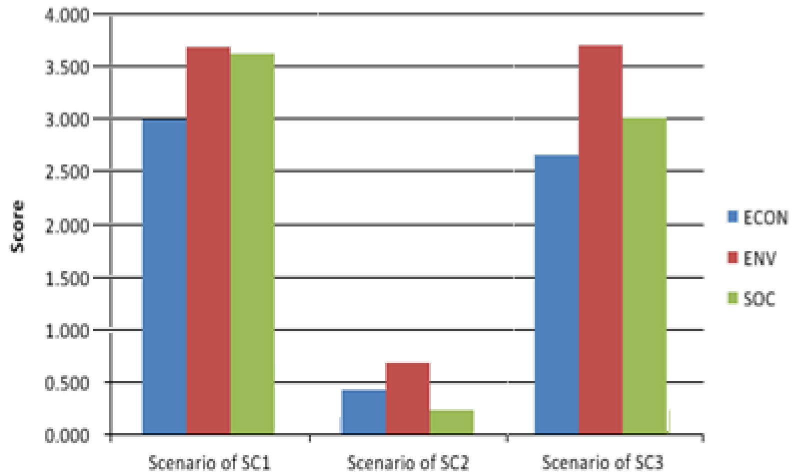

Figure 6: The table presents the scenarios comparison after objective analysis sessions.

3.4.5. Concerted analysis sessions: Criteria limits previously agreed by stakeholders was listed as follows (table 8).

Table 8: The table presents the criteria limits accepted by stakeholders groups in different sessions.

		Accepted limits		
Criteria		Economic session	Environmental sesion	Social session
Power production	rank	1 (75 GWh/yr min)	4 (44GWh max)	2 (70 GWh/yr min)
Evaporation _Losses	rank	2 (10 M^3/yr max)	2 (1 Mm^3/yr max)	4 (5 M^3/yr max)
Wet season shift	rank	4 (16 weeks min)	1 (2 weeks max)	3 (8 weeks max)
Agriculture recession	rank	3 (30% min)	3 (30% max)	1 (20% max)

The limits above are the mean values presented by different opinion groups. So it was difficult to adapt them for an eventual best result. After the calculation of indicators values, a new MCA set up was performed. Criteria, ranking, and weights were defined and optimized using the software. Three new sessions (Economic, Environmental and Social) were developed and compared. This comparison led to the ranking matrix (table 9) and the associated weighted score chart (figure 7).

Table 9: Synthetic decision matrix after concerted sessions' matrix comparison.

	ECON_Session	ENV_Session	SOC_Session
Scenario of SC1	2.539	1.615	1.308
Scenario of SC2	0.905	1.608	1.577
Scenario of SC3	2.219	1.031	0.723

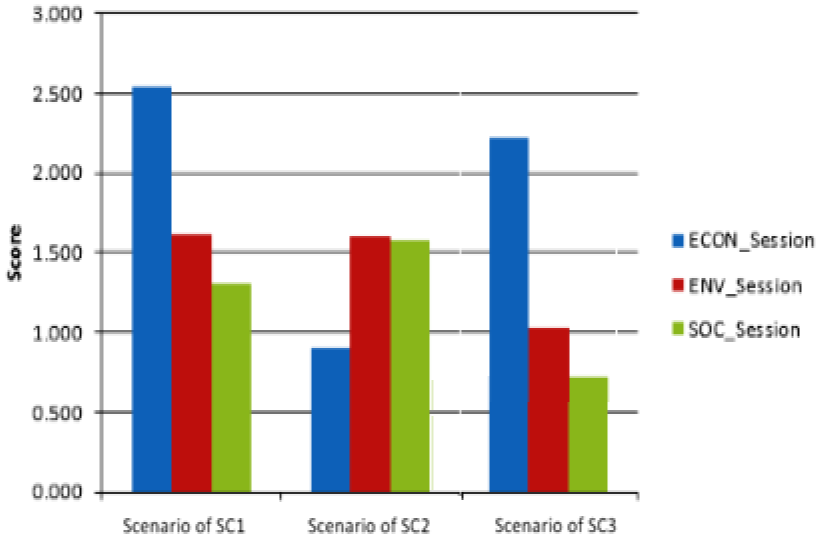

Figure 7: The table presents the scenarios weighted scores chart after concerted sessions' comparison.

After concerted sessions' decision matrix comparison, figure 7 and table 9 show that according to scenarios scores, scenario SC1 privileged by objective sessions remain the best water resources development option in Mpioka basin.

4. DISCUSSION

Focusing our attention on outputs of current research, figure 4 shows that the development of an irrigation scheme upstream generates a strong water deficit to Nkamba-Ntimansi node. People downstream were anxious because of the risk for them to lose their swamp where activities such as fishing and hunting are mainly done.

Comparison of current inflow of the Nkamba river node with inflow of the same node in SC1, leads to accurate measures of river flow stabilization downstream as predicted by Nlandu and al. (2008) [20]. The storage water volume in the reservoir should explain this situation. That is the main difficulty in selecting the optimal scenario. More, we should remind that the committed ministry promised to promote this project by a support to the third scenario.

Fortunately, the study needs a powerful and appropriate software (NB-DSS) to be implemented for a neutral solution. Faced with conflicts of interest between different riparian communities, the use of a decision support system based upon a Graph Model as recommended by Peng (1999), held to perform suitable scenarios for competing opinions arbitration about the Mpioka basin water resources management [22]. Comparison is done against Economical, Environmental and Social Multicriteria sessions, as well as scenarios ranking matrix, revealed a conflict against the limits fixed by stakeholders. To get feeling on the real situation, it seemed necessary to hide those limits and perform first an objective sessions' comparison. True enough, this sessions comparison (table 9 and figure 6) gave a more explicit scenarios ranking matrix: both Economic and Social sessions prioritized SC1 while the Environment session has chosen SC3. Clearly, the Mpioka dam building is the priority for economists and social groups' opinion, when the Pilgrimage Centre development is the preferred option for environmentalists. Coming back to stakeholders acceptable limits fixing, it can be concluded that the so-called limits conflict in concern above, was mainly generated by Economists and Environmentalists limit values.

This study also noted that the great political influence of Kimbangu's church weighs strongly on this project. Thus, many factors should be taken into account before trying to convince church's leaders for real consideration of other stakeholders' opinion groups in the basin. The occasion offers by the Nile-SEC trough the Democratic Republic of Congo NB-DSS Office to debate on all the water resources development project remains a unique rescue to those populations.
Although all stakeholders concerns rejected SC2, irrigation scheme set up remains an imperative at authors' behalf, because there is no food production enough in the basin. But this scheme should be developed downstream to avoid water deficit which could be generated if such activity is sets up upstream. About SC3, Pilgrimage Centre building with touristic activities development is a real challenge for the basin development. Regarding the interest shown by the government about this activity, the political ascendance on development actions should allow profitable management and guaranteed funding besides its traditional backers. Such involvement of State should be an additional opportunity for the whole project set up.

This discussion cannot be closed without mentioning the many obstacles that have marked data collection phase. Indeed, we deplored reluctance of local population to confide in our investigative team suspected of wrongfully encouraging the expropriation of certain peasants from their lands for the benefit of the Kimbangu Church. Beyond that, we regretted the destruction of Mpioka hydrometeorological and gauging stations installed by Nlandu and al. (2004b), and the interruption of rainfall, temperature, sunshine, evaporation, wind velocity and others measurements and subsequent gauge readings. This interruption in the collection of field data deprived the study of sitting on more up-to-date information at the model entry [19].

5. CONCLUSION

The whole stakeholders' opinion groups agreed unanimously that the Mpioka dam construction (SC1) seems to be the first development priority in the Mpioka basin. Then, could follow, gradually: the construction of Pilgrimage Center (medium term) and the development of Nkamba agro-industrial irrigation scheme (long term). In view of the present study results strengthening, it would be desirable to carry more investigations out in order to complete the performed multicriteria analysis by a costs and benefits one. The latter will allow to assess the contributions of each development scenario in terms of economic gain for best decision making.

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