Evaluation of the Suitability of Pangani Falls Redevelopment (Hydro Power) Project in Pangani River Basin, Tanzania: An IWRM Approach

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Abstract

The Pangani Fall Redevelopment (Hydropower) Project which is in Pangani River Basin (PRB) in Tanzania has experienced years of declining discharges of the Pangani River, which has caused lower production (electricity) figures. Many streams and valleys that contained water before are now dry and contain water only during the rainy season and the Pangani Falls Hydro-power Station has over the last five years seen a declining production capacity. The Nyumba ya Mungu Reservoir and Power Station experienced during the 2005 the lowest water level ever. Human activities have been responsible for the degradation of many watersheds within PRB. Others will state poor management of resources, climate change and low rainfall as the reasons for declining discharges of Pangani River. The competing demands for water for small and large scale irrigation schemes, industrial and domestic consumption and for power generation have and may in the future create un-necessary turmoil's. This study therefore saw the need to look the problem of entire PRB in an integrated approach.

This study was therefore carried out to meet the following objectives;

- To assess the Institutional Arrangement of Pangani River Basin, that is, Pangani Basin Water Office (PBWO) looking at its strengths and weaknesses
- To compare the water use between hydropower production and irrigation looking at water use for different crops, economic returns from irrigated crops and hydropower generation and the impact of irrigation and hydropower production on water resources
- To analyze people's perception of the use and management of water for irrigation and environmental needs

To propose the future scenarios for water availability in the PBWO

The study has shown that PBWO has been able to bring fragmented water uses and users together, it has also internalized upstream/downstream and other conflicts, making them easier to deal with. The study has also shown that the management of the basin's water resources will require improved funding of which currently it is inadequate. People have now positively perceived the best management practices for watersheds which aim at correcting land use mistakes, conserving and protecting their biological value and to integrate watershed practices with other resource development efforts such as forestry, agriculture, energy and water resources. Likewise the study has shown that agriculture is the biggest user of water which has also more economic return per m^3 of water than hydropower.

Keywords: hydropower, irrigation, integrated watershed practices, integrated water resources management.

Introduction

The increasing scarcity of water resources in the Pangani River Basin, which is in Tanzania calls for strategic water resources management that will ensure the sustainability of water supply and the goods and services supplied by aquatic environments, as well as the efficient and equitable use of these resources. Sustaining water supplies for the numerous users in the basin will depend on reducing losses due to catchments degradation and wastage due to inefficient practices. One of the water users in the basin is Pangani Fall Redevelopment Project (Hydropower).

The Project (Hydropower) has experienced years of declining discharges of the Pangani River, which has caused lower production (electricity) figures. Many streams and valleys that contained water before are now dry and contain water only during the rainy season and the Pangani Falls Hydro-power Station has over the last five years seen a declining production capacity. The Nyumba ya Mungu Reservoir and Power Station experienced during the 2005 the lowest water level ever. Inflows to Nyumba ya Mungu reservoir from Ruvu and Kikuletwa are declining and very little or no water is actually provided to Pangani River by the Mkomazi Tributary. What are reasons? Human activities have been responsible for the degradation of many watersheds within Pangani River Basin. Vegetation degradation and soil erosion problems on both flat as well as steep terrains in watershed areas are associated with unsustainable land use practices, such as poor cultivation techniques, increased population pressure, de-forestation and overgrazing. These are of course depending on several factors of which one – degradation of watersheds in combination with too large amount of uncontrolled and controlled water abstractions from surface and ground water sources – is probably the main factor. Others will state poor management of resources, climate change and low rainfall as the reasons for declining discharges of Pangani River. The competing demands for water for small and large scale irrigation schemes, industrial and domestic consumption and for power generation have and may in the future create un-necessary turmoil's.

Therefore the study was carried out to assess the hydropower project after its completion. The study was carried out to meet the following objectives;

To assess the Institutional Set Up in Pangani River Basin, that is, Pangani Basin Water Office (PBWO) looking at its strengths and weaknesses

To compare the water use between hydropower production and irrigation looking at water use for different crops, economic returns from irrigated crops and hydropower generation and the impact of irrigation and hydropower production on water resources

To analyze people's perception of the use and management of water for irrigation and environmental needs

To propose possible future scenarios for hydropower water availability

Methodology

The study was carried out in the Pangani Basin which covers an area of about 58,800 km^2 administratively and includes the main Pangani River Basin and the smaller river basins of Umba, Msangazi, Sigi, and Coastal Rivers, including Mukulumuzi (Fig1.). The Pangani River itself has two main tributaries, both of which rise in the basin's northernmost portions. The first of these, the Kikuletwa, rises on the slopes of Mount Meru and the southern slopes of Mount

Kilimanjaro, while the second, the Ruvu, rises on the eastern slopes of Mt. Kilimanjaro and Lake Jipe. These rivers join at Nyumba ya Mungu, a reservoir of some 140 km^2 (Røhr and Killingtveit, 2002). The Pangani River drains the reservoir, flowing for 432 km before emptying into the Indian Ocean.

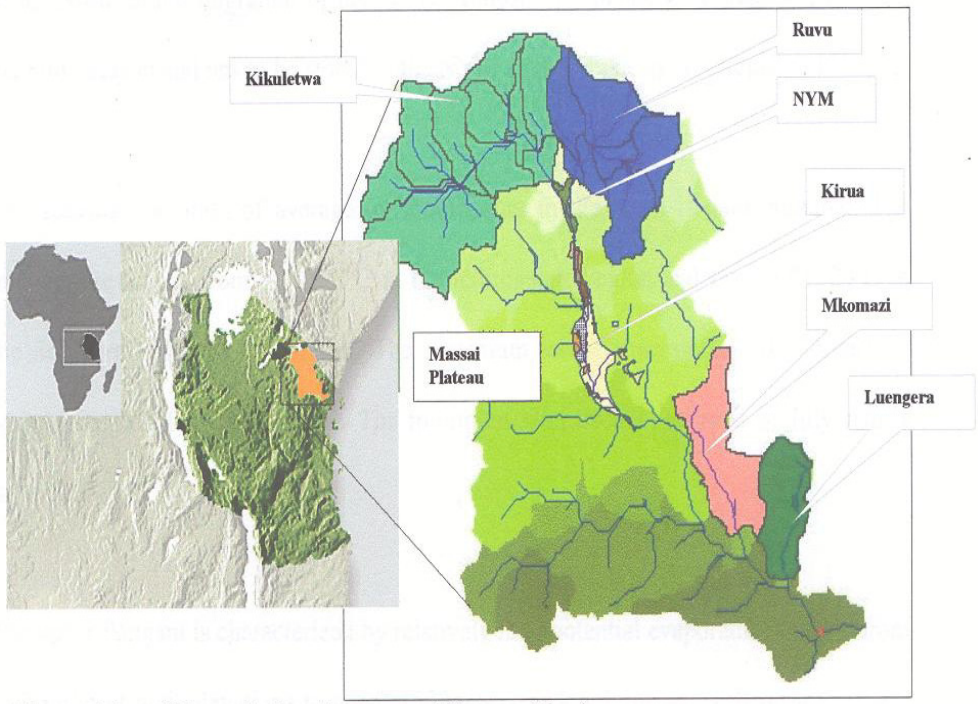

Fig. 1: Schematic Location Map of Pangani Basin (Moges, 2003)

The method that was used in carrying out this study was field trip and meeting with all stakeholders within the Pangani Basin. However, the key collaborator for this study was PBWO which provided much of information needed for this study. The information was later on synthesized to reach at the conclusions.

Results and Discussion

Institutional set up of Pangani Basin Water Office

The Pangani Basin Water Office established in 1991 under the Directorate of Water Resources in Tanzania and is responsible for allocating, managing, monitoring and controlling water use in Pangani Basin. It is also tasked with creating awareness on effective and efficient water use and launching water conservation programmes (PBWO, 2005). The institutional set up of PBWO is as shown in Fig.2.

The Basin Water Officer is in charge of the PBWO dealing with day to day activities in the office. He is also the secretary to the PBWB. The basin hydrologist is responsible for analyzing and documenting hydrological data of the basin. He is assisted by principal technicians and two senior technicians (PBWO, 2005). On functions and main activities, the PBWO is controlling and monitoring the water utilization in the basin. Specifically it does the following (PBWO, 2005); water use and water right inspection, water right applications, conflict resolutions, awareness campaign and updating the data base.

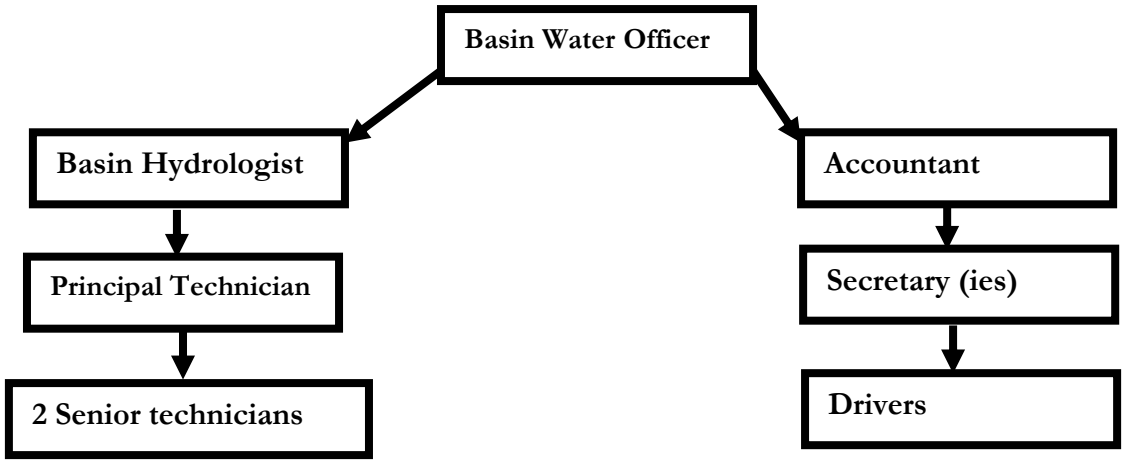

Fig.2: PBWO Organization Structure (PBWO, 2005)

Strength of PBWO

PBWO has been able to bring fragmented water uses and users together. PBWO has created a framework that deals with an entire Pangani river basin. All interests and stakeholders in the water affairs of the basin have suitable protection and adequate representation, including the natural environment and less powerful water users. The PBWO has also internalized upstream/downstream and other conflicts, making them easier to deal with. Because coordination involves voluntary agreement among participating jurisdictions, it provides a strong political base for action.

Weakness of PBWO

(i) Institutional Weakness

Tanzania has turned increasingly to Community-Based Natural Resources Management (CBNRM). Such a 'sectoral' approach to management is, therefore, present on both sides of the border (Tanzania and Kenya), and refers to situations where departments are involved with the management of forests, water, irrigation, wildlife and other resources. The PBWO has the weakness of ensuring that the various departments communicate with one another by sending representatives to the Pangani Basin Water Board (PBWB). The PBWO also lacks enough human resources to carry out all its functions including inspection and allocation of water rights.

(ii) Funding Weakness

As it is, the Pangani Basin Water Office can not meet their obligations adequately with their existing funding. This stems from (a) inadequate provision from central government (via the Ministry of Water) and (b) inadequate recovery of water user fees. The result of this is that the PBWO has inadequate resources for planning, enforcement and monitoring, let alone for setting in place a system for the optimal allocation of water resources.

Comparison of Water Usage for Different Water Users

Table 1 below summarizes water usage and their economic values.

Table 1: Average value of water per m^3 for different uses. (These are rough estimates only) (Turpie, et. al., 2005)

Type of Use	Estimated Water Consumption	Estimated average value (Tsh per m^3)
Domestic use	18 – 70 m^3/head	1,200 – 1,500
Coffee estates	1,000m^3/ha	723 – 6205
Sugar estates	12 – 17,000m^3/ha	32 – 101
Flower terms	18, 250 m^3/ha	3500 – 5300
Small scale irrigation		
Highland traditional furrow	3,000m^3/ha	211
Upper basin traditional furrow	3,000m^3/ha	475-574
Upper basin improved schemes	850-1,195m^3/ha	574-1,400
Lowland traditional furrow	3,000m^3/ha	109
Livestock		
Highlands (dairy cattle)	36m^3/head	2263
Upper basin (dairy & beef cattle)	27m^3/head	860
Lowlands (beef cattle, goats)	18m^3/head, 2.5m^3/head	479-926
Hydro-electric power production	2.4 – 19 m^3/kWh	73-300

Analysis of Perception of Traditional Irrigation Organizations on Water Management

Perception of Water Rights

In issues of water rights has been perceived differently by water user groups in Soni and Luengera sub-catchments. Some people understand the importance of water rights but others don't. This is attributed to historical and cultural backgrounds. However awareness campaigns are being conducted and this has born fruits as majority of people now understand the need of having water right. So the water right issue is positively perceived after 10 years of water users' sensitization. However, this is shown by a number of water rights applications received at PBWO. People now have realized that water is finite entity and need to be conserved.

Possible Future Scenarios for Water Availability for Hydropowe

Whether the Pangani Basin moves toward a more sustainable future concerning its water resources is largely a question of management. How can this shared resource be best used for the benefit of human populations on each side of the river and the region's uniquely diverse ecosystems? Potentially, there can be enough water, of acceptable quality, to support the domestic water needs of 3.7 million people in the area. To make this possible, agricultural use of water will have to be reduced significantly. Market mechanisms and mutually beneficial

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arrangements between cities and irrigation districts can bring about more efficient water use, making the rural-urban reallocation one of cooperation rather that conflict.

Conclussion and Recommendations

It is recommended to create incentives for catchment managers to maintain catchment forest areas, preferably through a system of 'payments for ecosystem services' which involves payment by those that benefit from the service, via PBWO, to catchment managers. The price increases required for this will also serve as a demand management tool that encourages more efficient use of the water that is allocated to various uses. Before water is allocated among different user sectors, it will be necessary to allocate sufficient water to aquatic ecosystems to maintain ecosystem functioning and the values derived from them. This can be achieved with the help of an 'instream flow assessment' which takes both ecological and socio-economic factors into account.

Acknowledgements

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