Water Resources Utilization, Conflicts and Interventions in the Tana Basin of Kenya

Jones F. Agwata

Department of Environmental Sciences, Kenyatta University
P.O. Box 43844, 00100 GPO Nairobi, Kenya
Email: agwatas@yahoo.co.uk

Abstract

Water is an essential resource necessary for social and economic development of any country. When it is available in sufficient quantities and acceptable quality, it is extensively used for domestic, agricultural and industrial purposes. Some of the uses include drinking; washing, watering of livestock, growing crops and the manufacture of finished goods in industry. In Kenya, adequate water is available only in 20% of the country's landmass whilst in the rest and biggest portion of the country including the arid and semi-arid lands, it has to be mined from the ground or harvested in dams, and pans. Due to the scarcity of water in the arid and semi-arid regions of the country and its uneven and poor distribution in the high and medium potential areas, its utilization for various functions in any basin often leads to conflicts. These conflicts require appropriate interventions in the form of conservation, protection of water sources and apportionment to meet various water needs in an integrated and sustainable manner. In this paper, a brief overview of the water resources in Kenya is provided and the utilization of water in the Tana Basin and the associated conflicts and interventions examined. The main issues related to water in the basin should be addressed to ensure that the available water is managed in an integrated manner. Also, some of the necessary institutional frameworks for integrated and sustainable water resource management in the basin are proposed.

Introduction

Water is essential for the national development of Kenya with much of it being used for hydropower generation, municipal and commercial needs, agriculture, recreation and industrial operations. With a largely agro-based economy and a rapidly expanding industrial sector, the

demand for water is constantly rising and in order to meet the increasing demands, available water resources have to be managed in a sustainable and integrated manner. The amount of renewable surface water in the country is estimated at 19 500 million m^3 or 650 m^3 per capita, but this is expected to drop to 250 m^3 per capita in 2025 when the population is projected to rise to 60 million (NEMA, 2003). When this is compared with the global recommendation of 1 000 m^3 per capita it means the country is chronically water scarce. This poses a very serious environmental challenge especially in the arid and semi-arid areas of the country that comprise about 80% of the country's total land surface area.

The country's surface water resources are grouped into five basins indicated in Figure 1 as 1-5 and are named as, Lake Victoria, Rift Valley, Athi, Tana and the Ewaso Ng'iro basins (GoK, 1992), while the water yield potentials of different basins are given in Table 1. However, a look at the drainage system in the country suggests that the Rift Valley basin would be divided into two different basins with the second basin indicated as Figure 2(a).

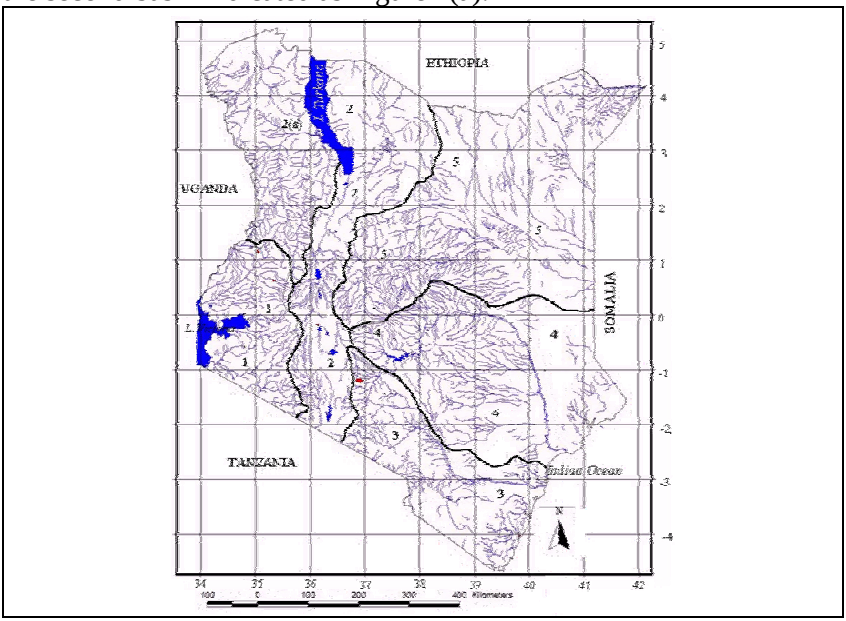

Figure 1: Major Drainage Basins of Kenya *(NEMA, 2003)*

Table 1: Major Drainage Basins and their Potentials (*NEMA, 2003*).

Basin Number & Name	Area/ km2	Mean annual rainfall/ mm	Annual basin discharge/ BCM
1. Lake Victoria	46 229	1 370	13.80
2. Rift Valley	130 452	560	3.26
3. Athi	66 837	740	1.31
4. Tana	126 000	700	3.70
5. Ewaso Ng'iro	210 226	410	0.34

The surface water resources in the drainage basins in Table 1 comprise of both permanent and seasonal rivers, lakes, dams, ponds/pans and the Indian Ocean. Due to the increasing demand for water from various rivers by livestock, agriculture, domestic and industrial uses, the water flow in the rivers and streams and the volume in the lakes, ponds and dams have shown decreasing trends. The groundwater resource varies in both quantity and quality and from basin to basin. It comprises of 14% of the total water resources in the country and is estimated to be 619 million cubic meters of which 69% is located in shallow aquifers and 31% in deep ones. The characteristics of groundwater in the basins are shown in Table 2.

Groundwater is recognized as an important resource that supplements surface water in socio-economic development in all areas, but more so in the arid and semi-arid areas that comprise nearly 80% of the total landmass in the country where it is widely utilized for domestic, agricultural and industrial activities. Several challenges face groundwater exploitation in the country (Mwatha and Gichuki, 1993). The challenges include rundown of existing boreholes, lack of rehabilitation or replacement of existing ones, low yielding aquifers and poor quality water from most of the boreholes. Other challenges are saltwater intrusion, leachate from garbage dumps in urban centres and infiltration of fertilizer and pesticides and pesticide residues from farms. Increasing demand for water, encroachment of recharge areas and unregulated utilization of the resource also threaten ground water resources. According to a recent estimate, most of the existing 4 500 boreholes in the arid and semi-arid areas of the country are in dire need of rehabilitation or total replacement (NEMA, 2003).

Table 2: Characteristics of groundwater in drainage basins (*JICA, 1992*)

Drainage Basin	**Characteristics**
Lake Victoria	Over 90% of the boreholes have good quality water
Rift Valley	Most of the water is fresh, soft and free from colour and turbidity. But about 50% of the borehole waters that has been tested have fluoride levels in excess of 1.5 ppm, which is the WHO recommended value.
Athi	The water around Nairobi is generally palatable although over 50% of the boreholes contain hard and saline water while the boreholes and shallow wells around the coast area prone to contamination
Tana	The water is generally fresh and free from colour and turbidity, but hardness varies from soft to moderately soft and some amounts of fluoride are experienced in some areas adjacent to cities
Ewaso Ng'iro	Boreholes tend to have high fluoride contents and occasional hardness with high levels of iron and manganese depending on geological formations. In most of the boreholes, water is often hard and contains varying salinity levels.

The Tana River Basin

The Tana Basin (Figure 1) consists of the Tana as the main river in the basin. Various tributaries that originate from Mount Kenya, Aberdare Ranges and the Nyambene Hills feed the Tana River. The river has a total length of about 1 012 kilometres from the farthest source to the Indian Ocean and has an annual mean discharge of five billion cubic meters. It covers a total catchment area of about 126 000 km^2, which is nearly 21% of the country's total surface area.

The Tana River Basin accommodates various agro-ecological zones. The physiography of the basin comprises of the upper, middle and lower catchment areas, with the upper catchment covering about 15 000 km^2 at an altitude of 1 000 metres above mean sea level. The middle catchment covers an area of 15 700 km^2 at an altitude of

between 1 000 and 200 metres above mean sea level, while the lower portion of the basin covers an area of 95 300 km^2 at altitudes below 200 metres (Hirji ., 1996). Agricultural production in the basin is varied since the basin extends over areas of diverse agricultural potential. The high potential zone produces coffee, tea, pyrethrum, wheat and barley; dairy, sheep and poultry. The medium potential zone having maize, sunflower and beans as the major crops with some poultry, sheep and dairy kept. The low potential zone has millet, cotton, tobacco and sorghum as the main crops. The irrigation potential in the basin is estimated at 132 000 hectares with the present developed and planned irrigation schemes covering an area of 54 676 hectares comprising 30 148 hectares under private schemes and 24 528 hectares managed by various government organizations. Different types of irrigation schemes found within the basin include small-scale group based schemes, mainly involving horticulture and floriculture as well as subsistence crops. Second, individual holder schemes providing nurseries for high cost crops such as macadamia, floriculture and ornamental crops with several greenhouses. The third category is the public irrigation schemes managed by government agencies e.g. the National Irrigation Board, Agricultural Development Corporation and the Tana and Athi River Development Authority.

Livestock is also reared for milk, beef and mutton while pig farming in the basin is widespread (Hirji, 1996). The many tributaries in the basin provide a major potential source of hydropower in the country estimated at 960 MW. Other resources with economic potential within the basin include mountain forests that are important wildlife conservation areas with several game parks and tourism destination centres. In the lower portions of the Tana, several riverine forests and the Tana Delta are famous for flora and fauna –also of touristic value.

Electric energy in the country is currently supplied mainly from the many hydro-generation plants on the Tana River with the main power plants located in the Seven Forks. Presently, six hydropower projects are located at various points along the main Tana River and provide nearly 70% of the total electric energy to the national grid. Nearly 80% of the basin is arid and semi-arid and requires some form of supplemental water in order for any meaningful agricultural production to take place. Demand for water is high due to an

increasing population especially in the upper parts of the basin, where rain-fed agriculture is practiced on 21% of the total land area in the basin. The various land use practices within the basin have led to increasing demand for water resources and thus to an increase in conflicts in water utilization due to competing interests. The conflicts arising out of the varied land uses are discussed in the following section.

Water Usage Conflicts in the Basin

The various land use activities in the basin require water for their operations and since there is lack of sufficient quantities of the resource to satisfy all water needs, there are serious conflicts due to different water demands in the basin. The first conflict has to do with water scarcity and distribution, which is as a result of the uneven distribution of water in the basin both seasonally and across locations. This means that water demands have to be met from areas with abundance and the excess stored during the wet season for use in the dry season. Also, consumptive uses such as irrigation, inter basin transfers are known to remove water from the basin that would otherwise be used for hydropower, irrigation, domestic, industrial and ecological maintenance. Due to a high demand, conflicts are bound to rise within the basin that require comprehensive planning to ensure that water diversion upstream of the power plants, dams, and irrigation schemes are managed in an integrated manner.

The use of water in the lower parts of the basin for flood recession agriculture often conflicts with regulating the river for hydropower production and for providing adequate water supplies, flood damage protection of the riverine settlements and infrastructure. One way to avoid this conflict would be the conservation of surface runoff as has been done in some parts of the adjacent Ewaso Ngi'ro River basin (Liniger, 1995).

Another conflict is due to sanitation, sewage and pollution resulting from the many industries such as coffee, pineapple processing and tanneries, as well as insecticide, herbicide and fertilizer applications that produce effluents and residues into the rivers. The generation of domestic and sewage wastes also degrade the quality of water in the rivers, if these are not properly treated and disposed of. As a result of

the poor quality of the water from the rivers, the water is not suitable for other purposes unless it is treated. This means that there is need to properly plan for the river basin's sanitation industrial effluents and urban sewage to avoid excessive pollution of the rivers of the basin.

Damming of rivers and streams in the basin causes deposition of sediments in the reservoirs causing less water reaching the flood plain areas where flood recession agriculture depends on alluvial waters for irrigation since sediment takes up useful storage space. The accumulation of the sediments in the dams and reservoirs also reduces the operational lifespan of the structures and affects the output in terms of power production. Competition for water is very critical in the basin due to the intensive irrigation together with heavy municipal water abstractions for use in surrounding towns and the City of Nairobi. These causes large water short falls to domestic and irrigation projects downstream of the basin.

Other conflicts are due to water use between upper catchment irrigation and hydropower and the lower Tana irrigation and livestock development due to riverine cultivation and livestock access to water. Another challenge is therefore water distribution management. The management of water involves several agencies such as Ministry of Water and Irrigation, National Water Conservation and Pipeline Corporation, Nairobi Water and Sewerage Company Limited, Tana and Athi River Development Association and private bodies, agencies and individuals. Although the Water Act 2002 regulates water abstraction and distribution, there is need to streamline water undertaking among various public institutions and other stakeholders. To this end the sewerage and sanitation functions, which are very vital to the conservation of water and pollution control, should be under local authorities, but regulated by the national body responsible for water resource conservation and distribution.

Proposed Interventions

Regulation of the Waters of Tana River

The waters of the Tana River should be managed by promoting water conservation efforts and by protecting water catchment areas and construction of reservoirs. Besides helping to minimize the conflicts

over water use, these measures will increase the potential of irrigated agriculture upstream of the basin; implement the development and expansion of hydropower potential on the middle Tana downstream of the densely populated upper Tana catchment. River regulation will increase the area downstream that is under irrigation and will reduce downstream flooding and the associated damage to settlements and riverine infrastructure.

Control of Soil Erosion

There is need to control soil erosion in the basin by ensuring that various land use practices such as agriculture, livestock husbandry, forest resource utilization, and infrastructure development in the upper parts of the basin are carried out to maintain the useful life of the reservoirs within the basin. Farmers need to be encouraged to protect soils from erosion processes through providing tree seedlings to reduce destruction of forests in river catchment areas. The protection of riverbanks to minimize changes in riverine channels should be made an integral part of flood recession agricultural in the basin.

Water Pollution Control

Water resources management involves the protection of water resources from pollution arising from domestic, agricultural and industrial effluents in the basin. There is need to re-examine the location of various industries vis-à-vis water sources and the industries' potential to pollute water. This may lead to the regulation of industrial locations in relation to sources of water in the basin. This can only work if statutory powers to enforce effluent release standards are given to River Basin Development Authorities to carry out all aspects of pollution control such as river monitoring, laboratory analysis, water pollution surveillance and prosecution.

Regulation of Utilization and Apportionment of Water

The apportionment of water and the regulation of its use are part of authority of the Water Apportionment Board and the Tana Catchment Board. The Tana River Development Authority currently is responsible for the regulation of Tana River flow to facilitate River basin water apportionment and the utilization of water with minimal conflicts.

Funding for Water Resources Management

There is need to address the issue of funding to ensure sustainable water resources management. This is vital since water resources availability sustains life and as an economic good permeates production and processing of various economic goods and products, which justifies the need to pay for it as a commodity and to develop appropriate infrastructure for its delivery to the users. It is important to appreciate the significant role that water provision plays in the production of hydropower, agricultural development, industrial production and commerce and so payment for its supply for these various functions is justifiable. The payment should meet the costs of water conservation, river regulation, infrastructure maintenance and development, pollution control enforcement and acquisition of necessary data (Al-Mohannadi, 2003).

Conclusions and Recommendations

With continued population growth that increases the demand for water to meet domestic, agricultural, industrial and municipal needs, there is an urgent need to manage water resources in the Tana Basin in a sustainable and integrated way. The country will continue to depend on hydropower from the basin and so the basin's hydropower potential and development will require that the available water resources are managed in a sustainable and integrated manner. The irrigation of the lower parts of the basin and the necessity for funding for water resources' quality and quantity conservation has to be rationalized, while a proper legal mechanism has to be put in place to accommodate integrated water resources management in the basin. To this end, it is recommended that:

The fragmented responsibilities within various government agencies need to be evaluated to ensure full benefits of integrated water resources management in the basin and the country in general.

Water be considered an economic good and therefore be paid for adequately by those who need it. The payment can be made to the basin authority in charge of water to meet the costs of river regulation, catchment and water quality protection and acquisition of relevant water data. There is need to enforce water quality and pollution control as an integral part of water conservation in the basin.

Necessary capacity is built in the development authority to meet the needs of integrated water resources management especially in the enforcement of water quality and pollution control aspects of water management.

Environmental impact assessment and audits of the existing and proposed water development projects within the basin should be implemented to avoid serious impacts to the environment.

Interdisciplinary approaches to planning, research, implementation and monitoring of water resource management practices within the basin are encouraged and promoted and needs and potentials for training and education programs in various agro-ecological zones and for different socio-economic groups are identified.

An integrated strategy that deals with sustainable use of all the natural resources such as land, vegetation and forests in the basin is put in place since water does not exist in a vacuum.

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References

AL-MOHANNAD, H. I., HUNT, C. O. AND WOOD, A. P. (2003): *Controlling Water Demand in Qatar: An Assessment. AMBIO, 32*:362-366.

GOVERNMENT OF KENYA, GOK (1992): *National Water Master Plan*. Government Printer, Nairobi.

HIRJI, R., PARTONI, F. M. AND RUBIN, D. (Eds) (1996): *Proceedings of the Seminar on Integrated Water Resources Management in Kenya*, The economic Development Institute of the World Bank. Washington, USA. Pp. 15-129.

JAPAN INTERNATIONAL COOPERATION AGENCY, JICA (1992): *National Water Master Plan*. Government Printer, Nairobi.

MWATHA, S. AND GICHUKI, F. N. (1993): *Evaluation of the Furrow Irrigation System in the Bura Scheme.* In: Gichuki, F. N., Mungai, D. N,. Gachene, C. K. And Thomas, D. B. (Editors): Land and Water Management in Kenya: Towards Sustainable Land Use. English Press Ltd., Nairobi. Pp. 267-272.

NATIONAL ENVIRONMENTAL MANAGEMENT AGENCY, NEMA (2003): *State of the Environment Report, Kenya*. Government Printer, Nairobi. Pp. 53-60.

LINIGER, H. (1995): *Endangered Water: A global overview of degradation, conflicts and strategies for improvement*. Centre for Development and Environment, Institute of Geography, University of Berne, Switzerland. Pp. 117.

UNITED NATIONS CENTRE FOR HUMAN SETTLEMENTS, HABITAT (1996): *Managing Water Resources for Large Cities and Towns*. Habitat, Nairobi, Kenya. Pp. 4-45.

UNITED NATIONS ENVIRONMENTAL PROGRAM, UNEP (2000): *Africa Environment Outlook: past, present and future perspectives*. UNEP, Nairobi. Pp. 167-175