CHAPTER 13

Socio-economic and Environmental Concerns of Water Resources Management in the Tana Basin, Kenya

Jones F. Agwata[1] and Peter Abwao[2]

13.1 Introduction

Water is an essential resource for the development of any country and its availability is the most limiting factor for socio-economic progress and advancement. Due to various factors, there is a growing need for more water such that to address the increasing needs in both rural and urban areas, water projects are being developed to ensure water availability for various competing demands. However, most of the water projects are environmentally unsustainable. There is need therefore to institute an integrated approach for sustainable management of water resources.

Water management is not an end in itself but a means through which poverty can be reduced and basic human rights guaranteed to all people and to preserve the natural resource base for sustainable development both now and in the future. Water use by one sector can influence users in other sectors and so it is important that the utilization of water resources be carefully regulated and managed to prevent unintentional hardships or conflicts. This is particularly so in cases where there is absence of legal instruments such as treaties, protocols and specific policies and legislation for effective and efficient management of water resources. Water as a resource of considerable complexity with many functions and as a consequence of socio-economic development, the complexity of freshwater ecosystems is continuously increasing in all its temporal, structural and spatial dimensions. Water management regimes have also changed since the colonial times and new approaches of management are now emerging. Sustainable development relates the environment to integration of social and environmental issues with water management at the local, national, regional and international level (Eriksen, 1998).

In this chapter, an overview of the water resource base of Kenya is provided and the occurrence and the socio-economic and environmental implications of water utilization in the Tana River basin examined. Some recommendations and review questions are provided at the end of the chapter.

[1]Kenyatta University, Department of Environmental Sciences: Email: agwatas@yahoo.co.uk
[2]Kenyatta University, Environmental Studies and Community Development. Email: abwaopeter@yahoo.com

13.2 The Water Resource Base of Kenya

Water in Kenya, as in most other countries, is essential for national development in terms of its usefulness for a multiplicity of functions such as 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. 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 to be 19 500 million m3 or 650 m3 per capita but this is expected to drop to 250 m3 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 m3 per capita, it shows that the country is chronically water scarce. Consequently, various regions of the country are faced with serious challenges related to water management for continued social and economic development. These challenges need to be addressed and the opportunities arising from the challenges appreciated for sustainable development and management of water in different parts of the country.

The country's water resources are grouped into drainage areas 1 (Lake Victoria basin), 2 (the Rift Valley basin), 3 (the Athi River basin), 4 (the Tana River basin) and 5 (the Ewaso Ng'iro River basin). The location of the basins is shown in Figure 1 while the water yield potentials of the different basins are given in Table 1.

Table 1: Drainage basins of Kenya and their potentials

Basin Number and Name	Area, km^2	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

(Source: NEMA, 2003)

Note that due to the drainage patterns, area 2 may be subdivided into two areas 2 and 2(a) as shown in the Figure 1. The surface water resources in these basins comprises 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 in the amount of water.

Groundwater is recognized as an important resource that supplements surface water in socio-economic development of all areas but more especially the arid and semi arid areas that comprise more than 80% of the total landmass in the country where it is widely utilized for domestic, agricultural and industrial activities. The main areas where groundwater is used include Nairobi, Mombasa, Lamu, Naivasha, Garissa, Kitui and Wajir. Most of the arid and semi arid regions in the country depend on groundwater from various reservoirs (aquifers) whose withdrawals are estimated at about 17 million cubic metres per year (Ogola et al., 1997).

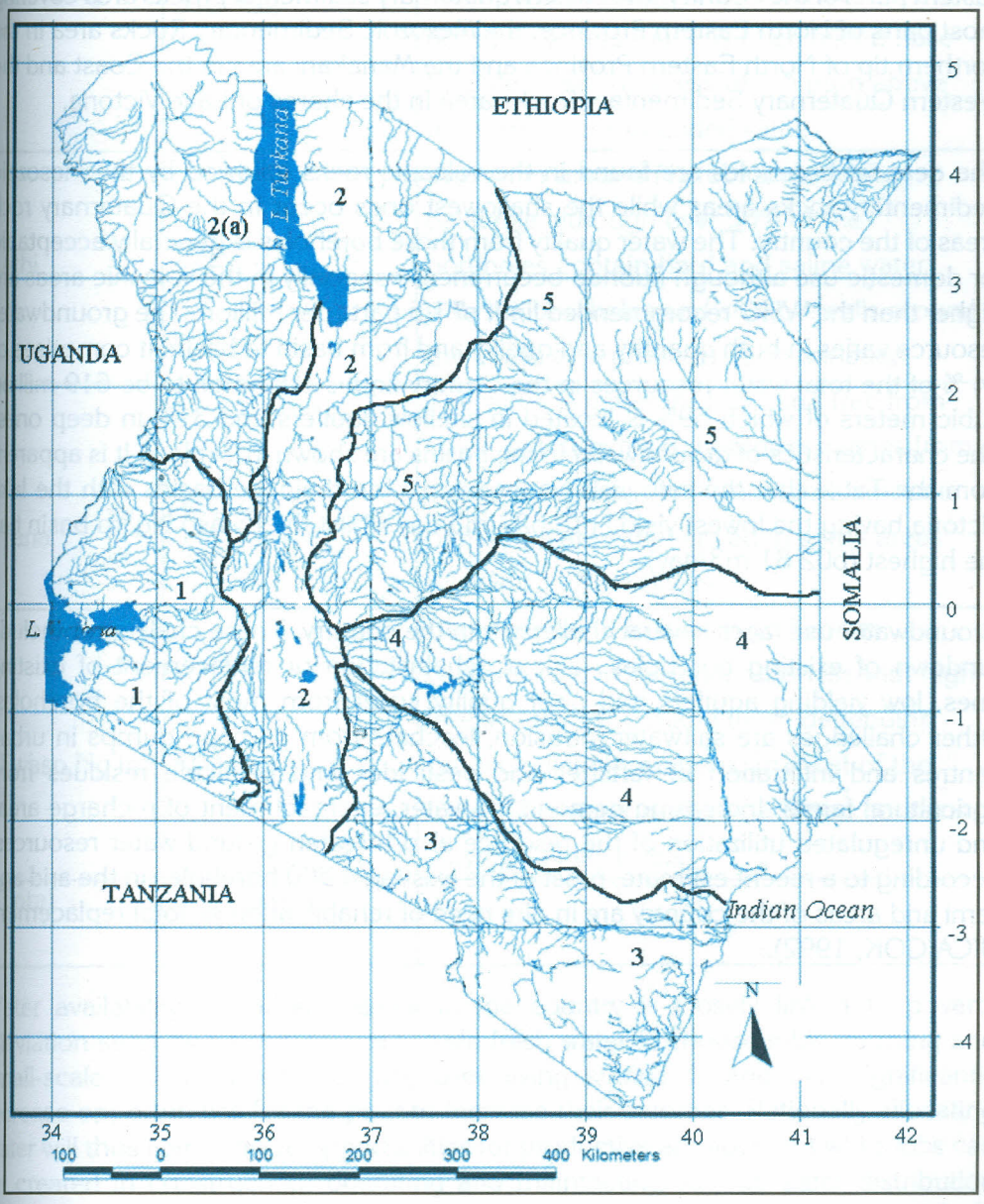

Figure 1: Major Drainage Basins of Kenya (Modified from: JICA/GoK, 1992). Basin names are indicated in Table 1.

The country's geological and hydro-geological conditions favour the occurrence of groundwater resources in varying quantities and quality that can be economically exploited for various socio-economic activities in various parts of the country.

There are six hydro-geological areas each of which has unique hydro-geological characteristics in terms of depth, water quality and quantity and drilling possibilities. The areas include the volcanic areas outside the Rift Valley, the Volcanic Rocks Area in the Rift Valley, the Metamorphic Basement Rocks area in the western and eastern parts of the country, the eastern quaternary sedimentary rocks area covering most parts of North Eastern Province, the Mesozoic Sedimentary Rocks area in the northern tip of North Eastern Province and the Mariakani area in the Coast and the Western Quaternary Sedimentary Rocks area in the shores of Lake Victoria.

The deepest boreholes are found in the volcanic rocks followed by the Mesozoic Sedimentary rocks areas while the shallowest ones occur in the Quaternary rock areas of the country. The water quality from these boreholes is generally acceptable for domestic use although fluoride occurrences especially in the volcanic areas are higher than the WHO recommended limit of 1.5 parts per million. 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. It is apparent from the Table that the safe yield varies across the drainage basins with the lake Victoria having the lowest yield (118 622 m3/day whilst the Ewaso Ng'iro basin has the highest (602 81 m3/day).

Groundwater use faces several challenges in the country. These 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 agricultural 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 (JICA/GOK, 1992).

Table 2: Characteristics of Groundwater in the Basins (Source: JICA/GOK, 1992)

Basin	Groundwater safe yield (m^3/day)	Groundwater characteristics
Lake Victoria	118 622	Over 90% of the boreholes have good quality water
Rift Valley	318 192	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 above the WHO recommended value
Athi	222 319	The water around Nairobi is generally palatable although over 50% of the boreholes contain hard and saline water with the boreholes and shallow wells around the coast area prone to contamination
Tana	431 499	The water is generally fresh and free from color and turbidity but hardness varies from soft to moderately soft and some amounts of fluoride are experienced in some areas adjacent to Nairobi city
Ewaso Ng'iro	602 281	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
Total	1 692 913	

Water availability in various basins in the country is closely linked to poverty alleviation strategies since access to safe fresh water for households, farming and small-scale industrial activities improves living standards and can significantly increase opportunities for the poor to increase their incomes. Rationally allocating water will thus help provide opportunities for productive employment while jobs can be created in constructing, operating and maintaining various water distribution infrastructures. This is particularly so because women and young girls especially in rural areas of the country and elsewhere spend long periods of time daily to fetch

water from distant sources. Bringing water closer to their homes would therefor afford them time to generate more income from other productive activities such a farming and commerce. It would also have tremendous benefits for their health.

13.3 Environmental Implications of Water use in the Tana River Basin

Overview of the Basin

The Tana River basin (shown as No 4 in Figure 1) has the Tana River as the main river and together with several streams originating from the Aberdares, Mt. Kenya and the Nyambeni Hills. 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 covering a total basin area of about 126 026 km2. It covers 18% of the country's total surface area with a population density of 40 persons per square kilometre. The total population in the basin was 5, 086, 137 in 1999 and this was projected to be 5, 562,033 in 2006. The physiography of the basin comprises of the upper, middle and lower catchment areas with the upper catchment covering about 15 000 km2 at an altitude of 1 000 meters above mean sea level, the middle catchment covers an area of 15 700 km2 at an altitude of between 1 000 and 200 meters above mean sea level while the lower portion of the basin covers an area of 95 300 km2 at altitudes below 200 meters (Hirji et al., 1996). A brief summary of the key features of the basin is shown in Table 3.

Table 3: Key Features of the Tana River basin

Basin Area	126,026 sq km
Annual average Rainfall	679 mm *
Surface Water Abstractions Rates	595.4 million m^3/yr (highest rate in Kenya)*
Groundwater Abstractions Rates	4.79 million m^3/yr *
Average Borehole Yield	6.58 m^3/hr.*
Borehole Specific Capacity	0.17 m^3/hr/m *
Hydropower Production	477 mw (74.5% of the total) *
Annual Runoff (mm)	39 mm*
Population	5,086,137**

* Surface water data (**Source:** JICA/GOK, 1992)
** 1999 National Population Census (**Source:** GOK, 2001)

The agricultural production in the basin is varied since the basin extends over areas of diverse land uses that have led to increasing demand for water resources such that there are conflicts in water utilization due to competing interests. The upper parts of the basin have the largest concentration of coffee and tea farms in the country. The basin also produces export flowers, horticultural crops, rice under irrigation and various food crops such as cereals, bananas and potatoes. Livestock is also reared for milk, beef and mutton while pig farming in the basin is widespread (Hirji et al., 1996). Other agricultural crops grown in the high potential zones include pyrethrum, wheat and barley; dairy, sheep and poultry whilst in the medium potential zones we have maize, sunflower and beans as the major crops with some poultry, sheep and cattle. The low potential zones have millet, cotton, tobacco and sorghum as the main crops. Jaetzold & Schmidt (1983) have described the various agro-ecological zones in the basin

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 organizations. A variety of irrigation practices found within the basin include small scale group based scheme with many of these schemes involved in horticulture and floriculture as well as subsistence crops irrigation; individual holder schemes used as nurseries for high cost crops such as macadamia, floriculture and ornamental crops with several greenhouses. The third category is the public irrigation schemes such as Mwea and Bura managed by government agencies such as the National Irrigation Board, Agricultural Development Corporation and the Tana and Athi River Development Authority (Hirji et al., 1996).

The basin provides a major potential source of water for hydropower production in the country estimated at 960 MW. The major dams and the hydropower capacities in the basins include Kindaruma (40 MW), Kiambere (144 MW), Gitaru (145 MW), Kamburu (91.5 MW), Masinga (40 MW), Tana (14.4 MW) and Wanjii (7.41 MW). Other activities with high economic potential in the basin include forests on the mountains that are also important wildlife conservation areas with several game parks such as the Aberdares, Mt. Kenya and Meru National Parks and various tourism destination centres. In the lower portions of the Tana several riverline forests and the Tana delta are rich in biodiversity for development of tourism. However, since nearly 80% of the basin is arid and semi arid, there is need for some form of supplemental water for any meaningful agricultural production to take place.

Due to various socio-economic activities that require water and due to the fact that the amount of water in the basin is limited, there is increasing demand for water for various competing uses. The increasing demand for water has caused serious problems and led to conflicts that have to be addressed to ensure that available water is utilized in a sustainable and appropriate manner.

Environmental Implications of Water use in the Basin

Various land use activities in the Tana 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 the upper zones with abundance and the excess stored in various dams and reservoirs during the wet season for use in the dry season. Also, consumptive uses such as irrigation and water transfers to Nairobi are known to remove water from the basin that would otherwise be used for hydropower, irrigation, domestic, industrial and ecological maintenance. The transfers are necessitated due to increasing demands for water in the city.

Due to various water demands, the resulting challenges require to be properly managed to ensure that water transfers and diversions upstream of the hydropower plants and irrigation schemes are managed in an integrated manner so as to minimize the conflicts. This can be done through integrated watershed management. The use of water in the lower parts of the basin for flood recession agriculture often conflicts with the regulation of river water for hydropower production and for providing adequate water supplies to industry, and for domestic needs, flood damage protection of the riverline settlements and infrastructure. To ensure continuous availability of water in various parts of the basin through conservation of surface runoff through storage in pans and small dams has been done in some parts of the adjacent Ewaso Ngi'ro River basin (Liniger, 1995).

Water demand and use in the basin leads to conflicts between agriculturalists, pastoralists, agro-pastoralists, industrialists and domestic users. This is due to variations in the demand for water in the highlands for domestic use, irrigation and industrial purposes. In the lowlands of the basin the conflicts are basically due to use of water by nomads for domestic and livestock and also the need for wildlife, the tourist industry and irrigation. To address the challenges of water management in the basin and elsewhere in the Ewaso Ng'iro, several strategies have been tried. They include improving perception of the value of water, reducing population growth, using advances in technology for improved management, integrating indigenous and innovative knowledge in management, improving overall basin planning and management, improving knowledge, monitoring and training (Liniger, 1995 & Agwata, 2005).

Another conflict is due to sanitation, sewage and pollution due to the many industries such as coffee, pineapple processing and tanneries, as well as insecticide, herbicide and fertilizer applications that discharg effluents and residues into the rivers causing pollution of water. The generation of domestic and sewage wastes also degrade the quality of water in the rivers of the basin unless the various wastes are properly

treated and appropriately disposed. As a result of the poor quality of the water from the rivers, the water is not fit for various uses in its raw form. There is need to plan the basin's sanitation and disposal of agricultural, industrial and commercial effluents and urban sewage to avoid excessive pollution loads in the rivers.

Damming of rivers and streams in the Tana basin causes huge losses of water due to increased evaporation and deposition of sediments in the reservoirs. This leads to reduction of 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 also affects the output in terms of hydropower production. The need for water for other uses such as intensive irrigation together with heavy municipal water abstractions and demand from surrounding towns and transfers to the City of Nairobi causes large water shortages for domestic and irrigation projects in the lower parts 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 river line cultivation and livestock access to water.

Another challenge has to do with water distribution management. Until recently, the management of water in the basin involved several agencies such as Ministry of Water and Irrigation, National Water Conservation and Pipeline Corporation, Tana and Athi River Development Association and private bodies, agencies and individuals. But since the revision of the Water Act and the recent operationalization of the New Water Act of 2002, water management has been streamlined in terms of regulation, abstraction and distribution of water resources. It is important to note that sewerage and sanitation facilities, which are very vital to the conservation of water and pollution control, should be properly planned and regulated for sustainable water resource management in the basin.

Environmentally sound and sustainable development and management of water resources implies that development is controlled. This is to ensure that the resource itself is maintained and enhanced, and that adverse effects on other resources are considered, options for future development are not foreclosed and efficiency in water use and in the use of capital is key criterion in strategy selection. What is required to foster the adoption of the three elements necessary for environmentally sound development and management of water resources is the recognition of the concept of sustainable development, incorporation of a more comprehensive perspective, and the pursuit of higher levels of efficiency in the management of water resources. These concepts require that institutional arrangements compatible with the philosophy of sustainable resource use and management be put in place for integrated and sustainable water resources management.

Water resources development and management may lead to various effects on the environment in the basin. Some of the effects include disruption of human

settlements due to construction of dams and reservoirs, creation of favourabl habitats for parasitic and waterborne diseases, such as schistosomiasis, malaria filiariasis and river fluke infections and occurrence of physical and/or chemica disruption resulting from the alteration of land use changes in the surface o groundwater regime, usually as a consequence of the construction of irrigatior projects or flow control works, such as dams.

Other effects include serious sedimentation and siltation of reservoirs and dams due to deforestation and other land use activities upstream of where the structures are located. This is particularly the case for reservoirs built for controlling flow or generation of sediment, which is so rapid that a major reduction of reservoir capacity occurs within a few years of the construction of the associated dam. This obviously reduces the generating capacity of the hydroelectric plants and reduces the useful life of the reservoir due to increasing sedimentation resulting from deforestation upstream of the area where the structures are built. There is also the ecological impact on flora and fauna through the spread of aquatic weeds such as the water hyacinth, which spreads so rapidly that within a short period of time, it covers a large portion of reservoir surfaces. The spread of weeds has a number of secondary impacts, notably water losses through evapo-transpiration.

13.4 Obstacles to Effective Water Resources Management in the Basin

Some of the obstacles hindering effective water management in the basin include the promotion of short-term rather than long-term perspectives in decision-making; values and attitudes that underestimate local community's skills and intelligence and lack of necessary funding to implement policies and decisions related to water management. Lack of education, training and the strengthening of local organizations and interested parties are also some of the obstacles that hinder effective water resources management. Other obstacles are lack of necessary funding for the development of appropriate water infrastructure.

To address some of these challenges, it is necessary to forge partnerships in order to turn tackling the water crisis into a basis for sustainable development of the basin and the entire country. This is because water consumption often causes unprecedented, serious pollution and overexploitation of both surface and groundwater resources and these present serious risks to humanity and the environment. They threaten health, social and economic well being, food security and biodiversity and economic development itself. Besides, they exacerbate tensions and conflicts both within and between and amongst various water users in different economic sectors of development.

It is also necessary that an integrated approach that covers everything ranging from the various rivers, streams, aquifers, wetlands and the ocean be put in place. This

is because water management can no longer be seen as a sectoral issue, since it cuts across several sectors ranging from irrigation, industry to domestic uses and fisheries demanding for new skills, institutional and operational structures and planning methods and procedures (UNEP, 1996).

The provision of water supply and sanitation services should combine technological development, design and construction with integrated water resources management. It should be appreciated that managing demand, including pricing mechanisms for water is a surer way to providing water security than focusing solely on supply. Also, water management has to be closely integrated with land management if other critical issues such as degeneration of ecosystems and irreversible degradation of aquifer systems that reduce soil fertility leading to a serious decline in the accessibility, quantity and quality of water are to be tackled (Habitat, 1996; UNCHS, 1997).

There is also need to strengthen various capacities in the drainage basin to manage water resources in a sustainable and integrated way. This requires giving priority to and supporting capacity development including fostering innovations that promote sustainable water resources management, training and developing professional staff in demand management methods and planning and increasing local capacity to gather and disseminate information and the capacity to analyse critical issues related to sustainable management of water resources. At the national level, there is need to put in place appropriate mechanisms and strategies to assist the development of policy frameworks that support the adoption of integrated management approaches to water resource systems. Further, efforts should be made to increase awareness at the basin level to reduce discharge of pollutants, especially from small- and medium-scale industries so as to avoid water getting too polluted to be usable, thereby severely undermining the livelihoods of various water users (UNDP et al., 2002). A catchment level ecosystem approach should be applied based on integrating land use, water and ecosystems management.

13.5 Addressing Challenges of Water use in the Basin

Several mechanisms can be put in place to minimize the various challenges that face water utilization in the basin. Some of these strategies include the following.

(a) Regulation of the Basin's Water Resources

The water of the basin needs to be managed through the promotion of appropriate and innovative water conservation methods and by protection of various water catchment areas. This would include storage structures to capture both rainwater and surface runoff to ensure availability of water during critical drought periods. Alternative settlement sites should be provided to ensure water catchment areas are

preserved. Besides helping to minimize various conflicts related to water demand and use, these measures will increase the water yield and the potential of irrigated agriculture in the middle and lower portions of the basin, ensure development and expansion of hydropower production and afford continued availability of water in the basin. River regulation will increase the area downstream that is under irrigation; reduce downstream flooding and the associated damage to settlements and riverline infrastructure.

(b) Conservation and Management of the Basin's Soils

The soils of the basin need to be conserved and managed via soil erosion control. This can be done in such away that the various land use practices including agriculture, livestock husbandry, forest resource utilization and infrastructure development in the basin are carried out so as to maintain the useful life of water conservation structures within the basin. One way to do this is to encourage farmers to protect the soils from erosion processes through extension programs by providing tree seedlings at a minimal fee to reduce destruction of forests in the water catchment areas. Appropriate land use practices should be promoted to ensure minimal water resource degradation in the basin. Riparian reserves and buffer zones should also be provide and rules regarding settlement near river banks strictly enforced effect on the water The protection of riverbanks to minimize changes in river line channels should be made an integral part of flood recession agriculture in the basin. There is need to conduct a survey to identify, map, and describe determine the full potential and vulnerability of the soils to erosion so that land use activities may be appropriately planned.

(c) Management of Water Degradation in the Basin

Water resources management involves the protection of water resources from various forms of degradation such as pollution arising from domestic, agricultural and industrial effluents in the basin. The location of various industries in relation to water sources should be put into consideration when planning pollution prevention measures. This can only work if statutory powers to enforce effluent release standards are given to the water management authority in charge of the basin to carry out all aspects of pollution control such as river monitoring, laboratory analysis, water pollution surveillance and prosecution. The possibility of levying charges to polluters of the water courses should be pursued based on the polluter pays principle. There is need to undertake water quality assessment and prioritise water allocation in the basin based on the quality in accordance with requirements for domestic, commercial, agricultural and ecological sustenance.

(d) Sustainable Utilization and Apportionment of Water

The apportionment of water and the regulation of its use should be managed in such away to reduce conflicts due to various water users in the basin. This can be done through the establishment of various water users associations to be in charge of licensing water users in various catchments of the basin. The flows of the River Tana and several of its tributaries need to be regulated to facilitate River basin water apportionment and the utilization of water with minimal conflicts.

(e) 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 it 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.

13.6 Conclusions and Recommendations

With continued rising of population that puts increasing demand for water to meet domestic, agricultural, industrial and municipal needs, there is urgent need to manage available water in a sustainable way. This is because water demand will continue to increase for continued socio-economic development. For water resources to be sustainably developed and managed, it is recommended that:

- Responsibilities within various government agencies be evaluated and harmonised to ensure that full benefits of integrated water resources management are realized in Tana River basin and other important water basins in the country
- Appropriate funding be provided for to meet the costs of river regulation, catchment and water quality protection and acquisition of relevant water data in the Tana basin
- Water quality and pollution control be enforced as an integral part of water basin conservation and management. This requires that appropriate mechanisms be put in place and strategies for their enforcement within the basin
- Necessary technical capacity be built to meet the needs of integrated water resources management especially regarding the enforcement of water pollution control, water abstraction and distribution to various water users within the basin
- Environmental impact assessment and audits of the existing and proposed water development projects be done to avoid serious impacts to the

environment

- Interdisciplinary approaches to planning, research, implementation and monitoring of water resource development and management practices be encouraged and promoted
- Needs and potentials for training and education programs be identified and instituted
- An integrated strategy dealing with sustainable use of all natural resources such as land, vegetation and forests be put in place.

To have direct positive impact on households, all housing projects should be expected by law to integrate roof water harvesting designs to tap and utilise rainwater for domestic purposes. This will also expect firms that produce roofing materials to factor human safety requirements in their operations.

13.7 Review Questions

i. Using specific illustrations, critically examine possible scenarios for water resources and community well-being in Kenya in the next 50 years
ii. Discuss the linkages between water resources development and environmental quality in Kenya
iii. Using specific stakeholders, critically examine their roles in a framework for sustainable water resources management and development in Kenya

Bibliography

Agwata, J. F. 2005. Water utilization, Conflicts and Interventions in the Tana Basin of Kenya. In: Försch, G., R. Winnegge & S. Thiemann (Editors), Topics of Integrated Watershed Management, University of Siegen, Germany. Pp 13-24.

Akunda E and mango C (eds). 2002. Sustainable Environmental Management for Poverty Alleviation in the lake Victoria basin. Workshop, 27-29th march 2000, Maseno University, Kenya, Journal of Food Technolgies in Africa, Special Publication, No. 12, ISSN: 1028-6098.

Eriksen, S.H. 1998. "Shared River and Lake Basins in Africa: Challenges for Cooperation." ACTS, Nairobi, Kenya.

Gichuki, F. N., Mungai, D. N., Gachene, C. K and Thomas, D. B. (eds)1993. land and water management in Kenya: Towards Sustainable land use. Proceedings of the 4th national Workshop, Wida Highway Motel, Kikuyu, Kenya, 15-19th February 1993., Department of Agricultural Engineering-University of Nairobi.

Government of Kenya, GOK, 2001. National Population Census, 1999. 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.

Jaetzold, R. and Schmidt, H. 1983. Farm Management Handbook of Kenya, Vol. II, Part C - East Kenya. Ministry of Agriculture/GTZ, Nairobi.

Japan International Cooperation Agency, JICA/GOK 1992. National Water Master Plan. Government Printer, Nairobi.

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. 117 PP

National Environmental Management Agency, NEMA 2003. State of the Environment Report, Kenya. Government Printer, Nairobi. Pp. 53- 60.

Ogola, J. S., Abira, M. A. & Awuor, V. O. 1997. Potential Impacts of Climaze Change in Kenya, Climate Network Africa, Nairobi, Kenya.

Richter, J., Wolff, P,. Franzen H and Franz, H (eds). 1997. Strategies for Intersectoral Water Management in Developing Countries - Challenges and Consequences for Agriculture. Proceedings of the International Workshop held from 6-10th 1996, Berlin Germany. Deutsche Stiftung fuer Internationale Entwicklung (DSE)

UNDP, WMO, GOK, IGAD and DMCN, 2002. Factoring Weather and Climate Information and Products into Disaster Management Policy, A Contribution to Strategies for Disaster Reduction in Kenya, Nairobi, Kenya.

UNEP. 1996. "Our Planet" Vol. 8, No.3.

United Nations Centre for Human Settlements (UNCHS). 1997. Managing Water Resources for Large Cities and Towns, Habitat, Nairobi, Kenya

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.