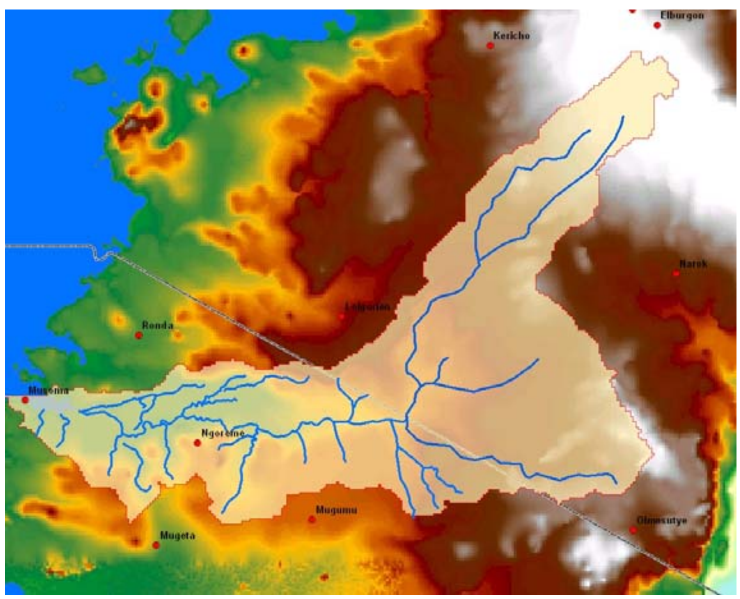
NILE BASIN INITIATIVE
NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAM

Mara River Basin Transboundary Integrated Water Resources Management and Development Project

Mara River Basin Monograph

Final Report



Water Resources and Energy Management (WREM) International Inc.

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WREM International

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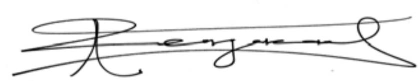
Atlanta, December 2008



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List of Abbreviations and Acronyms

BWB	Basin Water Board
BWO	Basin Water Office
CBO	Community-based Organisation
CIDA	Canadian International Development Agency
CBFM	Community Based Forest Management
CFMG	Community Forest Management Group
CFR	Community Forest Reserve
CMSSS	Community Management Support Services Section
COM	Council of Ministers
COWSO	Community-Owned Water Supply Organisation
CSD	Commission for Sustainable Development
CWC	Catchment Water Committee
DED	District Executive Director
DfID	Department for International Development – U.K
DFO	District Forest Officer
DWR	Division of Water Resources
DWSS	District Water Supply and Sanitation
EAC	East African Community
EIA	Environmental Impact Assessment
EWURA	Energy and Water Utilities Regulatory Authority
FAO	Food and Agricultural Organization
GEF	Global Environmental Fund
GIS	Geographical Information System
IGAD	Inter-Governmental; Authority on Development
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IRBMP	Integrated Reviver Basin Management Plan
IWRM	Integrated Water Resource Management
JFMC	Joint Village Forest Management Committee

LA	Local Administration
LC	Local Council
LG	Local Government
LGDP	Local Government Development Program
LGA	Local Government Authority
LGRP	Local Government Reform Programme
LVDP	Lake Victoria Development Program
LVEMP	Lake Victoria Environnemental Management Programme
MDG	Millennium Development Goals
MIS	Management Information System
MTEF	Medium Term Expenditure Framework
MKUKUTA	Mkakati wa Kukuza Uchumi na Kuondoa Umaskini Tanzania
MoE	Ministry of the Environment
MoF	Ministry of Finance
MoHSW	Ministry of Health and Social Welfare
MoU	Memorandum of Understanding
MoW	Ministry of Water
NAWAPO	National Water Policy (Tanzania)
NBI	Nile Basin Initiative
NEMC	National Environment Management Council
NGO	Non-Governmental Organisation
PRSP	Poverty Reduction Strategy Paper
RWSSP	Rural Water Supply and Sanitation Programme
NSGRP	National Strategy for Growth and Reduction of Poverty
NWB	National Water Board
NWSDS	National Water Sector Development Strategy
O&M	Operation and Maintenance
PFRA	Participatory Forest Resource Assessment
PMO-RALG	Prime Minister’s Office – Regional Administration and Local Government
RBMSIIP	River Basin Management and Smallholder Irrigation Improvement Project
RDP	Rural Development Policy
RDPS	Rural Development Policy and Strategy
RS	Regional Secretariat

RWSD	Rural Water Supply Division
RWSS	Rural Water Supply and Sanitation
RWSSP	Rural Water Supply and Sanitation Project
RWST	Regional Water and Sanitation Teams
SWAP	Sector Wide Approach to Planning
TAC	Technical Advisory Committee
TC	Technical Committee
TECCONILE	Technical Committee for the promotion of the Development and Environmental Protection of the Nile Basin
USD	United States dollar
UWSA	Urban Water and Sanitation Authority
UWSS	Urban Water Supply and Sewerage
UWSSP	Urban Water Supply and Sewerage Programme
VNRC	Village Natural Resource Committee
VLFR	Village Natural Forestry Reserve
WATSANs	Water and Sanitation Committees
WDC	Ward Development Committee
WEO	Ward Executive Officer
WRM	Water Resources Management
WRMP	Water Resources Management Programme
WSSA	Water Supply and Sanitation Authority
WSDP	Water Sector Development Programme
WUA	Water User Association
WUF	Water User Fee
WUG	Water User Group
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEMA	National Environment Management Authority

1.0 Introduction

1.1 Overview of the Mara River Basin

The Mara River Basin is shared between Kenya and Tanzania and covers seven districts: Nakuru, Bomet, Narok, Transmara, Serengeti, Tarime, and Musoma Rural. The river has a catchment area of about 13,750 km^2, with an upper basin area of about 8,941 km^2 (65%) in Kenya and a lower basin area of about 4,809 km^2 (35%) in Tanzania. The location and some features of the Mara river basin is shown in Figure 2.1 in Chapter 2 below.

The river, which discharges into Lake Victoria and is thus part of the Nile River Basin, rises from the Enapuyapui swamp in the forested Mau Escarpment as the Amala and Nyangores tributaries which flow through the Mau forest, tea plantations, settlements, and small-scale agricultural lands in Kenya before converging to form the Mara River in a region dominated by large-scale agriculture. The Mara River meanders through Masai Group Ranches, the Masai-Mara National Reserve, and the Serengeti National Park. In these protected areas two other main tributaries, the Talek River and the Sand River, join the Mara River. The main-stem Mara River continues flowing through the savannah grasslands of the Serengeti region in Tanzania before entering the Mara Swamp and finally discharging into Lake Victoria near Musoma town. Thus, the Mara River is part of the Lake Victoria drainage system as well as the greater Nile River Basin.

Although the Mara River contributes about 5% of the volume of water flowing into Lake Victoria, it is regarded as one of the most important rivers flowing into the Lake. The basin is of profound environmental and biodiversity conservation interest and owes its importance and international recognition to the world-famous Masai Mara-Serengeti ecosystem.

The population of the basin is approximately 1.1 million people (2002 population census), with a population growth rate of 2.7%. About 775,000 people live in the Kenyan sub-basin, and the remaining 325,000 live in the Tanzanian sub-basin. Musoma and Bomet are the largest urban centers with about 120,000 and 95,000 residents respectively. The rest of the population lives in rural areas, and is predominantly engaged in small scale agricultural activities. About 23% of the Mara population in Kenya and 20% in Tanzania live on less than $1 a day. The need for economic growth to improve the quality of human life is compelling.

The basin receives rainfall with mean values varying from 1400 mm/yr on the highlands to 600 mm/yr on the plains. The high, reliable, and well-distributed rainfall in the highlands and the fertile soils are favorable for agriculture, livestock, and wildlife activities. These favorable conditions have attracted heavy migration into the basin exerting high pressure on the limited land and water resources.

The basin is characterized by a diversity of land use patterns ranging from natural forests in the upper reaches to large-scale mechanized farms, smallholder subsistence farms, communal pastoral grazing lands, open savannah in the animal parks, and wetlands and marsh vegetation just before the river discharges into Lake Victoria. Despite the diversity in land use patterns, the dominant socio-economic activity remains crop farming. About 62% of the households are smallholder farmers, with livestock rearing being the second dominant activity. Tourism is a major economic activity in the basin predominant in the Masai Mara Game Reserve on the Kenyan side and the Serengeti National park on the Tanzanian side.

The Mara River Basin is facing serious environmental problems primarily created from wide spread encroachment on protected forests and other fragile ecosystems for settlement and cultivation. These specifically include: (i) Soil Erosion and high sediment loads; (ii) Deforestation resulting from encroachment and human settlement in the Mau forest areas; (iii) Wildlife-human conflicts resulting from large-scale farming that has extended into wildlife corridors; (iv) Declining water quality and quantity due to poor agricultural practices and excessive water abstractions; (v) Pollution due to unregulated wastewater discharges, especially from mining activities, poor sanitation facilities and excessive use of agro-chemicals for pest and disease control in crops and livestock; (vi) Increased frequency and intensity of floods and droughts due to climate variability and land use change; (vii) Uncoordinated water resources planning and management processes due to lack of a comprehensive cooperative framework for transboundary water resources management.

The situation is further exacerbated by the weak and poorly enforced water related laws and regulations, and water resources management institutions with inadequate technical and financial capacity to monitor and ensure compliance with established standards and regulations.

These issues notwithstanding, the Mara basin is well endowed with natural resources which, if managed and developed sustainably, can become the engine of social and economic development. This is the objective of the Mara Transboundary Integrated Water Resources Development and Management (TIWRMD) project: To develop a comprehensive investment strategy to address these challenges and bring to bear positive and sustainable socio-economic change.

1.2 Mara River Basin Monograph Purpose and Development Approach

The Mara River Basin Monograph is a key output of the Mara TIWRD Project aiming to develop a comprehensive information and knowledge base on the existing conditions in the Mara basin that can help guide future planning and development initiatives. The Monograph contains data and information on the Mara natural resources, land and water use activities, environment and ecology, built infrastructure, energy resources, trade and industrial activities, and socio-economic conditions and development opportunities. Cross-cutting and transboundary issues are particularly relevant, as they can only be addressed through an integrated water resources planning and management approach.

The Mara Monograph comprises the knowledge and information upon which the Mara Cooperative Institutional Framework and Investment Strategy are based. Figure 1.1 highlights the project component linkages and exemplifies the need for the integrated project implementation approach.

All data compiled in the process of developing the Monograph are contained in the Mara Decision Support System (Mara DSS) which also includes a suite of analysis and modelling tools designed to assess current basin conditions and quantify the tradeoffs, benefits, and impacts of alternative development scenarios. The intervention measures and projects presented in the Mara Investment Strategy are based on detailed analyses of water resources issues and challenges contained in the Mara Monograph and the assessments conducted using the Mara DSS.

Much like all project outputs, the development of the Mara River Basin Monograph was based on active and sustained stakeholder engagement. Combined with the significant local expertise in the Consultant's team, this approach leveraged the riparian knowledge and understanding of local issues, challenges, and solution opportunities.

As part of the Monograph development, a detailed review of the available relevant documents and reports was carried out to gain a thorough understanding of the basin features, key issues, and ongoing and planned efforts to address them. A list of the documents reviewed is contained in the bibliography of this report.

In addition, the Consultant's team spent a significant amount of time physically visiting and consulting with local government officials, NGOs, CBOs, and local communities in all basin districts. Additional consultative meetings and discussions were held with officials from national and regional agencies including EAC, LVBC, NBI, NELSAP, and LVFO, among others.

Lastly, several national and regional workshops and meeting were organized to solicit input from different stakeholders and seek clarification and guidance on some of the information acquired, issues identified, analysis results obtained, potential intervention measures, and recommended actions. The development of the Mara Monograph was a collaborative effort among the project team and the Mara stakeholders at the regional, national, and local levels.

1.3 Outline of the Report

Chapter 1 of the Monograph gives a brief overview of the Mara Basin and outlines the Monograph objective, development approach, and linkage with the other project outputs.

Chapter 2 begins the detailed description of the Mara River Basin focusing on its hydro-climatology, surface and groundwater resources, water quality conditions, monitoring issues, watershed degradation issues, and potential intervention measures.

Chapter 3 is dedicated to water supply and sanitation (WS&S) and discusses the current WS&S coverage in the basin, sources and water supply facilities, institutional structure, water tariffs, sanitation and hygiene issues, solid waste management, sector financing, role of women, and potential intervention measures.

Chapter 4 addresses agricultural conditions and activities including, among others, climate and agro-ecological zones, soil types, land tenure systems, small and large scale farming systems, food crops, cash crops, irrigated agricultural activities, livestock, veterinary services, livestock diseases, and sector gaps and potential intervention measures.

Chapter 5 discusses fisheries with focus on Lake Victoria fisheries, wetland fisheries, aquaculture, management structure, fisheries issues, and potential investment opportunities.

Chapter 6 is on the Mara environment, ecosystems, wildlife, and tourism. This chapter describes the unique Mara basin ecosystems including forests, wetlands, savannahs, and open woodlands; the renown Mara wildlife including the Masai-Mara game reserve and Serengeti national park and human-wildlife interactions; and the tourism activities including facilities, trends, issues, and potential interventions.

Chapter 7 expands on energy resources and hydropower development. The chapter covers the main energy sources used in the Mara Basin, the condition of and access to the electricity grid, tariffs, renewable energy resources, energy sector issues, and development opportunities.

Chapter 8 covers the state of land, water, and air transport, and summarizes the associated issues and development opportunities.

Chapter 9 is on demographics, family planning, urbanization, migration, education and literacy, public health trends, HIV/AIDS, health institutions, food security and poverty, gender inequality, and potential intervention measures.

Chapter 10 discusses trade, industries (agricultural, service, and mining), and macro-economic development.

Chapter 11 outlines and assesses the existing water management institutions in relation to transboundary and integrated water resources management. This is a summary of a more extensive treatment of this subject provided in the Mara Cooperative Framework report.

Finally, **Chapter 12** summarizes the recommended Mara investment strategy, including regional transboundary and national programs, and the associated funding and implementation plans.

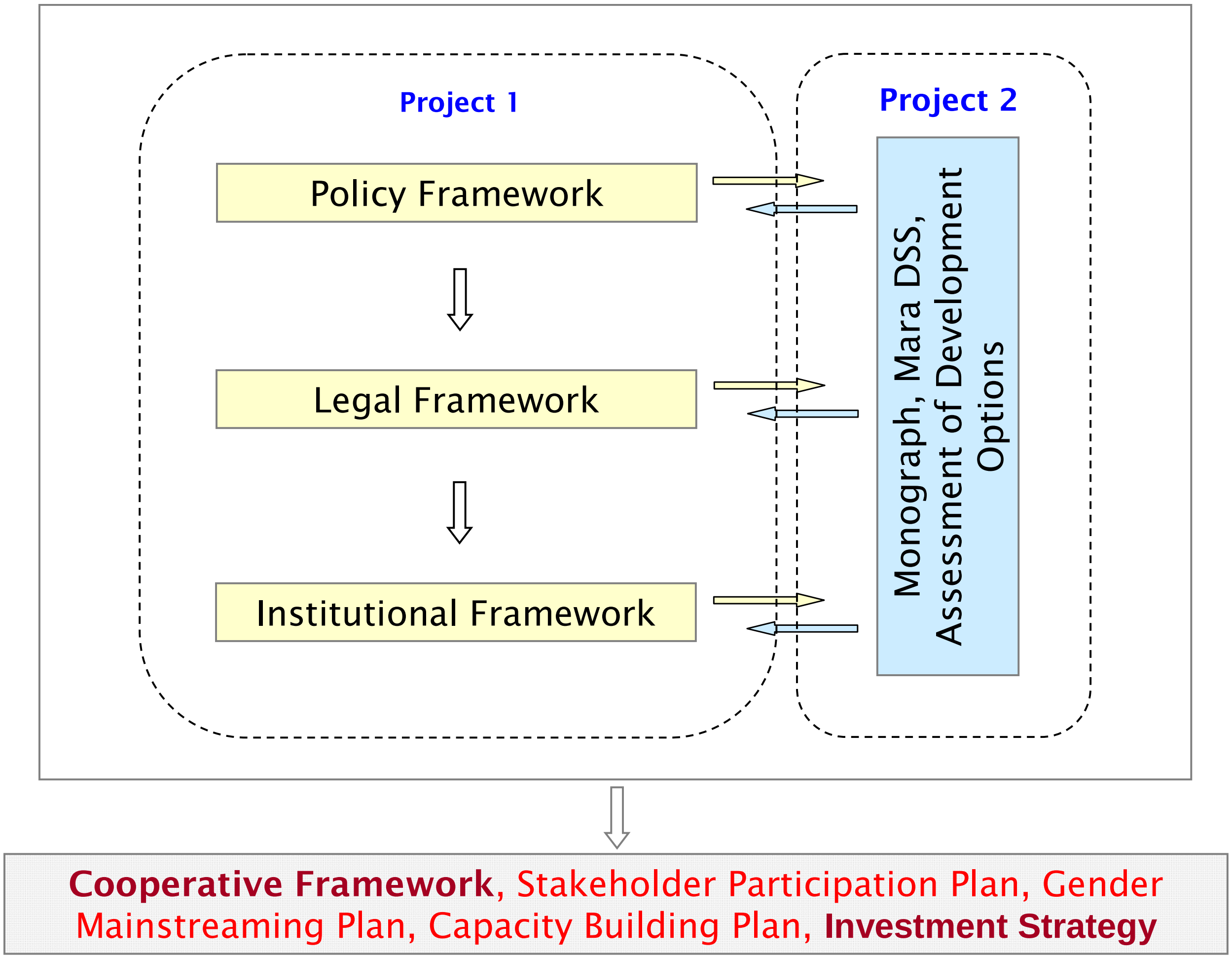


Figure 1.1: Project Component Linkages: Mara River Basin Transboundary Integrated Water Resources Management and Development Project

2.0 Hydro-Climatology of the Mara River Basin

2.1 Introduction

This chapter presents the climatic conditions and the hydrology of the Mara River Basin. The Mara River system (Figure 2.1) originates from the forested Mau Escarpment along the western rim of the Eastern Great Rift Valley in Kenya at an altitude of 2,900 meters above sea level, flows through agricultural and rangelands before entering the Masai Mara Game Reserve in Kenya and the Serengeti National Park in Tanzania, and ends its 395 Km journey in Lake Victoria at Musoma Bay at 1,134 metres above sea level (asl). The equatorial extent of the Mara River Basin and the range of different landforms, including high mountains and large inland lakes, make its climate highly variable.

The only perennial tributaries forming the Mara River are the Amala and the Nyangores rivers, which originate from the Western Mau Escarpment. The two rivers join downstream of Kaboson Market to form the Mara River. Other notable but seasonal tributaries include the Talek and the Sand River. The Talek River originates from the Loita Hills in the east and joins the Mara River in the Masai Mara Game Reserve.

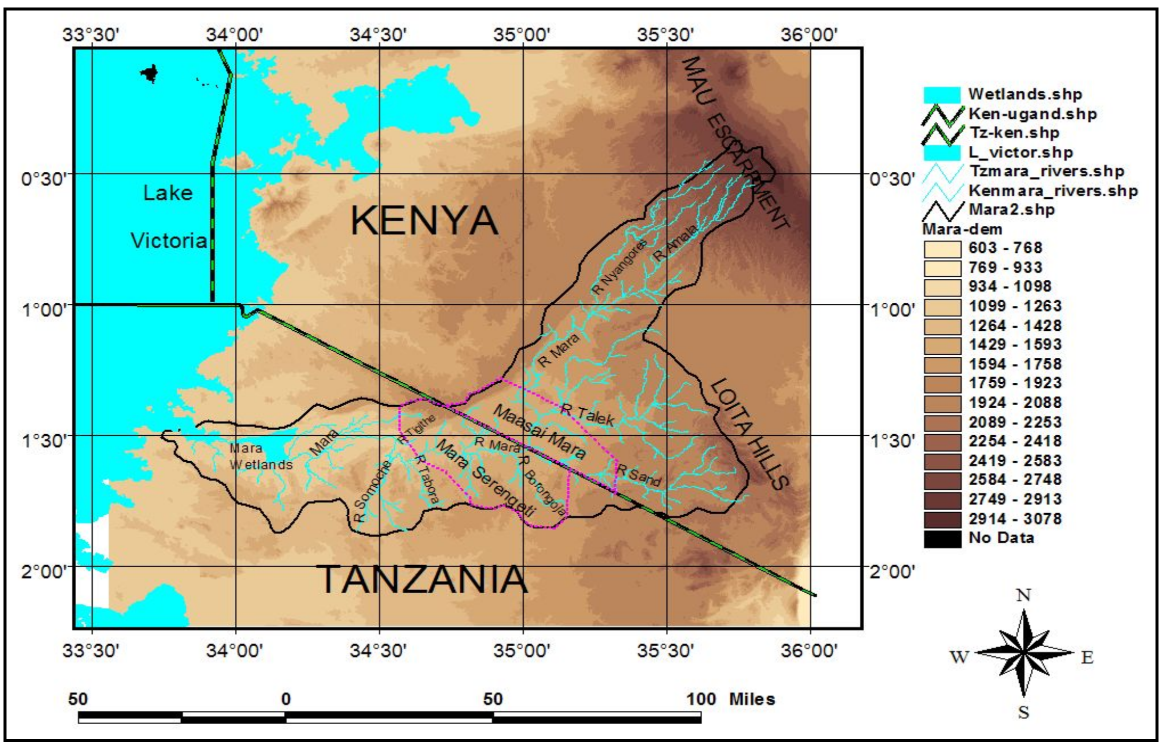


Figure 2.1: River Network and Other Features of the Mara River Basin

The Sand River also originates from the Loita Hills and joins the Mara at the Kenya/Tanzania border. Further downstream into Tanzania, Mara tributaries include the Borogonja, Tabora B, Somoche, and Tigithe Rivers (Figure 2.1).

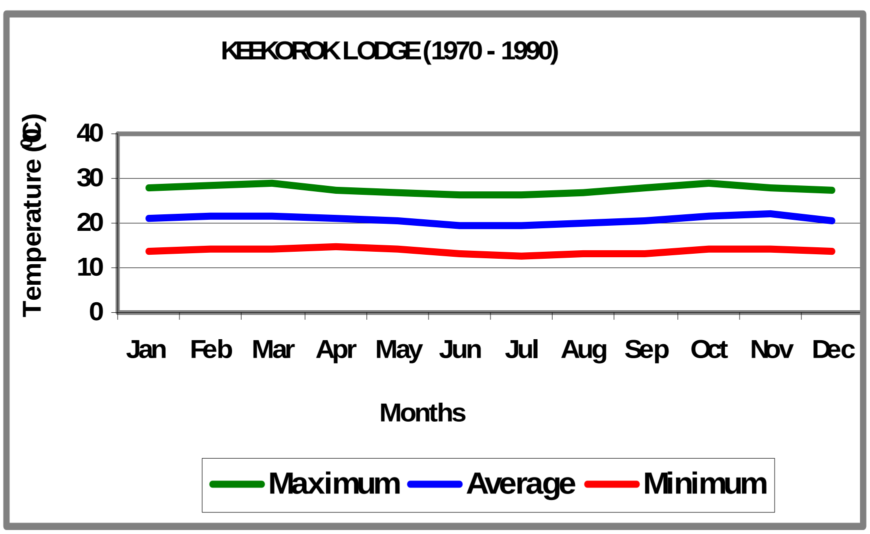
2.2 Climate of the Mara River Basin

2.2.1 Temperature

Climatological data such as air temperature, evaporation, wind speed, solar radiation, sunshine duration, dew point, humidity, and barometric pressure are not readily available within the Mara Basin due to lack of climatological stations. However, the available sparse observations on the Kenyan side indicate that temperatures are much cooler in the highlands. The mean annual temperature is approximately 25.5 ^{0}C. In general, temperatures in the basin increase southwards. Representative values of the monthly average maximum, minimum, and mean temperatures at Keekorok Lodge in the Masai Mara Game Reserve (Lake Victoria Database, FAO) and Narok town (Kenya Meteorological Department, KMD), just outside and to the east of the Mara Basin in Kenya, are illustrated in Figure 2.2a,b.

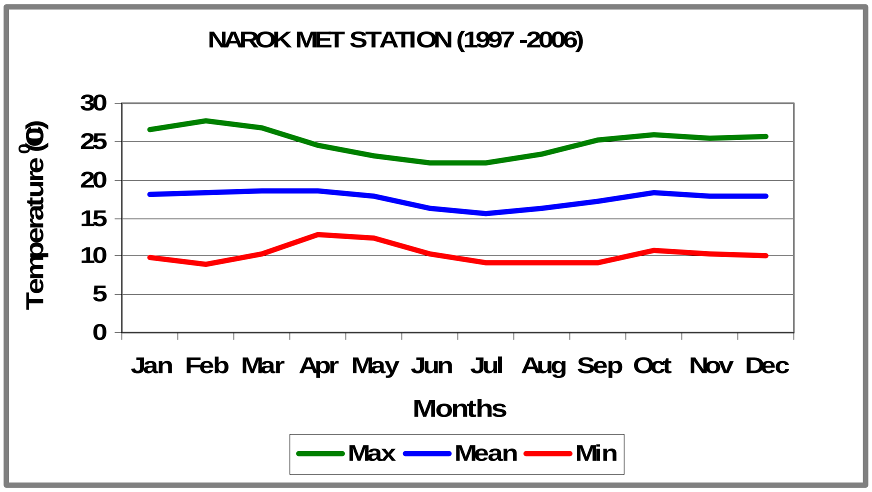
Climatic stations are also not available in the Tanzanian side of the Mara River Basin. Thus, temperature data recorded at the Musoma Meteorological station is used to reflect the temperature of the Mara Basin lowlands. The annual mean maximum temperature determined from this data is 28 °C, while the annual mean minimum temperature is 17 °C. The mean annual temperature is 23°C. The variation of both maximum and minimum monthly temperatures at Musoma Met station was observed to be low. This is due to the moderating effect of Lake Victoria, limiting the variation range. Seasonal temperature values determined from the data from Musoma Met. station obtained from the Tanzania Meteorological Agency (TMA) are presented in Figure 2.3 below.

(a)



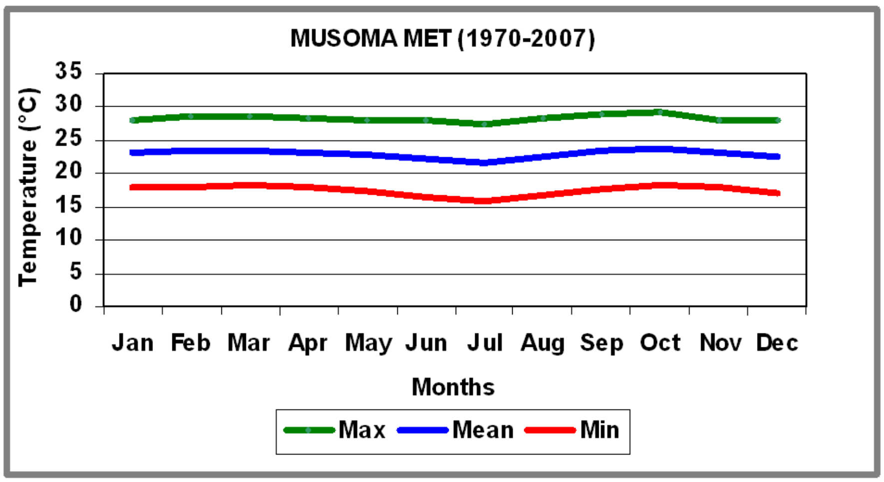
Source: FAO Lake Victoria Database

(b)



Source: KMD

Figure 2.2: Monthly Average Maximum, Minimum, and Mean Temperatures in the Mara Highlands (Keekorok and Narok, Kenya)



Source: TMA

Figure 2.3: Monthly Average Maximum, Minimum, and Mean Temperatures in the Mara Lowlands (Musoma, Tanzania)

2.2.2 Evaporation, Evapotranspiration, and Relative Humidity

Potential evaporation in the catchment varies from 1800 mm near Lake Victoria to 1400 mm in areas over 2000 m elevation. Woodhead (1968) established that potential evaporation is about 1730 mm per year around the Serengeti, and that maximum monthly evaporation is 169 mm in October (Woodhead, 1968). A water balance study of the Mara River, Brown et al., 1981, estimated that potential evapotranspiration is equal to about 71% of free water evaporation on an annual basis.

The mean monthly evaporation based on data at the Keekorok Game Lodge in the Masai Game Reserve (1970 – 1990) and at Narok Met. Station (1997-2006) is shown in Figure 2.3a,b. The trends inherent in the spatial distribution of evaporation are similar to those observed for air temperatures. Maximum evaporation occurs in the months of October and March with limited variation within the year. Daily evaporation rates are measured by a standard Class A Evaporation Pan.

Pan evaporation and relative humidity values determined from Musoma Met. Station data are presented in Figure 2.4. The mean monthly pan evaporation is 57 mm which is equivalent to 1885 mm per year. The maximum evaporation is observed during the month of September. The minimum evaporation is observed during the months of May and June. The variation of monthly pan evaporation is relatively high during the period from mid-August to mid-October. For the rest of the year, the variation is small.

Potential evapotranspiration, ET_0, is the total water vaporised by plant transpiration, from free water surfaces, and the soil. Thus, ET_0 depends on topography, soil types, vegetation cover, and rainfall. The Study on the National Water Master Plan (Kenya, 1992) showed that the potential evapotranspiration is related to the elevation by the following equation:

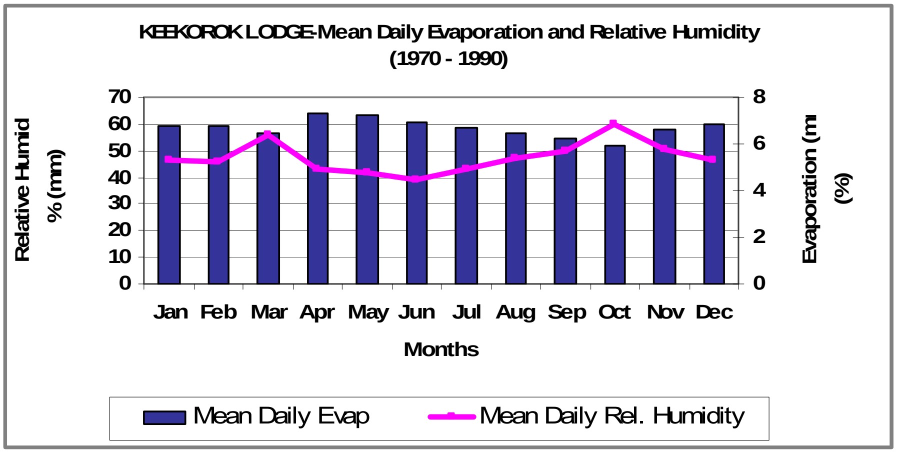
$$ET_0 = 2,329.9 - 0.03235 \times EL$$

where: ET_0 denotes potential evapotranspiration in mm;
EL denotes elevation in m.

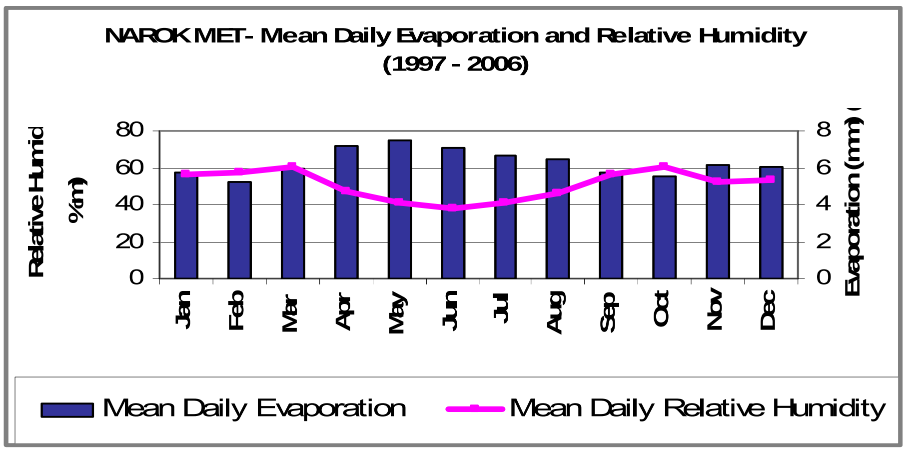
Based on the above analysis, the potential evapotranspiration in the Mara basin in Kenya is estimated at 2200 mm per year.

Relative humidity is the ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in percentage form and measures the percentage of saturation. The average relative humidity measured at Keekorok Lodge and Narok is 59% and 63% respectively. The mean daily relative humidity for Keekorok Lodge and the Narok Meteorological Station are depicted in Figure 2.4.

Relative humidity values determined from the data from Musoma Met. station are presented in Figure 2.5. The average relative humidity is 72%. Figure 2.5 shows that humidity is high during the months of April to May coinciding with the rainy season and it is low during the months of July to September. The relative humidity variation is small because of the Lake Victoria influence. The source of the relative humidity data is the Tanzania Meteorological Agency (TMA).

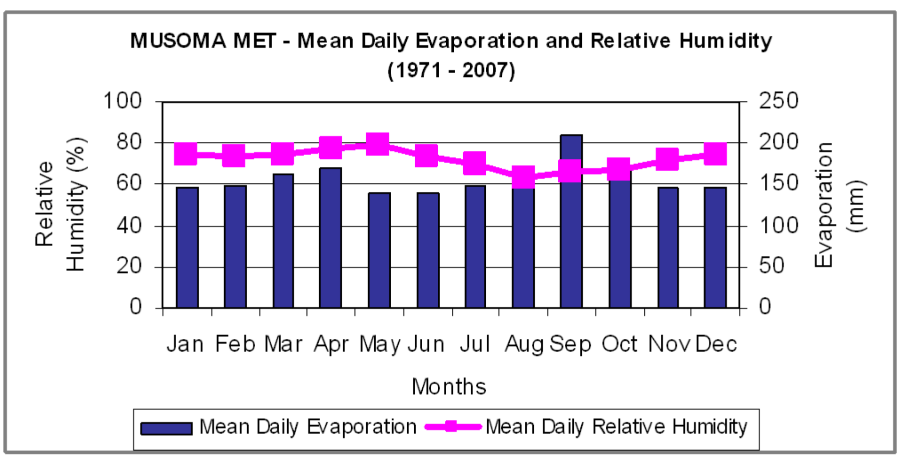


Source: Lake Victoria Database



Source: KMD

Figure 2.4: Mean Daily Evaporation over the Masai Mara Game Reserve



(*Source:* TMA)

Figure 2.5: Monthly Pan Evaporation and Relative Humidity at Musoma, Tanzania

2.2.3 Rainfall

2.2.3.1 Monitoring Network

The Kenya Meteorological Department in the Ministry of Transport and Communications is responsible for the general operation and maintenance of the meteorological network in the country. The data recording is done by local observers trained in data entry.

The monitoring stations are equipped with standard rain gauges which are read once daily at 9:00 AM by individuals hired by the institutions and paid honoraria. Other stations are manned by the Provincial Administration through the Chief and District Officers offices.

The Ministry of Water and Irrigation through the new Water Resources Management Authority (WRMA) is also establishing a network of meteorological stations specifically for water resources management. The Authority is in the process of developing a database for water resources management. The currently available data and information is not well documented. In addition, private operators, especially large-scale farmers, operate rainfall measuring stations in their farms.

The Mara River catchment area was equipped with a reasonable network of rainfall and evaporation stations. However, lack of adequate resources, both financial and personnel to operate and maintain the stations, has reduced the number of stations that are operational today. Table 2.1 gives a summary of the rainfall stations in the Mara River basin on the Kenyan side and their current status.

Table 2.1: Inventory of Rainfall Stations in the Mara River Basin, Kenya

S/No	Code	Station Name	Lat	Long	Alt (m)	Period of record	
						Start	End
1	9035067	Kiroboni F. Co. MOLO	- 0.416	35.683	2697	1959	1977
2	9035079	Tenwek Mission – Sotik	- 0.750	35.366	2012	1959	2001
3	9035085	Olenguruone D.O's Office – Molo	- 0.583	35.683	2743	1959	2004
4	9035126	P B.K Olenguruone Field Office	- 0.583	35.683	2591	2001	2006
5	9035227	District Office – Bomet	- 0.783	35.333	1951	1959	1992
6	9035228	Kiptunga Forest- Elburgon	- 0.45	35.8	2957	1961	2006
7	9035241	Baraget Forest – Elburgon	- 0.416	35.733	2865	1961	1997
8	9035265	Bomet Water Supply	- 0.783	35.35	1951	1966	2006
9	9035284	Mulot Police Post	- 0.933	35.433	1829	1973	1997
10	9035302	Nyangores Forest	- 0.7	35.433	2219	1979	2006
11	9035303	Nairotia Forest	- 0.766	35.533	2310	1979	2006
12	9035324	Karinget Forest	- 0.483	35.633	2560	1984	1999
13	9135008	Kaboson Gospel Mission – Sotik	-1.00	35.233	1646	1960	1985
14	9135010	Aitong Hydromet – Sotik	-1.183	35.25	1829	1960	1992
15	9135013	Keekorok Hydromet – Narok	-1.583	35.233	1602	1965	1996

16	9135022	Africa Gospel Church – Naikara	-1.55	35.633	2462	1967	1999
17	9135025	Ilkerin Integral Develpment Project	-1.783	35.7	2195	1973	1999
18	9135026	Governor's Camp	-1.283	35.033	1585	1973	2004
19	9135035	Kichwa Tembo Camp	-1.233	35.016	1887	1987	2002

In Tanzania, the Tanzania Meteorological Agency (TMA) and the Hydrology section in the Ministry of Water and Irrigation are responsible for the operation and maintenance of meteorological networks. Other ministries and organizations, i.e., the Ministry of Agriculture, religious institutions, and private organizations (large farm estates) are also involved in the collection of meteorological data, especially rainfall data.

The inventory of rainfall stations in the Mara River Basin includes about 17 rainfall stations that have operated on the Tanzanian side of the basin (Table 2.2). However, five of these stations ceased to operate at different periods (1930s, 1950s, 1960s, and 1970s). Thus, currently, rainfall data are available from various sources including the TMA, the Southern African FRIEND database at the Department of Water Resources Engineering of the University of Dar es Salaam, and the Mara Region Hydrology Office.

Table 2.2: Inventory of Rainfall Stations in the Mara River Basin, Tanzania

S/No	Code	Station name	Location		Alt (m)	Period of Record	
			Lat	Long		Start	End
1	09133000	Musoma Met.	-1.50	33.80	1147	1921	2007
2	09133001	Busegwe mission	-1.70	33.93	1219	1940	1990
3	09133002	Shirati Mission	-1.13	33.98	1158	1902	1990
4	09133004	Nyabangi Mission	-1.55	33.87	1158	1949	2004
5	09133007	Kiabakari Prison	-1.77	33.85	1219	1954	1990
6	09133011	Lukuba Island	-1.40	33.70		1975	1989
7	09133018	Nyambono Primary School	-1.88	33.68		1977	1989
8	09134000	Tarime Agriculture	-1.37	34.38	1524	1933	1978
9	09134008	Nyabassi (Nyarero)	-1.35	34.57	1829	1943	1990
10	09134014	Bwiregi Primary School	-1.40	34.63	1799	1952	1976
11	09134016	Kisaka Nguruime	-1.57	34.47	1219	1952	1979
12	09134026	Tarime Hydromet	-1.33	34.33	1280	1969	1989
13	09134029	Buhemba Tr.Centre	-1.77	34.08	1448	1969	2007
14	09134031	Nyiboko Pr. School	-1.50	34.55		1970	1984
15	09134033	Mugumu Primary School	-1.87	34.72		1970	2007
16	09134044	Geitasamu Pr. School	-1.73	34.62		1980	1989
17	09234005	Seronera	-2.33	34.92	1540	1960	1990

While the 17 rainfall stations which historically operated in the basin meet the minimum requirements for a precipitation network, the status on the ground is that most of the stations are now inoperable. The existing precipitation network has deteriorated and is unable to characterize the distribution of rainfall. All above-mentioned rainfall stations mentioned need to be rehabilitated.

The deterioration of the rainfall monitoring network is mainly due to lack of funds to (1) support the operation and maintenance of the stations and (2) transport to facilitate frequent station inspection and proper functioning.

There is no full climatic station in the Tanzanian side of the basin recording the typical array of climatic variables, i.e., rainfall, evaporation, wind speed, solar radiation, sunshine duration, air temperature, dew point, humidity, and barometric pressure. The Musoma meteorological station is the only full climatic station that is located in the neighbourhood of the basin near the Mara River exit to Lake Victoria.

Figure 2.6 shows the spatial distribution of rainfall and climatic stations in the whole of Mara River Basin.

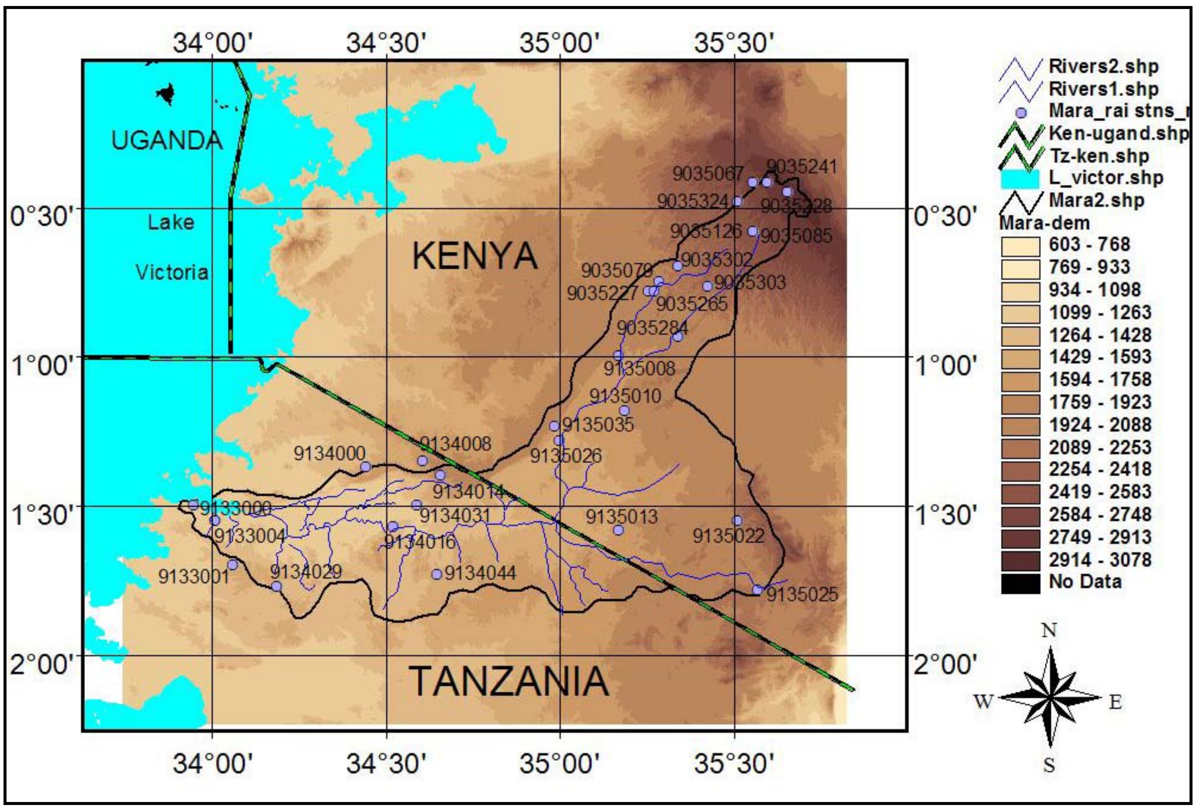


Figure 2.6: Geographic Distribution of Rainfall Stations in Mara River Basin

2.2.3.2 Seasonal Rainfall Variability

The equatorial location of the Mara River Basin and its range of landforms, including high mountains, expansive plains, and a large inland lake, make for highly variable rainfall. There are two main wet seasons. The short rains season occurs during the months of October, November, and December, and the long rains season occurs from March through May. The January-February period receives very little rainfall compared to the main two seasons, except in the upper catchment. The Southeast Trade Winds (Indian Monsoons) from the Indian Ocean enhance basin rainfall between March and May but weaken considerably between June and September producing a drier summer period (Indeje *et al.*, 2000). The southwest trade winds, also known as the Congo airmass, bring rain from the west in July with storms and hailstorms. Across the basin, rainfall decreases from west to east, particularly across the Mara basin plains in the Masai Mara Game Reserve. This can be seen in Table 2.3 where mean monthly rainfall for stations in the western part of the basin is compared with rainfall from stations on the eastern part of the basin including the Loita Plains.

Table 2.3: Rainfall Variation from West to East in the Mara Basin

Station/No	Location		Altitude (m, asl)	Mean Monthly Rainfall (mm)											
	Long.	Lat.		J	F	M	A	M	J	J	A	S	O	N	D
Kichwa Tembo/ 9135035	35.02	-0.93	1887	147	116.6	188.7	218	162.6	92.7	81.9	97.7	56.4	79.4	165.4	215.7
Governor's Camp/ 9135026	35.03	-1.28	1585	96.8	107.7	126.9	158.9	96.6	82.7	53.7	50.5	69.0	43.4	83.3	113.0
Naikara A. Gospel/ 9135022	35.63	-1.55	2462	75.6	70.3	73.3	81.8	62.1	47.0	31.0	30.0	38.9	16.2	66.0	51.8
Ilkerin Int. Dev./ 9135025	35.7	-1.78	2195	63.0	67.0	91.4	116.9	66.8	34.7	22.3	17.4	23.5	19.8	65.6	72.0

Spatial patterns of rainfall variations within a year show remarkable differences in the Basin in terms of monthly amounts and months of high rainfall. Most parts of the basin receive more than 50 millimeters (mm) of rain per month. Rainfall regimes are typically unimodal in the upper basin region (Mau Escarpment), where mean annual rainfall varies between 1000 mm to 1750 mm and highest rainfall occurs during April through August. In the Loita Plains to the south east of the basin in Kenya, annual rainfall drops to about 600 mm.

Further to the south, the rainfall regime becomes bimodal with highest monthly rainfall amounts occurring during October to December (short rains) and March to May (long rains). The seasonal rainfall variation in selected Kenya stations in the Mara Basin is illustrated in Figure 2.7. Additional rainfall statistics are included in Appendix 2A. These results are based on analysis of rainfall data received from the Kenya Meteorological Department.

Figure 2.7 also includes the monthly maximum and minimum recorded rainfall amounts. This data shows that the monthly rainfall variability is very marked. Specifically, in dry years, many stations register negligible amounts for several months, while in wet years, the rainfall amounts exceed the mean by three- and even four-fold. The high rainfall variability indicates that the Mara Basin is vulnerable to climatic extremes, thus creating the need for water infrastructure investments.

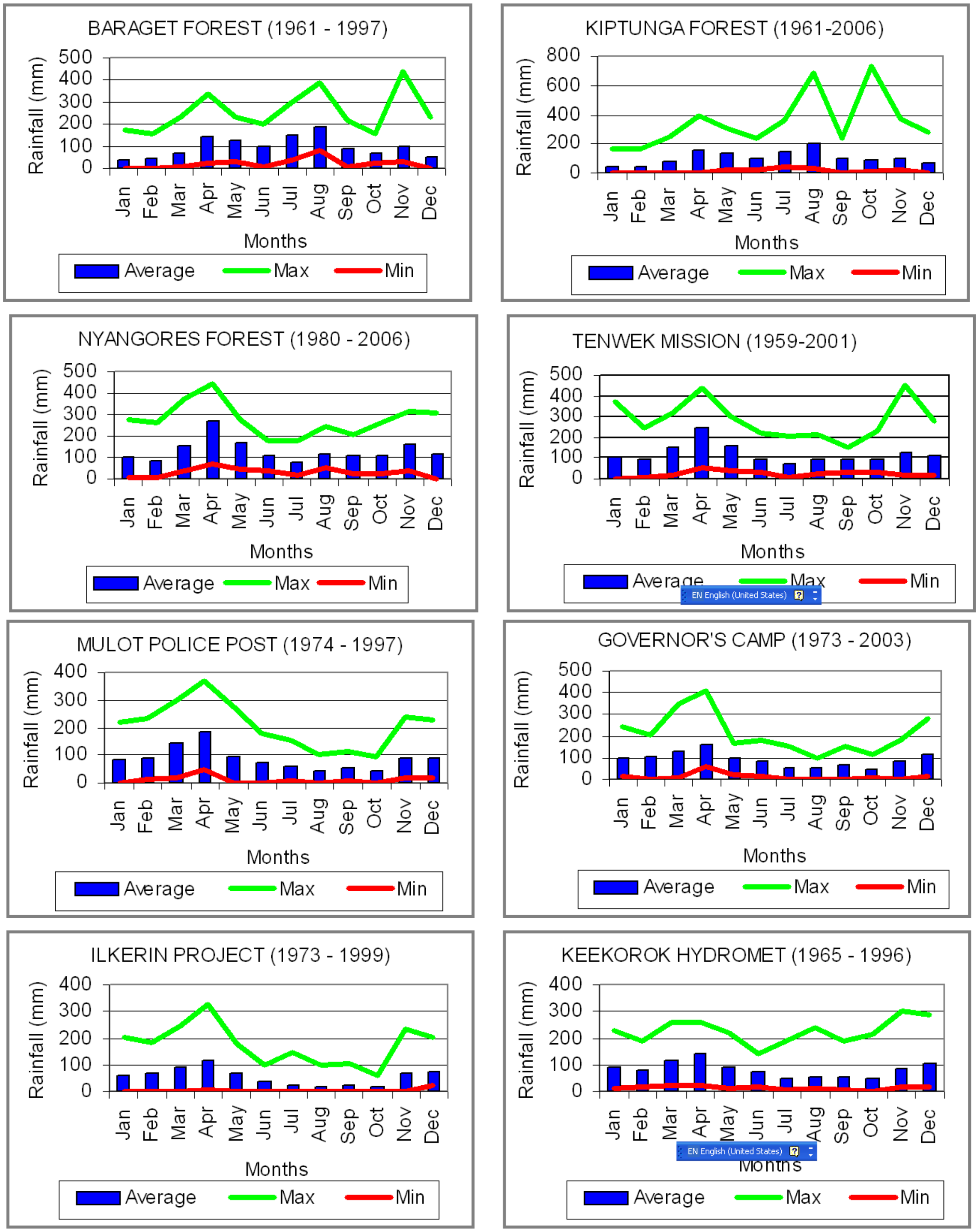


Figure 2.7: Seasonal Rainfall Patterns in the Mara Basin, Kenya

Three rainfall stations on the Tanzanian side were selected to describe the rainfall pattern on the lower part of Mara River Basin. The selected rainfall stations were Tarime Hydromet, Mugumu Primary School, and Musoma Met. station. The seasonal rainfall pattern in the Mara basin in Tanzania from these stations is illustrated in Figure 2.8. This figure shows that the rainfall regime in the lower part of Mara River Basin is typically bimodal with one rainfall peak occurring during the month of November (Short Rains), and the second occurring in April (Long Rains). These stations also help demonstrate the rainfall distribution across the basin. The northern part of the basin which includes part of Tarime district receives high average annual rainfall of 1465 mm (Tarime Hydromet station). The southern part of the basin which includes part of the Serengeti district experiences moderate average annual rainfall of 1160 mm (Mugumu Prim. Sch. station). Lastly, the western part of the basin which is within Musoma Rural district receives low average annual rainfall of 840 mm (Musoma Met. station).

As in the Kenyan side, the maximum and minimum rainfall data indicate significant monthly rainfall variability. However, the Tanzanian data indicate rainfall variability is higher during the short rains season (with the exception of Tarime). This is also observed in Keekorok, Kenya. Thus, flooding and water availability concerns are expected to be more pronounced during October and November.

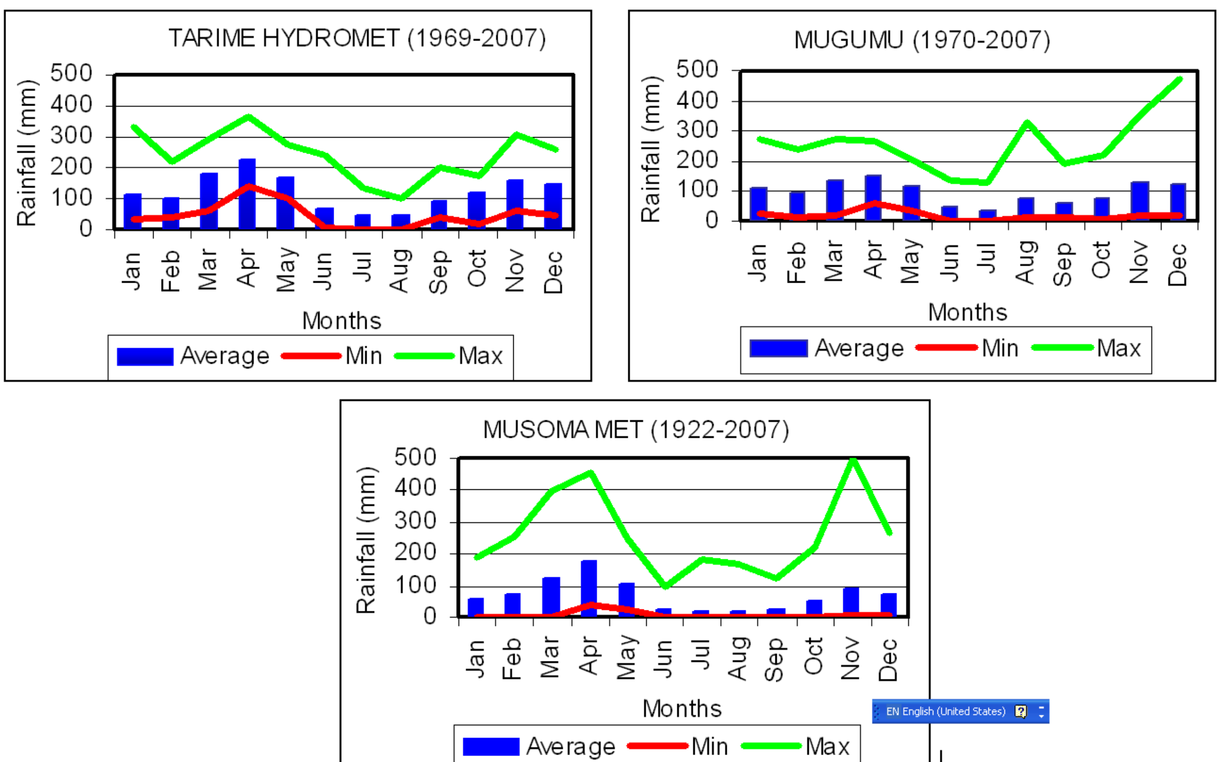
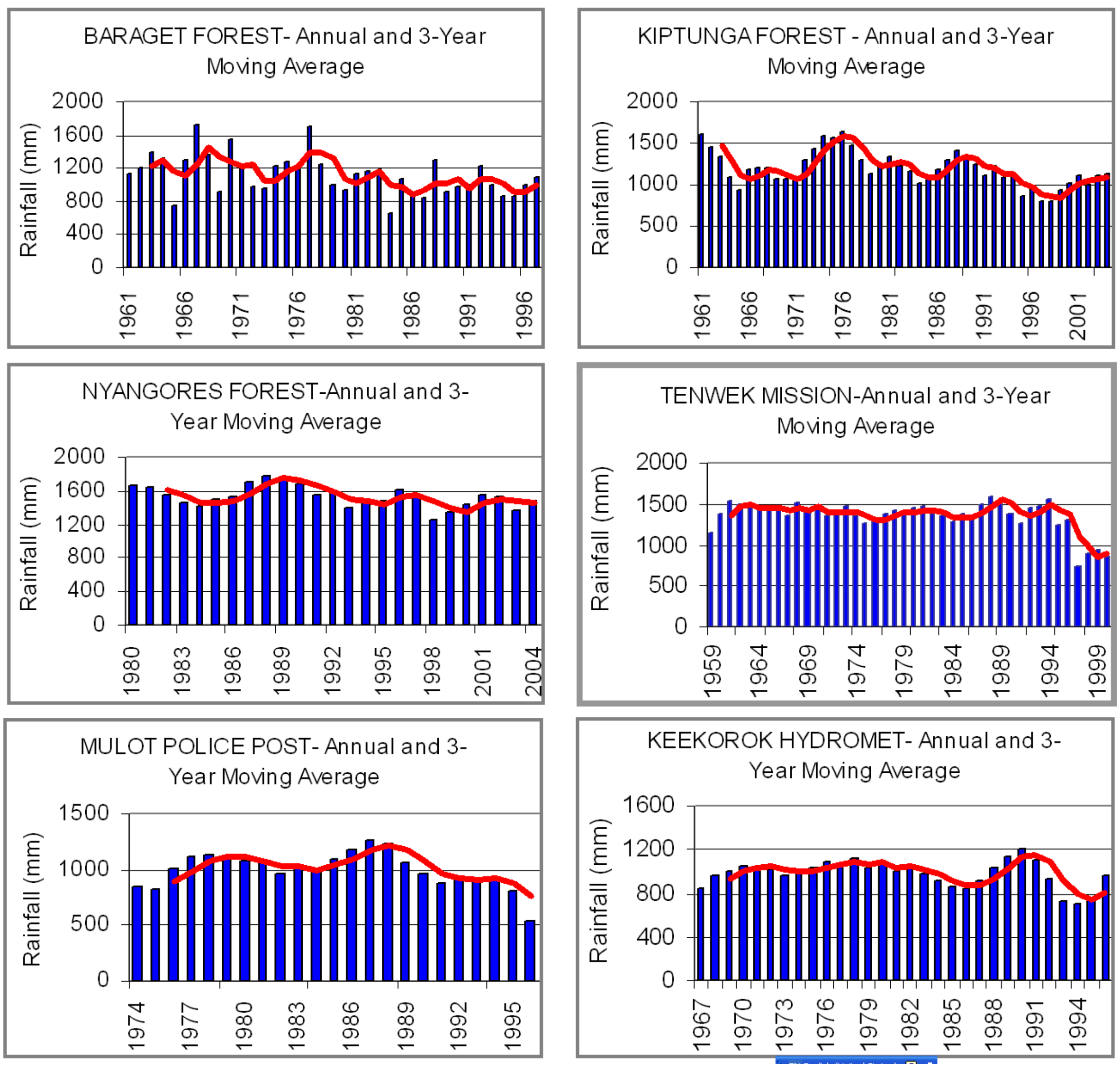
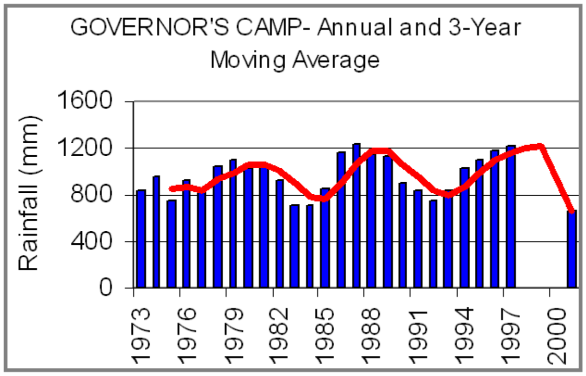


Figure 2.8: Seasonal Rainfall Pattern in Mara Basin, Tanzania

2.2.3.3 Multi-year Rainfall Variability

To study the vulnerability of the Mara basin to dry and wet climates, an analysis of three-year moving average rainfall was carried out (Figure 2.9). The three-year moving average series is indicative of long-term rainfall trends and persistence. This analysis shows droughts and wet years tend to persist. Furthermore, a general downward trend is observed in Kenya since the 1990s. Such a trend can potentially be attributed to the deforestation of the Mau complex which serves as Mara's water tower, or to a regional climate change, or both. More detailed data and assessments are needed to support or disprove these hypotheses. The same trends are also observed at additional stations included in Appendix 2B.





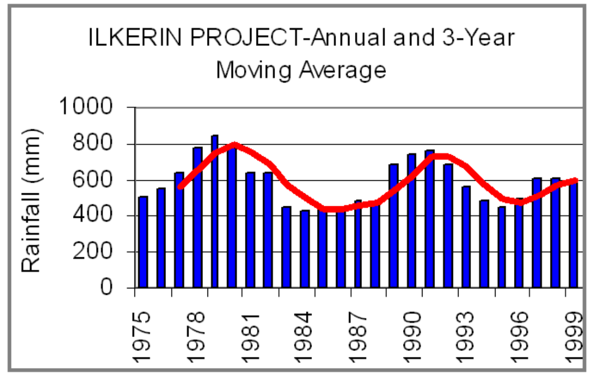


Figure 2.9: Annual (blue bars) and Three-Year Moving Average (red solid line) Rainfall in the Mara Basin, Kenya

The same analysis was also carried out for annual rainfall amounts on the Tanzania side using data from one rainfall station with long and continuous records (Musoma Met.). Unfortunately, the use of other rainfall stations was not possible due to data gaps and short record lengths. The Musoma station includes data for 86 years over the period from 1922 to 2007. This station is situated near the location where the Mara River discharges into Lake Victoria. The three-year moving average analysis for this rainfall station is shown on Figure 2.10. It is observed that annual rainfall is characterized by high variability, with wet year rainfall amounts reaching up to 1400 mm and dry years delivering only 400 mm. Over the period of record, at least four extreme *dry* years have occurred: 1924, 1934, 1949, and 1976. Extreme *wet* years occurred in 1936, 1961, 1988, and 1997. Some of these occurrences coincide with the El Nino phases in the Northern Pacific Ocean. Specifically, 1997 is documented to be El Nino year (warm phase). Furthermore, the Indian Ocean temperature variations have also been linked to East Africa rainfall.

The Musoma data indicate that dry and wet years come in clusters of three or more years. Such extreme periods coincide with the troughs and peaks of the three-year moving average line on Figure 2.10. Thus, the Mara basin is vulnerable to droughts and floods, and there is need for infrastructure that can mitigate their adverse impacts. Unlike the Kenyan stations, the Musoma station does not exhibit a downward trend.

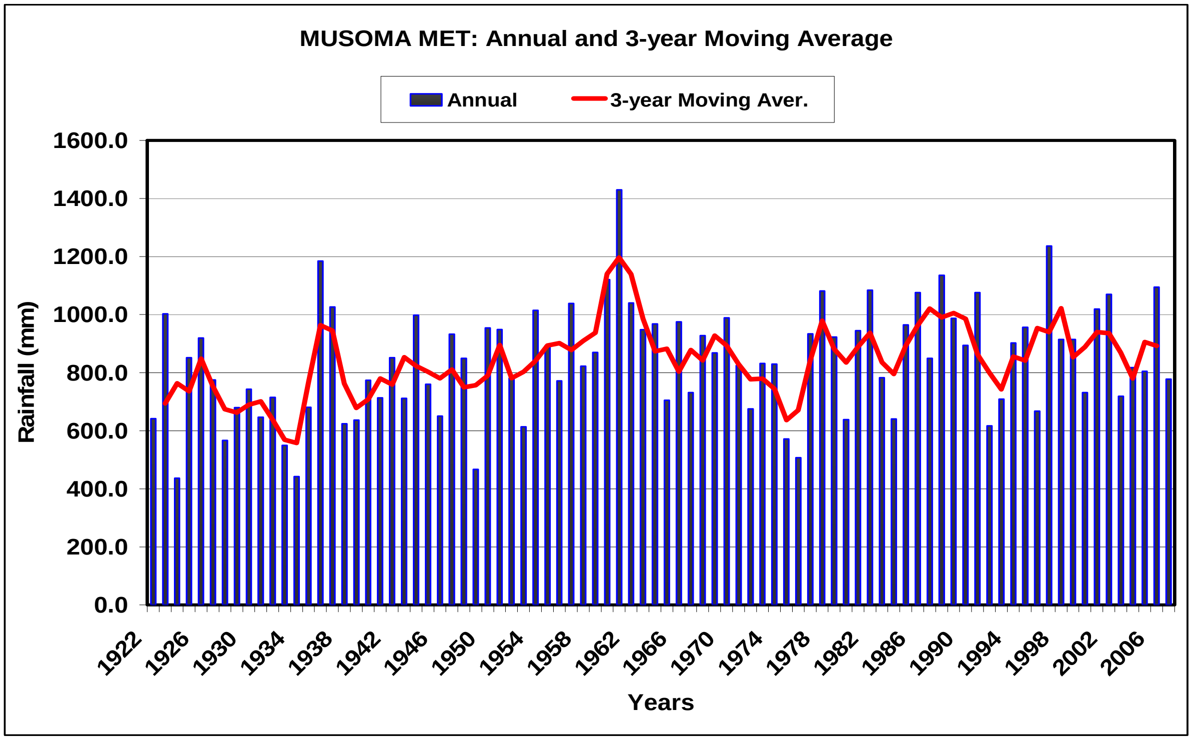


Figure 2.10: Annual (blue bars) and Three-Year Moving Average Rainfall (red solid line) at Musoma, Tanzania

2.2.3.4 Comparative Rainfall Analysis

Comparative rainfall analysis was carried out by developing rainfall frequency curves of monthly rainfall amounts at four stations located at the lower (09133000), middle south (09134033), southeast (09135025), and upper (09135241) parts of the Mara basin. The method followed similar procedure for constructing flow duration curves. This involved

i) sorting monthly rainfall amounts in descending order;
ii) ranking the descending series;
iii) computing the plotting positions of the ranked series;
iv) establishing rainfall amounts at specified excedence percentages; and
v) plotting the rainfall frequency curves (RFCs), i.e., the excedence rainfall amounts against the excedence percentages.

Owing to different record periods (starting date and length), the period 1970-1999 common to all records was used for basin wide comparisons. Additionally, the longest record at 09133000 was used to compare the pre-1970 (1922-1969) and post-1970 (1970-1999) RFCs. To investigate the changes over the 1970-1999 period, separate RFCs were established for the 1970s, 1980s and 1990s and plotted on the same axes with the 1970-1999 RFCs.

The results of the analysis (Figure 2.11) indicated some changes in rainfall amounts considering the period from the 1970s to the 1990s. The RFC representative of the upper part of Mara Basin (Mau Mountain) indicated a decreasing rainfall trend. The station in the south-east did not indicate any rainfall trend. The station in the middle south indicated decrease in high rainfall values while the one at the lower part of the basin indicated increase in high rainfall values. Overall, the most significant change noted in the analysis is the declining monthly rainfall amounts in the upper catchments in the Mau escarpment.

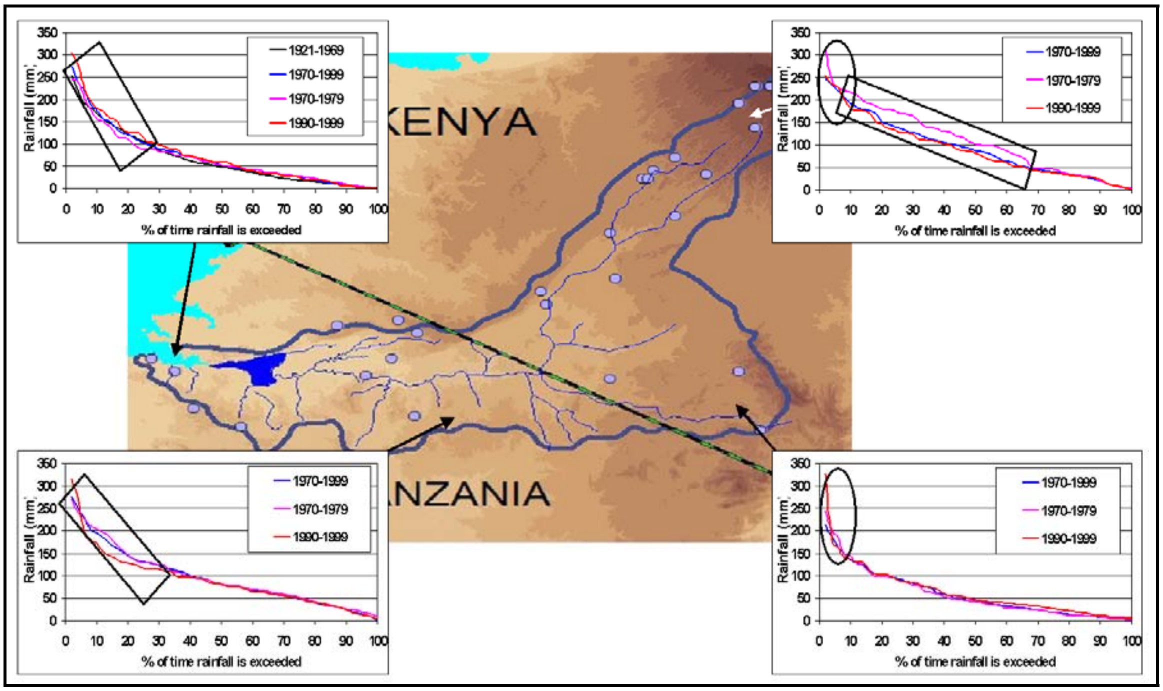


Figure 2.11: Rainfall Trend Analysis in the Mara River Basin.

2.2.3.5 Rainfall Analysis for Wet and Dry Years

Water resources planning and management must consider the time-space variability of these resources influenced by rainfall/climatic variations and human-induced stresses. The time variability can be seasonal (intra-annual) or multiyear (inter-annual), while its magnitude may differ in various parts of the basin, depending on local climate (microclimate). As discussed earlier, seasonal variability is related to the distribution of water resources within the year, and multiyear variability depends on the occurrence of wet, normal, or dry years. In what follows, we provide a more detailed characterization of intra-annual and inter-annual rainfall variability and its implications for water resources planning and management. The analysis was carried out using available rainfall data obtained from the Tanzania Meteorological Agency.

2.2.3.6 Identification of Seasons

Dividing the year into seasons pertinent to the Mara River basin is essential for the analysis and management of water resources. Since rainfall is the main driver for the availability of freshwater resources, surface water resources seasonality follows that of rainfall. Plots of *average* monthly rainfall amounts in various locations in the Mara River basin indicate remarkable variation throughout the year (Figure 2.12). The unimodal regime prevails in the upper catchments of the basin with high rainfall amounts in April-August and average monthly amounts typically exceeding 50 mm. The bimodal regime exists in lower catchments towards the lake where two main rainy seasons, the October-December Vuli rains and March-May Masika rains are separated by a January-February intermediate Season while June-September is usually the “Dry” season with monthly amounts below 50 mm.

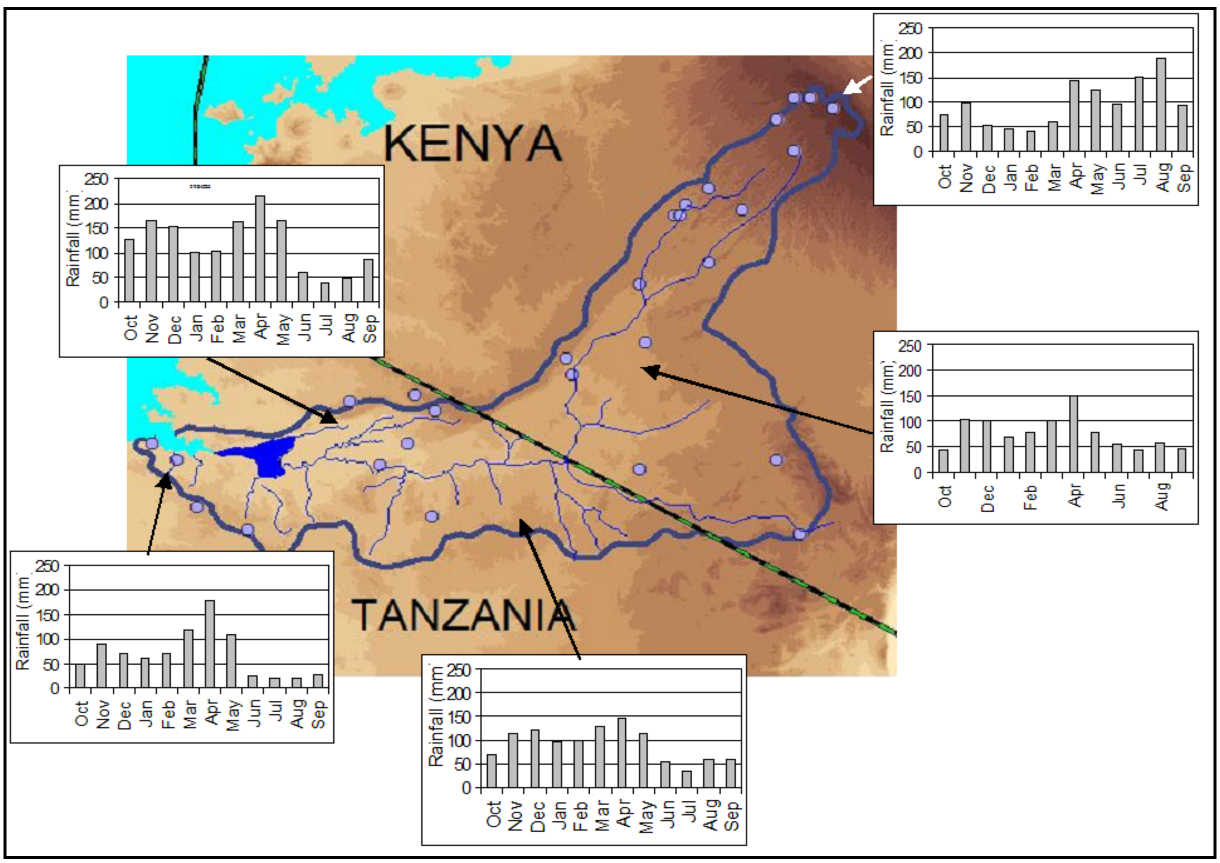


Figure 2.12: Monthly Rainfall Patterns in the Mara Basin

For consistency across the basin, the seasons at the lower catchments of the basin were therefore adopted. The reason for the selection of these four seasons lies on the fact that factors for rainfall occurrence during the four seasons are similar throughout the basin. It is the magnitude that is variable across the basin. The October-November-December-January (ONDJ) rainfall is predominantly orographic attributable mainly to low-level moisture, surface winds, and topography; the March-April-May (MAM) rainfall is predominantly convective attributable to high temperatures in December-January-February, land dynamics, and atmospheric circulation. Finally, the June-July-August-September (JJAS) rainfall is attributable to the cross-equatorial penetration of the northern hemisphere rainfall season into the basin. The analysis year was considered as the hydrological year between October of the first year and September of the following year. Seasonal rainfall amounts were therefore computed from monthly amounts while annual rainfall amounts were computed from seasonal amounts.

2.2.3.7 Identification of Wet and Dry Seasons and Years

Seasonal and annual rainfall amounts were used to classify seasons and years broadly into wet, normal, and dry. The classification procedure is as follows:

i) Compute the exceedence annual and seasonal rainfall amounts using all available data records (not just the 1960-1999 period) and select the rainfall exceedence amounts to define indices of wetness, normality, and dryness. The seasonal and annual rainfall amounts are ranked according to decreasing magnitudes, and probability plotting formulae are used to estimate rainfall amounts exceeded 1, 2, 3, …, 100% of the time. These are plotted on a curve we refer to as rainfall duration curve, or rainfall probability plot.

ii) Express the indices as anomalies from the 1960-1999 average statistics, standardized by the 1960-1999 standard deviation. These indices are different for wet, normal, and dry periods (3 indices). To facilitate the interpretation of reduced rainfall amounts across the basin with different climatic modification, it is easy to use standardised anomalies that remove the spatial differences of actual magnitude. Normally, periodic (e.g., long-term, year 1- year 2 period, etc.) averages are subtracted from the actual values and standardised by either the same averages or standard deviations (of actual values) for the same period. The period 1960-1999 actually comprises the wet 1960s and several dry periods in the 1970s, 1980s, and 1990s. This is indicated by almost all long records, not only in the Mara River basin but also across East Africa, and has been linked to the ENSO predominance (Active in pre-1930s, calm in 1930s-1950s, active again since 1960s). The standardised index is computed as

$$SPI_{OND,Anom} = \left(\frac{SPI_{OND} - \overline{OND}_{1960-1999}}{\sigma_{OND\,(1960-1999)}} \right) \qquad \text{Eq. 2.1}$$

where $SPI_{OND,Anom}$ is the standard precipitation index anomaly, SPI_{OND} is the standard precipitation index (amount) for the short rains (October-December, OND), and $\overline{OND}_{1960-1999}$ and $\sigma_{OND(1960-1999)}$ are the 1960-1999 average and standard deviation of OND rainfall amounts.

iii) Express the seasonal and annual series as standardized anomalies and extract years with anomalies above (or below) the wetness (or dryness) index.

$$OND_{i,Anom} = \left(\frac{OND_i - \overline{OND}_{1960-1999}}{\sigma_{OND\ (1960-1999)}} \right) \qquad \text{Eq. 2.2}$$

where $OND_{i,Anom}$ and OND_i are the OND rainfall anomaly and actual OND seasonal amount in year *I* respectively, $\overline{OND}_{1960-1999}$ and $\sigma_{OND(1960-1999)}$ are the 1960-1999 average and standard deviation of OND rainfall amounts.

iv) Compute the percentages of records which identify the years as wet or dry, and consider the year wet if more than 50% of records identify it as wet. For this study, a normal year is one which is defined by anomalies between the wet (+1.5) and dry (-1.0) anomalies.

The upper part (R1-R20[1]) of the rainfall duration curves (RDCs, already explained in (i) above) for seasonal and annual amounts was investigated to select an appropriate wetness index. The Kriging method built into the SURFER plotting software was used to perform spatial interpolation of station values. For high R1-R6 exceedences, there were high spatial differences of the magnitude of the anomalies while for moderate R10-R20 the spatial difference was small. For annual wetness R5 index, for example, the range of anomalies was 0.9-4.5 averaging at 2.3 while for R10 the range was 0.6-2.8 averaging at 1.7. The spatial variation of R10 anomalies (Figure 2.13a) indicates prevalence of anomalies exceeding 2 in the middle and to the southeast of the basin while much of the remaining basin area comprises anomalies 1.4-1.8. Therefore, the anomaly index of 1.7 was finally selected to define a wet year.

On the lower side of the RDCs, there is small spatial variation across the basin. This is illustrated by R90 anomalies (Figure 2.13b) which range between –0.6 and –1.5 averaging at –1.0. R70 and R80 anomalies average below –1.0 resulting in a number of years classified as dry while R95 anomalies vary between –0.8 and –1.8 spatially averaging at –1.2. Although there is slight different between average R90 and R95 anomalies, R95 anomaly failed to identify the prevailed drought of the mid 1970s (1975/76) as identified by R90 (Figure 2.14). Therefore, R90 average anomaly of -1.0 was adopted to define a dry year.

[1] RX is the rainfall amounts, which has been exceeded X% of the time.

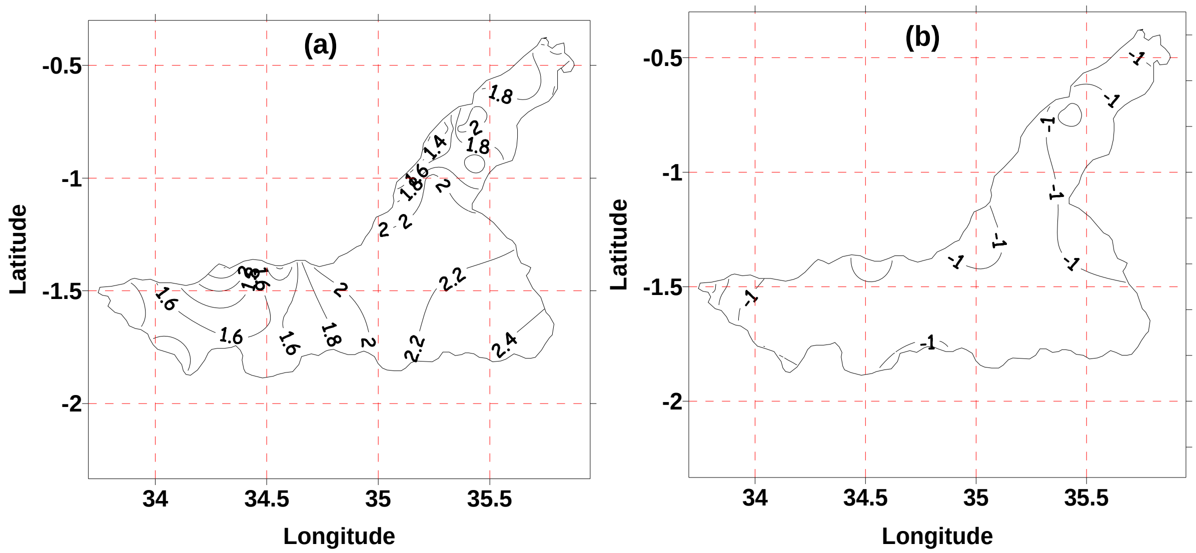


Figure 2.13: Spatial Variation of a) R10 and b) R90 Anomalies in Mara River Basin

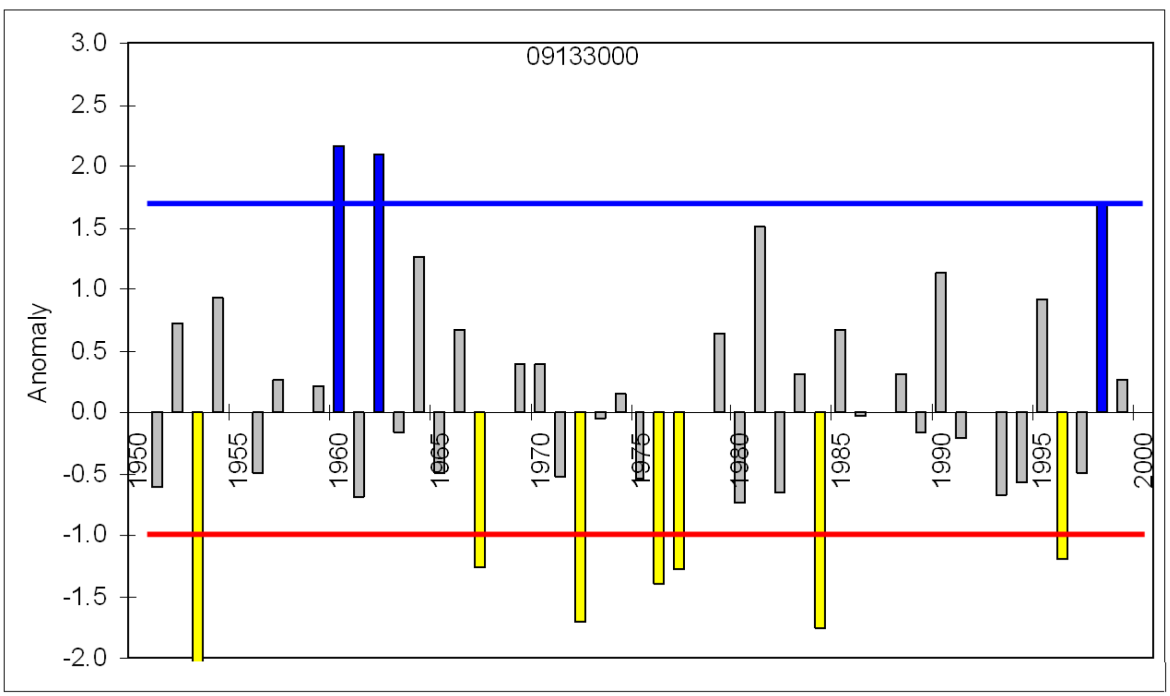


Figure 2.14: Time Series of Annual Rainfall Anomalies demonstrated for one rainfall station in the Mara River Basin (wet years are shown in blue and dry years in yellow)

The indices of wetness and dryness were used to identify wet and dry years from selected 29 rainfall records at stations within the basin and its close proximity. With the consideration of more than 50% records identifying the year as either wet or dry, only three years 1961/62, 1977/78 and 1997/98 were identified as wet with the wettest year being 1961/62 following the abundant *Vuli* (October-December, OND)rains of 1961. The procedure further identified three years 1983/84, 1991/92 and 1996/97 as dry with the 1983/84 being the driest year following the failed *Masika* (March-May, MAM) rains of 1984.

2.2.3.8 Spatial Variation of Rainfall in Wet and Dry Years

To facilitate a visual analysis of the spatial extent of seasonal and annual wetness and dryness in the Mara River basin, anomalies of rainfall amounts for each season and for the year were computed as the difference from the 1960-1999 averages and standardized by the 1960-1999 standard deviations (Table 2.4). The spatial variation of anomalies of seasonal and annual rainfall amounts during the wettest 1961/62 and driest 1983/84 are presented and discussed.

The pattern of spatial variation of annual rainfall amount during wet years shows a general north-south gradient of rainfall amounts with higher amounts received in northern part and highest in the Mau escarpment (Figure 2.15). Although at some locations in the basin the year 1961/62 did not reach the wet anomaly criterion, a wet positive anomaly was experienced throughout the basin. The annual rainfall spatial variation pattern during the 1961/62 is also reflected on the spatial rainfall variation during the *Vuli* (October-December, OND) rains (Figure 2.15), which, historically, were the most abundant *Vuli* rains in most parts of Mara River basin and Tanzania in general. However, the magnitude of the annual anomalies is much less than those of the seasonal anomalies. This is illustrated by the different spatial variation patterns of OND, MAM, and JJAS rains (Figure 2.15).

Table 2.4: The 1960-1999 Seasonal and Annual Averages and Standard Deviations

No.	Station details				Annual		OND		JF		MAM		JJAS	
	Code	Lat	Long	Alt (m)	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
1	09035079	-0.750	35.367	2012	1530.6	313.0	343.0	137.8	256.8	116.1	572.7	154.6	352.1	85.5
2	09035085	-0.583	35.683	2743	1591.5	480.8	307.2	181.6	163.0	103.6	485.8	193.3	642.1	194.1
3	09035117	-0.367	35.817		1265.4	343.6	280.9	177.6	146.5	105.6	381.3	154.0	460.0	140.1
4	09035138	-0.617	35.883				183.5	108.3	93.6	86.5	286.5	115.7	499.0	218.9
5	09035199	-0.300	35.267	1981	1700.1	406.6	295.4	140.6	229.4	102.2	616.0	174.0	607.3	224.8
6	09035227	-0.783	35.333	1951	1410.0	313.0	321.4	134.5	254.6	116.8	537.8	149.8	309.5	104.1
7	09035232	-0.533	35.950		1204.9	337.0	252.0	122.8	138.7	106.8	393.1	170.7	408.4	135.5
8	09035236	-0.900	35.100		1323.4	451.1	289.3	159.6	250.5	172.6	442.5	200.2	316.5	83.3
9	09035241	-0.417	35.733	2865	1151.5	267.9	208.5	137.9	102.0	70.0	327.2	117.2	533.9	149.9
10	09035260	-0.617	35.317		1853.4	465.5	407.4	161.8	244.8	129.8	639.0	208.7	546.2	147.5
11	09035265	-0.783	35.350	1951	1437.6	245.2	336.8	118.7	267.4	117.1	531.0	175.7	337.8	84.9
12	09035284	-0.933	35.433	1829	1099.8	324.8	230.4	91.0	234.0	91.0	418.2	149.1	219.9	68.8
13	09035302	-0.700	35.433	2219	1650.1	271.6	378.7	150.5	252.8	96.6	600.3	156.8	418.1	76.3
14	09133000	-1.500	33.800	1147	950.3	237.0	245.4	145.2	203.3	105.3	423.2	117.6	88.2	54.3
15	09133001	-1.700	33.933	1219	1033.1	281.6	293.8	136.4	221.5	133.7	439.5	178.4	123.9	66.8
16	09133002	-1.133	33.983	1158	895.1	199.6	234.6	125.5	171.7	102.0	418.5	136.2	123.8	64.6
17	09133004	-1.550	33.867	1158	882.6	278.3	230.6	102.9	179.5	104.9	383.6	140.3	87.0	56.7
18	09133007	-1.767	33.850	1219	1166.7	202.2	343.7	111.0	256.5	125.8	471.4	155.6	103.0	72.5
19	09133011	-1.400	33.700		898.8	194.7	211.8	128.6	193.4	126.4	398.2	121.5	93.9	55.9
20	09133018	-1.883	33.683				283.9	124.4	258.9	244.3	463.7	282.7	99.3	118.1
21	09134008	-1.350	34.567	1829	1375.9	361.7	419.2	230.4	230.1	83.6	522.7	138.7	265.0	105.1
22	09134011	-1.000	34.883	1981	1718.2	438.3	396.6	143.6	295.5	140.3	538.3	216.7	389.9	112.7
23	09134019	-1.333	34.683		1771.5	738.5	485.2	275.9	298.9	198.0	537.9	235.3	340.4	148.7
24	09134026	-1.333	34.333	1280	1469.1	255.1	455.7	160.9	261.7	67.6	547.6	145.6	237.3	71.1
25	09134029	-1.767	34.083	1448	1142.4	196.0	321.5	97.1	208.2	71.2	447.0	119.1	143.6	68.0
26	09134033	-1.867	34.717		1095.8	222.2	312.5	154.2	229.0	94.0	391.0	123.0	212.2	61.9
27	09135008	-1.000	35.233	1646	1008.7	321.1	252.9	153.3	186.0	81.5	335.4	131.2	204.7	62.8
28	09135019	-1.100	35.400				157.0	41.4	174.7	69.6	294.1	150.4	172.8	79.5
29	09234005	-2.333	34.917	1540	1039.1	438.2	256.7	182.3	229.5	140.2	366.3	195.6	137.4	95.4
				Min:	882.6		157.0		93.6		286.5		87.0	
				Max:	1853.4		485.2		298.9		639.0		642.1	

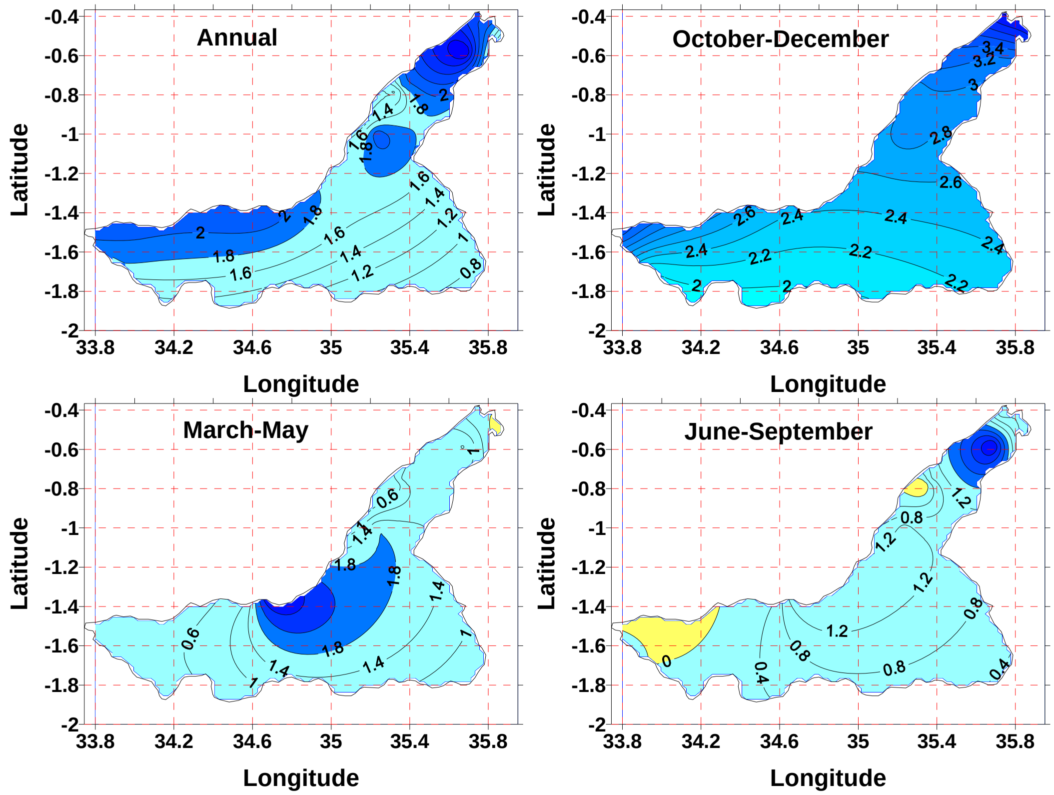


Figure 2.15: Spatial Variation of Rainfall Anomalies in 1961/62 (wet year) in the Mara River Basin
(*Note:* Blue colours represent wet and yellow colours dry conditions.)

Contrary to the north-south pattern the annual rainfall during the wet years, the corresponding pattern during dry years shows a general east-west gradient in lower catchments and northwest-southeast gradient in middle and upper catchments, with the lowest amounts received on the western part near the lake and northwest (Figure 2.16). Similar to the wet conditions, the driest years are experienced throughout the basin with variable magnitude of the event. Unlike the predominance of variations in one season on the variation at the annual timescale, there is generally a lack of predominant season during the driest years (Fig 2.16). The east-west gradient in the lower part of the basin could be a combination of persistent dry conditions since the *Vuli* (OND) through the *Masika* (MAM) to the "dry" the dry season (JJAS). A similar argument could be attributed to the northwest-southeast gradient in the upper catchments at the annual timescale, which is not very evident at the seasonal timescale. The same stations were used in wet and dry years spatial interpolation and the patterns displayed reflect the range of variability of determined values in the basin.

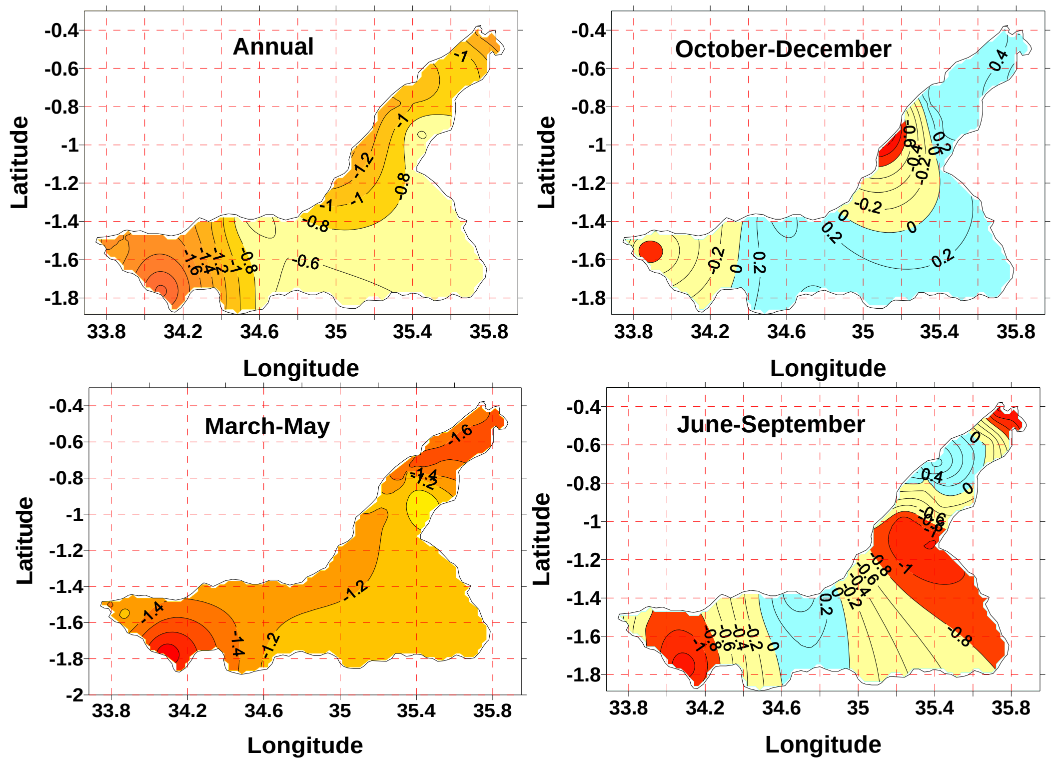


Figure 2.16: Spatial Variation of Rainfall Anomalies in 1983/84 (Dry Year) in Mara River Basin
(*Note:* Blue colours represent wet and yellow colours dry conditions.)

In summary, this analysis shows that the Mara River Basin is vulnerable by both climate extremes, floods as well as droughts. These findings suggest that water control and storage projects would benefit the region by mitigating floods and securing water supplies during dry years. Moreover, there is a critical need to upgrade the climatic monitoring network to (1) monitor climatic variability and change, and (2) quantify the adverse impacts of land use change.

2.3 The Mara River System

The 395 km long Mara River system originates in the mountain forests of the Mau Escarpment and flows all year round to Lake Victoria. Rivers Amala and Nyangores form the headwaters of the Mara River. Springs and shallow wells are abundant in the upper catchment area of the basin indicating the availability of adequate groundwater resources. The Nyangores River originates from the Eastern Mau Forest, and its head waters comprise a number of tributaries including the Sissmdo and the Kanunda streams. These streams pass through the South Western Mau Forest within which other small tributaries join the two streams before they join (while still in the forest) to form the Nyangores River.

The Amala River also originates from the Eastern Mau Forest as Absege, Kipsomoro, and Shabaltaragwa streams, which converge in the Ol Pusimoru Forest to form the Amala River.

The Amala River flows through the Transmara forest within which it is joined by other minor tributaries including the Nairotia stream. The Engare Engito stream is the last major tributary joining the Amala River approximately one kilometre downstream of the Mulot Market.

In the Masai Mara Game Reserve, study and analysis of the topography indicate the presence of springs along the Soit Ololol (Siria) Escarpment. The flow direction of these springs is towards the Mara River and there is a likelihood that these springs contribute appreciably to the Mara River discharge during low flows across the basin.

After crossing the Kenya/Tanzania border, the Mara River flows through open savannah grassland, protected by the Serengeti National Park, and through the flood plain before discharging into Lake Victoria.

The Mara River with its perennial tributaries, minor tributaries, springs, and seasonal streams constitute the surface water resources in the catchment. These resources are highly exploited for large scale irrigation, domestic water supplies, livestock, and wildlife watering.

2.3.1 Hydrological Monitoring

Kenya

Until recently, the Ministry of Water and Irrigation in Kenya had been responsible for the operation and maintenance of the water resources monitoring network in the country. However, under the reformed institutional set-up of the water sector, the Water Resources Management Authority (WRMA) is responsible for the management of water resources. The management of water resources in the Mara River Basin falls under the WRMA Lake Victoria South Catchment Area (WRMA-LVS) whose regional offices are in Kisumu and a sub-regional office in Kericho.

The Ministry of Water and Irrigation had previously established a sparse surface water-monitoring network in the Mara River catchment area as part of the resource management. The network, which has been adopted by the WRMA, comprises a number of gauging stations established from upstream to downstream on the Nyangores and the Amala tributaries and on the Mara River itself. These stations are equipped with vertical staff gauges. Water levels at these gauging stations are recorded twice daily (where possible) by private gauge readers engaged and paid an honorarium by WRMA. However, the river gauging network has suffered from vandalism and often lack of trained gauge readers. Some of the gauges are also washed away by floods.

Consequently, there are major gaps in the water resources data. It is, however, expected that WRMA will re-establish and mange gauging stations equipped with up to date monitoring equipment. The surface water monitoring network in the Mara River catchment is summarized in Table 2.5.

In the past, water level and river discharge records were submitted to the Ministry of Water and Irrigation headquarters in Nairobi for further analysis and storage. However, this procedure has changed, and the data is submitted to the regional office of the Water Resources Management Authority in Kisumu through the sub-regional office in Kericho.

On monitoring shared water resources, the establishment of river gauging stations and the measurement activities have always been undertaken independently by the two countries, partly due to the different monitoring approaches adopted by each country. In particular, each country is using separate datum sets for stream level references. Unfortunately, this situation was not rectified during the Hydrometeorological Survey of the Catchment of Lakes Victoria, Kyoga and Albert project in the 1970s and 1980s.

Table 2.5: River Gauging Stations in the Mara River Basin, Kenya

RGS No.	River Name	LOCATION		Period of Record	Rated
		Lat.	Long.		
1LA01	Nyangores	- 0.739	35.358	1951 – 1964	No
1LA02	Keringet	- 0.413	35.689	1956 – 1987	No
1LA03	Nyangores	- 0.786	35.347	1963 – 2007	Yes
1LB01	Amala	- 0.947	35.417	1953 – 1954	No
1LB02	Amala	- 0.897	35.438	1955 – 2007	Yes
1LA04	Mara	- 1.233	35.036	1970 – 1992	Yes
1LA05	Mara	- 1.467	35.033	1991 – 1993	No

Tanzania

On the Tanzanian side of Mara River Basin, there are only three hydrometric stations that have ever been in operation in the Mara River Basin. Two gauging stations operated by the Lake Victoria Basin Water Office LVBWO are located on the downstream part of the controlled Serengeti National Park. The first station, Mara River at Mara Mines (5H2), was established in 1969. Staff gauges ranging from 0 - 7 meters are installed at the station to record river flow levels. The operation of this station has not been continuous. Specifically, the station ceased to be operational from 1983 until recently, when it was partially rehabilitated under LVEMP (Lake Victoria Environmental Management Project). The rehabilitation was limited to the re-installation of staff gauges only. Facilities for measuring discharge such as the cableway were reported to have been vandalized to the extent that what remains are heavy-duty cableway posts. Furthermore, the small house, constructed for use by the gauge reader, is no longer in existence also due to vandalism. The present status with regard to this particular station is that recording is done for water level only. Measurement of discharge is impossible without the cableway. The failure to measure discharge at the Mara Mines gauging station implies that streamflow records of the required quality are unavailable.

The second station, Mara River at Kirumi Ferry (5H3), was established in 1970. The measuring facilities at this station are staff gauges ranging from 0-3 meters. This particular station was established to record or monitor river flow levels only. The station was reported to have been continuously in operation during the period from 1970 to 1979. Thereafter, it was destroyed during the construction of a new road bridge to replace the ferry. The station was re-established by LVEMP in 2001 by installing new staff gauges.

The third station, Mara River at Kogatende, was established by the Serengeti National Park at a location near Kogatende Range Post. The information characterizing the first two gauging stations is presented in Table 2.6.

Table 2.6: River Gauging Stations in Mara River Basin, Tanzania

RGS No.	River Name	LOCATION		Period of Record	Rated
		Lat.	Long.		
5H2	Mara (Mines)	-1.549	34.554	1969-1978 (Discharge) 1969-1991; 2001 to date (Stage)	Yes
5H3	Mara (Kirumi)	-1.531	33.978	1970-1979; 2001 to date (Stage)	No
	Mara (Kogatende)	-1.563	34.887		No

The existing hydrometric networks on the Tanzanian side are inadequate to provide the hydrological data requirements for the formulation of detailed development plans for design and construction of water resources projects, as well as for the management of water resources in Mara River Basin. The area corresponding to the two hydrometric stations is 2600 km^2 per station, which makes for a network of grossly inadequate density.

The Mara River Basin Project, under the Nile Basin Initiative, has initiated a study to carry out a comprehensive assessment and design of the hydro-meteorological network for the Mara River Basin. This study recommends a total of 5 river gauging stations to be established in the basin. The existing distribution of the river gauging stations in the whole of Mara Basin is shown in Figure 2.17.

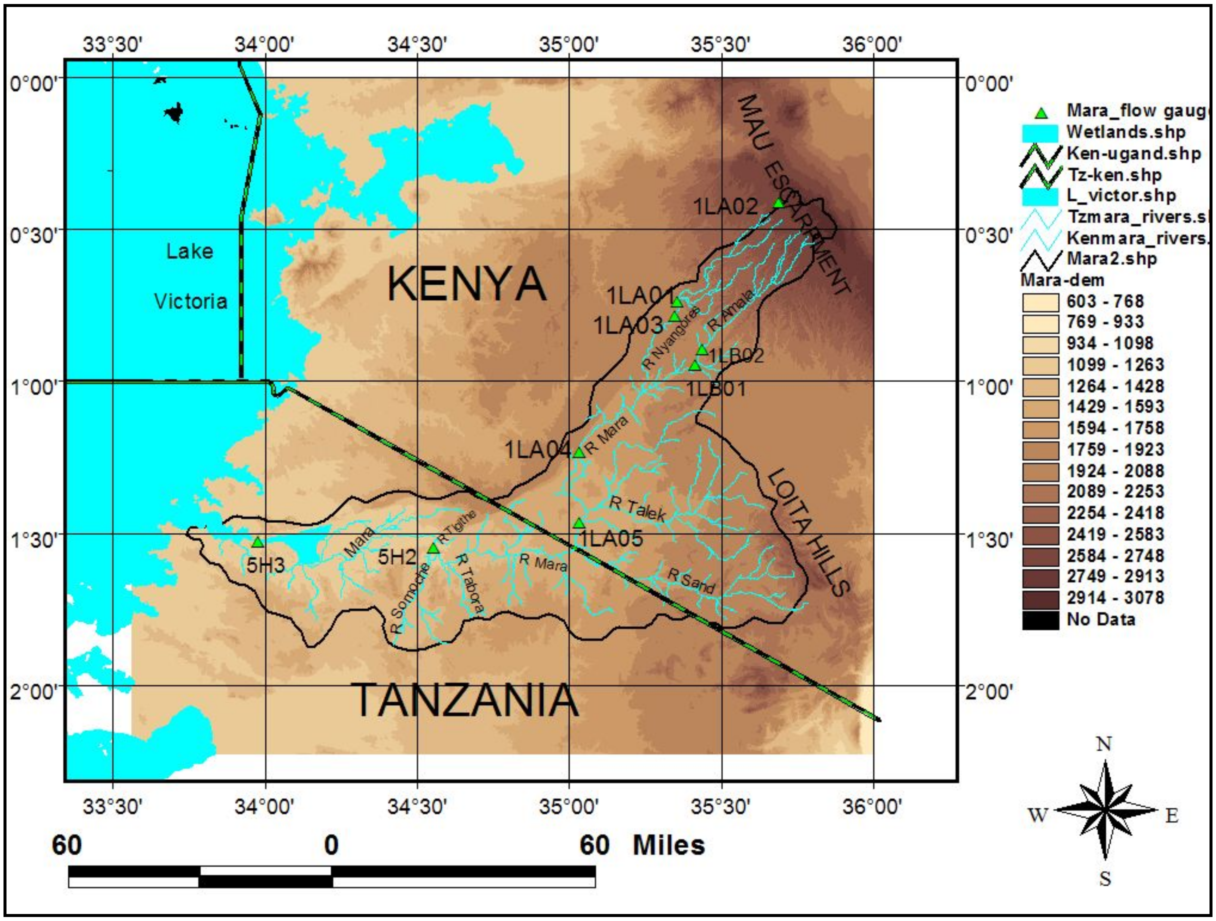


Figure 2.17: River Gauging Station Locations in the Mara River Basin

2.3.2 Rating Curves and Stream Flow Data

Kenya

Water level–discharge relationships have been developed for some of the river gauging stations in Kenya shown in Table 2.5. The recommended practice is to undertake current meter discharge measurements at least once a month, visiting one station at a time. The discharge measurements are used for generating and updating rating curves that relate water levels to corresponding river discharges. Unfortunately, during the 1990s, the systematic current meter gauging was interrupted for most of the stations in the Mara Basin as well as most other Kenyan catchments. However, depending on the stability of river cross sections where the gauging stations are situated, the water level/discharge relationships could be reliable and would only require seasonal checks to ensure the validity of the level-discharge relationship.

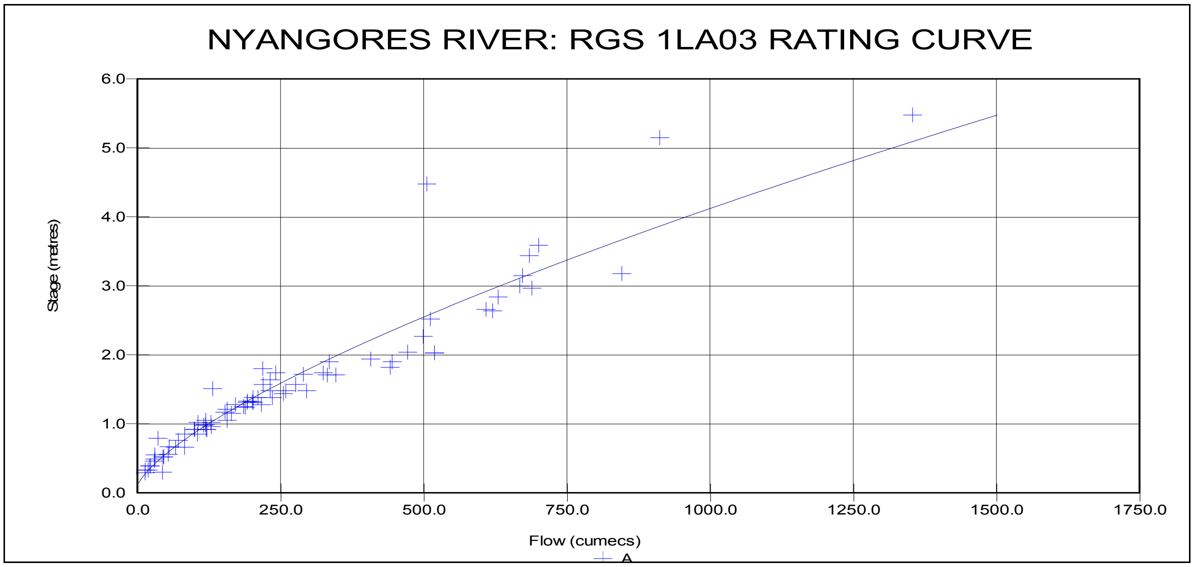
The discharge measurements are carried out using conventional current meters (CM) or the Acoustic Doppler Current Profiler (ADCP), which has been introduced in the Lake Victoria

Basin in the last eight years through the FAO Project on the Nile Basin Water Resources and was continued by the LVEMP.

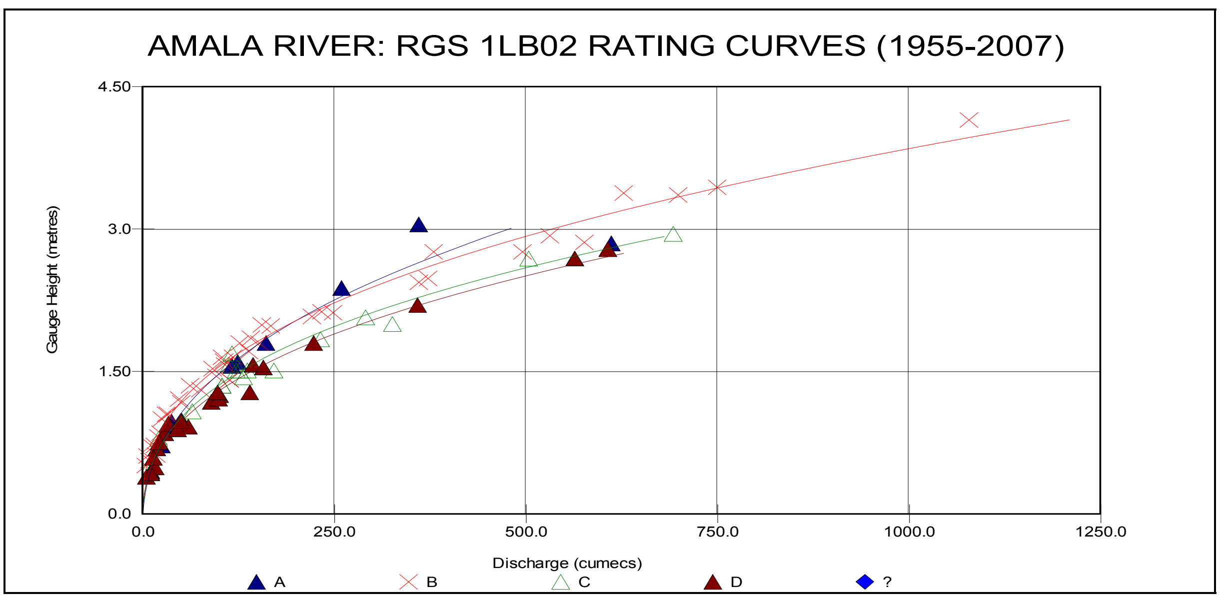
Figure 2.18 a,b,c shows the quality of rating curves for stations located in the Mara basin. A review of the current meter gauging shows that very few measurements were undertaken in the 1990s. The rating curves show a system that is affected by high levels of system noise in particular for the Mara River at 1LA04. The Amala River indicates a systematic change in the river cross-section as represented by the different curves.

The Nyangores River shows some major deviations in measurement after 1991. This error in the rating curve is reflected in the flow hydrograph. Comparison of the water level hydrograph and the flow hydrograph for the Nyangores (1LA03) shows that after 1991, while the water levels are consistent before and after 1991, the discharge volume declines drastically. The data for the Nyangores River after 1991 would be highly unreliable if the proposed rating curve for that period is used. It is, however, suspected that there was a human error in the establishment of the rating curve. Notwithstanding the possible error in the establishment of the rating curve and considering the history of the 1LA03 gauging station, which has been stable for all years, a single rating curve should be used for the whole period. Accordingly, the flow hydrograph for Nyangores River indicated in Figure 2.16 is based on a single curve for the period 1963 to 2007. For the Mara River at 1LA04, the gaps are too large to allow for any reliable reference except for a short period in the 1970s.

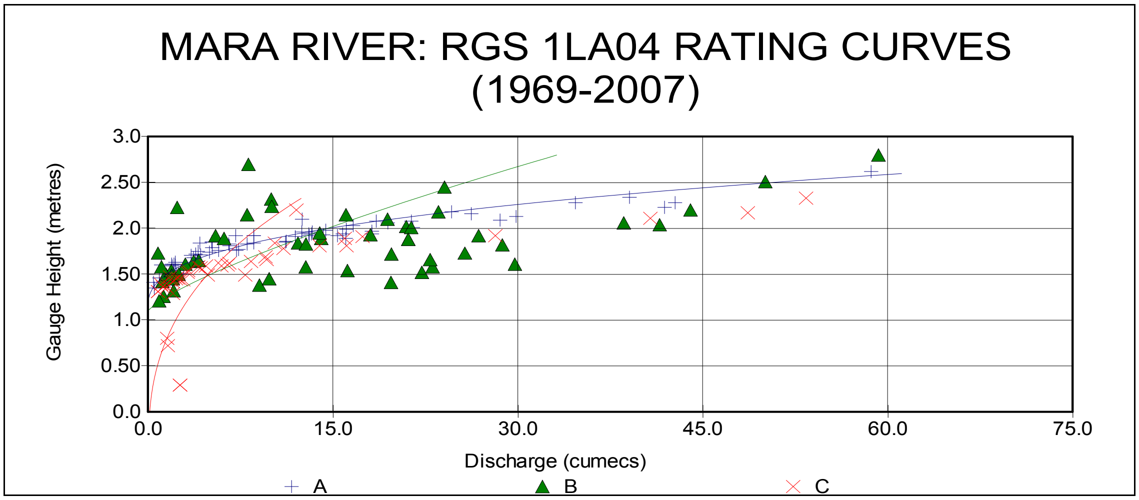
Figure 2.19 a,b,c shows the hydrograph plots for selected river gauging station in Kenya. The inconsistency in the rating curves and hence the discharges indicate a key issue in the operation of the hydrological network in the Mara River basin. Namely, it shows that lack of sufficient current meter gauging has affected the reliability of the Mara River observations. Measurement of low and high flows is particularly problematic for most of the stations. Quite often, monitoring teams are not able to capture flood events as these pass long before the teams arrive due to difficulties in disbursing monitoring funds or lack of specialized monitoring equipment.



a) Nyangores River at RGS 1LA03

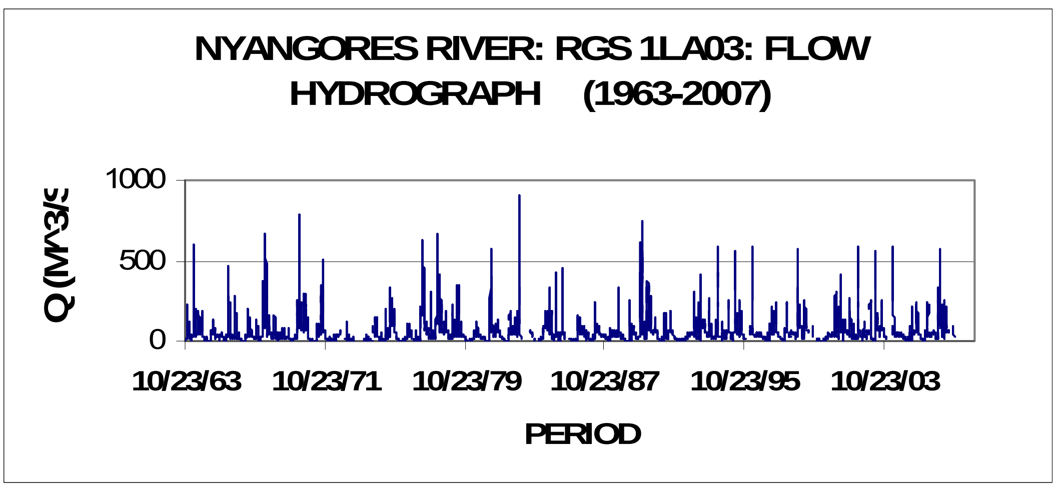


b) Amala River at RGS 1LB02

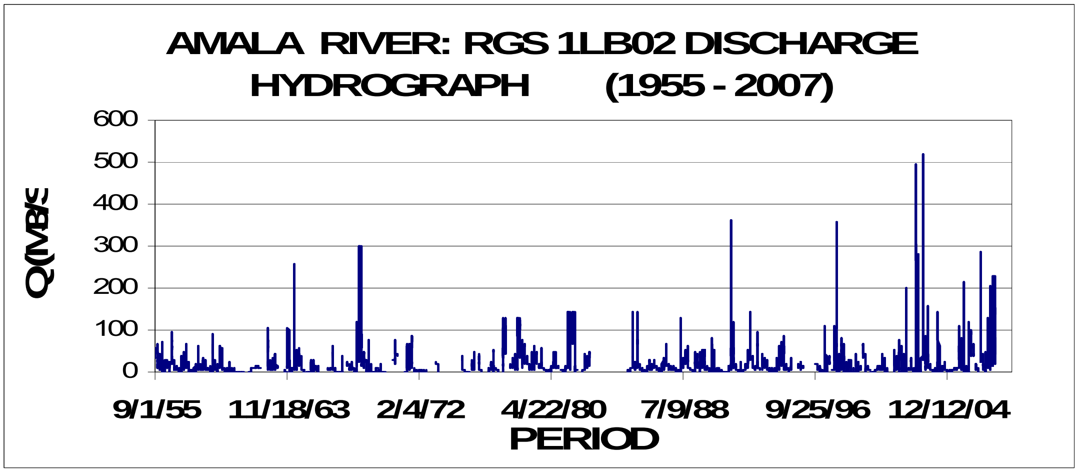


c) Mara River at RGS 1LA04

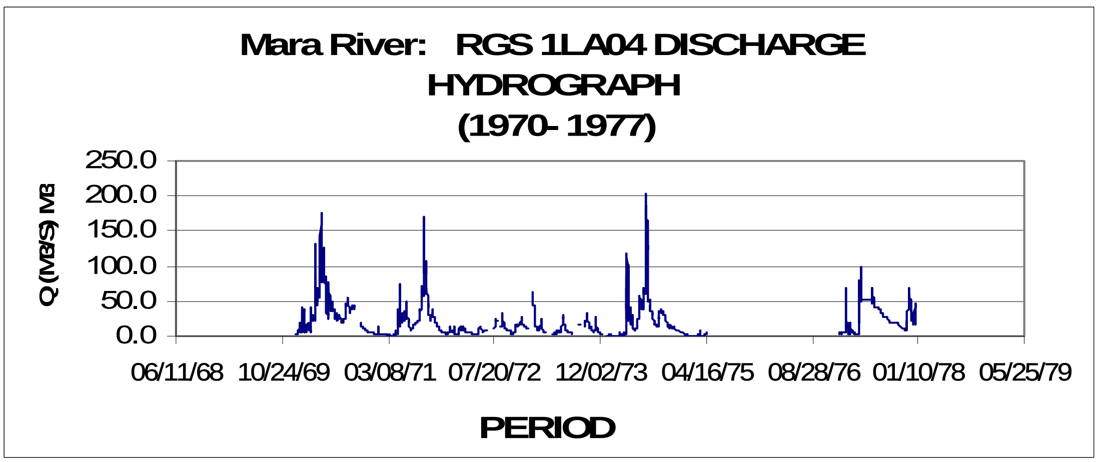
Figure 2.18: Rating Curves at River Gauging Stations, Kenya



a) Flow hydrograph for Nyangores River, RGS 1LA03



b) Flow hydrograph for Amala River, RGS 1LB02



c) Flow hydrograph for Mara River, RGS 1LA04

Figure 2.19: Flow Hydrographs for the Mara River, Kenya

Tanzania

Figure 2.20 shows the rating curve for one gauging station (Mara River at Mara Mines – 5H2) in Tanzania. The data for current meter measurements are available for the period from July 1970 to April 1981. The rating curve comprises of two rating curve segments. The first segment represents water levels between 10 m and 11 m, and the second for water levels between 11 m and 12.4 m. The third segment for water levels higher than 12.5 m has resulted from inconsistent measurements during February and April 1979. The rating curve for this station has not been updated since the early 1980s. This situation has seriously impacted the quality of stream flow records estimated after 1980.

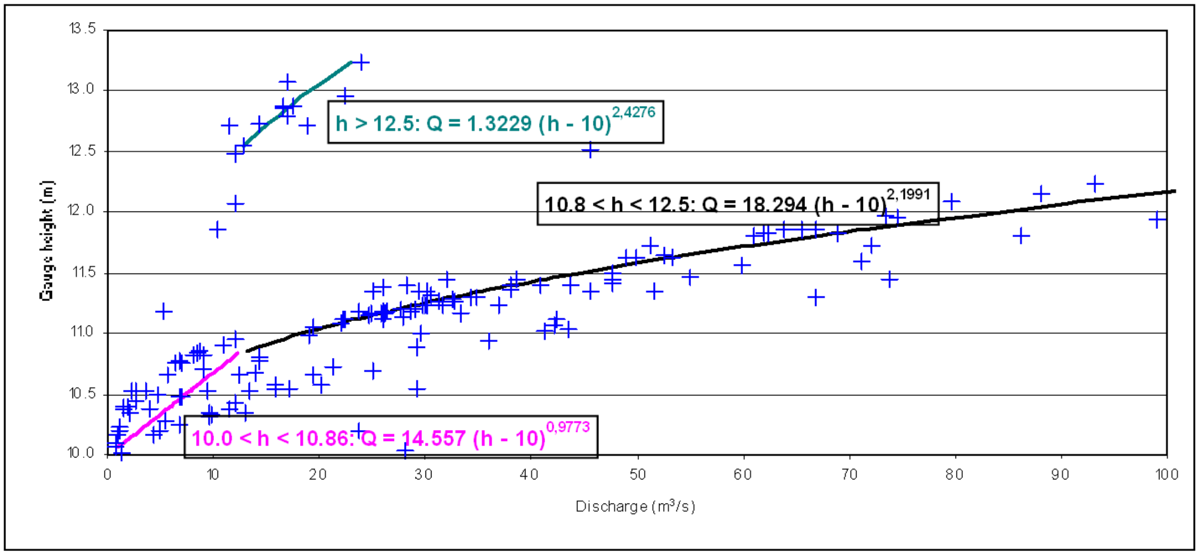


Figure 2.20: Rating Curves for River Gauging Stations, Mara River, Mara Mines, Tanzania

The streamflow hydrograph observed at Mara Mines in Tanzania for the period 1970-1979 and 1982 is presented in Figure 2.21. The hydrograph is characterized by gaps of missing data and high variability of river flow. The annual peaks are relatively high, ranging from 80 - 600 m^3/sec with an average of 300 m^3/sec. The annual minimum flows are close to zero. The long-term average daily flow is estimated at 40 m^3/sec and the mean annual flow volume at 1,300 million m^3.

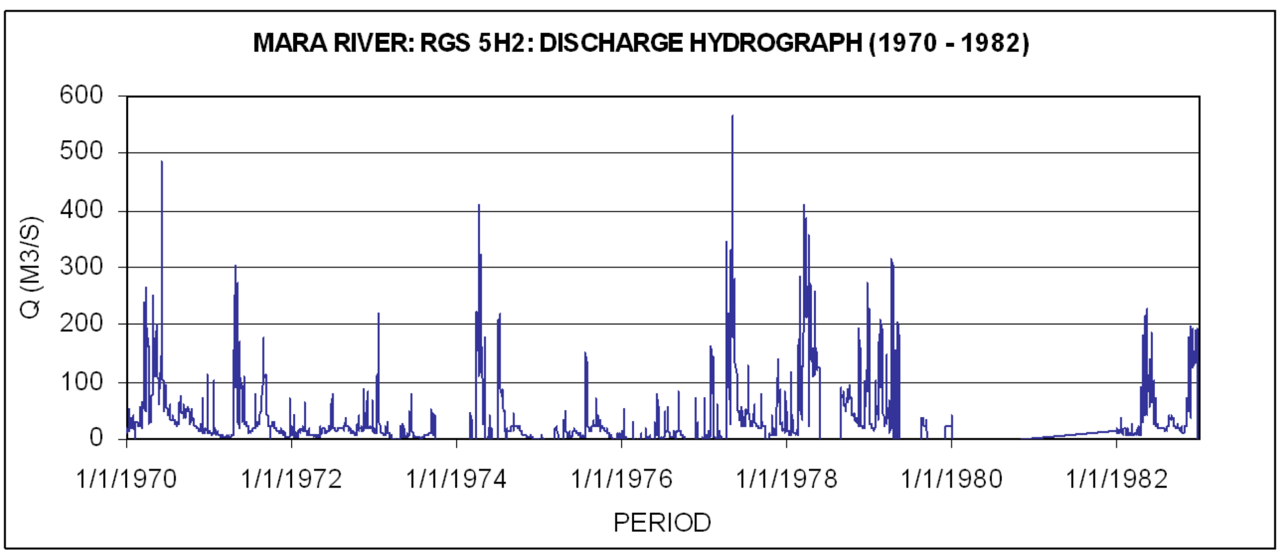


Figure 2.21: Flow Hydrograph for Mara River at Mara Mines at RGS 5H2, Tanzania

2.3.3 Flow Duration (or Frequency) Curves

A flow duration curve shows graphically the relationship between any given discharge and the percentage of time that this discharge is equalled or exceeded. A flow duration curve is helpful to provide answers to the following and related questions asked frequently.

- Does the river have uniform flow or does its flow fluctuate widely?
- What are the low-flow and high-flow river characteristics, i.e., is the river flashy?
- What percentage of the time does the river flow at certain discharge levels?
- If the river is to be used for power generation, provide water supply, provide deep water for transportation, receive and dilute sewage effluent, etc., what percentage of time can the river support such services?

Kenya

Flow duration curves for Nyangores and Amala Rivers in Kenya are depicted on Figures 2.22 and 2.23 respectively while the basic characteristics for the two rivers are shown in Table 2.7. These data are based on recorded (not naturalized) discharges; hence the main aim is to show the potential flow variation.

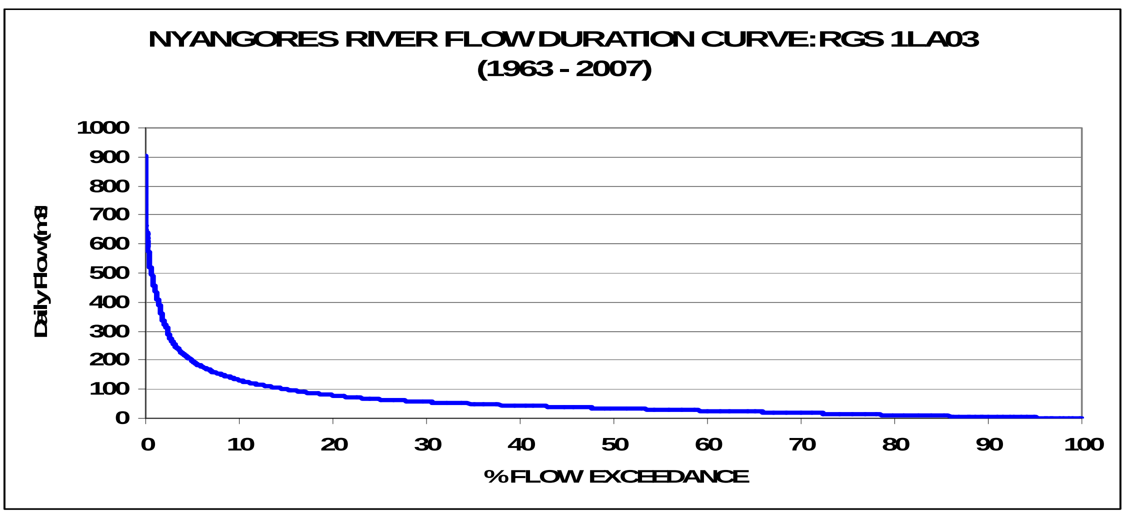


Figure 2.22: Flow Duration Curve for Nyangores River at RGS 1LA03

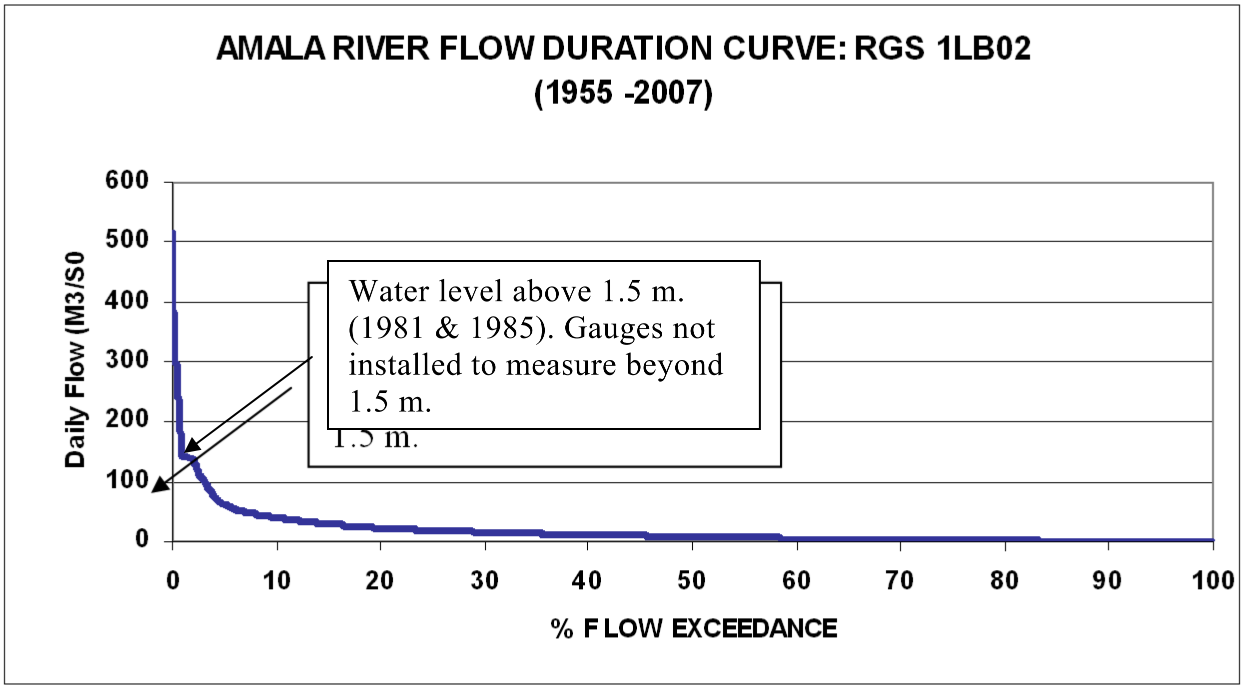


Figure 2.23: Flow duration curve for Amala River at RGS 1LB02

Table 2.7: Flow duration parameters for the Mara River system (m^3/s)

Percentile	**Nyangores (1LA03)**	**Amala (1LB02)**
95 percentile (Q_{95})	2.18	0.70
80 percentile (Q_{80})	10.45	2.16
50 percentile (Q_{50})	33.89	7.50
20 percentile (Q_{20})	77.47	22.94
5 percentile (Q_{5})	184.94	61.57
Mean daily flow	57.84	9.173

The Nyangores River was further investigated on the effect of flow variations over time by splitting the discharge record at RGS 1LA03 into two periods, namely 1963 – 1991 and 1992 -2007. It was observed that the latter period exhibited lower high flow peaks compared with the previous period. However, the base flow has remained almost constant. These observations are shown on Figure 2.24.

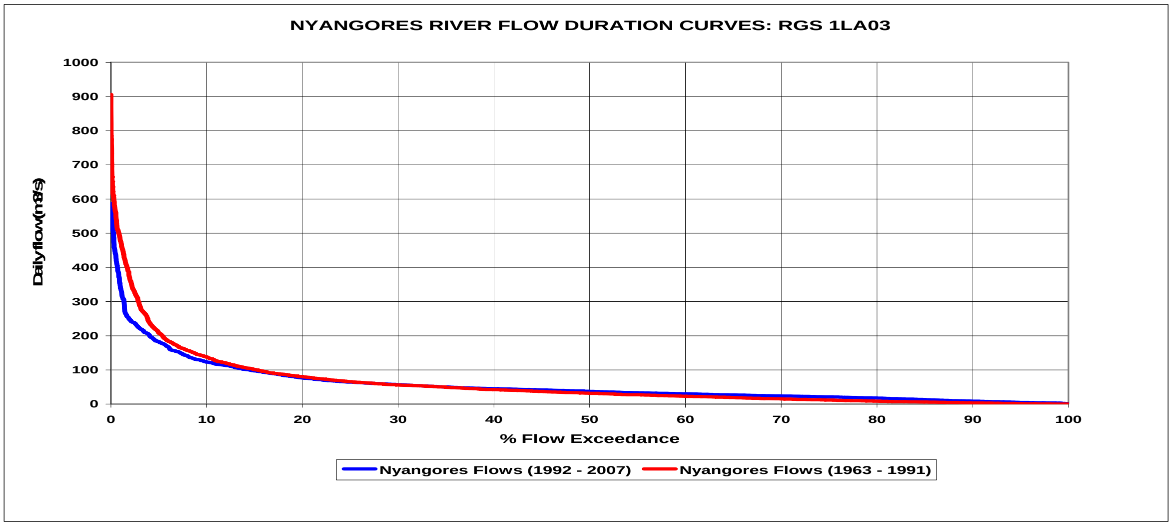


Figure 2.24: Nyangores River Split Flow Duration Curve: RGS 1LA03

Tanzania

Table 2.8 and Figure 2.25 show the flow duration curve for the gauging station 5H2 (Mara River at Mara Mines) in Tanzania. It can be observed that the derived flow duration curve is quite steep indicating that flow reduces from high flows to low flows fairly quickly, and the river flows at low discharge for most of the time. This is characteristic of the basin whereby groundwater contribution or baseflow is quite low. The results show that the Mara River does not have a promising low flow potential. A flow magnitude of 4 m^3/sec exceeded 90 % of the time is on the lower side to allow for any substantial water abstraction for any water development project. The purpose of water development projects is to modify the flow duration curves by lowering the high end and augmenting the low end to more reliably support the various water uses.

Table 2.8: Low flow indicators for Mara River

Percentile	**Mara River (5H2)**
95 percentile (Q_{95})	2.0
90 percentile (Q_{90})	4.1
80 percentile (Q_{80})	8.0
50 percentile (Q_{50})	20.2
20 percentile (Q_{20})	75.0
5 percentile (Q_{5})	175
Mean daily flow	40.0

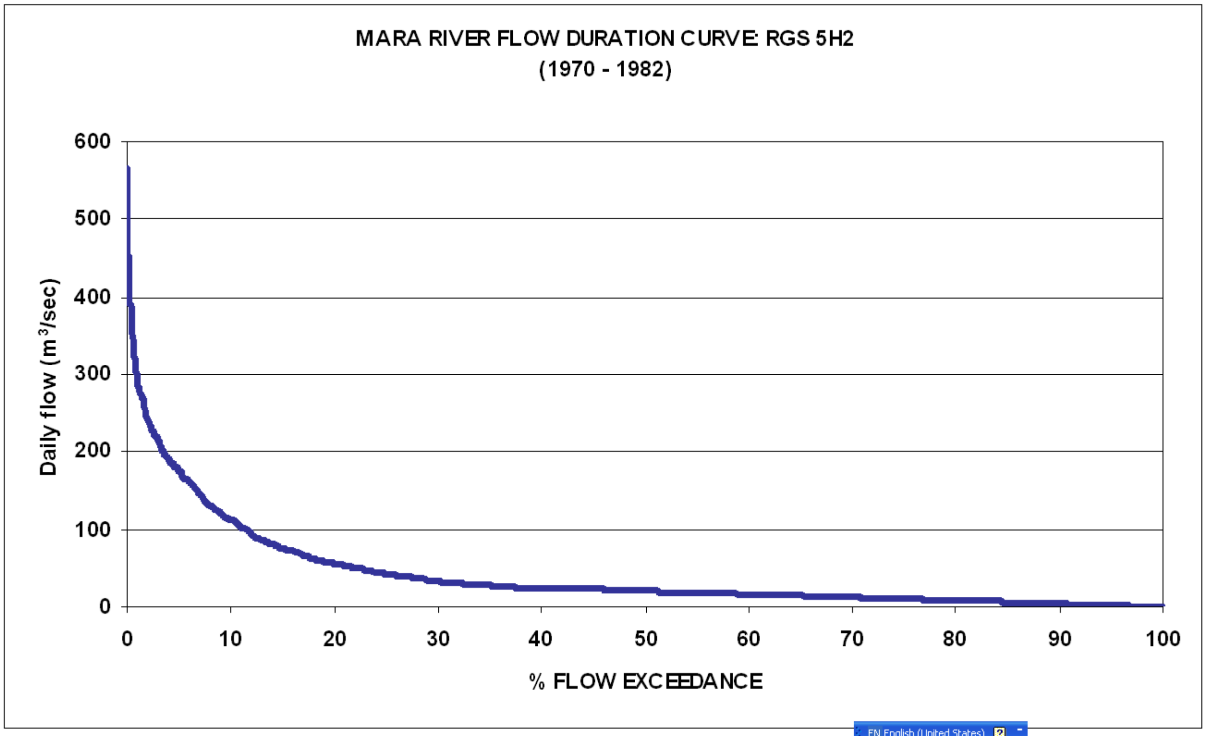


Figure 2.25: Flow Duration Curve, Mara River at Mara Mines, Tanzania

Comparison of flow duration curves

This comparison is made between the flow duration curves derived for two river gauging stations located on the upper part of the basin (1LA03 - Nyangores and 1LB02 - Amala) and a third located in the lower part of the basin (5H2 - Mara Mines). The curves presented in Figure 2.26 indicate that high flow magnitudes up to 25% flow exceedence are fairly comparable for Nyangores and Mara Mines. This shows that Nyangores river contributes much of the high flows reaching the lower part of Mara River. On the other hand, medium flow levels at Nyangores are higher than those observed at Mara Mines, in spite of the added Amala flow. This indicates considerable abstractions and channel flow losses between RGS 1LA02 and 5H2.

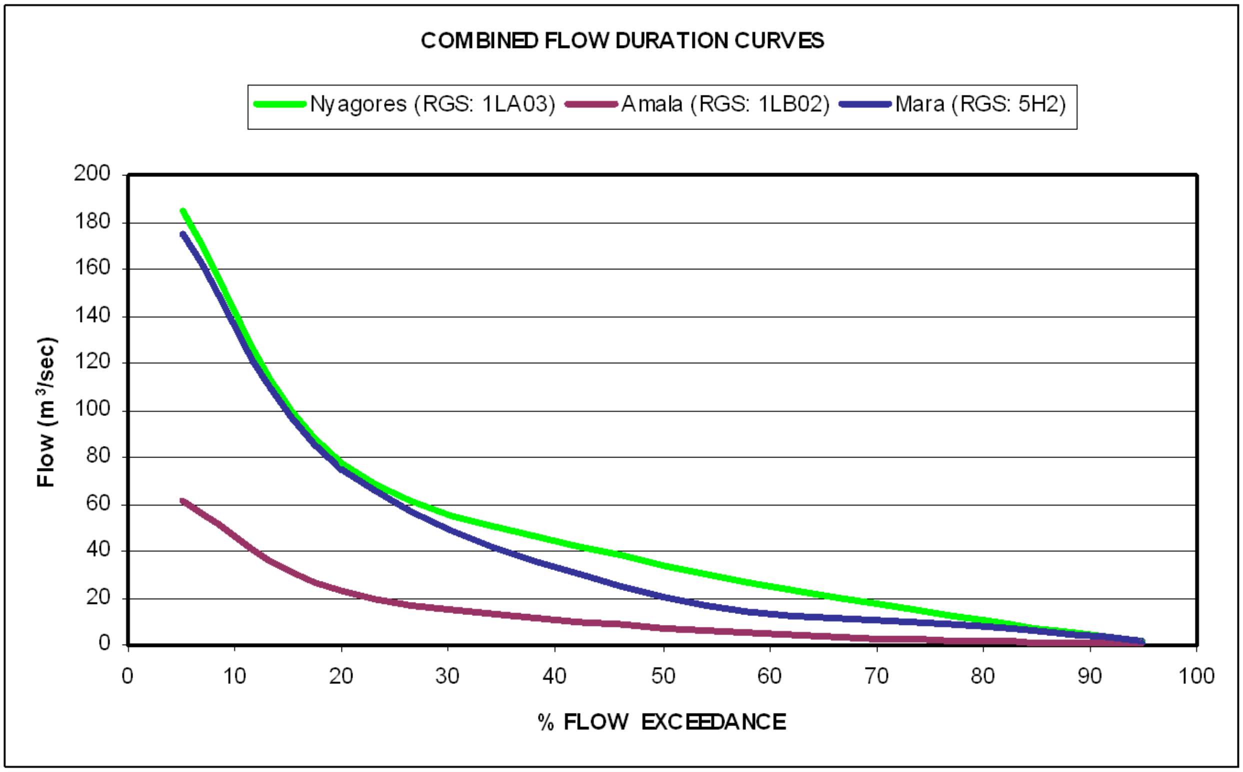


Figure 2.26: Combined flow duration curves for RGS Nyangores, Amala, and Mara Mines

2.4 Groundwater Resources

Groundwater constitutes a very important water supply source in the Mara Basin. Groundwater is abstracted through shallow wells and medium to deep boreholes. In Kenya, up to date records on boreholes and shallow wells are not available due to uncoordinated development. In the Mara River basin, the few records that are available indicate that there are 34 boreholes in Narok South district whose records are with the Water Resources Management Authority (WRMA). The WRMA is presently encouraging borehole and shallow well owners to register their boreholes and wells with the Authority, in accordance with the new Water Resources Management Rules. In the Tanzanian part of the Mara Basin, there are currently 193 shallow wells and 39 boreholes in Musoma Rural; 286 shallow wells and 96 boreholes in Serengeti; and 198 shallow wells and 23 boreholes in Tarime.

2.4.1 Geology

The geology of the Mara River basin is mainly composed of volcanic rocks of the Tertiary and Nyanzian age. The volcanic rocks cover about 26% of Kenya, particularly to the west of the Rift Valley where the formation exhibits a linear alignment with the Rift Valley. The general pattern is north-south, stretching from Tanzania into Sudan and Ethiopia.

The geology of Mara Basin in Tarime district is characterized by rocks of the Nyanzian system consisting of volcanic rocks and granites of Archean age. It is in these granites that greenstones are formed into greenstone belts rich in mineral deposits. On the other hand, the geology of the basin in areas of the Serengeti and Musoma districts is generally characterized by massive outcrops of granites especially at higher elevations. The soils are grey sandy soils which dry up quickly during the dry season. The geology can generally be described as Nyanzian granite gneiss to Kavirondian conglomerates, coarse arkosic, and feldpathic grits and quartzites. Mbuga clays are also known to cover most of the lower parts forming the well known Black cotton soils.

2.4.2 Groundwater Potential

Groundwater availability is determined by the basin geology and rainfall regimes. The Mara Basin has generally two types of aquifers: stratum and fissure. Stratum aquifers can be divided into two categories including shallow and medium aquifers. The types of aquifers considered exploitable are the medium depth stratum aquifers and the deep fissure aquifers, based on their yield, geological structure, and water quality.

The medium depth stratum aquifers consist of decomposed Precambrian rock units mainly composing the secondary deposits or weathered granite, distributed from 20 m to 50 m in depth from the surface. An estimated yield of between 5 to 15 liters per min (l/min) is most common (HESAWA, 1997, and Mara FIP, 2000). The water quality is generally good. Most shallow wells are sensitive to rain and their water quality exhibits a seasonal fluctuation.

The deep fissure aquifers consist of granite, Nyanzian rock units (Precambrian rocks) and are normally encountered at 20 m to 100 m depth. The exploitable area is near the existing lineaments. High yields of more than 70 l/min can be achieved if coarse-grained fissure zones are captured.

On the Kenyan side, a number of production boreholes have been drilled across the catchment with varying degrees of success (National Water Master Plan, 1992). The boreholes drilled in areas of volcanic rocks are deep, averaging about 125 m while boreholes in rocks of the Basement Complex and sedimentary rocks are shallower with mean depths of 80 m. Boreholes sited in areas of quaternary sediments such as in flood plains are shallow, unconfined, and easily impacted by droughts and pollution.

The water yield, depth to aquifer and static water level, vary with rock type. Water struck level and water rest level in areas with volcanic rocks are at 94 m and 49 m on average respectively, and at 55 m and 26 m in rocks of the Basement Complex. The difference between the water struck level and the water rest level is an indication of whether the aquifer is confined or unconfined.

Table 2.9 presents the aquifer characteristics in the Mara River Basin in Kenya, whose rock types cover the whole range of rocks from volcanic, sedimentary, basement, volcanic over basement, sedimentary over basement, sedimentary over volcanic, and volcanic over sedimentary.

Table 2.9: Aquifer Characteristics in the Mara River Basin, Kenya

Mara River Basin	Elevation (m)	Total depth (m)	Water struck level (m)	Water rest level (m)	Pumping test yield (l/min)	Drawdown (m)	Transmissivity m^2/min
Minimum	1500	52	9	4	3.0	4.0	4.88E-04
Maximum	2819	289	280	233	212	114.0	9.77E-03
Average	2289.8	153.2	126.9	70.5	95	38.9	5.13E-03
S.D	390	67	67.4	61.4	58.9	33.8	6.57E-03

Source: The National Water Master Plan, Kenya, 1992

The information gathered from the catalogue of boreholes drilled in the districts in Mara Basin indicate that in Musoma Rural district, the depths of drilled boreholes ranged from 7 m – 213 m and the water yields ranged from 5-166 litres per min. In Serengeti district, the depths of drilled boreholes ranged from 36 m – 244 m and the water yields ranged from 8-250 litres per min. For the case of Tarime district, the depths of drilled boreholes ranged from 8 m – 230 m and the water yields ranged from 5-183 litres per min. Groundwater yields from boreholes drilled from the Kenyan side range from 3-212 litres per minute while for Tanzania the values range from 5-250 litres per minute. The values for Kenya and Tanzania are very comparable.

Furthermore, the catalogue showed that the type of aquifers recorded in Musoma Rural district included quartize, granite, gneiss, pegmatite, dolerite, biotite, sand, sand /clay, and fractured granite. In Serengeti, recorded aquifers included gravel/sand, quartzite, granite, and fractured granite; while for Tarime district, the aquifers included sand, granite, pegmatite, and dolerite. The type of aquifers reported here are based on the information compiled from the drilled boreholes. However, no groundwater map indicating the exploitable aquifer systems has been developed for the basin.

2.4.3 Groundwater Monitoring

Kenya

Groundwater resources monitoring in Kenya has not been given the necessary support required to monitor a resource that is vital to the country considering that over 85% of Kenya is arid and semi-arid. However, the new Water Resources Management Authority, being mandated to lead the management of water resources, has initiated a program to classify groundwater resources in terms of strategic importance of the aquifers. The authority has identified four classes of aquifers, namely, strategic, major, minor, and poor aquifers. The authority will then identify boreholes within each of the classes and monitor both the resource quality and quantity. The aquifers are classified in the above categories as follows:

- Strategic aquifer: An aquifer used to supply significant amounts/proportions of water to an area where there are no other alternatives, or where alternative developments would be too expensive;
- Major aquifer: A high-yielding aquifer with good quality water;
- Minor aquifer: A moderately-yielding aquifer with variable water quality;
- Poor aquifer: A low-yielding aquifer with poor to reasonable water quality;
- Special aquifer: An aquifer or parts of an aquifer designated as a "special aquifer" by WRMA.

Initial analysis of boreholes in the Mara basin in Kenya places the aquifers in the poor aquifer category. The authority is also developing a groundwater aquifer map for the catchment areas.

Tanzania

In Tanzania, the Lake Victoria Basin Water Office, Hydrogeology Office in Musoma, is responsible for carrying out groundwater monitoring in the basin. However, currently no groundwater monitoring is carried out despite of the fact that there exist drilled boreholes at various locations in the three Mara districts. Important parameters that should be monitored include static water level changes and water quality.

2.5 Lakes in the Basin

The Mara River discharges into Lake Victoria through Tanzania. Lake Victoria is the largest lake in Africa and the second largest lake in the world with open water surface area of 68,800 km^2. It has a land catchment area of 194,000 km^2 extending into Rwanda and Burundi. The lake itself is shared between Kenya 6%, Uganda 43%, and Tanzania 51%.

Lake Victoria constitutes a resource in which fish thrive providing protein for local consumption and a major export product. The lake is also a resource of aquatic biodiversity, transportation, recreation, and climate regulation. It is also the receptor of sediment carried by several rivers that discharge into it and pollution (from point and nonpoint sources). Lastly, the lake is a source of water borne diseases. All these lake aspects are discussed more extensively in other Monograph sections.

The Lake Victoria Basin with its high rainfall potential is particularly important for the development of agriculture and industry.

The annual rainfall over the lake is almost balanced by evaporation from the lake surface, implying that the contributions of the various lake tributaries are significant. The lake plays an important role in the hydrology of the basin, in particular the hydrology of the Mara Basin, as it moderates the rainfall patterns a significant distance inland.

2.6 Wetlands

The Enapuiyapui Swamp

The Enapuiyapui Swamp is a 6-hectare wetland situated in the Kiptunga Forest and constitutes one of the sources of Amala River. The swamp itself is a micro-catchment, collecting water during heavy rains and releasing it to the Amala River through the Nyabuiyabui stream. The swamp, one of the swamps found in the Mau Forest, is rich in biological resources that are of value to the local communities and immigrant stakeholders. The indigenous communities within the swamp catchment area comprise the Masai and the Ogiek communities.

The swamp is currently under great threat due to land use changes and population pressure, particularly from the immigrant communities. The size of the swamp, the quantity of water in the swamp, and the vegetation cover has been declining over the years. The communities living within the swamp catchment attribute the observed degradation of the swamp to forest loggers and immigrant farmers.

The Masura (Mara) Wetlands

At the lower reaches, the Mara River drains into the Masura (or Mara) wetlands before discharging its waters into the Lake Victoria. The wetlands are fed by inflows of Mara River and Lake Victoria water. Accordingly, the wetlands expand to a maximum area during the Masika (long) rains due to high inflows while extending to about 45 km off the lake shores and shrink to the minimum area during the dry season. According to local inhabitants, the wetlands have expanded significantly in the early 1970s (around 1973-1974) by about 387% (Mati *et al*, 2007).

2.7 Water Quality

The increasing socio-economic activities and settlements in the Mara River basin generate wastes which have adversely impacted the quality of the surface and ground water resources. Pollution falls in two categories. Point source pollution is related to contaminants discharged from discrete locations. Nonpoint source pollution refers to all other discharges that deliver contaminants to water bodies. Both pollution sources affect the Mara River basin.

The major point pollution sources include (1) sewage discharges to groundwater from domestic pit latrines, park hotels, and resorts and (2) untreated or partially treated industrial effluents and mercury from gold mining activities.

The major nonpoint pollution source in the Mara River basin is runoff from agricultural (livestock keeping and crop production) activities, human settlement, parks and game reserves, and mining areas. The largest concentrations of organic pollutants come from agricultural activities predominant in the upper catchments, and wild animals and plant decays within the Serengeti National Park (SENAPA) and Maasai Mara Game Reserve located in the middle catchments. Hazardous chemical pollutants such as mercury and cyanide are extensively used in gold mining activities in lower part of the Mara basin.

Kenya

Prior to the operationalisation of the Lake Victoria Environmental Management Project (LVEMP), water quality monitoring in the country had been undertaken by the ministry in charge of water affairs, the current Ministry of Water and Irrigation. After the operationalisation of the LVEMP, the project monitored the water quality in the Lake Victoria basin under LVEMP I. Within the Mara River Basin, the LVEMP had been monitoring the water quality of the Mara River and its main perennial rivers, the Nyangores and the Amala. Unfortunately, the monitoring has not been systematic. However, based on the available data, the water quality characteristics of the Mara River system is shown in Table 2.10. The water quality monitoring stations coincide with the water quantity monitoring stations. The LVEMP office in Kisumu has established a water quality database for the Lake Victoria and rivers discharging into the Lake. The data indicate that the water quality of the Mara river system is currently safe for livestock watering and irrigation. However, convectional treatment is required to make the water safe for human use. This observation is based on the water quality standards for sources of domestic water supplies as provided by the Kenya Legal Notice No. 120 on the Environmental Management and Co-ordination (Water Quality) Regulations, 2006. Comparison of the quality standards and the measured values indicate that the pH and the nitrogen components (Nitrites and Nitrates) are much lower than the recommended values (shown in brackets in the table). The Ammonia component on the other hand, indicates values which are slightly above the recommended levels particularly during the rainy season. Assessment of nitrogen and phosphate pollution would be more effective during the crop growing seasons which also coincide with higher river flows.

It is, however, regrettable that major conclusions cannot be made from these results due to lack of systematic monitoring and the incomplete analysis of water quality parameters.

Table 2.10: Water Quality Characteristics of the Mara River System, Kenya

Date sampled	**River Name/RGS**	**EC**	**pH** [6.5-8.5]	**Temp**	**TN (mg/l)**	**NO2 (mg/l)** [3 mg/l]	**NO3 (mg/l)** [10 mg/l]	**NH3 (mg/l)** [0.5 mg/l]	**TDN (mg/l)**	**TP (mg/l)**	**PO4 (mg/l)**	**TDP (mg/l)**	**TPP (mg/l)**
10/4/01	Mara	67.6		21.1		0.037	1.863			0.89			
11/4/01	1LA03	37		17		0.014	2.126			0.384			
31/8/01	1LA03				0.81	0.014	0.673	0.14	0.67	0.057		0.009	0.048
30/8/01	Mara				1.12	0.018	0.572	0.123	0.82	0.59		0.027	0.032
31/8/01	1LB02				0.7	0.015	0.44	0.501	0.67	0.08		0.021	0.059
23/3/02	1LA03		6.5			0.0106		0.924		0.106	0.064	0.078	
23/3/02	1LB02		6.5			0.105		0.603		0.099	0.087	0.069	
30/9/02	1LA03									0.043			
22/7/03	1LA03									0.285	0.03	0.30	
22/7/03	1LB02									0.208	0.036	0.052	
28/11/03	1LA03					0.02	0.836			0.034	0.023		
28/11/03	1LB02					0.045	0.461			0.037	0.044		
29/11/03	1LA05					0.028	0.497			0.071	0.038		
5/6/04	1LA03				0.696	0.001	1.11		0.501	0.053	0.003	0.043	
5/6/04	1LB02					0.002	1.239		0.662	0.201	0.003	0.041	
5/6/04	1LA05					0.004	1.455		0.932	0.044	0.065	0.041	

7/9/04	1LA03				0.44				0.15				
7/9/04	1LB02				0.58				0.88				
8/9/04	1LA05				0.9				0.62				

Source: LVEMP Database 2005 (Kisumu)

With regard to sediment, high loads are being observed in the Mara River. This is due to increased erosion as a consequence of forest clearing, intensification of agricultural activities in the upper catchments, cultivation along the river banks, and overgrazing. The upper and middle parts of the basin have been cleared to give way to agriculture and settlements. Saw-millers and subsistence farmers have removed most of the forest cover making the land prone to soil erosion and high evaporation. This environmental degradation is unfortunate because these forest areas are the main water catchments for the Mara River, sources of forest products, and dry season grazing areas for the pastoral Masai. There is urgent need to protect what is left and possibly restore what has been lost.

In the lower part of the basin, the grasslands have been subjected to overstocking, which has promoted degradation of the soils and wind erosion. The monitoring of sediment in the Mara River system has not been systematic and the above observations are mainly based on physical appearance of the flowing rivers. There was, however, a consistent one year monitoring of Mara River at RGS 1LA04 from March 1984 to March 1985. Unfortunately this was a period of very low river flows. This monitoring was discontinued until the year 2000 when sporadic sampling was resumed. It is necessary to sample the river system during the high flows in order to establish the impact of sediment load on river line infrastructure development. However, it is still possible to state that the sediment load of the Mara River has been increasing by comparing two specific values, namely the sediment load for the samples of 24th May, 1980 (discharge 59 m^3/s; sediment load 1123 tons/day) and 11th April, 2001 (discharge 86 m^3/s; sediment load 4281 tons/day). The two periods represent the rainy season, thus the sediment load being transported by the rivers would be an indication of the soil originating from the catchment. The sediment load for these two discrete measurements is depicted on Figure 2.27, and despite the discharge difference, provides evidence that sediment load in the Mara River is increasing.

Table 2.11 summarizes the existing sediment load measurements in the Mara River system. It is noted that except for the short period of systematic sediment monitoring undertaken during the 1980s, the latter monitoring period has been rather an adhoc undertaking which does not provide sufficient data for effective management considering the sensitive issues being associated with the Mau Forest and Escarpment.

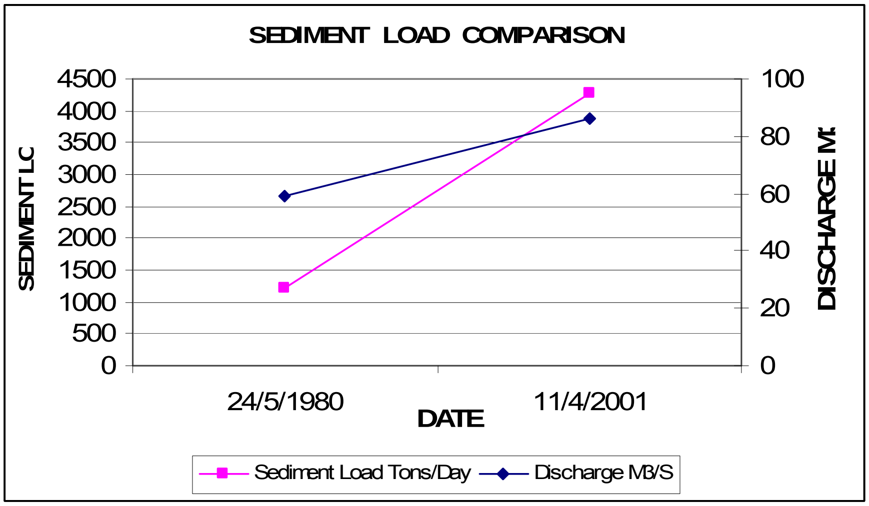


Figure 2.27: Sediment load magnitude in Mara River

Table 2.11: Sediment Load in the Mara River System, Kenya

RGS	River Name	Sampling Date	Gauge Height (m)	Discharge (m^3/s)	Sediment Load (Tonnes/Day)
1LA03	Nyangores	27/6/1980	0.48	6	39.4
1LA03	Nyangores	25/7/1980	0.52	10	45.8
1LA03	Nyangores	27/10/1980	0.2	2	2.9
1LA03	Nyangores	20/12/2000	0.47	7	29.1
1LA03	Nyangores	12/4/2001	1.16	21	190.4
1LA03	Nyangores	31/8/2001	0.61	10	36.8
1LA03	Nyangores	23/3/2002	0.4	4	32
1LA03	Nyangores	30/9/2002	0.39	4	3.8
1LA03	Nyangores	28/11/2003	0.3	2	2
1LA03	Nyangores	5/6/2004	0.41	5	5.1
1LB02	Amala	19/12/2000	0.36	3	11.7
1LB02	Amala	30/9/2002	0.24	2	1.5
1LB02	Amala	22/7/2003	0.66	10	44.2
1LB02	Amala	28/11/2003	0.26	2	2.2
1LA04	Mara	24/5/1980	2.8	59	1223.4
1LA04	Mara	15/7/1980	2.45	24	265.4
1LA04	Mara	29/10/1980	2.23	32	80.2
1LA04	Mara	27/11/1980	2.7	58	706.6

1LA04	Mara	30/3/1984	0.8	2	26.1
1LA04	Mara	25/4/1984	1.4	2	60.1
1LA04	Mara	25/5/1984	1.31	1	8.5
1LA04	Mara	22/6/1984	1.42	2	20.6
1LA04	Mara	21/7/1984	1.57	4	55.6
1LA04	Mara	20/8/1984	1.89	16	360.8
1LA04	Mara	25/9/1984	1.64	8	67.7
1LA04	Mara	25/10/1984	1.6	7	32
1LA04	Mara	22/11/1984	1.84	10	114.9
1LA04	Mara	29/11/1984	1.69	10	849.3
1LA04	Mara	24/1/1985	1.54	3	127.5
1LA04	Mara	21/2/1985	1.36	1	25.6
1LA04	Mara	27/3/1985	1.47	2	193.9
1LA04	Mara	19/12/2000		17	822
1LA04	Mara	11/4/2001		86	4281.3
1LA04	Mara	22/7/2003		31	160.9
1LA05	Mara	30/8/2001		13	140.7
1LA05	Mara	29/11/2003		4	4.7
1LA05	Mara	5/6/2004		9	31.5

Source: National Water Master Plan 1992 (Kenya) & LVEMP Database 2005 (Kisumu)

Tanzania

On the Tanzania side of Mara Basin, possible point source pollution comes from wastewater generated from towns such as Mugumu and Nyamongo. In the basin there is a major mining industry at Nyamongo (Mara North), the Barrick Gold Mine, the effluent from which is a likely source of pollution. Future point sources of pollution are expected to come from tourism hotels and industries. As in Kenya, nonpoint sources mainly come from agricultural activities.

The pollutants from point or nonpoint sources are either directly discharged into water bodies or brought to the rivers by direct runoff and wind erosion (sediment). Then, they are transported by the river to the lower reaches and ultimately into Lake Victoria. It is reported that nutrient loadings from the Mara River have contributed to eutrophication of Lake Victoria. The total annual Nitrogen and Phosphorus loadings from the Mara River into Lake Victoria have been reported to be about 1,701 tons/year (or 3.4% of total annual loading of 49,509 tons/year) and 304 tons/year (or 5.3% of total annual loading of 5,693 tons/year) respectively (Kayombo and Jorgensen, 2007)).

Furthermore, localised higher levels of mercury contamination are reported in the lower reaches of the Mara River compared to middle and upper reaches. Increasing small-scale and large-scale gold mining in the Mara basin are most likely the contributors to the increasing mercury contamination levels in the wetlands of the lower Mara than elsewhere in the basin. While petty gold diggers are scattered in various parts of the Tarime district, large-scale mining activities concentrate in areas of Buhemba and Nyamongo. The mercury finds its way to the Mara River through the uncontrolled use of mercury by small gold diggers and leakages from the gold mine tailing dam, which is located close to the Mara River.

The Water Quality Laboratory based in Musoma Sub-office of LVBWO is responsible for carrying out water quality monitoring in the Mara River Basin. This office is not carrying out monitoring on a regular basis but rather on an adhoc basis due to financial limitations. A total of twelve (12) sampling locations have been identified as priority points for water quality monitoring (Table 2.12). Water samples are being taken at these points for water quality analysis. Different water quality parameters have been analyzed to ascertain the water quality of the Mara River Basin. Figure 2.28 shows the identified sampling locations. The water quality parameters that have been considered for laboratory analysis include Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Total Phosphorus (TP), Total Nitrogen (TN), Total Suspended Solids (TSS) and Total Coliform (TC).

Table 2.12: Identified Sampling Locations in Mara River Basin

S/No	Location	S/No	Location
1	Tanzania/Kenya Boarder	7	Mara/Somonche
2	Borogonja Bridge	8	Mara/Somonche
3	Mara River/Borogonja	9	Mara Mines
4	Kogatende Rangers Post	10	Barick Gold Mine
5	Tabora B	11	Tigithe River
6	Somonche	12	Kirumi Bridge

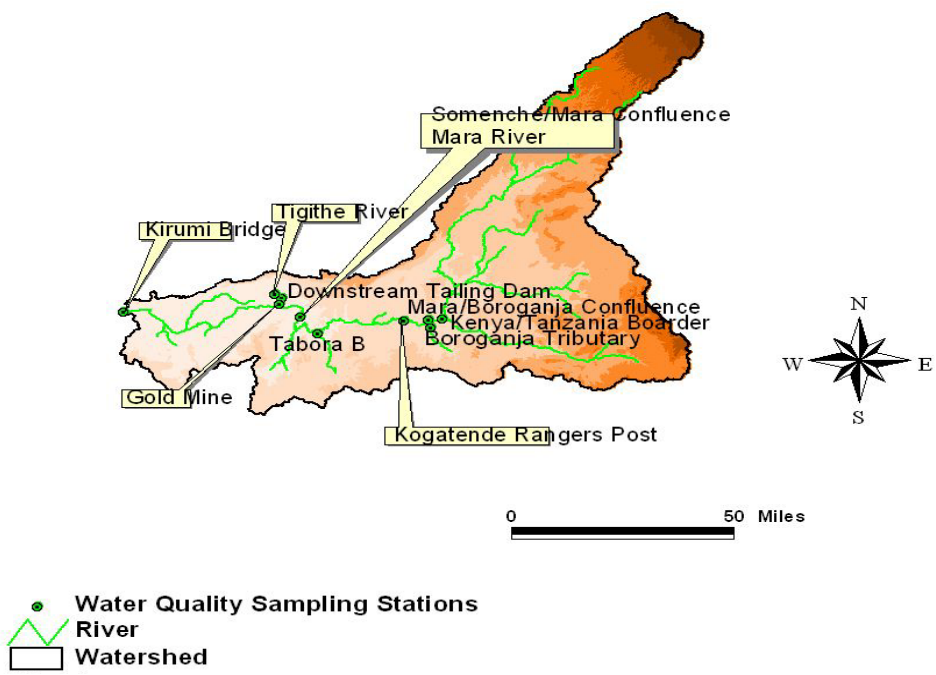


Figure 2.28: Sampling Locations for Water Quality Monitoring in Mara River Basin

Regarding water quality in the Mara River itself, the results of spot sampling suggest that the water quality of the River in Tanzania is not substantially affected. However, appropriate measures have to be taken now to make sure that the quality is not significantly impaired in the future.

As part of the Integrated Water Resources Management Project for the Mara River Basin, a study to develop an effective water quality-monitoring program is being carried out. The water quality-monitoring program is expected to recommend improved monitoring facilities and resources in the basin. However, funding for the implementation of the program has yet to be raised.

2.8 Issues on Climatic and Hydrological Monitoring

The descriptions presented in the above sections have pinpointed a number of issues related to the climatic and hydrological monitoring in Mara River Basin. The section below discusses further the important issues of concern to Mara River Basin.

Issues Relating to Data Availability

Good management and planning of water resources requires a good understanding of the availability and the requirements of the water resources in the catchment. A comprehensive and continually updated information base is a precondition for sustainable water resources management. Adequate and reliable rainfall and surface and groundwater (quantity and quality) data need to be available at all scales including local, river basin, national, and international.

However, the database and information flow in the water sector in both Kenya and Tanzania are characterized by data gaps due to discontinuous water resources assessment programs, weak monitoring systems, and an inadequate user database. Such a situation leads to unreliable reports, mistaken conclusions, partial and inconclusive assessments, and poor resource utilization.

The availability of water resources data and information for management and development in the Mara River basin is highly limited and inadequate. The data does not reflect the significant changes in flows, climatic changes, and sediment and pollution loads occurring as a result of catchment degradation, pollution, and other impacts.

There is no other way to address this situation other than to set up mechanisms for continuous monitoring and assessment of water resources, including strengthening of the institutional capacity of the agencies responsible for data collection, storage, and analysis. There is an urgent need to re-establish the hydro-meteorological network in the basin with provision of necessary logistical support for its operation and maintenance.

Issues Relating to Climate Monitoring

The existing network of climatic monitoring stations in the Mara basin is grossly inadequate. It is far inferior to the coverage that existed in the late 1980s when many more stations were operational. In addition, the existing stations contain many data gaps. Rainfall stations have deteriorated due to inadequate budgets and unavailability of inspection vehicles at the Kenya Meteorological Department and the provincial meteorologists. Recent data has either not been collected from many stations or data is not reflected in an up-to-date form within the central databases of the managing institutions.

Evaporation and other climate parameters are the most poorly estimated parameters in the Mara River basin as only one station (Keekorok) was available inside the basin to provide any evaporation data and is no longer operational. The other two stations, Narok and Musoma Meteorological stations, are outside the basin. There is no functional synoptic station in the Mara basin. Even those that exist are often missing essential parts. As such, the monitoring network provides only sparse information on climatic conditions and cannot support reliable rainfall-runoff modeling and assessment investigations that require continuous multi-year observational records. To aggravate the situation, there is no coordination in data collection and data exchange between the institutions collecting climatological data.

Issues Relating to Streamflow Monitoring

River flow monitoring in Mara River Basin has deteriorated considerably. Consequently, data and information regarding the state of the river flow has been insufficient and unreliable. The following is a summary of the identified deficiencies:

- Lack of harmonized monitoring procedures between Kenya and Tanzania;
- Lack of data and information exchange protocols between the two countries and the institutions within each country;
- Hydrometric stations on the Tanzania side of Mara River Basin are in-adequate to provide the required information on streamflow and sediment monitoring;
- The rating curves for the river gauging stations has not been updated for a very long period; The rating curves are no longer valid; Datum sets are not compatible between the two countries;
- Water measuring equipments are lacking;
- Capacity in terms of personnel and office facilities to support climatic, surface, groundwater and water quality monitoring is lacking;
- Databases and analysis tools are lacking at the basin level;
- Financial resources and transport facilities required to support the operation and maintenance of monitoring networks are lacking.

It is imperative that a significant investment be made to reverse the situation.

Groundwater Monitoring Issues

Much like surface water, groundwater monitoring has not been given the necessary attention required to monitor a resource that is so vital to the Mara basin ecology and people. Most of the Mara basin is in a semi-arid region, and reliable assessment and management of the available groundwater resources is particularly critical.

A comprehensive groundwater monitoring program in Mara River Basin is missing. There is need to develop a GIS based data base for Kenya and Tanzania with compatible geo-referencing systems, considering that Mara River Basin is a shared basin. This data base can be used to characterize the groundwater system and provide information on water levels and yields for well and borehole development. Lastly, there is a need to systematically build the capacity of the agency personnel (at the national and basin level) to enable them to perform their duties with competence and consistency.

Issues Relating to Water Quality Monitoring

In summary, Mara water quality issues are complex and widespread:

- Catchment degradation from forest clearing and cultivation of hill tops on the upper reaches of the Mara Basin, and overgrazing in the Mara lowlands has been reported for some time.
- These same factors cause soil erosion, higher sediment loads, and water pollution.
- The growing gold mining activities in Tanzania are generating unregulated effluents that pollute surface and groundwater resources.
- Improper use of agro-chemicals and lack of or poor solid and liquid disposal facilities cause nutrient loads in the Mara River and Lake Victoria to increase.

However, to plan and develop appropriate mitigation measures to improve the water quality of Mara River Basin, a regular water quality monitoring program in the Mara River basin is urgently needed. Both financial and human resources as well as equipment and facilities are required to set-up and operate a sustainable water quality monitoring program.

Table 2.13 provides a summary of issues, impacts, on-going intervention measures and potential investment projects.

Table 2.13a: Issues Table for the Mara River Basin in Kenya

Issues	Causes	Impacts	On-going and Planned Intervention Measures	Potential Investment Projects
1. Inadequate climatic and water resources data (data gaps)	i) Lack of and/or inadequate technical and financial resources to install appropriate monitoring equipment and ensure sustainable operation and maintenance of the monitoring network. ii) Unreliable data collection, processing, quality control and storage procedures and standards iii) Lack of data and information sharing protocols. iv) Discontinuous climatic and water resources monitoring programs v) Rating curves that are rarely updated vi) Limited water resources assessment capabilities	i) Inappropriate water resources planning ii) Most decisions regarding management of water resources are based on estimates of the quantity and quality of water to be managed. Water resources data form the basis for planning, design and operation of water systems- refer to the rating curves developed for the Mara River system and the rainfall graphs for the catchment which show major data gaps.	The LVEMP I and the FAO Nile Basin Project supported the re-establishment of a few water resources monitoring stations in the Lake Victoria Basin and limited training in data processing. However, these processes lacked effective coordination. The Mara River basin was not well covered.	i) Establishment of a comprehensive water resources monitoring network able to provide a reliable water resources assessment and support rainfall-runoff modeling activities. ii) Establishment of a comprehensive water resources database for the Mara River Basin.

2. The meteorological and hydrological monitoring network is broken down	i) Lack of competent personnel to operate and maintain the monitoring network. ii) Lack of water resources measuring equipment. iii) Lack of basic databases. iv) Lack of financial resources to: • train the operators • Rehabilitate and expand the network • Upgrade the network	i) Available data and information cannot support reliable water resources assessment investigations and rainfall-runoff modeling processes. ii) Between 1963 and 1983 the national hydrological, meteorological and water quality networks in Kenya remained relatively stable. Since 1984 the number of operational stations dropped drastically leaving only about 110 stations by 1996. The state of the rain-gauging, meteorological and water quality monitoring stations also continued to deteriorate. The El-Nino associated floods of 1997/98 compounded the problem by washing away many of the river gauging equipment.	The WRMA office in Kisumu has identified a few monitoring stations in the basin (RGS 1LA03, 1LA05 and 1LB02 under the LVS CMS) but these are not adequate. In addition and due to constraints on resources, the authority will identify a few rainfall stations which it can operate with a limited budget.	Establishment of a comprehensive water resources monitoring network including a comprehensive water resources database with GIS applications.

3. Groundwater monitoring network does not exist	i) Lack of knowledge (appreciation) on the importance of groundwater. ii) Lack of trained personnel to monitor groundwater resources. iii) Lack of financial resources.	iii) Degradation of wetlands. iv) Reduction of base flows in rivers. v) Deterioration of springs. vii) Deterioration of water quality. viii) Over-abstraction in some cases	WRMA has identified one borehole in Bomet town to utilize as a monitoring borehole. However the authority is constrained by lack of resources to establish a comprehensive network of dedicated monitoring boreholes.	Part of the comprehensive monitoring network will include the drilling of dedicated groundwater monitoring boreholes in the basin.
4. Water pollution	i) Improper use of agro-chemicals. ii) Watering of livestock in rivers. iii) Bathing in rivers, washing of clothes, utensils, vehicles and chemical containers in rivers. iv) Discharge of untreated effluents into the river systems. v) Sediment load from degraded catchment areas.	i) Poor water quality for human consumption and ecological functions. ii) Increase in water borne diseases. iii) Loss of aesthetic value. iv) Ecological damage in rivers and wetlands. Reference to Table 2.11 indicates that while the sediment loads in the Mara river were less than 2000 tons per day in the 1980s, the sediment loads had increased to over 4000 tons per day by year 2001	i) Under the new Performance Contracts of Civil Servants, the WRMA regional office is required to identify and classify water polluters which will lead into the enforcement of effluent control plans to ensure that effluents discharged into the river systems meet the national standards. ii) WRMA is required to classify the water resources in accordance to the Resource Quality Objectives which relate to the extent to which a water body is allowed to be adversely impacted by water use with respect to its natural state. iii) The WRMA is required to assist the V Resources Users Associations in the prep sub-catchment management strategies wh handle issues relating to the reduction of erosion and the production of sediment.	As part of the proposed comprehensive water resources monitoring network, water quality monitoring stations would also be established and water quality sampling and analysis undertaken on a continuous basis to provide the necessary data and information on the trend

Table 2.13b: Issues Table for the Mara River Basin in Tanzania

Issues	Causes	Impacts	On-going & Planned Intervention Measures	Potential Investment Projects
1. Water pollution	i) Inadequate sanitation facilities. ii) Improper discharge of effluents from gold mining and toilets into rivers. iii) Improper use of agro-chemicals. iv) Watering of livestock directly in rivers. v) Bathing and washing of clothes in rivers. vi) Lack/Poor solid and liquid disposal facilities.	i) Nutrients loadings, i.e., Nitrogen and phosphorus from Mara River Basin have contributed to eutrophication of Lake Victoria. The total annual Nitrogen and phosphorus loadings from Mara River into Lake Victoria have been reported to be about 1,701 t/y and 304 t/y respectively (Kayombo and Jorgensen, 2007). ii) Localized higher levels of mercury contamination are reported in the lower reaches of River Mara compared to middle and upper reaches. Increasing small-scale and large-scale gold mining in Mara region are most likely the contributors to higher levels of mercury in the lower reaches and in the Mara wetlands than elsewhere in the basin.	i) Improving management of liquid and solid waste disposal. ii) Establishing a water quality monitoring program in Mara River Basin.	i) Sensitize the community on good practices of using the water of Mara River without causing pollution in the river. ii) Sensitize the community on good agricultural practices to prevent water pollution in the river.

		iii) Fishery resources threatened.		
2. Flooding	Catchment degradation due to clearing of forests and cultivation of hill tops	i) Communities living in the floodplain in lower Mara River Basin have been reported that their settlements and farms have been affected by floods. ii) The grazing ground in lower Mara Basin has been reported to be flooded occasionally.	Communities have moved their settlements to higher grounds.	Carry out a study to map flood prone areas.
3. Expansion of wetlands	i) Siltation in the river channel. ii) Overgrowth of vegetation. iii) Decrease in river depth.	Increase in land being flooded for a longer duration	Conservation measures in upper Mara catchment Implementation is by district councils and Private institutions	Consolidate conservation measures in upper Mara catchment
4. Soil erosion	i) Deforestation and vegetation removal. ii) Cultivation on steep slopes. iii) Overgrazing. iv) Bank erosion due to cattle watering in the river.	High sediment loads have been observed in the Mara river system due to forest clearing and intensification of agricultural activities in the upper catchments	Conservation measures over the whole catchment Implementation is by district councils and Private institutions	Consolidate conservation measures over the whole catchment
5. Lack of adequate and reliable water resources data and information	i) Lack of and/or inadequate technical and financial resources to install appropriate monitoring equipment and ensure sustainable operation of the monitoring networks. ii) Unreliable data collection, processing, quality control and storage procedures and standards. iii) Lack of data sharing and information exchange protocols.	i) Poor planning and decision making processes in water related projects. ii) Poor designs for water related and drainage infrastructure.	i) Rehabilitation and expansion of hydro-meteorological network in Mara catchment. ii) Establish a formal Water Quality Monitoring Program for Mara catchment.	i) Establish a groundwater monitoring program. ii) Establish a database in water resources.

3.0 Water Supply and Sanitation

3.1 Water Supply Overview, Kenya Sub-basin

The water sector is one of the priority sectors in Kenya as it is recognized that water is the most important natural resource, indispensable for life, growth, and prosperity.

With the promulgation of the Water Act 2002, the Kenya Government provided an enabling legal and institutional framework for the implementation of a fundamental water sector reform. The Water Act is complemented by the National Water Services Strategy, the National Water Resources Management Strategy, the Economic Strategy for Wealth and Employment Creation, and the Poverty Reduction Strategy Paper.

As an outcome of the water sector reform process, the new Ministry of Water and Irrigation set up separates the functions of water resources management and development from water services delivery. In the new set-up, the ministry handles policy and strategy formulation, mobilization of funds, coordination, and monitoring. The Water Services Regulatory Board (WASREB) regulates the provision of water services. The Water Services Boards (WSBs) are in charge of assets and contracting Water Service Providers (WSPs) for water and sanitation services to the public, private, community, and civil society sectors. Lastly, the Water Resources Management Authority (WRMA) is in charge of water resources management.

A Sector Wide Approach to Planning (SWAP) was adopted in Kenya in 2006. The SWAP introduces a gradual move towards more coherent support for the water sector, including budget support where appropriate.

The National Water Services Strategy (NWSS 2007-2015) gives a greater pro-poor focus on water supply and sanitation services. To meet the challenge in the provision of services to the poor, a Pro-Poor Implementation Plan for Water Supply and Sanitation (PPIP-WSS) has been developed. The plan emphasizes the importance of implementing socially responsible and sustainable water supply and sanitation programs in order to meet the Millennium Development Goals (MDGs).

3.2 Water Supply Overview, Tanzania Sub-basin

Water is a fundamental commodity for life and environmental sustainability and plays a crucial role in Tanzania's social and economic development. It cuts across a variety of social and economic activities including domestic and industrial water supply, agriculture, livestock, fisheries, wildlife, forestry, energy, navigation, recreation, and ecosystems. Water plays a pivotal role in poverty alleviation through enhancing food security, domestic hygiene, energy generation, industrial development, mining, navigation, and environmental and ecological sustainability. Availability of adequate clean water reduces the time spent in fetching water from long distances, increases health standards, and facilitates children's school attendance. Contaminated water poses health risks as evidenced by the prevalence of water-borne diseases such as diarrhea and cholera. For these reasons, the Water Sector has been included among the priority sectors in the National Strategy for Growth and Reduction of Poverty (NSGRP/MKUKUTA) in Tanzania. At present, however, water in the country is poorly distributed in time, space, quantity, and quality, and it remains a finite and vulnerable resource.

In many regions of Tanzania, water demands exceed available supplies, causing water stress and scarcity. At the same time, water use is on the rise due to hydropower and agricultural expansion leading to increasing competition for water. Lack of proactive and coordinated water resources planning, inadequate data, and inefficient water utilization have resulted into conflicts between the energy and irrigation sectors, irrigation and ecosystems, hydropower and ecosystems, and upstream and downstream users. Furthermore, industrial and municipal effluents are degrading water quality.

The impact of low water supply coverage falls primarily on the poor. In urban centers, with inadequate water services, poor people collect water from long distances or end up in paying high prices to water vendors for small quantities and often unsafe water. In rural areas, many hours per day are spent fetching water over several kilometers. Thus, quality of life as well as agricultural productivity is directly impacted by poor water supply services.

The National Water Policy (NAWAPO) of 2002 outlines a water sector plan to achieve sustainable development and utilisation of the Nation's water resources and increase water supply, sewerage, and sanitation services. An important element of NAWAPO is that it embodies the principles of decentralization and subsidiarity of water supply management, whereby management should be devolved to the lowest appropriate level. These principles conform to the public sector reforms currently undertaken by the Tanzanian Government.

Furthermore, a National Water Sector Development Strategy (NWSDS) has been prepared outlining the implementation details of the National Water Policy of 2002. The NWSDS also points out appropriate institutional and legislative changes required to facilitate the implementation of the specified actions contained in the NWSDS.

Within the context of the NWSDS, the Water Sector encompasses water resources management (including resource planning, development, and protection, and control of pollution), water supply and sewerage services, and the provision of on-site sanitation.

3.3 Key Actors in the Water Supply and Sanitation Sector

3.3.1 Kenya

The water sector reform has led to a clarification of key players and defined clear roles and responsibilities. The key players comprise the institutions which have been established under the new Water Act 2002. These institutions include:

- The Water Appeals Board (WAB)
- The Water Services Regulatory Board (WASREB)
- The Water Services Trust Fund (WSTF)
- The Water Resources Management Authority (WRMA). The WRMA is the lead agency in the management of Kenya's water resources. It's aim is to guarantee access to good quality and adequate water for all by focusing on it's core areas to manage, regulate, and conserve water resources judiciously, involving stakeholders for enhanced equitable allocation and for environmental sustainability.
- Seven Water Services Boards (WSBs) which are responsible for the efficient and economical provision of water and sanitation services within their areas of jurisdiction. These boards comprise:

    - Lake Victoria North Water Services Board (LVNWSB) for the districts in the Lake Victoria North catchment area.
    - Lake Victoria South Water Services Board (LVSWSB) for the districts in the Lake Victoria south catchment area.
    - Rift Valley Water Services Board (RVWSB) for the districts in the Rift Valley catchment area.
    - Athi Water Services Board (AWSB) for the districts in the Athi River catchment area.
    - Coast Water Services Board (CWSB) for the districts in the Coastal catchment area.
    - Tana Water Services Board (TWSB) for the districts in the Tana River catchment area.
    - Northern Water Services Board (NWSB) for the districts in the Ewaso Ng'iro North catchment area.

- The National Water Conservation and Pipeline Corporation (NWCPC)
- The Water Services Providers (WSPs)
- The Kenya Water Institute (KEWI)

Kenya's institutional framework is summarised in Figure 3.1.

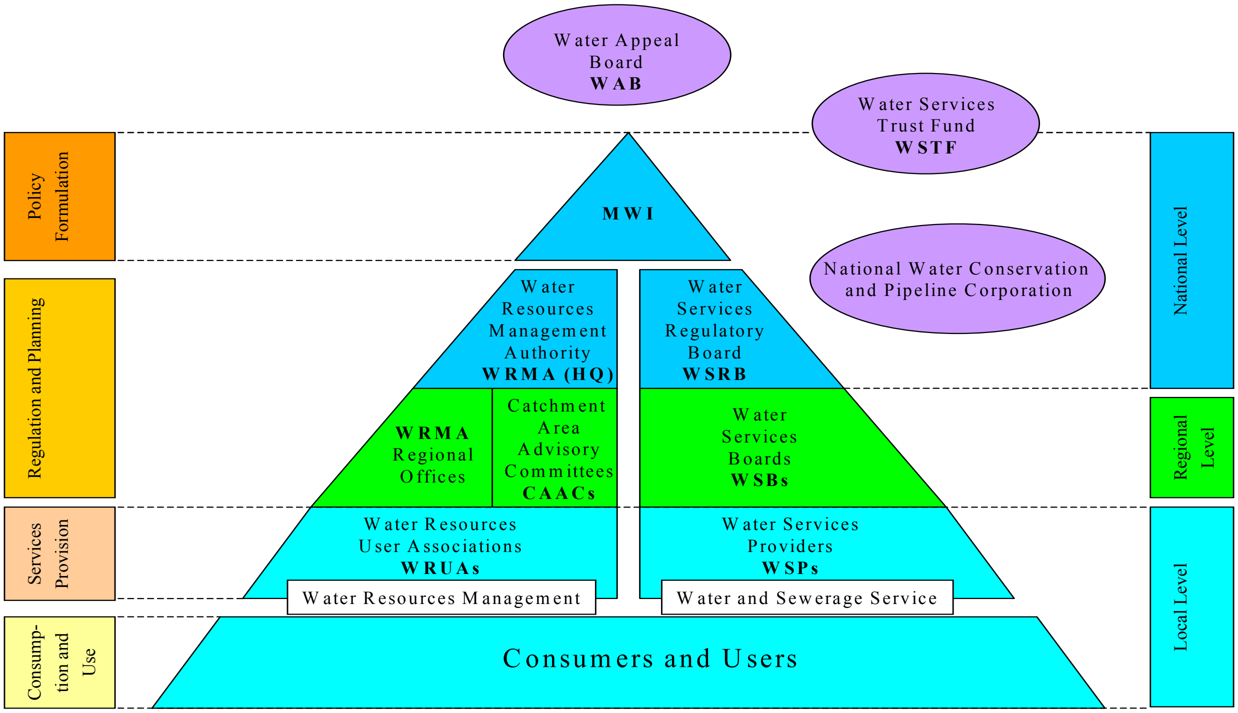


Figure 3.1: Institutional framework of the water sector in Kenya

The Water Service Boards have been established to spearhead the development of water supplies and sanitation in their areas of jurisdiction. Under the new institutional set-up, the districts within the Mara River catchment fall under the following WSBs:

- The LVSWSB which is responsible for the provision of water supplies and sanitation services to Transmara and Bomet districts, through Water Service Providers (WSP).
- The RVWSB which is responsible for the provision of water supplies and sanitation services to Narok North and Narok South districts, through Water Service Providers (WSP).

Water Services Providers sign Service Provision Agreements (SPAs) with the WSB to provide water supply and sanitation services to specific areas, particularly urban and large rural water supply areas. For areas where the board has not recruited a WSP, the District Water Officers operate the water supply systems on behalf of the board. These water supply systems include both urban and large rural water supplies. Other rural water supplies are managed by the communities through the establishment of Water Users Associations (WUAs).

With the introduction of the new water sector reforms in Kenya, the provision of water supply and sanitation services has been opened to a wider group of service providers, including the private sector.

Before the enactment of the Water Act 2002, rural water supplies were operated by the Government (through the District Water Offices) or by the communities themselves. Community ownership of the water supplies was effected under the Kenya Government National Policy on Water Resources Management and Development of 1999, where the management and, in some cases, the assets were transferred to the communities. The communities then formed Water Users Associations which were Community Based Organizations (CBOs) registered by the Ministry of Social Services or under the Societies Act.

The Water Act 2002 emphasizes the role of communities in service provision by defining a framework that enhances the role of the communities and their access to finances and technical support. Ideally, two rural water supply systems are recognized, namely, individual rural community systems and rural externally managed systems. Table 3.1 gives an outline of potential options for Rural Water Supply Providers (RWSP) for various rural water supply systems.

Table 3.1: Options for Rural Water Supply Providers

Water System Type	Asset Ownership	Typical Customer Size	Possible Water Services Providers	Remarks
Rural Community Systems	Government or Communities or Mix	< 1,000 (per individual system)	Community Water Users Associations	• Water Users Associations (WUAs) established • Strong technical and management support required for the WUA sustainability
Rural Externally Managed Systems	Government or Community or Mix	< 1,000 (per individual system, overall cluster may serve more)	External Management (Third Party Company)	• External company manages the community systems • Company (with legal status) can be private, public or NGO, etc.

Under the Rural Community Systems, the water supply system is managed by a Water Association or an Umbrella Water Association which decides on how to manage and operate the system. The Association can manage the system itself (hire its own staff) or it can outsource management to a private company. However, the Association remains as the Water Service Provider (WSP). In other cases, individual community Water Associations could join together to form an Umbrella Water Association which now becomes the WSP. The WSP enters into a Service Provision Agreement (SPA) with the Water Service Board. The role of the Board is monitoring of and compliance with the SPA, the provision of technical and managerial support, and asset ownership and development.

For externally managed water supplies, the External Management Company, which may be a private company or a public company formed under the Company's Act or and NGO formed under the Societies Act, become the Water Service Provider. This entity then signs the SPA with the Board and the communities are not directly involved in the SPA. Under this arrangement, it would be possible for the Board to cluster a number of rural water schemes within a defined geographic area to create economies of scale and enter into an SPA with the External Management Company. One such company is the Chemosit Water and Sanitation Company which operates the clustered water supply and sanitation systems of Bomet, Chepalungu, Sigor, and Longisa.

It is, however, recognized that most community water groups do not have the necessary technical and managerial skills to sustainably operate a water system. This implies that the water users associations require support from the Board in planning for investment, operational management to ensure performance enhancement, and cross-cutting issues which have a direct impact on the effective and efficient management of the water supplies. These cross-cutting issues include gender, governance, HIV/AIDS, pro-poor policies, and the environment.

Regarding provision of water and sanitation services in urban areas, most of the water supply systems have not been covering the operations and maintenance costs, thus sustainability has far from being achieved. In addition, the insufficient economies of scale and economically unviable tariffs hampered the sustainability of water and sanitation systems. Many of the small-sized systems led to high production costs and could not attract and maintain the necessary qualified professionals.

The low cost recovery and performance of the water service providers had resulted in high water losses, low water quality, erratic water supply, insufficient maintenance and the deterioration of the water assets, adding to further decline in the service level. In addition, consumption metering was limited or did not exist which promoted water wastage. The un-metered systems created distortions in consumer charges and loss of revenue, which was still very low. Water tariffs have been out of line with costs adding to financial difficulties.

However, in line with the water sector reforms, municipalities are required to form commercially oriented autonomous water companies and join together (cluster) to obtain economies of scale and professionalize the water and sanitation service provision. This has significantly improved performance of service provision, cost recovery and sustainability. Although not many of these municipalities have succeeded in forming these autonomous water companies, the water sector is in a position to duplicate the successes on a larger scale.

3.3.2 Tanzania

In Tanzania, the provision of water supply, sewerage, and sanitation services is currently categorized into (1) urban water supply and sewerage services, and (2) rural water supply services. The overall responsibility for the provision of water supply, sewerage, and sanitation services in the country lies with the Ministry of Water and Irrigation (MoWI). Nevertheless, a number of different central and local government departments or organizations have a mandate or legal requirement to be involved in various aspects of the provision of these services. In particular, the local government acting at the authority level of a city, municipal, town, district, or township has varying levels of responsibility for providing water supply, sewerage, and sanitation services to the population in its area of jurisdiction.

Under current legislation (The Waterworks Regulations, 1997, and the Water Laws Act, 1997, Miscellaneous Amendments), a total of 19 Urban Water Supply and Sewerage Authorities (UWSAs) have been established in the areas of municipal and town councils which make up the regional centers.

In addition, the Minister responsible for Water has declared 92 District Urban Water and Sewerage Authorities (DUWSAs) for towns which are also district headquarters. Both UWSAs and DUWSAs are accountable to, and monitored by, MoWI, although the respective local authority has representation on the respective Board. However, the UWSAs and DUWSAs are not responsible for on-site sanitation, which remains with the respective local government authority.

Both UWSAs and DUWSAs are distinguished in three categories dependent on their ability to meet all or part of their operation and maintenance costs. These organizations are encouraged to improve their performance so as to achieve a higher category status. Where the organizations are still reliant on the Government for part of their costs, annual budgets are subject to endorsement by MoWI.

MoWI is also responsible for assessing the need for and securing capital investment finance for water supply and sewerage schemes irrespective of whether they are run by UWSAs, DUWSAs, or the local government authorities.

In addition, under the same legislation mentioned above, the Minister responsible for Water may approve the formation of Water User Associations for specified areas. To date, 121 Water User Associations, including Water Companies and Trusts, have been established. In the areas where these associations have been established, MoWI is responsible for performance monitoring and support.

The MoWI secures investment finance for rural water supply schemes where it is responsible, or where it has approved the establishment of Water User Associations. Where investment is required for new rural schemes, MoWI may react to requests from the relevant District Council.

The Local Government Authorities are ultimately accountable to the Prime Minister's Office, Regional Administration and Local Government (PMO-RALG). The Local Government Acts of 1982 for both District and Urban Authorities give the respective authorities, and Township Authorities, powers to establish, maintain, operate and control public water supplies drainage and sewerage works.

The local government authority levels and differing responsibilities for the provision of water supply, sewerage, and sanitation services are shown on Table 3.2 below.

Table 3.2: Responsibilities for Water Supply, Sewerage and Sanitation

Local Authority Level	No.	Responsibility for Water Supply and Sewerage	Responsibility for Sanitation
City	3	UWSA	City Council
Municipality	14	UWSA	Municipal Council
Town	4	UWSA or Town Council	Town Council
District	97	DUWSA or District Council	District Council
Township	100	District Council	District Council

Source: NWSDS, 2008

The Energy and Water Utilities Regulatory Authority (EWURA) established under the EWURA Act, 2001, has the responsibility for regulation of water and sewerage services in the country. The extent of the regulatory functions conferred on EWURA in respect of water supply and sewerage services is to be determined by the sector legislation. Currently EWURA is responsible for regulation of commercial water supply and sewerage utilities in urban areas. The regulation of the water supply in rural areas is still under the MoWI. The approach to tariff structures differs according to the organization responsible for provision of water and sewerage services.

In urban areas, UWSAs determine their tariff structures and charges according to their particular operational and capital funding requirements, and the category in which they operate:

- Category A Authorities are expected to meet all direct and indirect operational costs;
- Category B Authorities are expected to meet all direct and indirect operational costs except personal emoluments for permanent staff; and
- Category C Authorities are expected to meet all direct and indirect costs except for an agreed part of their personal emoluments for permanent staff and electricity costs.

In water supply, sewerage and sanitation schemes run by local authorities, tariff structures and levels are determined by the respective District Council, but without specific targets of cost coverage. The tariffs are generally low and have not been revised for some years.

As a result of (1) many water meters being inoperable, (2) the consequent application of fixed, low charges, and (3) the inability to apply a tariff structure system of rising block tariffs, charges are not equitable and revenues do not reflect actual water consumption.

In rural areas, communities set the price per unit measure of the quantity of water, normally equivalent to a 20-litre container. This is commonly done democratically with the main goal being to meet operation and maintenance costs. In addition, communities are expected to contribute to capital costs in cash or kind. In the large rural schemes, the Government sets the tariffs in consultation with the communities involved.

The Mara River basin falls with the districts of Musoma Rural, Serengeti, Tarime, and Bunda. As such, the responsibility for the provision of water supply, sewerage, and sanitation services is with the District Urban Water and Sewerage Authorities (DUWSAs).

3.4 Provision of Water Supply and Sanitation Services (WS & SS)

3.4.1 WS & SS in Kenya

In Kenya, rural water supplies are community based and are developed on a demand driven approach with sanitation being individually managed. The majority of rural water supply sources are non-piped systems which are susceptible to pollution from anthropogenic activities. The water sources include point sources such as boreholes, shallow wells, protected springs, surface dams, and sub-surface dams which are developed in arid and semi arid zones with excess sandy sediments in the river channel. Piped rural water schemes are mainly found in areas with surface water potential. However, piped schemes face challenges of sustainability, water quality, and reliability.

Basic sanitation, where improved pit latrines are in operation, is commonly found in high to medium potential areas. These facilities might be missing in Arid and Semi-Arid Lands (ASAL) where the communities are pastoralists. Limited sewerage system coverage also exists in rural areas neighboring urban areas.

The survey on rural water supply coverage conducted by the Kenya Integrated Household Budget Survey (2005-2006) estimated coverage of 58% including water from vendors and tankers. When estimates from other sources (from dams, streams/rivers, ponds, and lakes) are deducted, and water meeting drinking water standards is only considered, it is estimated that the coverage of rural water supply is approximately 40%, while basic sanitation is estimated at 45%.

The Economic Recovery Strategy for Employment and Wealth Creation of 2003-2007 prioritizes the rehabilitation and development of water infrastructure aimed at increasing water coverage especially to marginalized areas.

The overall goal in the development of water supply services in the rural areas is in line with the Millennium Development Goal (MDG) No. 7 which is to reach at least 50% of underserved population in rural areas with safe, portable, and affordable water by 2015. To achieve this, at least 975,000 additional people will have to be served per year. The goal is to reach sustainable access for all by 2030.

For basic sanitation, there is need to increase access in rural areas to 72% by 2015 through up-scaling of infrastructure development.

It is envisaged that the above goals will be achievable based on the following considerations:

- There is enough man power locally to develop the water sector.
- The communities are well sensitized and know the benefits of improved water and sanitation services.
- There is a well developed financing tool – the Community Project Cycle.
- There is goodwill from government and Development Partners resulting in increased funding to the sector.
- There is increased interest and funding to the water sector through coordinated approaches by the government and Development Partners.
- The Water Act of 2002 has decentralized decision making for efficient service delivery.

In urban water supply and sanitation services, it is estimated that about 60% of the urban population in Kenya has access to clean water and only two million people have access to sewerage services. However, the water supply facilities are in most cases dilapidated, resulting in loss of water due to pipe bursts. Toward improving the water supply services in the urban sector, the service providers have established new trends. These include:

- Increase focus on rehabilitation, expansion, and upgrading of existing facilities rather than on developing new systems.
- Encourage private public sector collaboration in the development and management of water supplies and clustering of viable water supplies and sewerage under a single water service provider to improve system management and reduce operational costs.
- Extend the use of water metering to justify billing the consumers, reducing unaccounted for water, preserving water resources, and increasing the performance of service provision.

These trends are expected to support the goal of realizing an effective and efficient urban water service provision that calls for providing 80% of the population with water supply and 77% of the population with sanitation by 2015.

Table 3.3 depicts the national targets for water supply and sanitation services to meet the Millennium Development Goals and beyond as set by the National Water Services Strategy (NWSS).

Table 3.3: Kenya National Targets for Water Supply and Sanitation Services

	National targets for water supply and sanitation
Urban	Provide 80% of the population with water supply and 77% of the population with sanitation by 2015; thereafter access for all by 2030.
Rural	Provide 975,000 people with portable water per year to reach at least 50% of underserved population by 2015; thereafter achieve sustainable access for all by 2030, and, increase access to basic sanitation to 72.5% by 2015.

Source: MWI, Annual Water Sector Performance Report, October 2007

Based on the above national targets, the Regional Water Service Boards are expected to actively promote water supply and sanitation development within their respective areas of operation. Towards meeting their specific targets, the respective water development authorities in Narok South, Bomet, and Transmara districts have proposed water development projects for implementation between 2008 and 2012.

3.4.2 WS & SS in Tanzania

In Tanzania, the framework for Water Sector policy, strategies, and financial planning stems from Vision 2025 and the Poverty Reduction Strategy Paper. A number of these existing policy and strategy documents contain targets to be achieved in terms of level and timescale for improving service availability to the urban and rural populations.

The target of the National Development Vision 2025 for the water and sanitation sector is universal access to safe water by 2025 through (a) involvement of the private sector, (b) empowerment of local government and communities, and (c) promotion of broad based grass root participation in mobilization of resources, knowledge, and experience, that stimulate initiatives at all levels of society.

The National Strategy for Growth and Reduction of Poverty (NSGRP, 2005), also known as Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania (MKUKUTA), is derived from Vision 2025 and the Poverty Reduction Strategy Paper and identifies the close relationship between water resources management and the desired outcomes. The Water Sector Targets to be achieved by 2009/10 are (NSGRP, 2005):

- Increase proportion of rural population that has access to clean and safe water from 53% in the year 2003 to 65% by 2009/10 within 30 minutes of time spent on collection of water.
- Increase proportion of urban population with access to clean and safe water from 73% in 2003 to 90% by 2009/10.
- Increase access to improved sewerage facilities from 17% in 2003 to 30% in 2010 in respective urban areas.
- Increase access to basic sanitation for 95% of the people by 2010.

The water supply situation in Mara basin on the Tanzanian side is presented in section 3.6.2 below.

3.5 Projected Water Demands in Kenya

Nationally, domestic water demand projections for both rural and urban and for different time periods has been estimated through various studies including the National Water Master Plan of 1992; the Aftercare Study of 1998; and, Towards a Water Secure Kenya (Draft), 2003. Table 3.4 presents the summary of projected water demands nationally.

Table 3.4: Summary of Projected National Domestic Water Demands (x 10^3/day)

Year	1990	2000	2010	2020	2030
Domestic Rural	**516**	**708**	**1049**	**1333**	**1671**
Domestic Urban	**557**	**1105**	**1721**	**2430**	**3019**
Total domestic	**1073**	**1813**	**2770**	**3763**	**4691**

Source: Towards a Water Secure Kenya (2003)

For the Mara River basin, the National Water Master Plan Study estimated potential domestic, industrial, and livestock water demands for three time periods of 1990, 2000, and 2010. However, the estimates were based on districts existing in 1990 which have since drastically changed. More specifically, at the time of that study, the current districts of Bomet (carved from Kericho district), Transmara (carved from Narok district), Narok South (carved from Narok district), and Molo district (carved from Nakuru district) were not in existence. Nevertheless and for indicative purposes only, Table 3.5 is included to show the potential domestic, industrial, and livestock water demands for the larger districts within which the Mara basin is contained.

Table 3.5: Potential Domestic, Industrial, and Livestock Water Demands, Mara Basin, Kenya (m^3/day)

District	Domestic rural water demand			Domestic urban water demand			Industrial water demand			Livestock water demand		
	1990	2000	2010	1990	2000	2010	1990	2000	2010	1990	2000	2010
Nakuru	18,999	27,475	48,574	37,265	103,851	195,879	9,922	16,996	21,989	13,795	21,379	52,317
Narok	10,715	19,472	31,929	2530	8,559	16,903	228	422	606	32,127	44,700	54,809
Kericho	28,892	43,024	68,652	7,606	17,455	28,510	2,541	4,685	6,702	17,426	22,142	28,253

Source: National Water Master Plan, 1992

3.6 Sources and Water Supply Facilities in the Mara River Basin

3.6.1 Sources and Water Supply Facilities in Kenya

The main water sources in the Mara basin for domestic, irrigation and other uses are rivers, boreholes, springs, water pans, earth dams, and shallow wells. The water is mainly for domestic use, livestock watering, irrigation, tourism, and wildlife. Commercial enterprises in

Bomet town and other growing rural market centres such as Longisa, Mulot, and Kapkimolwa fetch water directly from the rivers, utilizing both human and draught animal power. The most important sources of water for households in the upper and middle Mara basin during the wet season are unprotected springs. The trend changes during the dry season when the major source is the Mara River itself supported by unprotected springs that have not dried. This situation is brought about due to lack of storage facilities at the household level for most of the population.

Some well-to-do households get their domestic water supplies from protected springs and open shallow wells, while others harvest rain water from their roofs. In specific cases, there are water supply schemes that are operated by communities, District Water Officers on behalf of the LVSWSB, RVWSB, and private operators especially in the Masai Mara Game Reserve. Table 3.6 presents a summary of major water supply production in Bomet district. Additional information on water supplies in the districts within the Mara River basin is provided in Appendix 3A.

Table 3.6: Major Water Supply Facilities in Bomet District

Water supply	Production(m^3/day)	No. Consumers
Bomet	382	512
Sigor	308	286
Chepalungu	318	345
Longisa	120	Longisa Hospital
Ndanai	-	164

The dams and pans are particularly important sources of water to pastoralists for their livestock. This water is also used for domestic purposes in some areas especially by the Masai community. Water from these sources does not meet water quality standards for human consumption since it is generally contaminated by livestock and wildlife and is also exposed to environmental effluents.

The majority of the population in the basin does not have access to piped water supplies. Piped water supplies are only found in parts of Bomet district and the hotels and lodges in the Masai Mara Game Reserve. In Narok district including Narok South district, the average distance to the nearest potable water point during the wet season is 5 km, while in the dry season it increases to 15 km. In Transmara and Bomet districts, the distances to the nearest portable water point is 13 km and 4 km respectively. Table 3.7 presents a summary of the water resources situation in the Mara basin while table 3.8 illustrates the percentage distribution of households served by drinking water source.

Table 3.7: Water Resources Situation in the Mara Basin, Kenya

Parameters	District		
	Narok*	**Bomet**	**Transmara**
Total number of households (1999)	76,450	76,493	35,700
No. of households with access to piped water	6,835	2,200	5,850

No. of households with access to portable water	16,750	1,500	8,663
No. of permanent rivers	8	3	3
No. of wells	16	1,040	50
No. of protected wells	21	30	49
No. of boreholes	80	1	1
No. of dams	35	59	12
No. of households with roof catchment (%)	6,768	750	576
Average distance to a portable water point	5/15km*	4km	13
No. of VIP latrines	2,111	200	N/A

* 5 km during the wet season and 15 km during the dry season
Source: District Development Plans (2002-2008)

Table 3.8: Percentage Distribution of Households by Drinking Water Source

Region	% Distribution of Households by Main Source of Drinking Water and Region										
	Piped into dwelling	Piped into plot/ yard	Public tap	Borehole with pump	Protected well	Protected spring	Rainwater collection	Unprotected well/spring	River/ pond/ stream	Tanker / Vendor	Bottled
Kenya	7.8	14.3	11.6	6.6	7.6	9.3	4.4	12.8	21.3	4.4	0.1
Rural (Kenya	3.9	8.4	7.2	8.1	8.7	11.9	5.4	16.6	27.5	2.3	0
Rift Valley Province	8.5	13.2	6.7	8.0	10.9	3.6	3.0	11.5	31.4	3.0	0.2
Narok	0.9	0.8	0.1	-	5.6	8.7	7.7	15.3	60.2	0.7	-
Bomet	0.2	3.2	0.4	-	6.9	5.3	1.5	14.4	68.0	0.1	-
Transmara	0.6	1.3	13.2	-	2.8	7.4	-	45.3	28.8	0.6	-
Nakuru	8.1	27.8	6.0	18.1	5.3	0.3	6.3	0.9	17.6	9.6	-

Source: Kenya Integrated Household Budget Survey KIHBS, 2005/2006

The above table shows that the river remains the most dominant source of water especially in Narok and Bomet districts, while unprotected springs are common in Transmara.
Table 3.8 indicates that for the three districts in the Mara River Basin, namely, Narok, Bomet, and Transmara, over 75% of the population access their drinking water from unsafe sources. In Nakuru, less than 20% of the population accesses their drinking water from unsafe sources. The large difference between Nakuru and the other three districts brings into focus the need to improve safe water provision to the three districts. An improved water source together with better sanitation facilities is one of the most important contributions to better human health. Reference to the health situation of the populations in the districts (contained in another section of the monograph report) indicates that water-related diseases constitute the major morbidity causes and create high health care costs. Thus, improved

water services and sanitation would improve health and productivity, and would reduce health care costs.

3.6.2 Sources and Water Supply Facilities in Tanzania

This section presents the water supply and sanitation situation in three districts namely, Musoma Rural, Serengeti, and Tarime which are part of the Mara River Basin in Tanzania. For each of the districts, information is provided for townships as well as for rural areas. At district headquarters, water supply services are provided by DUWSAs, while at the village level, water supply services are managed by Water User Groups and Water Associations. Both Water User Groups and Water Associations manage, operate, and maintain their water facilities by operating bank accounts as part of the Water Fund program. The water funds are operated by the Water Committees. No less than 50% of the Water Committee members are expected to be women.

3.6.2.1 Musoma Rural District

The source of water supply in Musoma Rural is mainly from groundwater sources whereby water is abstracted mainly from shallow wells, medium and deep boreholes, and improved traditional water sources. Apart from groundwater, the other important water source is rainwater harvesting through the construction of dams and water tanks. Table 3.9 presents existing water supply facilities and information on operating and inoperable water facilities.

Table 3.9: Water Facilities in Musoma Rural District

No	Type of facility	Total number	Not Operating
1	Shallow wells	193	73
2	Deep boreholes	12	2
3	Medium boreholes	27	17
4	Improved traditional water sources	n.a.	n.a.
5	Charcoal dams	15	0
6	Dams	13	1
7	Tanks for rainwater harvesting	n.a.	n.a.
8	Pumping water schemes	14	8
9	Spring water schemes	0	0

Source: Water Department Office, Musoma Rural District Council

As far as the indicator for water supply development for Musoma Rural is concerned, only 50% of the population has access to clean and safe water as indicated in Table 3.10. The projection water demand for Musoma Rural (2007) was estimated to be 10,000 m^3/day (Water Department Office, Musoma Rural District Council).

Table 3.10: Water coverage for Musoma Rural

Population (2007)	373,688

Population served (2007)	186,650
Water supply coverage	50.00%

3.6.2.2 Serengeti District

Mugumu Town

The Mugumu small Town Water Project Authority was announced to be a full Authority in the government Gazette effective on 21st June 2002. Mugumu Township has a population of 17,000 people (census of 2002) with a water demand of about 1,128 m^3/day. The authority has a total number of 8 boreholes (Table 3.11) of which only 2 boreholes operate using mono pumps (of Australian origin) 640, run by ST 3 Lister engines. These 2 boreholes are faced with a number of problems:

- Intermittent supply of diesel due to high prices of fuel.
- Fluctuations in the yields of the boreholes especially during drought spells.
- Engine overheating and breakdowns due to old age of equipments.
- Occasional breakdown of mono pumps which were supplied and installed in 1995.

The daily total yield of the two boreholes is approximately 140 m^3 in the rainy season, covering about 12.5% of the water demand.

Table 3.11: Status of 8 Boreholes in Mugumu Town

S/No	Borehole No	Depth m	Yield m^3/h	Remarks
1	BH 146/98	44	1	Borehole is abandoned
2	BH 201/74	60	4.8	Not functioning pump
3	GH 101/75	84	6.2	The borehole is functioning
4	BH 267/74	90	1.6	Water is salty
5	GH 233/74	74	5	The borehole is functioning
6	BH 131/91	54	1.2	Borehole not functioning. Installed with a Dev. Head pump which has broken down. Also, borehole is very far from users.
7	BH 15/84	80	5.9	Borehole not functioning. No engine or mono pump installed.
8	BH 147/98	33	2	Borehole not functioning.

Source: Water Department Office, Serengeti District Council

The yield of existing boreholes has declined due to siltation. Possible intervention measures for improvement of the existing water supply system include flushing of four of the boreholes, electrification of two boreholes (BH 233/74 and BH 15/84), and replacement of mono pump engines with submersible pumps.

The other water source that is currently being developed is the Manchira Dam. The construction of the dam is currently supervised by the Drilling and Dam Construction Agency (DDCA), and it is in its final stages of completion. Water has started filling the dam since the start of the 2008/09 rainy season. The complete development of this water source plus the added infrastructure of the pipe network and a water treatment plant is expected to boost the water supply coverage of Mugumu town. The catchment for Manchira Dam is not part of (but is adjacent to) the Mara basin. Thus, the use of water from Manchira Dam for Mugumu town involves an inter-basin water transfer. The treated effluent from the Mugumu town will be discharged in the Mara River.

Serengeti Rural

The source of water supply in Serengeti Rural as for the case of Musoma Rural is mainly from groundwater sources. The water is abstracted from shallow wells, medium and deep boreholes, and improved traditional water sources. Rainwater harvesting through the construction of dams and water tanks is also used. Table 3.12 presents in summary form the existing water supply facilities in the rural areas.

Table 3.12: Water Facilities in Serengeti Rural

No.	Type of facility	Total number	Not Operating
1	Shallow wells	286	112
2	Deep boreholes	96	7
3	Medium boreholes	n.a.	n.a.
4	Improved traditional water sources	25	96
5	Charcoal dams	41	2
6	Dams	3	1
7	Tanks for rainwater harvesting	126	53
8	Pumping water schemes	11	1
9	Gravity schemes	3	0

Source: Water Department Office, Serengeti District Council

According to the information obtained from the office of the Serengeti District Water Engineer, about 47.2 % of the population has access to clean and safe water. The improvement of water supply in the district is constrained by the availability of funds to invest in developing water facilities.

3.6.2.3 Tarime District

Tarime Town

Currently, the Tarime Urban Water Authority (TUWA) is handling all matters related to the water supply in the Tarime township. The Tarime township, with a population of 33,700 people, is served by a piped water supply system. There are two main sources of water supply for the Tarime township, namely the Tagota reservoir and the Nyandurumo spring, located respectively 4 km and 7 km from the township centre. Water from these two separate sources is stored in three storage tanks with capacities 225 m^3, 135 m^3, and 45 m^3 located on the Tagota Hills. From the tanks, only a single distribution main conveys water to the township end users.

The Tagota reservoir is a reliable water supply source in that it is currently capable of supplying water at a constant daily rate of 900 m^3 throughout the year, unless pumping problems occur. The impoundment is constructed across the seasonal Nyeresa River, completely drying its downstream reach. The present reservoir volume is small, but the storage capacity can be greatly expanded by constructing a dam a small distance downstream of its current location. Because of the current storage, pump operation is limited to 6 hours per day to avoid depleting the reservoir. Enhancing the reservoir storage capacity, will allow the pump to operate at its design specifications.

The Nyandurumo spring source has a seasonally varying yield highly dependent on rainfall. The spring delivers up to 750 m^3 a day during the rainy season, but the average daily yield falls to about 120 m^3 during the dry season. Consequently, the spring supplies most of the water in the storage tanks during the wet season. Due to storage limitations, small inlet pipe diameter, and high daily yield of the spring, about 345 m^3 overflows the collection ditch each day during the rainy season. An improvement of the storage capacity and the rising main from this source would make beneficial use of the amount now spilled.

Currently, water demand for Tarime town is 4,200 m^3/day and the total available water supply is 1,360 m^3/day, or 32 % of the total daily water demand. Thus, the existing water sources fall grossly short of the population daily water needs, and the situation is worse during the dry season.

Tarime Rural

The main water supply source in Tarime Rural is also groundwater. The water is abstracted mainly from shallow wells, deep boreholes, and improved traditional water sources. Rainwater is harvested through the construction of dams. However, information on water harvesting tanks in the district is not available. Table 3.13 presents a summary of the existing water supply facilities in Tarime Rural.

Table 3.13: Water Facilities in Tarime Rural (2006)

No.	Type of facility	Total number	*Not Operating*
1	Shallow wells	198	
2	Deep boreholes	19	
3	Medium boreholes	4	
4	Improved traditional water sources	78	
5	Charcoal dams	24	
6	Dams	5	
7	Tanks for rainwater harvesting	n.a	
8	Piped water schemes	16	6
9	Springs water schemes	2	

Source: Water Department Office, Tarime District Council

According to the information obtained from the office of the Tarime District Water Engineer, about 37 % of the population has access to clean and safe water. Furthermore, improvement of water supply in the district is constrained by the availability of funds to develop new water facilities.

3.7 Monitoring Indicators

3.7.1 Monitoring Indicators in Kenya

The water sector has been undergoing transformation in the last few years and a Sector Wide Approach to Planning (SWAP) was launched in October, 2006. The SWAP implies a gradual move towards more coherent support for the water sector including budget support where appropriate. The core elements of the SWAP framework are shown in Table 3.14.

Table 3.14: Core SWAP Framework Elements

Framework	Core elements
Policy framework	1. Definition of the national sector framework (what to align to)
	2. Partnership principles (common donor policies on how to align)
Planning framework	3. Sector investment plan-SIP (tool for prioritization)
	4. Sector information system – sector monitoring
	5. Coordination – both inter-sectoral and external partners
Funding framework	6. Channels of funding (ladder of options – projects, basket, budget support
	7. Financial management (transparency, accountability, value for money)
	8. Resource mobilization (using SWAP to increase funding)

Source: MWI, Annual Water Sector Performance Report, October 2007

The Sector Investment Plan (SIP) is proposed in the SWAP as the instrument that would provide a common basis for all sector investments. It is the tool that would reflect agreed allocation principles, both within the different sub-sectors as well as regionally. It will be the means by which the achievements of targets are prioritized. The work on developing a comprehensive SIP is ongoing, and an interim SIP was prepared in 2006. Further development of the SIP is dependent on a better foundation of baseline data as well as the strategy framework for irrigation, drainage, and land reclamation.

The planning framework in the Kenya water sector consists of:
- The 3-Year Sector Plans for the Water Sector Institutions (WSIs) under the Ministry of Water and Irrigation.
- The Sector Investment Plan (SIP) 2015 that provides a strategic outlook and presents the investment needs to reach the Millennium Development Goals (MDGs).

Presently, the 3-Year Sector Plan covers the Fiscal Years 2007/08 to 2009/10 and has been prepared as a common planning document describing the sector activities funded by the Government of Kenya and Development Partners in the context of the SWAP.

The present version of the SIP 2015 is the Interim SIP developed in 2006 as the sector is working to establish more accurate and comprehensive data to support the development of a more effective investment plan. The SIP 2015, developed within the context of Vision 2030 of the Government of Kenya, will describe the overall sector development plans and the investment requirements for reaching the 2015 MDG targets.

Performance monitoring is an important tool for effective planning and strategy development. Water sector stakeholders have established a performance reporting format based on Key Sector Indicators (KSI) defined within the following areas:

1) Water and Sanitation Services;
2) Irrigation, Drainage, and Land Reclamation;
3) Water Resources Management; and
4) Water Sector Reform.

The following 16 KSI parameters are defined in these sectors:

1. Proportion of population (urban and rural) with access to improved water supply (%). Access is defined as persons using a minimum of 20 liters of clean water from improved drinking water sources with a maximum collection time of 30 minutes and an affordable price.
2. Proportion of population (urban and rural) with improved sanitation facilities (%). Improved sanitation facilities are defined as those capable of providing safe disposal and hygienic management of human excreta. Coverage for sewerage is the proportion of the population in urban areas connected to functioning water borne sewerage systems with adequate treatment and disposal in accordance with the effluent standards.
3. Proportion of schools with improved water and sanitation facilities (%). Adequacy in water coverage requires a minimum of 5 liters per pupil per day be available within a distance of less than 50 m. Adequacy in sanitation requires a maximum of 25 girls and 35 boys per stand (where there is a urinal). This standard has been difficult to realize, especially after the recent introduction of free primary education (in 2003) which caused a significant school population increase.
4. Unaccounted for water (%).
5. Functionality of the systems (%).
6. Cost recovery (%).
7. Unit cost of investment.
8. Hand washing practice.
9. Productive land under irrigation (ha).
10. Water use efficiency in irrigation (%).
11. Productive land under drainage (ha).
12. Productive land covered by water harvesting (ha).
13. Efficiency of water resources management regulations.
14. Increase in available/accessible water resources quantity.
15. Improved water quality.
16. Completion of sector reforms/SWAP benchmarks.

3.7.2 Monitoring and Evaluation in Tanzania

The framework for the Monitoring and Evaluation (M&E) system for the WSDP follows the existing national framework for monitoring and evaluating progress in poverty alleviation, development, and the water sector (WSDP, 2006) . The primary role for M&E in the WSDP rests with the MoW which generates an Annual State of the Water Sector Report covering all aspects of the sector. The report is discussed by the Water Sector Working Group and the Joint Water Sector Review. This report together with Resources Tracking Studies and Technical and Financial Audits, forms the basis of Joint Water Sector Reviews and provides data for the Annual National Strategy for Growth and Reduction of Poverty performance reviews.

Several other entities perform M&E activities for the WSDP. These include the Basin Water Offices, Energy and Water Utilities Regulatory Authority (EWURA), Urban Water and Sanitation Authorities/Water Supply and Sanitation Authorities, Regional Water and Sanitation Teams, Local Government Authorities and their District Water and Sanitation Teams, and MoW Executive Agencies. The essential components of the M&E framework for the WSDP are (1) the use of a results-based Logical Framework Analysis (LFA) and Performance Measurement Framework (PMF) and (2) Management Information Systems (MIS). A results-based management approach for monitoring and evaluation uses the LFA and associated PMF.

Monitoring & Evaluation Indicators

At the output level, performance indicators measure the progress towards construction of new schemes and rehabilitation of existing facilities. At the outcome-level, performance indicators track progress towards project results. These indicators focus on areas reflecting progress toward development objectives (PIM, 2006), including:

- water accessibility (collection times, quantities, and reliabilities);
- hygiene and sanitation (hand washing, latrine availability, and proper use);
- sustainability (water system status and maintenance, Watsan functionality, and collections).

Collecting monitoring data on these kinds of indicators enables program managers and communities to

i) Assess progress against planned targets and adjust targets to realities;
ii) Assess the efficient and effective use of resources;
iii) Identify bottlenecks and timely find corrective action;
iv) Ensure that quality workmanship is being maintained;
v) Provide a record of lessons learnt;
vi) Provide an information base for future evaluations; and
vii) Provide the basis for improved planning.

The Rural Water Supply Program in Tanzania (RWSSP) has highlighted issues to be monitored related to the implementation of rural water supply projects (PIM, 2006). The issues for monitoring are categorized under different headings namely:

i) Promotion, Social issues, Capacity Building and Training
- Community awareness and participation;
- Gender and equity;
- Training of WATSAN/WUG/WUA Committee;
- Caretaker/pump operator training;
- Training of district staff and private sector service providers;
- Working environment for District Water and Sanitation Teams.

ii) Community Organization and Money Management
- Committee awareness and capacity;
- Committee selection;
- Functioning of committee.

iii) Technical issues: Surveys, Designs, Construction, Coverage, Use and O&M
- Reliability and appropriateness of surveys, location of sites and design;
- Construction quality;
- Coverage and effective use;
- Operations and maintenance management.

iv) Program Costs and Finance
- Tendering /bidding process;
- Total production cost including depreciation of assets;
- Expenditures.

v) Water Resources Management
- Water flow;
- Water quality;
- Intake protection and pollution.

vi) Hygiene, Sanitation, and HIV/AIDS
- Hygiene and sanitation practices.

3.8 Water Tariff Structures

3.8.1 Water Tariffs in Kenya

The current operational water tariffs for domestic water supplies in Kenya were gazetted in 1999 and are expounded hereunder.

1. Rural Water Supplies: (Volumes in M^3)

a) No meter connection: Charges are 200 KShs per month.
b) With meter connection:
   < 10 m^3 per month, 200 KShs per month
   > 10 < 20 per month, 25 KShs per m^3 in excess of 10 m^3
   > 20 < 50 per month, 30 KShs per m^3 in excess of 20m^3
   > 50 < 100 per month, 45 KShs per m^3 in excess of 50 m^3
   > 100 < 300 per month, 75 KShs per m^3 in excess of 100 m^3
   > 300 per month, 100 KShs per m^3 in excess of 300 m^3

2. Urban Water supplies:
The rates for metered urban water supplies are similar to the metered rural water supply tariffs.
3. Water sold through metered water kiosks: 15 KShs per m^3
4. Water sold by a retailer at a kiosk: 2 KShs per a container of 20 liters
5. Bulk sale of water to an undertaker for resale: 15 KShs per m^3
6. Water demands for Boarding Schools:
   < 600 m^3 per month: 20 KShs per m^3
   > 600 < 1200 m^3 per month: 25 KShs per m^3 in excess of 600 m^3
   > 1200 m^3 per month: 25 KShs per m^3 for any other learning institution
   For all other supplies in excess of permissible demands: 45 KShs per m^3

(Exchange Rate, 2008: 1 US dollar = 65 KShs.)

For urban centres with sewerage facilities, effluent discharge is charged at 75% of water used. The above water tariffs were introduced before the introduction of the current water sector reforms. Under these reforms, water supply operators have to generate their operation and maintenance costs. In this regard, there will be need to vary the current water tariffs. Toward this end, each Water Service Provider is, in collaboration with the Water Service Board, preparing tariff proposals which are to be forwarded to the Water Services Regulatory Board for evaluation and approval.

The current operational water tariffs were set in 1999 when the government was responsible for the operation and maintenance of water supplies. However, under the sector reforms and the introduction of Water Service Providers, the tariffs are too low to allow recovery for the provision of water and sanitation services. The Water Services Regulatory Board (WASREB) has identified a procedure to ameliorate this situation. The board has established three steps towards the full cost recovery in the provision of water and sanitation services. These include:

Step 1: Coverage of operations and maintenance;
Step 2: Coverage of operations and maintenance and payment of debts;
Step 3: Full cost recovery.

The board also recognizes three types of Water Service Providers:
Type 1: WSPs which do not cover operations and maintenance;
Type 2: WSPs which cover operations and maintenance but do not pay debts;
Type 3: WSPs which cover operation and maintenance costs to between 100% and 150%

and pay debts.

However, the WASREB has not approved the new water tariffs which have been submitted by the various Water Services Boards and consequently the operation of the water and sanitation services are still supported directly by the government and the developing partners.

Currently, the setting of water tariffs in Kenya and Tanzania are not harmonized and each country sets its tariffs separately.

3.8.2 Water Tariffs in Tanzania

Musoma

Within Musoma Rural district, there is a major water supply project, named Mugango/Kiabakari/Butiama water project, which is intended to serve 64,255 people in 13 villages. At present, the project is supplying water to 38,533 people within a distance of 400 m, a coverage of 60% of the total population. This water project is run by the Mugango/Kiabakari/Butiama Water Authority established in 2004 and the Water Board. The water project has metered connections (110) and un-metered connections (277). The tariff structure set by the board is as follows:

- Domestic: 300 TShs per cubic meter
- Institutions: 300 TShs per cubic meter
- Commercial: 400 TShs per cubic meter

Serengeti

The entities responsible for providing water supply services in the Mugumu Township are the DUWSA for Mugumu, established in 2003, and its Water Board. The tariff structure set by the Water Board is as follows:

- Domestic: 1000 TShs per cubic meter
- Institutions: 1000 TShs per cubic meter
- Commercial: 1000 TShs per cubic meter

Tarime

Since there are no water meters currently installed in the township, all water tariffs in Tarime township are flat rates based on (1) the user category (industrial or domestic) and (2) and the nature of supply (rationed or non-rationed). Industrial connections are charged 40,000 TShs per month; domestic rationed customers pay 2,000 TShs per month; and domestic non-rationed customers are charged 3,000 TShs per month. (Exchange Rate, 2008: 1 US Dollar = 1150 TShs.)

Moreover, in the un-served areas, people mainly use water from hand pumps and shallow wells, while others buy water from street vendors at a price of 10 TShs per 20 liters bucket.

Tariffs for water supply in Tanzania are generally low as provision of this service is seen as a social service. Setting of the tariffs fails to consider the following factors:

- the real cost of providing the service;
- the need to improve efficiency levels, particularly in revenue collection and expenditure control;
- the use of internal cross-subsidization and external subsidization to provide affordable minimum levels of service to the poor and disadvantaged groups; and
- control and regulation of tariff levels to ensure value for money for consumers.

Currently, the approach to tariff structures differs according to the organization responsible for provision of water and sewerage services. In urban areas, UWSAs determine their tariff structures and charges according to their particular operational and capital funding requirements, and the category in which they operate:

- Category A Authorities are expected to meet all direct and indirect operational costs;
- Category B Authorities are expected to meet all direct and indirect operational costs except personal emoluments for permanent staff; and
- Category C Authorities are expected to meet all direct and indirect costs except for an agreed part of their personal emoluments for permanent staff and electricity costs.

In water supply schemes run by local authorities, tariff structures and levels are determined by the respective District Council, but without specific targets of cost coverage.

The national policy directs that tariff levels and structures to achieve sustainability will be controlled and regulated based on the levels of service to be provided, the cost-efficient provision of these services, and the cost-recovery targets to be achieved. Also, a minimum, or life-line, tariff will be introduced to protect poor and disadvantaged groups. The cost of this tariff will be met through internal cross-subsidization. Government subsidies will be aimed at encouraging efficiency improvements by service providers.

New tariff structures will thus be set aiming to:

a) ensure that tariffs are structured and set at the levels necessary to achieve cost recovery targets and are based on levels of water consumption;
b) promote cost-effective delivery of water and sewerage services;
c) protect poor and disadvantaged groups; and
d) regulate the setting of tariffs to ensure consumers receive "value for money" services.

3.9 Sanitation and Hygiene

3.9.1 Sanitation and Hygiene in Kenya

Sanitation and hygiene activities in Kenya involve several players. Besides the lead government agency (Ministry of Health), the Ministries of Education (MOE), Science and Technology (MOST), Local Government (MOLG), and Water and Irrigation are actively involved in sanitation and hygiene improvement for communities.

The Ministry of Health (MOH) is concerned with household, municipal, city, and institutional public health issues. The Ministry of Education is responsible for hygiene education, while the Ministry of Water and Irrigation is involved due to the traditional linkage between water supply and sanitation.

In rural Kenya, sanitation has been regarded as a household responsibility and has not received the same attention from the sector institutions as the water facilities. Many of the population's poor have no basic sanitation infrastructure and dispose waste in unsanitary and unhygienic ways.

In October 2007, the Ministry of Health launched the Environmental Sanitation and Hygiene Policy Strategy. The policy clarifies the roles of sector players through the linkage between water and sanitation for households, communities, and urban centres.

In the Mara River basin, sanitation is mainly by use of pit latrines. However, information available from the Kenya Integrated Household Budget Survey (2005/2006) indicates that more than half of households in Transmara and Narok districts lack toilets. The toilet coverage in Bomet and Nakuru is much higher compared with the other districts.
In the urban areas, Bomet water supply is the only major water supply infrastructure in the Kenyan portion of the Mara basin but there are no sewerage facilities. Fortunately, NELSAP is financing the construction of sewerage facilities for the town. However, other towns and rural markets in the basin lack sewerage facilities.

There are major problems in informal settlements in the towns where there is insufficient coverage of pit latrines. Some urban centres have introduced commercial public toilets and this has helped greatly. For the districts within the Mara catchment area in Kenya, the latrine coverage is shown in Table 3.15.

Table 3.15: Latrine Coverage for the Mara Districts in Kenya

District	**Latrine coverage (%)**
Bomet	82
Nakuru	99
Narok	44
Transmara	22

Source: Kenya Integrated Household Budget Survey (2005/2006)

The results presented above indicate a very low coverage of sanitation facilities in the main districts within the Mara River basin. This low coverage could partly be attributed to inadequate public awareness of importance of sanitation and hygiene and the communities being predominantly pastoralists.

3.9.2 Sanitation and Hygiene in Tanzania

Most of the population in Musoma Rural use pit latrines. Few facilities in commercial centres use pour flush or offsite with septic and seepage pits. The coverage for sanitation for the district is estimated at 54%.

In Serengeti, the Mugumu township completely lacks sewers. Few families have septic tanks, while most of the township population depends on on-site sanitation. As it is for Musoma Rural, most of the population in Serengeti Rural use pit latrines as the main on-site sanitation method. The coverage for sanitation for the whole district is estimated at 86%.

Similarly, Tarime township is without sewers and only few households have septic tanks, with most of the population depending on on-site sanitation. There are stormwater drains along the main streets of the township, but they are not frequently maintained and are partly blocked. The overall sanitation level in the district is 53%. Most of the people use pit latrines for on-site sanitation, and there are no facilities for the collection of solid wastes. This situation results in crude disposal of solid wastes in the streets of Tarime.

Under the new national water policy (NAWAPO), communities are owners of the completed water supply facilities. The community is responsible for planning, implementing, operating, and maintaining water facilities. One of the specific tasks of the community is to prepare and implement the hygiene and sanitation action plan.

The Water and Sanitation committee (WATSAN), the members of which are elected by the community, has the responsibility to manage the water and sanitation facilities on behalf of the community on a day-to-day basis.

Promotion of good health goes hand in hand with the availability of a water supply system and good hygiene and sanitation practices. The WATSAN committee has a role to promote and coordinate such desirable practices. The areas that need attention in promoting good hygiene and sanitation practices include the following:

- Water handling at the water source;
- Water handling during transportation;
- Water handling or storing in the home;
- Keeping home surroundings clean;
- Safe disposal of human feces;
- Hand washing before meals and after use of latrine;
- Body cleanliness.

One way at which WATSAN committee can promote good hygiene and sanitation practices is by conducting hygiene education sessions at community meetings, schools, health centers, churches, markets, social gatherings, and water sources. These efforts should especially involve women who play a major role in sanitation, hygiene, and disease prevention.

3.10 Solid Waste Management

Currently, solid waste management in all towns and rural growth centers within the Mara River basin in Kenya is inadequate, resulting in careless and indiscriminate open space dumping and the creation of unsanitary conditions on town streets and alleys. Such indiscriminate dumping leads to unpleasant odors and create fertile breeding grounds for flies, mosquitoes, and other disease carrying vectors. Furthermore, this practice results in blockage of drainage systems, impairment of soil permeability, and surface water and groundwater pollution through pollution leaching.

In Tanzania, solid waste in Mugumu town is generated from residential areas, shops, and public places. There are no facilities purposely built for the collection of solid wastes in the township. The waste is transported by wheel barrows, about 120 trips/day and disposed of at a dumping site where it is burnt (Plate 3.1). Solid waste is not sorted out into different compositions. This situation promotes crude disposal of solid wastes in the streets of Mugumu and could lead to serious pollution of surface and groundwater sources.

Plate 3.1: Transport and Burning of Solid Wastes in Mugumu Town

Likewise, Tarime has no solid waste collection facilities, and wastes are disposed directly in the streets.

3.11 Water Sector Financing

3.11.1 Water Sector Financing in Kenya

The Kenya Water Act 2002 has facilitated the establishment of the Water Services Trust Fund (WSTF; Water Act 2002, Section 83) whose objective is to assist in financing the provision of water services to areas of Kenya lacking such services. Funding for the fund is raised through the normal government processes and from donors. In this regard, donors supporting water supply and sanitation services are encouraged to channel their funding through the Water Services Trust Fund. The funds are managed by a board of trustees who provide grants to project proponents. For rural water supplies, communities develop water supply project proposals with the support of Support Organizations (SOs) and forward them to the WSTF through the relevant Water Service Board.

For rural water and sanitation programs, the water sector reforms in Kenya have created opportunities to improve access to water in all rural areas. The reforms have introduced effective regulations and the Water Services Boards are building capacities to improve support services to communities. The ongoing institutional changes have increased the commitment of donors and NGOs to the sub-sector. In addition and as stated above, the Government has increased its budget for water and sanitation programs while communities are more aware and willing to contribute and finance the operation and maintenance of their water supply installations. The Water Services Trust Fund (WSTF) as the poverty-oriented financing instrument in the sub-sector has developed a Community Project Cycle (CPC) to facilitate channeling finances directly to communities.

The Government is also financing water supply development through the National Water Conservation and Pipeline Corporation, a government owned parastatal organization. Other sources of funds for water supply and sanitation development are sourced from the Constituency Development Fund (CDF) and the Local Authority Transfer Fund (LATIF).

In the past five years, the water sector has seen its total budget increased from 5,704 million KShs in the 2002/03 financial year to 12,547 million KShs in 2007/2008. Likewise, over the same period, the actual expenditures have increased significantly from 3,781 million KShs to 8,870 million KShs, a 64 % five year increase. On the other hand, the recurrent expenditures used to support water services have increased gradually due to (1) slow salary growth attributed to voluntary early retirements and (2) water services providers assuming their responsibilities in areas of their jurisdiction.

The development budget for the 2007/2008 financial year is estimated at KShs. 8,460 million of which the Developing Partners will contribute KShs. 5,985 million leaving the government to fund the balance. Of the Kshs.5,985 million from donors, KShs. 2,820 million will be grants, while KShs. 3,160 million will be loans. The recurrent budget for the 2007/2008 financial year is KShs. 3,874 million of which KShs. 929 million will be funded through water user fees. These funds will be used to remunerate staff running water operations and to fund day-to-day operations of water schemes country wide. Table 3.16 shows the water sector funding trends in Kenya.

The success of the water sector in Kenya is dependent on the continued support of all players in the sector. Currently, all major players have supported the sector in its development agenda. Analysis of the sector development process indicates that:

- There is good will from the Government and the development partners resulting in increased sector funding;

- There is increased interest and funding to the sector through coordinated approaches by the government and the development partners;
- There is a well developed funding tool (CPC) for financing water supply and sanitation development in rural areas;
- The communities are more aware of their responsibilities as beneficiaries and the benefits of improved water services.

There are, however, threats to the success of the sector which manifest themselves as occasional resistance to change. Water consumers in Kenya have generally seen water as a free commodity but as the water service providers move towards meeting the operation and maintenance costs of the water supply services, the water consumers will have to pay higher water use tariffs. This situation might also introduce political interference in the sector which could slow down the pace of the reforms and development.

Table 3.16: Water Sector Funding Trends (million KShs) in Kenya

Budget Head	2002/03		2003/04		2004/5		20005/06		2006/07		2007/08
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Gross estimate
Development	3.709	2,140	6,097	4,854	6,465	4,669	7,237	5,016	9,534	6,201	8,460
Recurrent	1,995	1,641	2,355	2,090	2,421	4,325	2,698	2,239	3,013	2,669	3,874
Total	5,704	3,781	8,452	6,944	8,8886	8,994	9,935	7,255	12,547	8,870	12,334

Source: MWI, Annual Water Sector Performance Report, October 2007.

3.11.2 Water Sector Financing in Tanzania

Significant investments were made in the Water Sector during the 1970s and 1980s by the Government of Tanzania, in collaboration with Development Partners and Non-Government Organizations. However, from the early 1990s to date, the Water Sector has been experiencing a sharp decline in financing for both rehabilitation and new development. The current funding levels available to the sector are very low compared to the levels of 1970s and 1980s, and this declining trend has continued to the point where the scarcity of financial resources available for development and rehabilitation of the existing schemes cannot meet the infrastructure demand. This works against the stated policy objectives of increasing water coverage and poses a major challenge for the Government.

Capital investment finance in the water sector is the responsibility of the Government in collaboration with Development Partners. The mechanisms for channeling agreed finance to the water executing agencies under the National Water Sector Development Strategy (being prepared) is to:

- Invest in water resources infrastructure through the Ministry responsible for water and Basin Water Boards;
- Invest in infrastructure in cities, municipalities, towns with Water Supply and Sewerage Authorities, as well as other commercialized schemes through a National Water Fund;

- Invest in water system infrastructure run by communities through a system of grants to the respective councils;
- Invest in sanitation through a system of capital grants to the local government authorities.

Expenditure for the recurrent costs of water resources management has been derived primarily from two sources. Firstly, the Government Exchequer provides funds through budgetary allocations to the ministry responsible for water and, secondly, through charges for water abstractions. Budgetary allocations from the Exchequer have been below those required for effective water resources management and have been declining over the past ten years, with only 3 – 5% of the Ministry's budget allocation committed to support water resources management activities. The constraint of inadequate resources has resulted in poor performance of a variety of technical, administrative and legal activities, as well as in deterioration of infrastructure for continuous data collection important for water resources management.

To realize the recurrent funds necessary to support water resources management activities, it is proposed that abstraction and use of water resources and discharge of effluents carry appropriate charges. The level of abstraction and discharge charges and the criteria to be used in setting such charges will be subject to regular review and approval by the Minister responsible for water.

The Government has been disbursing recurrent budgetary allocations to MoW, the regional secretariats, and local government authorities to finance water supply and sewerage recurrent activities pertaining to personal emoluments, and operations and maintenance costs. However, the mechanisms for determining the beneficial utilization of these allocations to maintaining water supply and sewerage services are weak. In addition, government funding to support recurrent costs has continued to diminish over the years.

The performance in collection of water revenues from consumers by service providers is generally poor with many consumers not being metered. As a result, the level of unaccounted for water is unacceptably high. The combination of reduced government allocations and poor revenue collection has resulted in a monetary shortfall to carry out operation and maintenance. In turn, this has resulted in deterioration of both rural and urban water infrastructure. The Government has been sensitizing and encouraging rural communities to establish Village Water Committees and create Village Water Funds for the management of rural water supply schemes.

Sustainable operation and maintenance of water supply and sewerage schemes is foreseen to be based on adequate budgetary levels and appropriate channeling of financial resources. In urban areas, the source of funds for recurrent costs will be raised from consumers based on cost recovery tariff principles. Similarly, in rural areas, communities will be required to manage their own schemes and to pay full operation and maintenance costs, costs of higher service levels, and capital investment costs.

3.12 Role of Women in Water Supply

Although women carry the burden of fetching water for the households, they have little involvement in making decisions related to water resources development, management, or the provision of water supply and sanitation services.

However, under the new water sector reform process in Kenya, women's input to the water sector has been recognized and a new equal employment opportunity policy has been developed for the rural and urban water and sanitation sector. Stronger women representation in water resources management and development is also being encouraged. In order to support the new water sector business set up, institutions supporting communities in their water development programs encourage at least 30% women representation in management committees.

In Tanzania, there have been few attempts to mainstream gender aspects in the Water Sector especially at the decision-making, management, and technical levels. However, efforts to consider gender inclusion through creation of gender awareness and increased fair gender representation in village water committees have been a significant step forward.

In the case of urban and small town water supply and sewerage situations, there has been little consideration given to involving women in the decision making process.

The NWSDS has defined gaps in mainstreaming gender in the Water Sector and has identified the following main areas for gender inclusion:

- Fair representation of both women and men in water user committees;
- Consultation of both women and men in selecting and managing rural water supply schemes, and empowerment of women to actively participate in decision making, planning, supervision of implementation and management of operations, and maintenance of water supply schemes;
- Representation of both women and men in water boards and authorities; and
- Consultation of both men and women in critical discussions on life-line tariff and other affordability issues related to the provision of services in urban and town settings.

The strategy being considered under the NWSDS for increasing gender sensitivity includes the following elements:

- Monitor the relative involvement of men and women in various aspects of the Water Sector;
- Promote active participation of women in water affairs;
- Involve women and men equally in the provision of water and sewerage and sanitation services; and
- Cultivate and promote a culture of gender equality in communities.

At the community level, the Water and Sanitation committee (WATSAN) has an important role to play to ensure that women are included in the committee to ensure gender and equity issues are taken into account in the management of water facilities.

This is expected to be achieved through the National Water Sector Development Strategy which aims at achieving active and effective participation of both women and men in the provision of water supply, sewerage and sanitation services.

3.13 Water Supply and Sanitation Critical Issues

In Kenya, the water supply coverage in most of the districts is around 40% while basic sanitation is around 45%. Lack of sewerage facilities and toilets in combination with a high urban population growth has resulted in a situation where urban and human wastes are carelessly disposed of in the environment. This phenomenon is particularly observed in the low income settlements areas, market places, and along the existing open drainage system. This has created suitable breeding grounds for disease epidemics including cholera, typhoid, and dysentery.

For areas with septic tanks and no exhauster facilities, overflow from septic tanks is directed into the environment and the rivers, thus increasing pollution. River water pollution is exacerbated by surface runoff into the rivers from the towns and rural markets.

In Tanzania, the water supply coverage in most of the districts is around 50%. This level of development is still far from achieving the millennium development goals on water and sanitation. This is partly due to the very low government funding levels available to the sector compared to the levels of 1970s and 1980s. Declining investments have created a situation in which water coverage and rehabilitation of the existing schemes cannot cope with the demand.

The water supply and sanitation services situation in the three districts of the Mara River basin underscores a number of issues concerning development in the sub-sectors. Non-functioning of water facilities is relatively high denying a large number of people clean and safe water. Lack of proper maintenance is mainly the cause of this situation. Also, this is becoming worse due to the lack of funds and equipment to carry out maintenance of medium and deep boreholes.

Capacity in terms of personnel and facilities for the departments involved in providing water supply and sanitation services is completely lacking, the main cause being lack of funds and incentives to attract new Civil Engineering graduates. Increase of water coverage would require more engineers and hydro-geologists to implement water and sanitation solutions and projects.

Mapping of groundwater in the three districts is very crucial as far as development of groundwater resources for water supply. Groundwater resources are currently the main water source in the three districts. Groundwater mapping information to guide the exploitation of the resource is lacking. Continuous groundwater monitoring is also not being carried out.

Climate variability has caused some shallow wells to dry up during the dry months of July to October.

Low coverage of functional water meters, the consequent application of fixed and low charges, and the lack of a tariff structure system of rising block tariffs result in low revenue collection to support the operation and maintenance of water supply facilities. As a result, the revenues collected do not reflect actual water consumption.

The establishment of Village Water Committees and subsequently creating of Village Water Funds for the management of finances for operational and maintenance of rural water supply schemes by the communities is very necessary to ensure the functioning of water facilities. More efforts are required by the government to sensitize and encourage rural communities to establish Village Water Committees and open Village Water Funds to support operation and maintenance of water facilities.

There is no sewerage system in the Mara basin townships. All urban dwellers depend on on-site sanitation, namely, pit latrines. Facilities for the collection, transport, disposal, and destruction of solid wastes generated in the towns are inadequate or non-existent. Crude waste dumping in open spaces is widespread, posing groundwater contamination hazards from waste leachate.

Poor farming practices and forest clearing in the Mara River basin causes widespread soil erosion and water pollution. Cattle watering directly into the rivers exacerbate river pollution through direct excreta into the river and the de-stabilization of river banks.

A summary of the main issues, causes, impacts, on going intervention measures, and investment opportunities in water supply and sanitation are summarized in the following table.

Table 3.17: Matrix of Issues on Water Supply and Sanitation Services

Issues	Causes	Impacts	On-going and Planned Intervention Measures	Potential Investment Projects
Low safe water and sanitation coverage	-Dilapidated water supply and sanitation infrastructure due to poor maintenance and low funding. -Lack of competent personnel to manage the water supplies particularly at community level. -Poor operation and maintenance of developed water supply and sanitation facilities resulting in low operational efficiencies and frequent breakdown of the facilities. -Rapid population growth that increases demand on available water supplies. -Uncoordinated development of sewerage facilities and water supply facilities. -Low investment in sanitation facilities. - Separate ownership and management of water supply facilities from sanitation	-High prevalence of water related diseases resulting in high infant mortality rates, reduced productivity, and unnecessary health expenses. -High drop-out rates of female students from schools due to poor sanitation facilities. -Low productivity of women and girls who spend most of their time walking long distances to fetch water. -Low water supply coverage in Musoma rural (50%), Serengeti district (47.2%) and Tarime district (37%). -Low water supply coverage in Urban areas, i.e., Mugumu town (less than 10%) and Tarime town (32%). -Low sanitation	-The Kenya Government through the Ministry of Water and Irrigation together with the institutions in the water sector has formulated the National Water Services Strategy (2007-2015) to give guidance in the development of and provision of water supply and sanitation services. -The National Water Services Strategy has set targets for achieving the MDGs and the Kenya Vision 2030 in the provision of water supply and sanitation services. This will require the following: • Development of new water sources • Rehabilitation and expansion of existing water supply schemes • Construction rainwater harvesting schemes • Procurement of equipments and services for the rehabilitation of boreholes In Tanzania, Musoma rural, Serengeti, and Tarime district councils and the Ministry of	-The stakeholders in the Mara basin districts through the District Water offices in Kenya have identified projects that, if implemented, would improve on the availability of safe water supplies to the population and contribute towards meeting the MDGs on the provision of safe water supplies. However, funding for the intervention measures is yet to be availed. Mobilization of adequate funds is required to consolidate the implementation of the proposed intervention measures.

	facilities in the urban centres. -Management of sewerage by water service providers is often seen as a by-product of water services and is given little attention	coverage in Musoma rural (54%), and Tarime district (53%). -Sewerage facilities in Mugumu and Tarime towns are completely lacking	Water and Irrigation are responsible for the implementation of the intervention measures. The projects for Tanzania are included in the 2008/09 budget and they are expected to be carried forward up to 2010/11. Overall the development of water supply and sanitation facilities in the Mara River Basin (Kenya and Tanzania) are expensive undertakings requiring support from all financial sources.	
High levels of unaccounted for water	-Dilapidated water supply systems; -Unauthorized and unpaid for water connections; -Un-metered water supply systems	-Failure to meet water demands of the increasing population; -Distortions in water use charges; -Loss of revenue	-Introduction of commercially oriented companies to operate the water and sanitation systems.	
Water pollution	-Inadequate sanitation facilities -Poor planning and location of sanitation facilities (e.g. pit latrines near water sources); -Improper discharge of effluent from industries(e.g. abattoirs);	Poor water quality for human consumption and ecological functions; -Increase of water-borne diseases; -Loss of aesthetic value; -Ecological damage of wetlands and rivers;	-The NWSS has recommended that from 2008, all rural water projects will have a sanitation and hygiene education component.	-Increased financial support in the development of sewerage systems in urban areas

	-Watering of livestock directly in rivers; -Bathing, washing of clothes, utensils and chemical containers in rivers; -Unplanned tourist facilities; -Lack of solid waste management plans; -Laxity in the enforcement of environmental rules and regulations.	-Fishery resources threatened; -Increasing threat for wildlife and the tourist industry.		

4.0 Agriculture

4.1 Introduction

Kenya

The Kenyan economy is largely agro-based. The agricultural sector accounts for approximately 26% of the gross domestic product (GDP) and 60% of export earnings. In addition, agriculture indirectly contributes 27% of the country's GDP through manufacturing, distribution, and other services. The agricultural sector employs 80% of Kenya's workforce and contributes 57% of national income both directly and indirectly. Agriculture is therefore the most important sector for promoting national development (Ministry of Agriculture, Strategic Plan, 2006-2010). Kenya's agricultural policy is focused on poverty reduction and food security. Therefore, it embraces a broad-based agricultural growth and development in rural areas and all of Kenya.

Agricultural growth is dependent on weather patterns, despite development of a pro-active drought policy. Other negative effects have emanated from market liberalization and global competitiveness. Growth trends have fluctuated with both declines and recovery, depending on weather and availability of markets. However, appropriate policy interventions, which became more focused and consolidated with the launch of the Strategy for Revitalizing Agriculture (SRA) in 2004, have contributed to sustained agricultural recovery. From a depressed -3.0 % real decline in 2002, the sector recovered to a 2.6% real growth in 2003 before finally registering an impressive 6.7% real growth in 2005.

Empirical data collected and analyzed by the Ministry of Agriculture suggest that the rally experienced by the sector as shown in Figure 4.1 encountered a slow down in 2006. This slow down was the result of poor performance of industrial crops in 2006 with production of tea dropping by 5.5% to stand at 310,578 tons. Similarly, sugar production dropped by 3% to 475,670 tons, while pyrethrum production declined by 24% to 763 tons. However, the performance in 2006 was mostly underpinned by the resurgence in the dairy industry and above average production of food crops including maize and beans. This increase was driven by above average and well distributed rainfall across the country.

In particular, harvests in the eastern parts of the country registered significant improvement from good rains experienced during the short-rains season of 2005. Thus, production of maize increased by 11% from 32.4 million bags in 2005 to 36.1 million bags in 2006. In the same period the production of beans peaked at 5.9 million bags from 4.2 million bags representing an increase of over 41%.

In the same period, the value of horticultural exports increased by 14% from 37.998 billion KShs in 2005 to 43.271 billion KShs in 2006. Other commodities that performed well include rice production that rose by 12% from 57,942 tons in 2005 to 68,840 tons in 2006 mainly attributed to increased crop area. Other key food crops that registered significant production increases were cassava (16%) and sweet potatoes (8%). Industrial crops, however, did not perform well in 2006 with decreasing production of tea by 5.5% to 310,578 tons, sugar by 3% to 75,670 tons, and pyrethrum by 24% to 763 tons (Ministry of Agriculture-Kenya-Economic Review of Agriculture, 2007).

In the Mara River Basin districts of the wider Narok (including the recently created Narok South), Bomet, Transmara and the newly created Molo, agriculture is the main economic base for the rural inhabitants. Agriculture is the source of income and employment for about 70-80% of the population. The sector also provides raw materials for agro-based and forestry related domestic industries (District Development Plans-2002-2008).

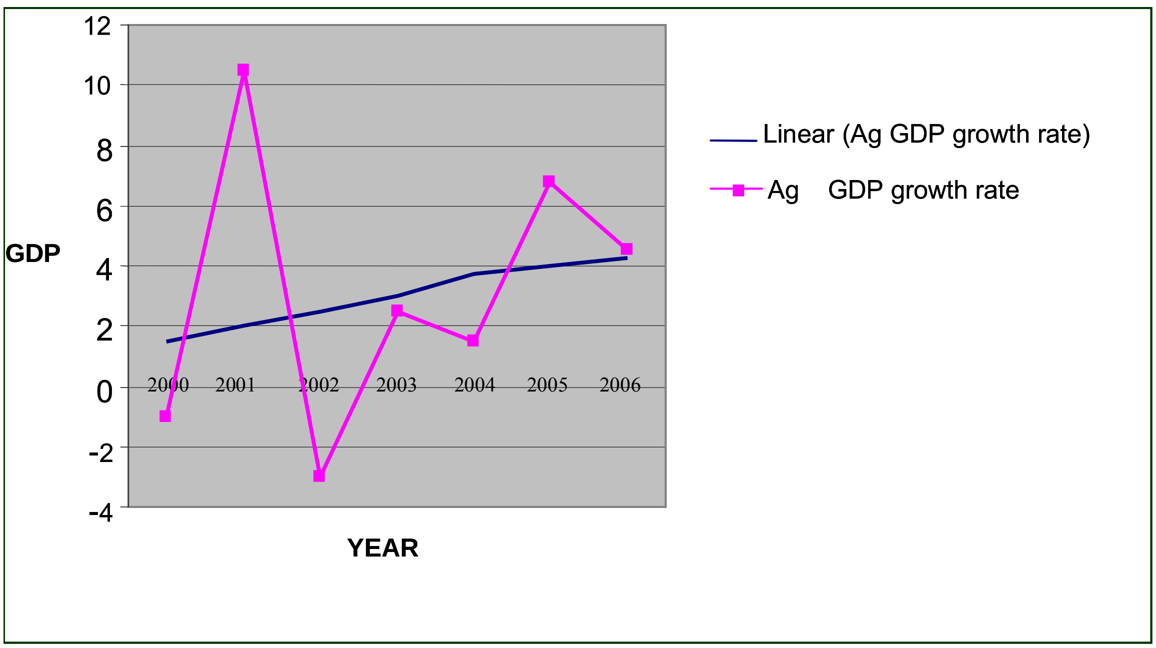


Figure 4.1: Kenya's Agricultural GDP Growth Rates, 2000-2006

Tanzania

The Tanzanian economy is equally agro-based and the agricultural sector consists of crops, livestock, fisheries, forestry and wildlife, contributing about 48% of the country's Gross Domestic Product (GDP) and about 65% of the export earnings in 2000 (Economic Survey, 2000). More than 80% of the adult population in the country earns their living from agricultural activities, mainly at subsistence level. The agricultural policy in Tanzania is aimed at promoting crop and livestock growth rate of 4 to 5% to ensure the country's basic food security, increase output earnings, and raise the peoples' nutritional status and standard of living.

In 1999, the agricultural sector recorded a Gross Domestic Product (GDP) of 1,500,572 million TShs at current prices. The nation's economic performance showed some growth between 1999 and 2005 and had increased to 3,483,352 million TShs at current prices, in 2005. The rate of growth from one year to the next varied and initially grew by 25.1% in 1999; 25.2% in 2000 and 2001; 25.3% in 2002; 25.6% in 2003; 26.1% in 2004; and 26.7% in 2005 (Basic Data Agricultural and Cooperative sector, 1998/99-2004/05).

Table 4.1: Gross Domestic Product at Factor Cost by Industry and Current Prices

Percentages							
Industry	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
A: MONETIZED SECTOR							
Agriculture	25.1	25.2	25.2	25.3	25.3	26.1	26.7
Crops	18.3	18.5	18.7	19.2.91	19.1	19.9	20.6
Livestock	3.1	3.1	2.9	1.2	2.9	2.8	2.7
Forestry and Hunting	1.3	1.2	1.3	2.3	1.2	1.2	1.2
Fishing	2.4	2.4	2.3	1.8	2.3	2.2	2.2
Mining and Quarrying	1.4	1.5	1.6	7.3	2.1	2.5	2.8
Manufacturing	7.3	7.5	7.4	7.3	7.2	7.0	6.8
Electricity and water Supply	1.7	1.7	1.6	1.7	1.6	1.6	1.6
Construction	4.2	4.2	4.4	4.5	4.6	4.7	4.7
Trade, Hotels and Restaurants	12.4	12.3	12.2	11.9	11.7	11.6	11.6
Transport and Communication	4.9	4.9	4.7	4.7	4.6	4.5	4.4
Finance and Business Services	5.8	5,7	5.5	5.7	5.7	5.6	5.7
(Percentages)							
Industry	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Public Administration	10.9	10.6	10.5	10.3	9.7	9.2	8.8
Less Financial Services-Indirectly Measured	-2.4	-2.3	-2.1	-1.9	-2	-1.8	-1.7
TOTAL A	71.0	71.2	71.0	71.2	71	71.0	71.5
B: NON-MONETIZED SECTOR							
Agriculture	20.0	19.8	19.5	19.3	19.4	20.0	19.5
Crops	16.3	16.2	16.0	15.8	15.9	16.5	16.1
Livestock	1.5	1.5	1.4	1.4	1.4	1.3	1.3
Forestry and Hunting	1.9	1.9	1.9	1.9	1.9	1.9	1.8
Fishing	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Construction	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Owner Occupied Dwellings	7.9	8.0	8.6	8.6	8.1	8.1	8.1

TOTAL B	28.7	28.8	29	28.8	29.0	29.0	28.5
C: TOTAL GDP(A+B)	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: The Economic Survey 2005, Planning Commission. B.o.T (Economic Bulletin Quarter, March 2005)

Table 4.2: Gross Domestic Product at Factor Cost by Industry and Current Prices

Industry	1999	2000	2001	2002	2003	2004	2005
A: MONETIZED SECTOR							
Agriculture	1,500,572	1,690,855	1,919,704	2,205,161	2,508,853	2,958,063	3,483,352
Crops	1,096,536	1,240,503	1,427,781	1,649,209	1,877,152	2,252,582	2,686,155
Livestock	187,737	206,042	220,973	248,102	281,408	312,363	348,285
Forestry and Hunting	74,831	83,271	95,366	107,764	121,234	139,419	161,726
Fishing	141,468	161,039	175,584	200,086	229,059	253,698	287,187
Mining and Quarrying	85,792	107,846	120,454	152,977	210,574	278,262	368,141
Manufacturing	434,544	499,726	564,689	638,663	710,951	791,416	891,135
Electricity & water Supply	101,301	112,753	124,789	145,753	156,963	177,614	202,499
Construction	253,447	282,150	335,924	389,671	454,163	532,017	619,799
Trade, Hotels and Restaurants	740,181	823,025	926,870	1,038,094	1,153,323	1,319,172	1,513,090
Transport and Communication	294,180	328,259	361,558	404,945	451,281	509,948	580,754
Financial and Business services	345,071	382,969	421,511	494,801	564,334	637,127	739,110
Public Administration	649,553	709,351	796,930	893,083	956,209	1,044,229	1,154,682
Less Financial Services-Indirectly measured	-144,756	-151,359	-157,785	-168,830	-194,155	-204,494	-215,833
TOTAL A	4,259,885	4,785,575	5,414,643	6,194,318	6,972,496	8,043,355	9,336,729
B: NON MONETIZED SECTOR							
Agriculture	1,193,802	1,331,394	1,486,442	1,679,360	1,909,002	2,269,394	2,542,496
Crops	974,491	1,087,285	1,216,257	1,374,643	1,564,638	1,872,304	2,098,713
Livestock	90,097	100,351	107,626	120,839	137,061	152,138	172,886
Forestry and Hunting	112,984	125,351	143,050	161,646	181,852	215,633	237,707
Fishing	16,230	18,408	19,509	22,232	25,451	29,320	33,190
Construction	52,412	61,205	69,235	80,313	91,958	105,752	122,113
Owner-Occu	471,601	537,625	654,295	745,896	842,863	913,138	1,061,979
TOTAL B	1,717,815	1,930,224	2,209,972	2,505,569	2,843,823	3,288,284	3,726,588
TOTAL GDPfc {A+B}	5,977,700	6,715,801	7,624,615	8,699,887	9,816,319	11,331,638	13,063,317

Source: The Economic Survey 2005, Planning Commission. B.o.T {Economic Bulletin Quarter, March 2005)

The statistical data available in 2004 indicate that foreign trade was dominated by agricultural produce. Cut flowers had the lead earning 9,568,489,290 TShs; 10,387,642,503 TShs; 6,287,307,798 TShs; and 15,251,027,900 TShs respectively for 2001, 2002, 2003 and 2004. There was an increase of 7.8 % between 2001 and 2002.This was followed by a slowdown of up to 41% and then rose to peak off of 15,251,027,900 TShs, an increase of 31.88% in 2004.

During the same period, fruits generated 1,190,956,808 TShs in 2001; 1,114,803,760 TShs in 2002; 2,640,614,884 TShs in 2003; and 916,596,465 TShs in 2004. Likewise, vegetables generated 19,852,110 TShs in 2001; 34,332,784 TShs in 2002; 18,388,962 TShs in 2003; and 11,016,651 TShs in 2004. The recorded quantities and values of exports of traditional crops between 1997 and 2005 are shown in the tables below: (Basic Data Agricultural and Cooperative sector, 1998/99-2004/05).

Table 4.3: Quantity of Traditional Crop Exports, Tanzania ('000 tons)

Crop	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Coffee	47.30	44.70	39.00	54.40	48.22	36.37	46.22	38.53	46.10
Cotton	86.30	37.30	26.30	36.80	36.80	33.30	40.34	47.33	112.90
Sisal	15.10	11.60	15.50	13.40	13.90	12.84	13,03	11.93	9.30
Tea	21.60	22.10	21.40	22.60	23.00	24.31	20.86	21.72	21.80
Tobacco	27.90	26.30	21.40	19.20	18.70	24.15	22.51	29.20	31.10
Cashews	121.90	164.70	102.00	101.80	95.00	75.87	73.39	83.19	62.00

Source: The Economic Survey 2005, Planning Commission.

Table 4.4: Value of Traditional Crop Exports in Millions of TShs, Tanzania

Crop	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Coffee	72,743.7	72,280.2	56995.0	67,058.2	49,603.4	33,684.0	51,163.0	53,176.0	83,577.0
Cotton seed	79,623.4	31,647.3	21,744.7	30,262.9	29,173.2	27,039.0	42,430.0	54,295.0	127,178.0
Sisal	5,591.0	4,507.5	5,380.8	4,165.6	5,864.8	6,311.0	6,946.0	7,447.0	8,178.0
Tea	19,498.4	20,091.1	18,305.6	26,213.2	25,275.4	28,341.0	25,726.0	32,480.0	28,837.0

Tobacco	33,060.1	36,671.5	31,998.6	30,718.9	32,292.4	48,147.0	47,295.0	61,585.0	91.394.0
Raw Cashew nuts	55,513.3	71,806.1	79.197.2	67,652.1	50,940.7	45,275.0	43,377.0	74,069.0	54,244.0

Source: The Economic Survey 2005, Planning Commission. B.o.T {Economic Bulletin Quarter ended March 2005)

The Mara region recorded a Gross Domestic Product of 95,360 million TShs in 1995 at current prices. The region's economic performance trend over 1995 to 2000 showed some growth, and by the year ending 2000, the region's GDP had reached 245,495 million TShs, an increase of 157%. The rate of growth from one year to the next varied, initially growing by over 20% during the first three years, followed by a period of slower growth during 1998 and 1999, and then picking up to 21% in 2000 (Mara region socio-economic profile, June, 2003).

Table 4.5: GDP and Per Capita GDP 1995 to 2000, Mara Region, Tanzania

Year	GDP at current prices in TShs Millions	% change	Per capita GDP at current prices in TShs and in US Dollars			Average % contribution to National GDP
			TShs	Exchange rate	US Dollars	
1995	95,360	-	81,476	575	142	3.41
1996	117,423	23	97,686	580	168	3.40
1997	146,924	25	118,734	612	194	3.43
1998	173,550	18	136,055	665	205	3.39
1999	202,241	17	153,804	744	207	3.38
2000	245,495	21	181,113	800	226	3.68
Average	204,372		128,145		190	3.45

Source: National Accounts of Tanzania, Bureau of Statistics Dar es Salaam, 2000.

The Mara region contributed significantly to the Nation's economy with contributions from 3.38% in 1999 to 3.68% in the year 2000. On average, the region's annual GDP contribution in the national GDP in the six years was 3.45%, ranked 13th among Tanzania mainland regions (Mara region socio-economic profile, June, 2003).

Table 4.6: Regional GDP Contributions to the National Economy, Tanzania

Region	Average annual contribution	Ranking
Mara	3.45	13
Dodoma	3.49	12

Arusha	7.59	3
Morogoro	4.55	7
Kilimanjaro	4.23	8
Tanga	4.11	9
Coast	2.17	18
Dar es Salaam	17.67	1
Lindi	2.22	17
Mtwara	3.35	14
Ruvuma	3.80	10
Iringa	6.46	5
Mbeya	5.72	6
Singida	2.99	15
Tabora	3.80	10
Rukwa	3.76	11
Kigoma	2.45	16
Shinyanga	8.09	2
Kagera	3.80	10
Mwanza	7.24	4

Source: National Accounts of Tanzania, Bureau of statistics Dar es Salaam, 2000.

In Mara region average individual annual income (per capita GDP) had improved greatly from 81,476 TShs in 1995 to 181,113 TShs in 2000 at current prices. This was an increase of 122%. Notwithstanding the fall of TShs from 575 to 800 relative to the US Dollar during the period, the people in the region were still economically better off than before. In 1995, they earned per capita 142 US Dollars, while in 2000 they had per capita income 226 US Dollars. (Basic Data Agricultural and Cooperative sector, 1998/99-2004/05).

The table below shows the Mara region's per capita GDP ranking among other regions in Tanzania mainland for 2000. The Region was ranked 9th overall; namely, it was among the 10 best performing regions in the country in terms of annual income per capita. (Basic Data Agricultural and Cooperative sector, 1998/99-2004/05).

Table 4.7: Regional Per Capita Ranking in 2000, Tanzania

Rank	Region	Per Capita Income (TShs)
1	Dar es Salaam	512,710
2	Shinyanga	260,040

3	Arusha	248,664
4	Ruvuma	222,406
5	Mtwara	221,378
6	Rukwa	219,990
7	Iringa	214,575
8	Mwanza	184,513
9	Mara	181,113
10	Singida	179,795
11	Tabora	176,325
12	Mbeya	174,544
13	Morogoro	171,530
14	Lindi	171,052
15	Coast	167,879
16	Tanga	163,695
17	Kagera	138,557
18	Kilimanjaro	137,597
19	Dodoma	135,718
20	Kigoma	133,127

Source: National Accounts of Tanzania, Bureau of Statistics Dar es Salaam, 2000.

4.2 Crop Production

4.2.1 Features of Kenyan and Tanzanian Agriculture

4.2.1.1 Land Resource Base

Kenya

Land is the most important resource in crop production, and limited availability of productive land inhibits increased agricultural production. Kenya has a total area of 587,000 km^2 of which about 11,000 km^2 is water. Of the remaining 576,000 km^2 landmass, only 11% is arable (i.e., of high and medium agricultural potential with adequate and reliable rainfall). This high and medium potential arable land is dominated by subsistence and commercial agriculture with cropland occupying 31%, grazing land accounting for 30%, and forests occupying 22%. The remaining land is used as game parks and reserves, urban centers, markets, homesteads, and infrastructure.

Approximately 84% of Kenya is arid and semi-arid and therefore is not suitable for rain-fed crop production due to low and unreliable rainfall. The Arid and Semi Arid Lands

(ASAL's) are used by ranches, semi-pastoralists and pastoralists as rangelands. In the Mara River Basin (Narok, Bomet, Transmara and Nakuru districts), total land area is 26,677.2 km^2, water surface 293 km^2 , arable land area 12,608 km^2, non arable land area 12,558 km^2, gazetted forest cover 1,688.94 km^2, non gazetted forests 930 km^2, County Council forests 480 km^2 and urban area 1,602.5 km^2.

Tanzania

Tanzania is the world's 31st largest country with a total area of 945,087 km^2. Central Tanzania comprises a large plateau with plains and arable land. The eastern shore is hot and humid with the island of Zanzibar lying just offshore. Tanzania is mountainous in the northeast where Mt. Kilimanjaro, Africa's highest peak, is situated. To the north and west are the great lakes of Lake Victoria (Africa's largest lake) and Lake Tanganyika (Africa's deepest lake, known for its unique fish species). Tanzania contains many large and significant wildlife parks including the famous Ngorongoro crater and Serengeti National park in the north, Selous Game reserve and Mikumi National park in the south, and Gombe National park in the west. The Mara region has a total surface area of 30,150 km^2, of which 10,584 km^2 is water (mainly Lake Victoria), leaving a total land area of 19,566 km^2. The Mara region has the third largest water surface area after the Kagera region at 11, 885 km^2 and the Mwanza region at 15,092 km^2. The region comprises Musoma rural, Serengeti, and Tarime districts with a total land area 19,566 km^2, each consisting of 1,957 km^2, 3,885 km^2, and 10,942 km^2 respectively.

Table 4.8: Distribution of Land and Water Areas, Mara Districts, Kenya (km^2)

District	Total surface area	Water area	Arable land	Non arable land	Gazetted forest area	Non Gazetted forest area	County Council Trust land forest	Urban areas
Narok	15,087	Non	4,500	10,588	724	930	480	943
Bomet	1,416.2	Non	1,204	212	50.04	Nil	Nil	225
Trans mara	2,932	10	1,580	1,300	Nil	Nil	Nil	10
Nakuru	7,242	283	5,274	1,685	914.9	Nil	Nil	424.5
Totals	26,677.2	293	12,608	12,558	1,688.94	930	480	1.602.5

Source: District Development Plans 2002-2008 for Narok, Bomet, Transmara and Nakuru Districts
Nil: No forest areas

Table 4.9: Distribution of Land and Water Areas, Mara Districts, Tanzania (km^2)

District	Total surface area	Water area	Land area	Arable land	Non arable land	Gazetted forest area	Non Gazetted forest area	Urban areas
Musoma Rural	4,309	2,352	1,957	**	**	**	**	**
Tarime	11,137	7,252	3,885	**	**	**	**	**
Serengeti	10,942	-	10,942	**	**	**	**	**
Totals	30,150	10,584	19,566	2,500	**	**	**	**

Source: Tanzania. Mara Region Socio-Economic Profile, June, 2003
**: Data not available

4.2.1.2 Climate and Agro-ecological Zones in the Mara Region

Kenya

Based on soils and climatic conditions, Kenya is divided into the following seven distinct agro-ecological zones: Tropical Alpine, Upper Highland, Lower Highland, Upper Midland, Lower Midland, Lowland, and Coastal Lands. The country is further divided into high, medium and low rainfall zones. The high rainfall zone receives over 1000 mm per annum, occupies less than 20% of the productive agricultural land, and carries more than 50% of the country's population. Most food and livestock are produced in this zone under semi-intensive and intensive systems. The zone accounts for all the tea, pyrethrum, coffee, potatoes, and nearly 75% of milk and vegetables. The medium rainfall zone receives between 750-1000 mm of rainfall annually, occupies between 30-35% of the country's land area, and is home to 30% of the population. There is a significant immigration of people from the densely populated high rainfall zone to the medium rainfall zone. Farmers in this zone keep cattle and small stock, and grow drought resistant crop varieties. The low rainfall zone is characterized by 200-350 mm of rain annually and has about 20% of the country's population, 80% of the country's livestock and 65% of wildlife (Strategy for Revitalizing Agriculture, 2004-2014).

Mara Region

The Mara region districts (Nakuru, Bomet, Narok and Transmara) exhibit similar climatic and agro-ecological zones. Nakuru District represented by Ole Nguruone and Mau Narok Divisions at approximately 2,400 meters above sea level is in a high rainfall zone, with approximately 1,270 mm of annual rainfall. The major crops are tea, potatoes, and pyrethrum. Dairy and wool sheep farming are also practiced. The population recorded during the last census was 215,250 persons for the two divisions representing the newly created Molo District.

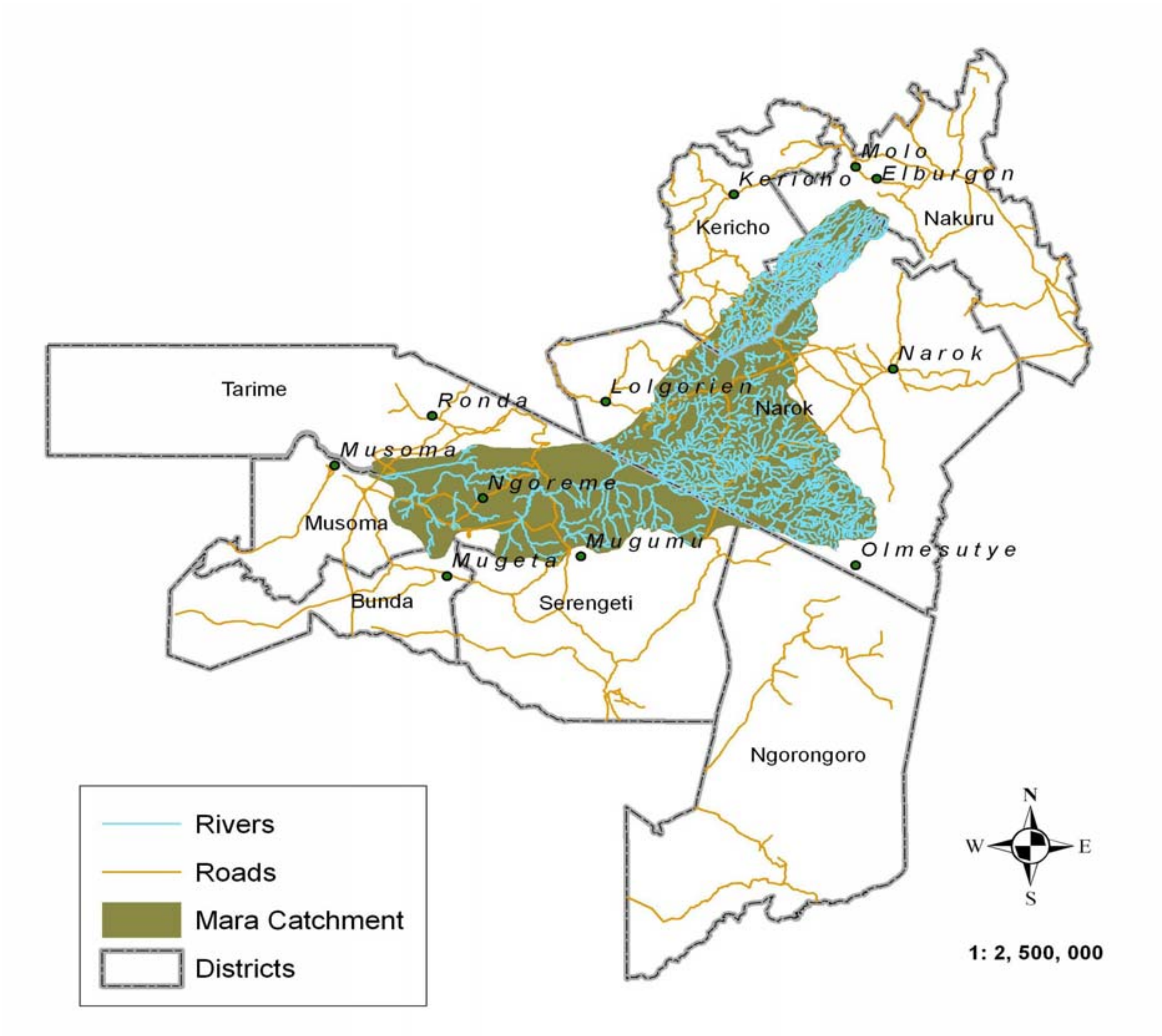


Figure 4.2: Mara Basin Catchment

Bomet District extends between 900-1,850 meters above sea level, has both high and medium rainfall zones, and experiences 1,100-1,500 mm of annual rainfall. There are large-scale wheat farms as well as smaller mixed maize and bean farms in the district.

The Mara River flows within the boundaries of the newly created Narok South District. At 1,000 -3,098 meters above sea level, this district is in high, medium, and low rainfall zones. Annual rainfall averages 500-1,800 mm. The population recorded during the 2002 census was 403,812 persons. The district is famous for its wheat production and boasts of large-scale farms (exceeding 10,000 hectares) making up the landscape. The lower reaches of the district comprise the savannah grassland system that is home to the famous Masai Mara Game Reserve. The reserve is located between 1,500 and 2,100 meters above mean sea level and occupies approximately 1,510 km^2. There are a number of ranches in this zone, which provide alternative grazing areas for the game reserve and are popularly known as the dispersal areas.

The Transmara District is between 900-2,500 meters above sea level and, as in the case of Narok South District, is within medium and low rainfall zones. The Mara Triangle, an extension of the Mara Game Reserve is located in this district. Annual rainfall averages 930.9 mm. The population recorded during the last census was 182,070 persons.

Tanzania

In Tanzania, the identification of different agro-ecological zones is primarily based on the topographic, geographic, and climatic features. The Mara region falls into low land, middle land, and high land distinct agro-ecological zones.

The low land zone at 1,120-1,300 meters above sea level is a lake shore strip of land approximately 10-15 km long in the Tarime and Musoma rural districts. Annual rainfall averages 900 mm. The projected population for the two districts in 2003 was approximately 958,000 persons. The farming system has been influenced by population pressure, infertile soil and alternative economic activities such as fishing. The main food crop is cassava intercropped with sweet potatoes, occupying 35% of the food crop land in the zone. The other food crops grown in the zone include sorghum, maize, finger millet, ground nuts, and other legumes. Cotton is the main cash crop.

The midland zone, between the lake shore and the highlands strides all three districts. Annual rainfall ranges between 900-1,250 mm, increases with altitude, and is highly variable. Cotton and chickpeas are cultivated as cash crops.

The high land zone is confined exclusively in the Tarime District. The annual rainfall exceeds 1,500 mm and is distributed in two rainy seasons. The projected population was 182,000 persons in 2003, over 12% of who make their living from agricultural activities. Farming in this zone is based on cattle, maize, cassava, and sorghum. Coffee is the main cash crop followed by sorghum and tobacco.

4.2.1.3 Soil Types in the Mara Catchment

Kenya

In Kenya, the soils geologically consist of volcanic rocks and the crystalline bedrock located in the Mau escarpment. In the middle and along the river basin, the geology is dominated by river alluvium rocks. The upper catchment is dominated by well drained and moderately deep, reddish brown to brown soil types. The middle basin is dominated by the imperfectly drained, moderately deep to deep soils. The lower basin is characterized by very dark, and gray to black soils.

These soils support a variety of farming activities including tropical forests at the top of the Mau escarpment, the tea cultivation in the high rainfall zone, the large scale maize, wheat and barley growing in the medium rainfall zone, and the savannah grassland that is the Masai Mara Serengeti ecosystem. The savannah grassland supports a rich biodiversity including wildlife and domestic livestock in the low rainfall zone.

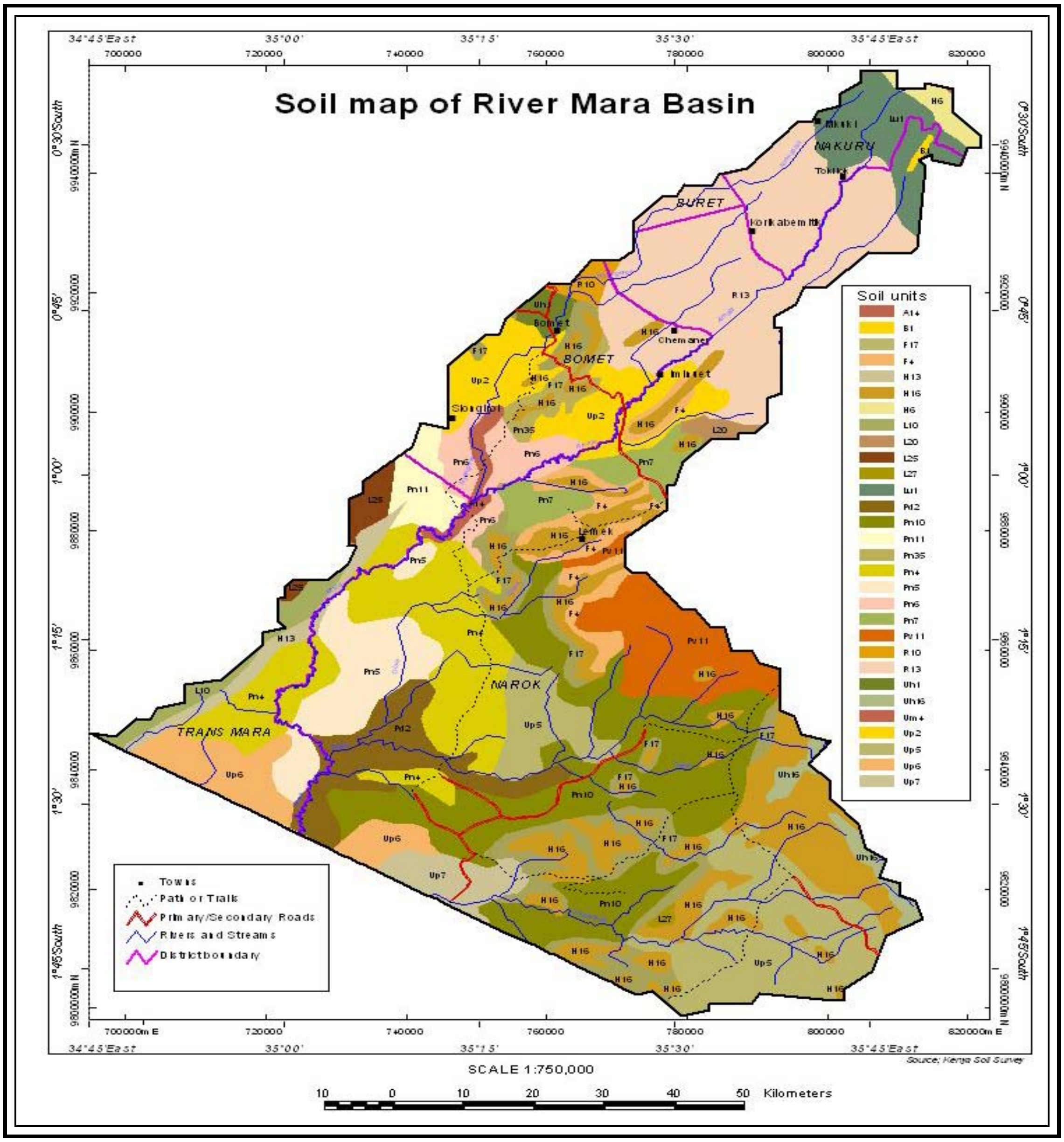


Figure 4.3: Soil Map of the Mara Basin, Kenya

Tanzania

The Mara River traverses the Mara–Serengeti savannah grassland ecosystem and crosses into the Mara region. The geological stratum of the basin is a flat sheet of dark gray basalt associated with volcanic rocks. These rocks have enriched the soils in the middle and lower reaches of the river. The soils have provided adequate nutrients to the Serengeti savannah ecosystem and support a large variety of herbivores along the river. In the Tarime District, the soils are deep, well drained and brown. These soils are fertile and support high potential croplands in the district. A number of valuable cash crops including coffee, groundnuts, and tobacco are cultivated in the district. Cotton and sunflower are also cultivated. In Musoma Rural, the alluvial deposits carried by the river from the Mau escarpment in the Kenyan highlands are deposited to provide a rich flat layer for cultivation. The main food crops are cassava intercropped with sweet potatoes.

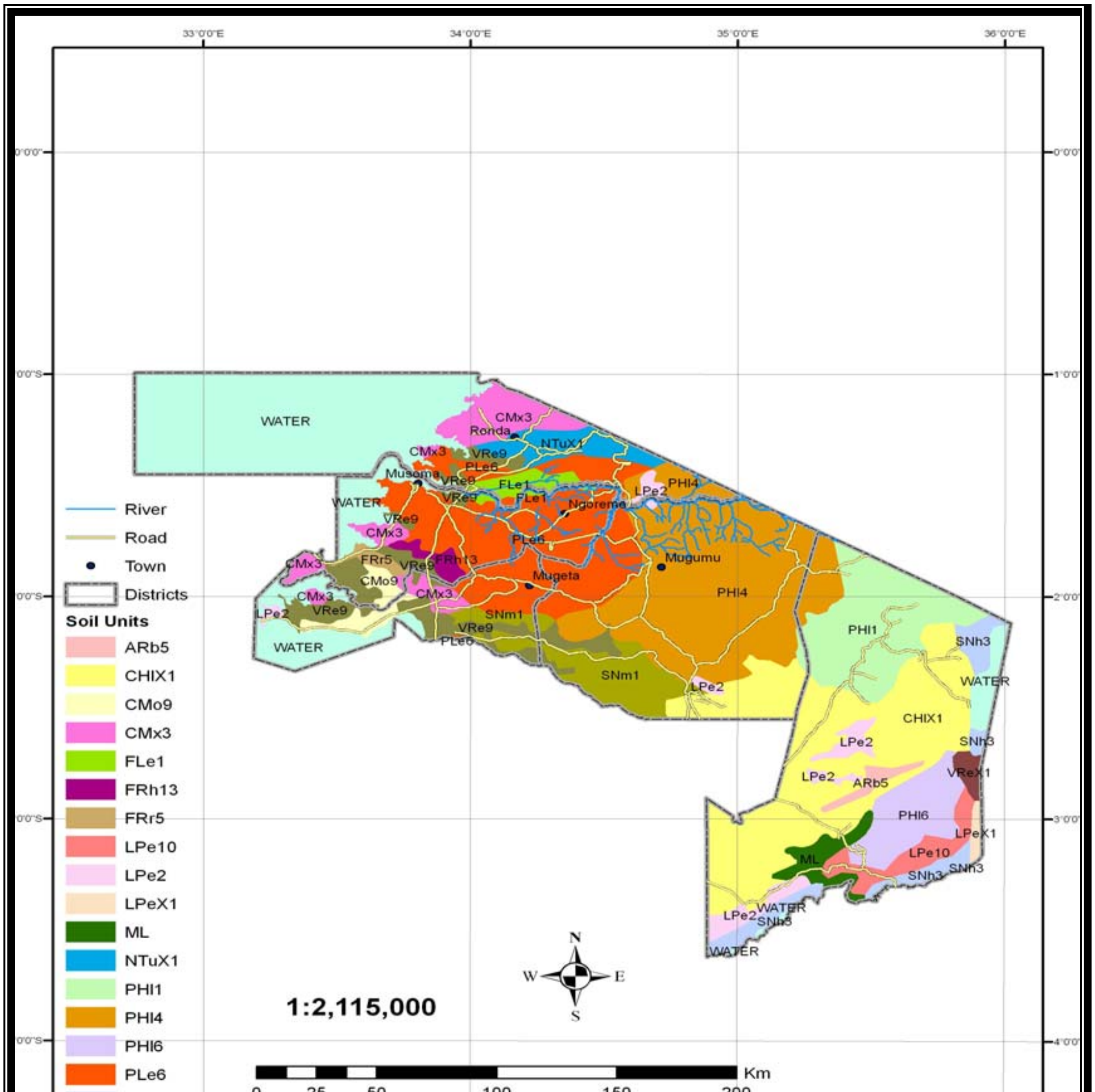


Figure 4.4: Soil Map of the Mara Basin, Tanzania

4.2.1.4 Land Tenure Systems

Kenya

The land tenure regime in Kenya is classified into three broad categories: communal, government trust, and private. The communal land ownership system is based on traditional customary rights, according to which all individuals born in that community have a right to use but not sell this land. Government trust land is held by ministries, state corporations, or other public institutions for public use (such as buildings, forests, research and national parks). Privately owned lands are registered and the owners hold titles under a freehold or leasehold system. The owners of private land are free to use their titles as collateral for bank credits. This system has encouraged investment in permanent and long term improvements and development on agricultural farms and has created a market for land.

In the Mara River Basin land tenure system is mixed. The highlands (upper catchments), where the small-scale farmers are found, are predominantly private holdings sold by the original title holders. In this upper section of the basin, land is mainly privately owned, with 46% of the population owning the land and having title deeds, and 22% owning the land without title deeds (Aboud et al 2002). In the middle section and the lowlands, land ownership is still communal, family ranches, or group ranches. Rangelands are largely used as group ranches but with an increasing trend towards subdivision into individual holdings. Most of the high potential ranches have been leased to commercial wheat farmers.

The mean land holding size in the upper catchments is 46.0 ha ranging between a minimum size of 0.6 ha and a maximum size of 630 ha. By contrast, in the middle catchment, land holding size ranges from 1.0 to 2.0 hectares (Aboud et al 2002). In recent years, the government of Kenya has adopted a policy promoting subdivision of group ranches in this region. This policy has serious implications for the Masai people and natural resources sustainability within the Mara River Basin.

Cultivation is far less compatible with wildlife than pastoralism, and any changes toward cultivation will have significant implications to wildlife that utilize the Mara Game Reserve and adjacent group ranches as dispersal areas. The government should promote conservation under the individual tenure system by encouraging wildlife-based enterprises and conservation easements.

Tanzania

The legal and administrative land tenure system in Tanzania mainland has its roots in the colonial period. The land regimes established by the Germans (1885-1916) and the British (1918-61) colonial authorities assumed that the indigenous occupants had no ownership rights over land. This was only a convenient assumption since the colonial state was interested in exercising political sovereignty as well as exploiting the natural and human resources.

The British land policy was influenced by two major considerations: the status of Tanganyika as a trust territory and the development of the colonial peasant/plantation economy for the production of cheap agricultural raw materials. The legal regime developed by the British was based on giving the state a free hand and when necessary to control and alienate indigenous land unencumbered by any legal obligations. On the other hand, the colonial state had to legitimize laws and actions in the interests of the native population as required by the trusteeship agreement.

The land ordinance passed by the British in 1923 sought to do this by preserving state control over land by vesting the radical title in the state and defining customary tenure regime without entrenching customary titles. Section 2 and 3 of the ordinance declared all land to be public lands under the control and subject to the disposition of the Governor. The omission of the Customary rights from the 1923 land ordinance raised criticism in the permanent Mandates Commission of the League of Nations; hence, the 1928 amendment was developed, which expanded the right of occupancy to include the native (or a native community) title lawfully using/occupying the land in accordance with the native laws and customs. Since then, the Customary Land titles have come to be called 'deemed rights of occupancy' (Tanzania Ministry of Lands Housing and Urban Development Arusha, Dar es Salaam (1995).

The post independence government inherited the colonial land law, which reinforced the perception among politicians and bureaucrats that all lands not occupied under granted rights were public and at the disposal of the President. Such lands were occupied not so much as a matter of legal rights but at the discretion of the President. The Tanzania National Land Policy sought to promote equitable distribution of land and its access by all citizens. The major thrust was land conversion as an economic asset to which all citizens should have equal access. The policy also sought to recognize, clarify and secure in law the existing rights in land especially customary rights of small holders Tanzania Ministry of Lands Housing and Urban Development Arusha, Dar es Salaam (1995).

The Rural Lands (planning utilization) Act of 1973 (No.14) was an attempt to confer open-ended powers on the President and appropriate ministers to extinguish customary rights without due process or any legal redress. The act gave the President uncontrolled powers to declare any part of Tanzania a 'specified area.' Villages and Ujamaa villages Act of 1975 (No. 21) did not provide for land tenure as such, but it is an enabling piece of legislation delimiting the territorial jurisdiction of villages and providing for their registration. Demarcation of the boundaries does not amount to vesting any ownership rights in the village.

All land in Tanzania is held in trust by the President on behalf of all Tanzanians and is therefore public property. In order to ensure higher security of land tenure, Tanzania has three laws, namely, the Land Act No. 4 of 1999, the Village Land Act No. 5 of 1999, and the Land Disputes Act No. 2 of 2002. The general purpose of these laws is to make sure that the land policy objectives are achieved. There are three types of land ownership in Tanzania.

- Reserved land: Categorized as land under wildlife, forests, national parks, and other similar land types;
- The general land: Refers to land under the management of the Commissioner of Lands, and it includes all land not occupied under granted rights of occupancy;
- Village land: Categorized as all land inside the boundaries of villages. Under the Villages and Ujamaa villages Act of 1975 (No. 21), directions were given by the minister in charge providing for the allocation of land in villages. Village councils and assemblies were given power, through the Village Land Act, to oversee the distribution and management of village land. The village land was to be allocated by the District Development Councils. The village councils would in turn allocate each household (kaya) a piece of farmland and an acre of land for a dwelling house. An allotee could not dispose of this land without approval of the village council.

In the Mara region in particular, villages were relocated and boundaries redrawn. This left boundary problems between and among villages which remain unresolved to this day. Unscrupulous officials have taken advantage of this confusion to allocate village land to powerful and rich outsiders at the expense of villagers. To prevent encroachment and land grabbing by outsiders, a village titling program should be initiated to facilitate individual subtitling. This will also provide the basis of mortgage credit (Shirji, 1998).

4.2.1.5 Land Use

Kenya

According to recent discussions with district government officials in 2008 (Mara region Kenyan districts), land ownership regime has been the driving force of change in land use in the upper catchment of Mara River Basin. The various land uses in this section are causing forest cover to decline rapidly and are degrading water catchment areas. The impacts of these ecological changes are soil erosion in the highlands, heavy siltation downstream, and increased flood risk. Secondly, the reduction of catchment areas to cultivation has reduced the level of water reaching the downstream plains.

In general, however, land use types and patterns in the basin follow the rainfall regimes and are therefore determined by the dominant soils and climatic characteristics in a particular locality. The land use types in the Mara River basin can therefore be divided into four specific sections. The first (upper catchment) and second sections dominate the Kenyan side, where as the third section strides the Masai Mara Game Reserve in Kenya and Serengeti National Park in Tanzania.

The first (upper catchment) section comprises the forested Mau Escarpment at approximately 2400-2900 meters above sea level. This section mainly includes the upper catchment and source of the Mara River and the Mau Forest at 2500 meters above sea level, and it covers approximately 82,410 ha. This forest therefore constitutes the uppermost part of the Mara River Basin. The mean annual rainfall is about 1400-1800 mm. The Enapuiyapui swamp located in the Kiptunga forest is in this section as well. The protected South West Mau Forest

Reserve between 2,000-2,400 meters above sea level, forms the southwest boundary of the river and occupies approximately 43,516 ha. This forest has a very important ecological function as it is the source for many rivers flowing into Lake Victoria, and offers sanctuary to many birds' species and animals, particularly elephants. Besides the Mau, there are a few forest plantations that provide timber for tea factories in the area.

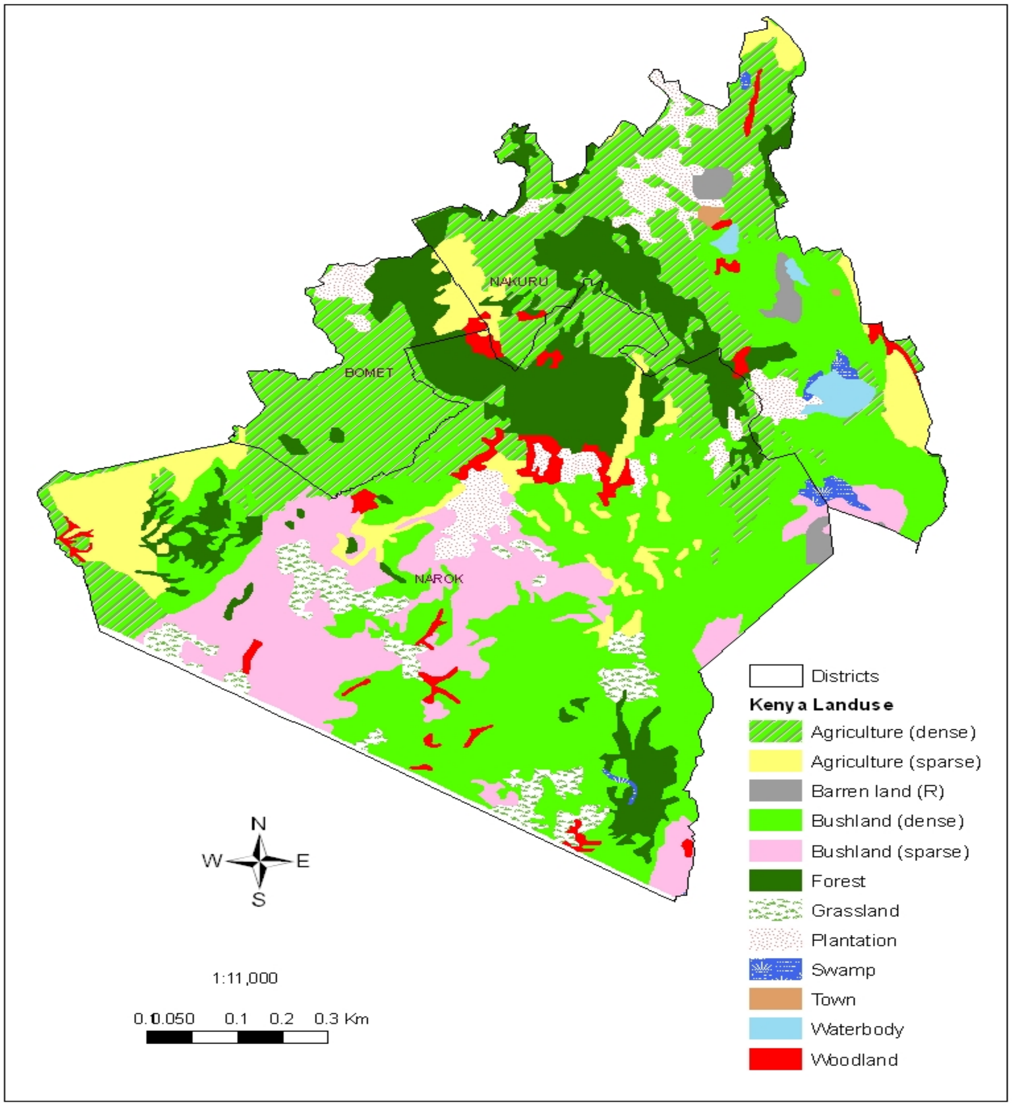


Figure 4.5: Mara Land Use Types, Kenya

The second section includes the large-scale wheat, barley, and maize farms, laying just below the Mau forest with the protected South West Mau Reserve to the west. This section is dotted with production plots in excess of 100 hectares. The agricultural activities also include dairy farming and sheep rearing. The high potential growth areas east of Mau and parts of Transmara, at approximately 1600-2000 meters above sea level, provide suitable agronomic and conducive socio-economic conditions for vibrant small and medium scale farming systems. Production plots range between 5-20 hectares.

The farmers in these areas practice mixed cropping of maize, beans, and potatoes. The main cash crops are tea and dairy farming. The average family size is eight. In the medium potential areas at, approximately 1300-1600 meters above sea level, subsistence farming activities persist and maize and beans are the main crops cultivated. Land holdings in these areas average 2-3 acres. The average family size here is also eight.

The third (shrub lands and grasslands used for grazing or as game reserves, savannah grasslands) section, between 1500 and 2100 meters above mean sea level, includes the group ranches and the sprawling Masai Mara–Serengeti Wildlife ecosystem and occupies approximately 1510 km2. This section is characterized by marginal areas with low and unreliable rainfall. The main activity is livestock production (ranches) and wildlife conservation (Technical Report No.160-DRSRS, March 2006).

Tanzania

The fourth section covering the Mara River flood plains lies wholly in Tanzania, at the mouth of the river estuary into Lake Victoria, the ultimate destination of the Mara River at Mara Bay. This section is characterized by high population density and has 20% of Tanzania's livestock population. The latest head count (2003) recorded approximately 2.1 million heads of cattle and a large portion of sheep and goats. The predominant land use pattern in this section is small scale, mixed farming for maize, beans, and sorghum. The Masurura swamp, an extensive wetland, occupies the lower reaches of the river and extends to the Mara Bay, which is the discharge point into Lake Victoria. The expansive Masurura swamp strides the lowland flood plains before the river finally discharges into the Lake. Fishing is an important and integral part of the economic activities (Mara River Basin Transboundary Water Resources Management and Development Project Document).

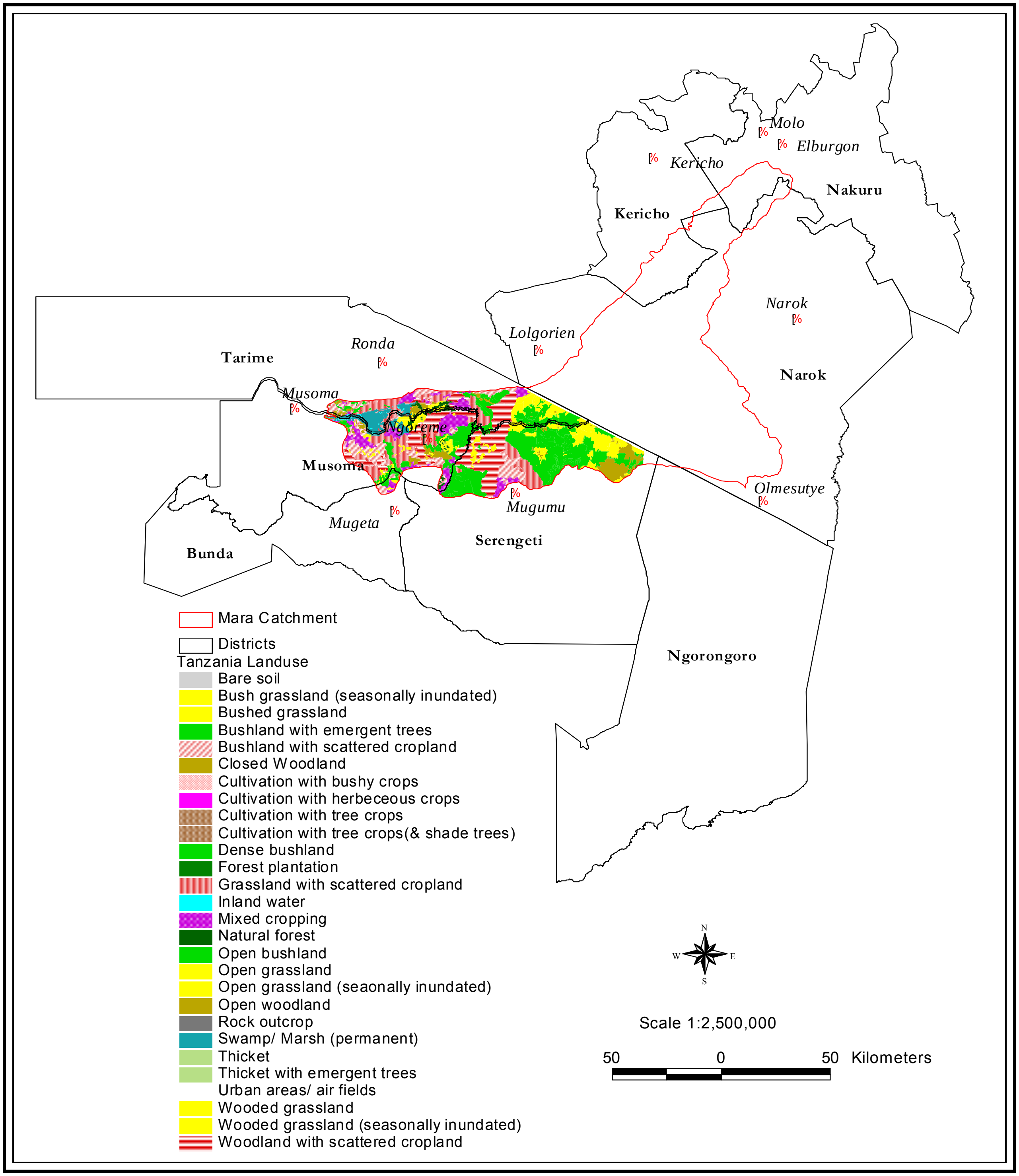


Figure 4.6: Mara Land Use Types, Tanzania

4.2.1.6 Land Use Issues

In general, the major land use/covers in the Mara Basin include closed forest, open forest and tea in the upper mountain slopes, agricultural land, shrub lands and grasslands used for grazing or as game reserves, savannah grasslands, which comprise shrub-grasslands, and wetlands. The Mara River Basin is predominantly a rangeland and in 1986 (based on satellite imageries), about 69 % (9,594 km^2) of the land was under natural pasture, as savannah, grasslands or shrub lands, mostly used for grazing livestock and/or wildlife reserves (Mati, et al 2005).

However, by 2000, these rangelands had been reduced by 24 % to only 7,245 km^2 due to encroachment by agriculture, whose area has increased by 55 % (Mati, et al 2005). The natural vegetation has been declining as closed forests reduced by 23 % due to forest clearing for tea and human settlement, timber harvests and wood fuel (collection by the indigenous communities) which have increased opened land by 82 % (Mati, et al 2005). In the Mara River flood plains, the Masurura wetland in Tanzania expanded from 791 km^2 in 1986 to 1,394.4 km^2 in 2000. This build up has been associated with sediments downstream as a result of serious soil erosion in upper catchment in Kenya.

Kenya

In the upper catchment, land use issues are confined to changes to two ecological states:

- Mau forest complex cover is declining rapidly;
- Water catchment areas are being destroyed.

The impacts of these ecological changes are soil erosion in the highlands, heavy siltation downstream, and increased flood risk. Secondly, the reduction of catchment areas to cultivation has reduced the level of water reaching the downstream plains.

In the second (middle) section, expansion of large scale wheat cultivation and sub-division of group ranches has the dual impact of forest deforestation on one hand and fragmentation on the other. These issues are summarized below:

(i) Encroachment by agriculture into the forested areas:

- In 2000, farming activities had taken over 50% of forests in Narok, Transmara and Bomet, e.g., increased tea/open forest by 875 km^2 or 82% between 1986 and 2000.
- Private farms have encroached and reduced Mau forest complex by 50% from the original 45,000 hectares in 1986 due to unclear forest boundaries.
- In 1986, the Nyayo Tea Zone Corporation planned to excise 4,713 hectares of forest land for tea plantation in South east Mau, Transmara, and west Mau. In the end, approximately 2,152 hectares were cleared, and only 542 hectares were planted.
- The official buffer zone for the indigenous forest was marked at 100 meters; however, unscrupulous encroachment occurred up to 5 km inside the forests in all three districts.

- Excision of over 50% from Masai Mau forest to private farms due to unclear forest boundaries.

(ii) Deforestation/Clearing for tea cultivation and human settlement:
- Between 1986 and 2000, 204 km^2 of closed forest was cleared for tea growing in the Mau forest complex in Transmara, Bomet, Narok, and Nakuru districts.
- Excision of 20,000 hectares Mau forest complex for human settlement in Transmara, Bomet, Narok, and Nakuru districts leaving 16,832ha under forest cover in 1986.

(iii) Excision of forest land for human settlement:
- Between 1964 and 1999, 34,000 hectares of gazetted forest were excised in the Mau Forest Complex to settle landless people.

(iv) Encroachment into wetlands (Enapuiyapui swamp):
- The swamp size reduced from previous 50 acres in 1986 to less than 20 acres currently.

(v) Land fragmentation (Kenya):
- Originally (before 1986) mean land holding size in the upper catchment was 46.0 hectares with range between minimum size (0.6 hectares) and maximum size (630 hectares).
- Currently the land holdings are as follows due to fragmentation because of the sub division of group ranches and inheritance. Transmara-small scale-30 acres and large scale 100 acres; Narok-small scale 10 acres and large scale 80 acres; Bomet –small scale 5 acres and large scale 15 acres; Nakuru-small scale 2.5 acres and large scale 1,100 acres.
- In the lower catchment land holdings are approximately 1.9 hectares per agricultural household.

(vi) Expansion of urban development into agricultural lands.
- This phenomenon is currently happening in the newly created Narok South district. The district headquarters is located at Olulunga township. This is a wheat growing area and this township development will encroach into wheat growing land.

Tanzania

In the Mara region (Musoma Rural, Tarime, and Serengeti districts) land use issues include:

- Border problems between and among villages which remain unresolved to this day.
- Allocation of village land to powerful and rich outsiders at the expense of villagers.
- Heavy siltation downstream.
- Increased frequency of floods.
- Expansion of Masurura wetlands into predominantly agricultural lands in the flood plains of the Mara River basin.
- Soil acidification.

- Soil erosion.

These issues are summarized below:

(i) Encroachment and land grabbing by outsiders:

- The Government should encourage village titling program to facilitate individual subtitling. This will also provide the basis for mortgage credit.

(ii) Expansion of wetlands into agricultural lands:

- The Masurura wetland in Tanzania expanded from 791 km^2 in 1986 to 1394.4 km^2 in 2000.This build up has been associated with sediments downstream as a result of erosion in the upper catchment.

(iii) Soil acidification:

- Soil acidification has been reported to be associated with excessive use of nitrogenous fertilizers in crop fields and removal of basic cations such as Ca, Mg, and K due to leaching. Soil acidification reduces the productivity of poor and fragile soils.

(iv) Soil erosion:

- Livestock keeping and encroachment of forest has been reported to be major soil erosion causes in Tanzania. Soil erosion is also very common on steep slopes where there is vegetation clearing, intensive cultivation, and poor land management practices.

4.2.1.7 On-Going and Planned Mitigation Measures\Interventions

Table 4.10: On-going and Planned Interventions, Kenya

Land use issue	Districts covered	On-going intervention	Planned interventions
Encroachment by agriculture into the forested areas	Nakuru, Bomet, Narok Transmara	WWF-Integrated MRB Program for the protection of Mau forest complex.	Protection of forest cover. Community management of indigenous forests district-wide.
	Nakuru, Bomet, Narok Transmara	WWF-Integrated Mara River Basin Program for protection and restoration Mau forest complex ecosystem	WWF project to continue.
	Nakuru, Bomet, Narok Transmara	**Afforestation of degraded hills of Kapune, Nakuyana, Oloboisito, Olaui and Olondogopit**	Intensification of reforestation efforts through community mobilization
	Nakuru	Forest Department Projects: Establishment of forest plantation; Protection of Mau Forest complex; Fire break boundary clearing.	Agro-forestry extension program
Encroachment into wetlands	Nakuru(Molo)	WWF-MRB-dialogue Project for the restoration of Enaspuyipui swamp	Encouraging wetlands protection by

(Enaspuyipui swamp)		biodiversity status. Mara River Basin Initiative Project to document biodiversity values of the swamp.	educating farmers on sustainable agricultural wetlands use e.g. planting wetland friendly crops
Deforestation/ Clearing for tea cultivation and human settlement	Narok, Transmara Nakuru, Bomet	WWF-Integrated MRB Program for the protection of Mau forest complex.	Capacity building in wetland management. Intensify family planning campaign.
Excision of forest land for human settlement	Narok, Transmara Nakuru, Bomet	WWF-EARPO-Project (Protection of Mau forest complex). Population control. Family planning project in Transmara, Bomet and Nakuru districts.	Set aside land for industrial activities. Encourage family planning.
Land fragmentation	Narok, Transmara Nakuru, Bomet	Forest conservation. WWF Mau Forest Conservation Project	Incorporate the community in forest conservation.
Expansion of urban development into agricultural lands	Narok, Transmara Nakuru, Bomet	Ololunga project. The new district headquarters for Narok south.	Promote planned urbanization. Land Adjudication.
Expansion of wetlands into agricultural lands	Narok, Transmara Nakuru, Bomet	The Mara River Basin Management Initiative. WWF project.	Protection of river banks to prevent erosion. Encourage erosion conservation in hotspots such as hilltops.
Land degradation (soil erosion and Acidification) middle catchment	Narok Transmara Nakuru Bomet	LVEMP-Integrated Soil and Water Component. NALEP-Sida - Soil and Water Conservation Component. Capacity building in land management through Serengeti-Luangwa Ecosystem Management Project.	Land adjudication. protection of river banks to prevent erosion.
	Narok, Transmara Nakuru, Bomet	Ministry of agriculture Project: NALEP-.National Soil and Water Conservation project	
Land degradation in lower catchments including the Serengeti and Masurura swamp	Narok, Transmara Nakuru, Bomet	WWF-EARPO-Project (Protection of Mau forest complex and Enaspuyipui swamp) Narok, Transmara Nakuru, and Bomet. Improved management of human activities that degrade the Mara River Basin. Integrated Water Management project by LVEMP.	Intensification of upstream reforestation efforts through community mobilization

Table 4.11: On-going and Planned Interventions, Tanzania

Land use issue	Section	On-going intervention	Planned interventions
Village boundary conflicts/Village land use plans	Musoma Rural Serengeti Tarime	Conducting village land use plans; registering villages and obtaining registration certificates in accordance with the Village Land Act No. 5 of 1999. Secure land tenure to villagers will facilitate activities related to sustainable management of the Mara River Basin.	Land adjudication and demarcation.
Soil erosion	Musoma Rural Serengeti Tarime	District Agricultural Development Program, Environmental Education Program covering Musoma and Tarime Districts (executed by the WWF Eastern Africa Regional Program Office). Environmental education (EE) targeted as a development issue.	Integrated soil and water management.
Expansion of Masurura wetland into agricultural lands	Musoma Rural Tarime	WWF-Integrated MRB Program for biodiversity conservation in the Masurura swamp.	Soil and water conservation.
	Musoma Rural Serengeti Tarime	WWF Participatory and Integrated River Basin Management Project (IRBM). LVEMP Integrated Water Management Plan for the Mara River funded by the World Bank NGO (e.g. the Vi Agro forestry).	Soil and water conservation.
Restoration of Riparian Ecosystem	Musoma Rural Serengeti Tarime	Integrated River Basin Management (IRBM) and poverty eradication exist.	Protection of river banks to prevent erosion. Encouraging erosion conservation in hotspots such as hilltops.
Problem of poor water quality and	Musoma Rural Serengeti Tarime	Integrated River Basin Management (IRBM) and poverty eradication exist, Musoma laboratory project.	Water quality analysis.
Flood control and restoration of riparian ecosystems	Musoma Rural Serengeti Tarime	Village forest reserves project to enhance restoration of riparian ecosystems and flood controls. Mara region officials and communities are proposing to create village forest reserves totaling 64,205 ha.	Extension of micro-catchment damming for irrigated rice farming in the basin.

4.2.1.8 Proposed Mitigation Measures\Interventions

As emphasized above, lack of clear land use and environmental policies in both Kenya and Tanzania has resulted in serious land use impediments and constraints. In pursuit of strategic interventions, dynamic equilibrium, sustainable agricultural land use, and environmental conservation practices, the following are recommended:

Kenya

(i) Enact a participatory land use policy to regulate land use practices and enforce land resource allocation. This will reduce destruction of the Mau Forest and help regulate the rapid encroachment into the water catchment areas and threatened wildlife habitats.
(ii) Intensify and support current efforts on Soil Conservation Programs including SIDA funded National Agriculture and Livestock Extension Project (NALEP) in Nakuru, Narok, Bomet and Transmara districts.
(iii) Provide additional support (finance and personnel) for integrated soil and water management component of LVEMP. This is a transboundary project and can coordinate soil and water conservation in both countries.
(iv) Support (funding/personnel) Mau Complex Protection project by Kenya's Forest Department.
(v) Provide additional Support to WWF projects in Kenya.

Tanzania

(i) Support land adjudication and demarcation of village boundaries.
(ii) Consider computerization of land data to minimize illegal land transfers and ownership conflicts.
(iii) Intensify and support District Agriculture Development Programs specifically targeting soil conservation in Serengeti, Musoma Rural, and Tarime districts.
(iv) Provide additional support to WWF Integrated River Basin Management to mitigate against Masurura swamp expansion into grazing and agricultural land.

4.2.2 Agricultural Production Systems

Kenya

Kenya's agriculture is predominantly small scale farming in the high potential areas. Small scale farming accounts for 75% of the total agricultural output and 70% of marketed agricultural produce. Small scale farmers produce over 70% of the maize, 65% of the coffee, 50% of the tea, 80% of the milk, 85% of the fish, and 70% of the beef and related products. Small-scale production is carried out on farms averaging 2-3 hectares mainly for subsistence and commercial purposes.

Large scale farming on the other hand is practiced on farms averaging 50 hectares and accounts for 30% of the total marketed agricultural produce. These farms grow crops such as tea, coffee, horticulture, maize, and wheat, and keep livestock for commercial purposes. The latter comprises 10 million beef cattle, 3 million dairy and dairy crosses, 9 million goats, 7million sheep, 800,000 camels, 520,000 donkeys, and 300,000 pigs. The population of both indigenous and improved poultry breeds averages about 30 million (Economic Review of agriculture, 2007).

Tanzania

Agriculture is the leading sector of the economy of Tanzania. In the main land, approximately, 10.1 million ha were cultivated although it is estimated that agricultural potential is 44 million ha. This is equivalent to about 47 % of 94.2 million ha of main land area. It is further estimated that out of the 10.1 million of cultivated area, 1.0 million ha is assessed as area suitable for irrigation, of which only 0.2 million ha is currently irrigated. This implies that land and water resources can be developed significantly (National Sample Census of Agriculture 2002/03).

Tanzanian agriculture is dominated by smallholder farming systems with farm sizes ranging between 1 to 3 hectares. Most of these smallholders use the hand hoe as the main cultivating tool. Ox ploughs are used by about 20% of the farmers and about 10% use tractors (National Sample Census of Agriculture 2002/03; Basic Data Agriculture and Cooperatives Sector 1998/99 to 2004/05 and Mara Region Socio-economic Profile June, 2003).

Apart from providing food, agriculture remains the country's main source of income for the rural population, which forms 80% of the total population and employs 70% of the active labor force. Agriculture contributes about 50% of the GDP and about 75% of the foreign exchange earnings. A wide variety of crops can be grown in Tanzania due to its wide climatic variation and agro-ecological conditions. Area cultivated for food production makes up the bigger part of land under crop production. Maize and rice are principal food crops as well as commercial crops, while cassava and bananas are important subsistence crops. Traditional export crops of Tanzania are coffee, cotton, tea, sisal, and cashew nuts. Other widely grown crops include beans, sorghum, millet, sweet potatoes and various types of oil seeds. A wide variety of fruits, vegetables and flowers are also grown in Tanzania (Basic Data Agriculture and Cooperatives Sector 1998/99 to 2004/05).

4.2.2.1 Small Scale Farming Systems

Kenya

In the upper catchment, small scale farming systems dominate the four districts. Food crops production mainly mixed maize and beans cultivation dominate the landscape. In 2002-2008, the average small scale farm size was about 2.5 hectares and the main food crops produced were maize, beans, Irish potatoes and vegetables for subsistence and commercial purposes. In the Bomet, Transmara and Narok Districts, the small-holder farm sizes were approximately 5, 30, and 10 hectares, respectively.

The average household sizes were 5, 5.1, 5, and 4 persons for Narok, Transmara, Bomet, and Molo respectively. The main food crops produced in all districts included maize, potatoes, vegetables, beans, onions, and tomatoes. The food crop acreages were 40,800; 18,700; and 45,777 hectares for Narok, Transmara, and Bomet districts respectively. The total food crop acreage in the upper basin therefore averaged 105,277 hectares. The economic contribution to the Kenyan agricultural development has been substantial (District Development Plans for Narok, Transmara, Bomet, and Nakuru 2002-2008).

Tanzania

In the Mara region of Tanzania, small-scale farming systems dominate the three districts of Musoma Rural, Serengeti, and Tarime. During the 2002/03 National Sample Census for agriculture it was established that the total number of agricultural households in the region was 188,203. Of these, 103,379, or 54.9%, were involved in growing crops; 2,412, or 11.3%, were involved in livestock keeping only; and 82,412, or 43.8%, were involved in both crop production and livestock keeping.

The census further established that the total area of land available to smallholders was 487,543 ha, and the average land area utilized for agriculture per household was only 1.9 ha. This figure is close to the national average of 2.0 hectares. During the same period (2002/03), the area planted with annual crops and vegetables was 333,525 hectares, of which 120,270 hectares (36%) were planted during the short rainy season and 213,255 hectares (64%) during the rainy season. The area planted with cereals was 161,701 ha (48.5% of the total planted area with annual and vegetable crops), followed by roots and tubers with 133,117 ha (39%), annual cash crops (20,587 ha, or 6.2%), pulses (14,438 ha, or 4.3%), fruits and vegetables (2,110 ha, or 0.6%), and oil seeds (1,572 ha, or 0.5%). The food crops cultivated included maize, sorghum, roots and tubers, cassava, sweet potatoes, pulses, fruits, and vegetables. The cash crops included mainly cotton, tobacco, coffee, and bananas (National Sample Census of Agriculture, 2002/03).

4.2.2.2 Large Scale Farming Systems

Kenya

Large scale farming system is predominantly practiced in the Mara River Basin in Kenya. During 2002-2008 plan periods, these farms averaged 15, 80, and 100 hectares in Bomet, Transmara, and Narok Districts, respectively. The cash crops cultivated were mainly tea, pyrethrum, coffee, sugarcane, citrus fruits, bananas, wheat, barley, potatoes, vegetables, onions, and tomatoes. The total area under large scale farming system in the basin was approximately 87,261 hectares.

Tanzania

In Tanzania, the total number of large scale farms are 1,212 out of which 710 (59%) are for crop farming and occupy 534,166 ha of land; 242 farms (20%) are for livestock rearing and occupy 414,425 ha; and the remaining 260 farms (21%) involved in both crop and livestock farming and occupy 156,534 ha. In the 1987/88 season, the total area planted under large scale farms was 1,105,125 ha. The Manyara region had the highest percentage (about 13%) of large scale farms, and Lindi the lowest percentage of large scale farms in the country.

During the 1987/88 to 2002/03 period, these farms had increased at a rate of 17% because of the entry of private investors into the agricultural industry. About 85% of theses farms were operated by private investors, and the remaining 15% of were operated by the Government and Parastatal organizations. The production in these farms comprised cereals 109,299 tons, pulses 14,788 tons, oil seeds 3,645 tons, roots and tubers 1,969 tons, and other crops producing as much as 11,891 tons. The permanent crops, including sisal, coffee, sugarcane, tea, bananas, and mangos, covered 109,940 ha (57%) in comparison to 81,508 ha (43%) of annual crops. In 2002/03, about 86% of the large scale farms depended on rain fed agriculture, while the remaining 14% utilized irrigation systems (Basic Data Agriculture and Cooperatives Sector 1998/99 to 2004/05).

4.2.2.3 Horticultural Crop Production System

Kenya

In Kenya, horticultural crop production provides much needed vegetables for domestic consumption and commercial purposes. The horticulture sub sector has grown more than 10% in the last 5 years in a declining agriculture sector. Horticultural crops are high value and suitable for production in a wide range of ecological zones. The enterprise is labor intensive, has high returns, and is adaptable to either large or small scale production.

Small holders produce 80% of total production. The industry contributes substantially to the Kenyan economy as highlighted in government policy documents including the Economic Recovery Strategy for Wealth and Employment Creation (ERS) and Kenya vision 2030. Horticulture contributes direct employment, food, self-sufficiency, and security. The sector also contributes raw material to the agro-processing industry and is the leading foreign exchange earner.

Out of total crop production, 97% is consumed in the fresh market (including processing) and only 3% goes to export markets. Kenya is the leading flower exporter to the European Union (EU) where it supplies about 25% of total horticulture imports. Potential alternative export markets exist including the US, Russia, Japan, and the Common Market for Eastern and Southern Africa (COMESA) region, and locally through processing.

Increasing workers disposable income will also increase consumption in the local market. There are several advantages for horticultural development including:

- Large water resources (rivers, dams, and groundwater). Water is a pre-requisite for off season production when prices are high (based on supply and demand);
- Suitable climate for year round production;
- Growing urban populations with increased consumption potential as living standards improve;
- Consumption potential at existing tourist hotels in the Mara region;

- Large tracts of land for expansion and development in Nakuru and Narok districts. These lands are currently utilized for cultivation of crops under rain fed conditions. This utilization could be intensified by irrigated cultivation of high value horticultural crops. These lands though fertile, are arid with low rainfall and require irrigation to be productive.
- Processing potential by established firms in Njoro and the newly created Molo districts;
- Partially developed infrastructure, especially paved roads to major consuming urban centers including Nairobi;
- Potential for diversification by introducing new crops; Crops currently grown include potatoes, cabbage, onions, tomatoes, peas, mangoes, temperate fruits, and passion fruit; Diversification can include flowers and export vegetables, e.g., snow peas, French beans, and runner beans;
- More processing firms can be established.

Table 4.11: Horticultural Crop Data for MRB Districts, 2006

District	Fruits	Vegetable	Flowers
Bomet	360	1,003	NR
Nakuru	2,055	9,607	743
Narok	160	1,459	NR
T/.Mara	123	605	NR
Total for MRB districts	2,698	12,674	743
Rift .Valley	11,679	30,303	1,826

Source: Horticultural Crops Development Authority Annual report for 2007
NR: No Return

Tanzania

Tanzania's climatic growing conditions can accommodate the production of a wide range of fruits, vegetables, and flowers. The most important fruits include pineapples, passion fruits, citrus fruits, mangoes, peaches, pears, and bananas. Vegetables include tomatoes, spinach, cabbages, okra, and other types. Flowers include many tropical varieties and some temperate types. While some can be produced throughout the year, the majority of these products are highly seasonal. Most of food crops are consumed at farm level, leaving the domestic market with gluts or severe scarcity during on and off seasons respectively. Horticulture production in Tanzania is largely undertaken by small-scale producers. These producers still commonly practice traditional methods of growing fruits and vegetables. Production of fruits and vegetables is carried out in various parts of the country according to the prevailing climatic conditions.

In the coastal areas, which cover the Dar-es-Salaam, Coast, Tanga, Mtwara, and Lindi regions, major horticultural crops include oranges, mangoes, coconuts, limes, chilies, and eggplants. Others are watermelons, paw paws, tomatoes, okra, onions, and cabbage. In the central plateau, which covers Dodoma, Singida, and Tabora, the main horticultural crops include tomatoes, onions, and grape vines. Another horticultural zone is the Lake area zone, which produces cabbages, tomatoes, beans, onions, mangoes, and sweet bananas. Arusha, Kilimajaro, and the Usambara mountains in the Tanga region make up the northern highlands, while Iringa, Mbeya, some parts of Morogoro, Rukwa, and Ruvuma make up the southern highlands. Crops grown in these highland areas include tomatoes, cabbage, onions, potatoes, carrots, cauliflower, pears, peaches, plums, avocadoes, cooking bananas, and sweet bananas (Basic Data Agricultural and Cooperative sector, 1998/99-2004/05).

4.2.3 Major Crops and their Annual Yields

4.2.3.1 Food Crops

Kenya

Food crops are generally classified into: cereals (maize, wheat, sorghum, rice, millet); pulse (beans, pigeon peas, cow peas, chick peas, and green grams), and roots and tubers (sweet potatoes, cassava, arrow roots, and yams). In Kenya, food crops are dominated by maize which is the main staple food in the country with an annual consumption of 34 million bags. (A bag is 90 kilograms.) However, maize production varies between 16.6 and 34.8 million bags depending on weather conditions and producer prices. Maize production increased by up to 11.4% from 32.4 million bags in 2005 to 36.1 million bags in 2006. This increase was attributed to favorable weather conditions and increased crop area. Similar trends were registered for pulse crops where beans production had an approximate 41% increase from 4.2 million bags in 2005 to 5.9 million bags in 2006.

Wheat is a staple food especially for the urban population but its production has been on general decline from 4.21 million bags in 2003 to 4.17 million bags in 2005 and 3.98 million bags in 2006. The wheat crop area has decreased by 5.6%, with the decrease attributed to maize crops that yield higher prices. The production trend for other food crops is indicated in Figure 5.

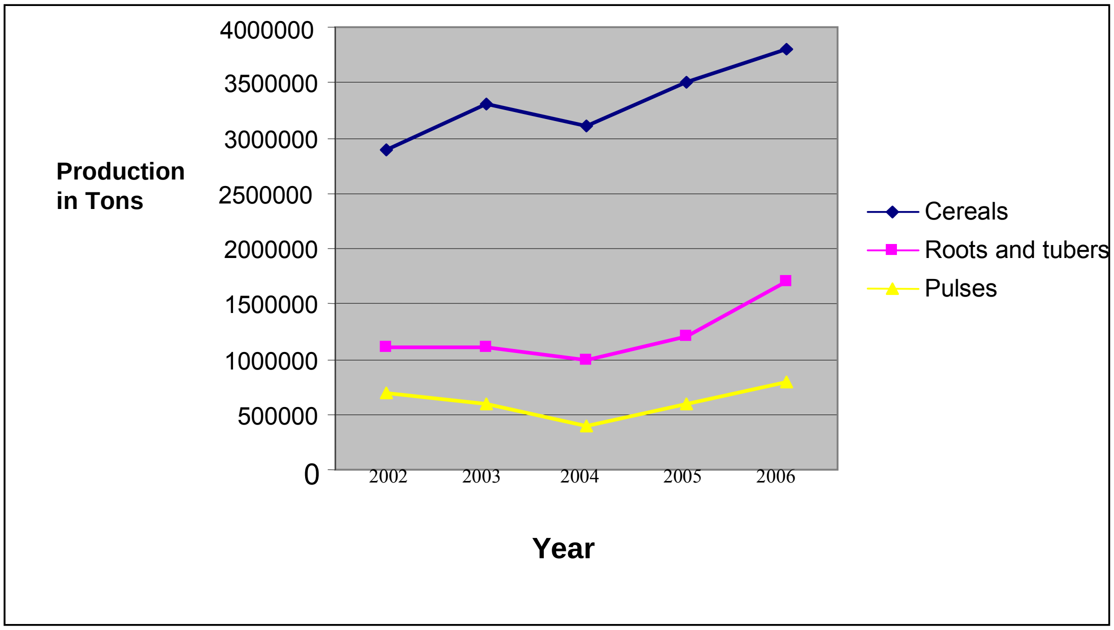


Figure 4.7: Food Crop Production Trends 2002-2006

Table 4.12: Kenya Maize Production 2002-2006

Year	2002	2003	2004	2005	2006
Area (Ha)	1,592,315	1,670,914	1,819,817	1,660,618	1,888,185
Production					
# 90 kg bags	26,762,182	30,120,530	27,249,721	32,423,963	36,086,406
Metric tons	2,411,007	2,713,561	2,454,930	2,918,157	3,247,777
Unit price per bag	1,052	1,358	1,482	1,363	1,300
Average yield (bags\ha)	17	18	15	18	19
Consumption(bags)	29,165,000	30,150,000	31,135,000	32,120,000	33,105,000
Imports (tons)	16,326	115,905	241,757	49,621	-
Total value (billion KShs)	28.13	40.90	40.38	44.19	46.91

Source: Department of Land and Crops Development and Management and NCPB

Table 4.13: Kenya Wheat Production 2002-2006

Year	**2002**	**2003**	**2004**	**2005**	**2006**
Area (Ha)	144,794	151,135	145,359	159,477	150,488
Production					
# 90 kg bags	3,413,501	4,207,278	4,173,652	4,063,294	3,978,454
Metric tons	307,523	379,034	379,005	365,696	358,061
Unit price per bag	1,552	1,718	1,995	1,639	1,714
Average yield (bags\ha)	24	28	29	25	26
Consumption (bags)	884,350	883,120	889,020	893,120	903,120
Imports (tons)	515,179	502,115	404,060	621,839	-
TOTAL VALUE (BILLION KSH)	5.30	7.23	8.33	6.66	6.82

Source: Department of Land and Crops Development and Management and NCPB

The other food crops are rice, sorghum, beans, pigeon peas, cow peas, green grams, arrow roots, cassava, sweet potatoes, and yams.

The production of food crops is distributed in all the administrative districts of Kenya. Nyanza produces mainly maize, beans, sorghum, rice, millet, cassava, and soya beans. In the Rift Valley, the major food crops are maize, beans, wheat, and millet, while the eastern province produces maize, beans, sorghum, millet, cow peas, green grams, pigeon peas, arrow roots, and yams. The western province produces maize, beans, and millet, while the Central region produces maize and rice. Finally, the coastal area produces cow peas, green grams, and cassava.

The Mara Region (Nakuru, Narok, Bomet, and Transmara Districts) contributes significantly to national production of two staple food crops: wheat and maize. In the cropping season 2006, 75,335 hectares were cropped with wheat leading to the production of 2,239,594 bags. During the same period, 173,420 hectares were cropped with maize with a production of 4,082,470 bags recorded. Rice, another important staple food for urban dwellers, has recorded disappointing performance over the years. However, the production of rice is not significant in the Mara districts.

The production of other food crops including legumes and root crops has also declined due to a number of factors including the effects of heavy rains, pests, and diseases as well as lack of quality planting materials.

Table 4.14: 2006 Maize Production in the Mara Region

District	Area (Ha)	Production (90 kg bags)
Narok	34,800	696,000
Bomet	24,950	809,720
Transmara	38,000	850,000
Nakuru	65,670	1,626,750
TOTAL	173,420	4,082,470

Source: District Agricultural Officers Annual Reports for 2006

Table 4.15: 2006 Wheat Production in the Mara Region

District	Area (Ha)	Production (90 kg-bags)	Value (Ksh)
Narok	62,950	1,880,500	3,200,000,000
Bomet	19	380	646,000
Transmara	-	-	-
Nakuru	12,366	358,614	636,000,000
TOTAL	75,335	2,239,594	3,836,646,000

Source: District Agricultural Officers Annual Reports for 2006
- No data available

Tanzania

Crop production in Tanzania has for a long time included maize, sorghum, finger millet, paddy, wheat, sweet potatoes, Irish potatoes, beans, cow peas, pigeon peas, soya beans, bananas, and cassava. The major staple for the population is maize. The acreage under maize (expressed in '000 hectares) increased from 957.55 hectares in 1998/99 cropping year to 3,109.59 hectares in 2004/2005, an increase of 8.1% over a period of six years.

There was a 16.81% decrease in maize acreage in 2000/01 to 845.95 hectares, mainly due to the lower rainfall recorded during that year. A resurgence of the average annual rainfall in the following three years resulted in a marked increase in the maize acreage peaking at 3,109.59 hectares in the 2004/05, an increase of 2,152.04 hectares which represents an impressive increase of 69.12 % over just four seasons.

The maize production over the same period (measured in '000' tons) followed the same trend with an overall increase from 1998/99 to 2004/05 from 2,420.94 tons to 3,131.61 tons.

Table 4.16: Areas Growing Maize 1998-2005 (in '000 hectares)

Region/ Year	1998/1999	1999/2000	2000/2001	2001/20002	2002/2003	2003/2004	2004/2005
Arusha	129.46	139.90	147.90	244.30	99.99	51.00	44.40
Coast	NIL	NIL	NIL	40.00	70.32	26.50	37.90
Dar es Salaam	NIL	NIL	NIL	5.52	3.64	0.90	1.98
Dodoma	61.68	81.60	59.15	180.10	345.89	183.00	132.95
Iringa	187.23	203.80	121.33	285.12	253.89	330.40	370.13
Kagera	58.83	60.10	45.06	101.81	102.34	111.47	93.80
Kigoma	69.83	74.60	56.25	115.00	83.90	148.00	154.37
Kilimanjaro	90.00	88.80	99.49	99.82	96.59	84.68	92.62
Lindi	69.16	69.20	60.53	69.49	71.47	72.20	58.10
Manyara	NIL	NIL	NIL	NIL	187.90	192.80	222.20
Mara	49.02	48.00	47.52	58.92	91.81	65.20	61.79
Mbeya	124.20	135.10	101.79	295.10	231.74	303.30	310.70
Morogoro	75.96	74.30	81.43	136.30	195.09	166.90	143.00
Mtwara	42.18	42.20	25.50	86.72	72.02	76.52	75.10
Mwanza	109.12	109.60	84.81	173.06	208.51	203.30	184.75
Rukwa	118.52	120.50	97.62	166.00	150.03	177.10	144.60
Ruvuma	110.67	110.70	90.26	127.90	139.54	135.30	133.80
Shinyanga	211.71	211.70	133.99	341.81	400.27	331.50	386.56
Singida	57.28	58.20	56.11	92.00	137.28	73.20	79.57
Tabora	78.34	78.30	67.20	180.00	232.86	176.20	189.20
Tanga	86.64	108.60	128.72	157.74	287.48	263.60	192.07
Total	957.55	1,017.60	845.95	1,718.20	3,462.54	3,173.07	3,109.59

Source: Statistical Unit, Ministry of Agriculture, Food and Cooperatives, 2003

Table 4.17: Maize Production 1998-2005 ('000 tons)

Region/ Year	1998/1999	1999/2000	2000/2001	2001/20002	2002/2003	2003/2004	2004/2005
Arusha	213.78	42.00	177.48	562.90	92.12	73.00	53.10
Coast	NIL	NIL	NIL	30.50	22.99	89.68	44.35
Dar es Salaam	NIL	NIL	NIL	4.55	0.96	1.61	0.87
Dodoma	28.86	40.80	94.64	307.80	149.49	257.40	53.70
Iringa	373.68	285.30	315.47	492.47	265.95	636.60	549.05
Kagera	65.34	72.20	103.64	124.31	100.31	113.08	75.89
Kigoma	119.87	97.00	129.39	154.00	106.17	192.40	158.82
Kilimanjaro	181.13	97.7	159.2	124.6	105.22	102.77	117.12
Lindi	66.19	76.10	72.63	93.66	24.85	87.7	29.60
Manyara	NIL	NIL	NIL	NIL	147.77	285.40	266.90
Mara	68.14	57.60	95.03	97.70	110.66	254.50	87.35
Mbeya	235.05	189.20	234.11	381.40	286.21	546.80	415.90
Morogoro	96.58	89.20	162.86	245.30	115.57	298.40	180.70

Mtwara	39.80	42.20	30.60	81.04	29.61	67.02	38.10
Mwanza	129.38	131.50	152.66	260.65	150.80	228.00	158.95
Rukwa	203.71	180.70	224.52	225.40	163.43	317.30	174.00
Ruvuma	199.83	155.00	162.46	267.69	179.31	272.70	185.60
Shinyanga	103.81	169.40	200.94	310.08	191.40	297.61	135.4
Singida	32.95	29.10	61.72	176.00	54.40	146.20	41.00
Tabora	103.83	101.80	120.96	103.20	143.12	205.40	88.23
Tanga	158.86	108.60	154.46	238.40	173.60	177.80	277.13
Total	2,420.94	1,965.40	2,652.81	4,408.42	2,613.97	4,651.37	3,131.61

Source: Statistical Unit, Ministry of Agriculture, Food and Cooperatives, 2003

The acreage under other crops also increased exponentially peaking in the 2004/2005 cropping season as illustrated below.

Table 4.18: Other Crop Acreage 1998-2005 in '000'hectares

Year	**1998/1999**	**1999/2000**	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**	**2004/2005**
Sorghum	659.87	736.20	691.69	655.38	449.59	697.22	737.08
Finger millet				162.53	81.76	101.00	115.31
Bulrush millet				196.3	120.09	246.91	167.87
Paddy	379.1	415.6	275.8	565..6	620..8	613.13	701.99
Wheat	57.37	71.70	52.12	30.67	26.89	34.38	35.37
Sweet Potatoes	282.02	47.20	511.51	423.44	135.47	517.53	469.11
Irish Potatoes				77.72	48.17	89.31	125.99
Beans				629.2	745.40	687.81	811.01
Cow peas					73.17	159.0	150.4
Pigeon peas					0.16	142.1	162.4
Soya beans				0.3	1.19	1.29	3.13
Bananas	252.96	303.50	289.62	370.63	394.05	316.10	322.04
Cassava	1,824.48	905.50	752.74	1,191.86	1,313.06	1,345.13	1,252.05
Ground nuts			247.30	366.94	347.98	374.55	409.32
Sim sim			32.88	72.56	65.16	124.13	156.25
Sunflower			71.86	139.66	115.50	224.32	144.81

Source: Statistical Unit, Ministry of Agriculture, Food and Cooperatives, 2003

Table 4.19: Other Crop Production from 1998-2005 (in '0000 tons)

Year	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Sorghum	561.17	598.20	691.69	635.74	198.87	648.54	729.74
Finger Millet				147.70	54.18	60.06	77.89
Bulrush millet				85.71	37.10	186.19	140.87
Paddy	728.60	722.10	306.85	1,514.97	594.62	1,169.32	1,077.05
Wheat	82.4	32.7	72.03	47.95	21.62	28.23	94.16
Sweet Potatoes	565.22	777.30	950.10	1,466.12	207.83	1,501.62	1,414.82
Irish Potatoes				637.72	141.16	731.12	651.01
Beans				560.4	309.6	447.71	626.34
Cow peas					16.88	123.6	80.5
Pigeon peas					0.10	96.3	118.5
Soya beans				0.39	0.51	0.93	2.63
Bananas	749.92	700.90	752.07	2,204.62	1,899.80	2,489.01	2,007.48
Cassava	1,795,38	1,780,70	1,698.95	3,420,55	2,843.53	2,956,54	3,060.08
Ground nuts			206.80	346.79	159.73	331.66	293.87
Sim simm			14.36	55.1	22.33	67.41	103.64
Sunflower			80.87	104.4	55.04	247.84	134.36

Source: Statistical Unit, Ministry of Agriculture, Food and Cooperatives, 2003

Mara Region

Cereal grains and root crops are the staple foods for the Mara region communities. Food security expressed as household failure to produce enough grains for annual consumption differs for every agro-ecological zone of the region. The pattern reflects the agro-ecological zonation and increases with increasing distance from the lakes. The lowlands have the lowest security, middle land is moderate, and the highlands are most secure. High poverty levels and lack of alternative cash crops result in food crops being sold to supplement family incomes. Dual purpose food crops are available in differing proportions in the region.

The major food crops grown in the Mara districts (Musoma Rural, Serengeti, and Tarime) are cassava, maize, sorghum, sweet potatoes, finger millets, paddy, and beans. Production during the period 1996 to 2002 indicates that the average crop area was 194,523 hectares with maize, cassava, sorghum, and sweet potatoes being the major food crops. The data sheets below indicate yield and production levels for selected food crops.

Table 4.20: Starch Food Production Mara Region 1996 to 2002

Food production (tons)	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
Cassava (dry)	73,000	62,170	49,540	120,690	177,950	144,760
Sorghum	31,140	26,690	26,700	82,580	90,940	83,650
Maize	28,640	26,000	51,590	63,570	93,010	86,850
Sweet potatoes	54,190	55,910	64,430	44,350	89,820	61,750
Finger millet	4,890	3,980	6,270	13,500	13,890	12,800
Paddy	2,890	6,120	4,460	5,200	12,450	8,800
Total starch food produced	194,750	180,870	202,990	329,890	478,060	398,610

Source: Regional Commissioners Office, Musoma Rural, 2002

Table 4.20 above shows food crop production between 1996/97 and 2001/02. From 1996/97 to 1998/99, most crops record low harvests. By contrast, the second half of the period almost all food crops reported increased tonnage. Averages of 303,692 tons were harvested annually. Cassava dominated and accounted for 19% of total production. The year 2001/02 recorded the highest production and 1997/98 the lowest.

Tables 4.21, 4.22, and 4.23 show food surplus and deficits in the Mara region from 1996 to 2002. In general, the first three years indicate food shortages except for Serengeti District, and the last three years were favorable with adequate food for all districts. In 1997/98 and 1998/99, Musoma district experienced food shortages. High and extensive cassava production secured food for the district in the 2001/02 and accounted for 46% of food production. The district has experienced surplus food production since that time. Tarime has not met its food requirements except for 2000/01 and 2001/02 .The highlands are self-sufficient and generate surpluses; however, the region's high population (up to 35% of the overall region) creates higher food demand than the district can produce. Serengeti with its small population and virgin soils produces surpluses every year.

Table 4.21: Starch and Protein Food Availability and Requirements (tons) by District, Mara Region 1996-2002

Musoma

Food production (tons)	1996/97	1997/98	1998/1999	1999/2000	2000/01	2001/02
Cassava (dry)	27,380	10,450	8,910	27,380	47,040	52,470
Sorghum	20,270	3,910	2,600	20,270	12,060	14,630
Maize	7,160	4,650	7,680	7,160	11,480	15,770
Sweet potatoes	20,950	11,360	19,460	20,950	21,130	23,510
Finger millet	930	580	200	930	340	3,270
Paddy	640	4,940	80	640	1,210	1,430
Total starch production	77,330	35,890	38,930	77,330	923,260	111,080
Starch Food Available						
Cassava (dry)	21,904	8,360	7,128	21,904	37,632	421,976

Sorghum	12,162	2,346	1,560	12,162	7,236	11,704
Maize	2,864	1,860	3,072	2,864	4,592	6,308
Sweet potatoes	16,760	9,088	15,568	16,760	16,904	18,808
Finger millet	465	290	100	465	170	1,635
Paddy	128	988	16	128	242	286
Total available starch food	54,283	22,932	27,444	54,283	66,776	80,717
Projected population	391,000	401,000	410,000	420,000	429,000	439,000
Starch food requirement	46,920	48,120	49,200	50,400	51,480	52,680
Starch food Surplus (+) Deficit (-)	+7,363	-25,188	-21,756	+3,883	+15,296	+28,037
Protein Food Available						
Protein food category	1996/97	1997/98	1998/1999	1999/2000	2000/01	2001/02
Beans	1,140	760	830	1,140	3,210	2,890
Available as food	456	304	332	456	1,284	1,156
Projected population	391,000	401,000	410,000	420,000	429,000	439,000
Protein requirement	23,460	24,060	24,600	25,200	25.740	26,340
Surplus (+) Deficit (-)	23,004	23,756	24,268	24,288	-24,456	-25,184

Table 4.22: Starch and Protein Food Availability and Requirements (tons) by District, Mara Region 1996-2002

Serengeti

Food production (tons)	1996/97	1997/98	1998/1999	1999/2000	2000/01	2001/02
Cassava (dry)	22,320	14,680	23,090	59,200	88,970	31,280
Sorghum	2,420	10,560	11,290	28,130	31,510	19,170
Maize	7,180	8,410	14,350	20,240	27,500	24,160
Sweet potatoes	4,200	14,060	8,660	4,200	16,850	7,110
Finger millet	1,510	2,560	1,690	1,420	4,500	7,180
Paddy	30	440	40	1,040	2,860	3,740
Total starch production	37,660	50,710	59,120	114,230	172,190	92,640

Starch Food Available						
Cassava (dry)	17,856	11,744	18,472	47,360	71,176	25,024
Sorghum	1,453	6,336	6,774	16,878	18,906	11,502
Maize	2,872	3,364	5,740	8,096	11,000	9,664
Sweet potatoes	3,360	12,248	6,928	3,360	13,480	5,688
Finger millet	755	1,280	845	710	2,250	3,590
Paddy	6	88	8	208	572	748
Total available starch food	26,301	35,060	38,767	76,612	117,384	56,216
Projected population	150,000	155,000	160,000	165,000	170,000	177,000
Starch food requirement	18,00	18,600	19,200	19,800	20,400	21,240
Starch food Surplus (+) Deficit (-)	+8,301	+16,460	+19,567	+56,812	+96,984	+34,976
Protein Food						
Protein food category	1996/97	19997/98	1998/99	1999/2000	2000/01	2001/2002
Beans	70	410	250	1,270	1,140	4,620
Available as food	28	164	100	508	456	1,848
Projected population	150,000	155,000	160,000	165,000	170,000	177,000
Protein requirement	9,000	9,300	9,600	9,900	10,200	10,620
Surplus (+) Deficit (-)	-8,972	-9,136	-9500	-9,392	-9,744	-8,772

Table 4.23: Starch and Protein Food Availability and Requirements (tons) by District, Mara Region 1996-2002

Tarime

Food production (tons)	1996/97	1997/98	1998/1999	1999/2000	2000/01	2001/02
Cassava (dry)	14,110	30,950	12,050	23,910	25,560	45,970
Sorghum	4,260	4,750	9,490	13,910	16,810	37,090
Maize	8,370	9,400	19,510	31,520	34,250	36,320
Sweet potatoes	8,260	17,150	14,570	14,560	14,890	18,920
Finger	720	430	4,230	1,420	6,540	1,040

millet						
Paddy	360	320	300	120	2,670	50
Total starch food production	36,080	63,000	60,150	85,440	100,720	139,810
Starch Food Available						
Cassava (dry)	11,288	24,760	9,640	19,128	20,448	36,776
Sorghum	2,556	2,850	5,694	8,346	10,086	22,254
Maize	3,348	3,760	9,640	19,128	20,448	36,776
Sweet potatoes	6,608	13,720	11,656	11,648	11,912	15,136
Finger millet	360	160	150	60	1,335	250
Paddy	72	64	60	24	534	100
Total available starch food	24,232	45,314	35,004	51,814	58,015	89,044
Projected population	428,000	440,000	452,000	465,000	478,000	493,000
Starch food requirement	51,360	52,800	54,240	55,800	57,360	59,160
Starch food Surplus (+) Deficit (-)	-27,128	-7,486	-19,236	-3,986	+655	+29,884
Protein Food						
Protein food category	1996/97	1997/98	1998/99	1999/2000	2000/201	2001/2002
Beans	30	2,170	1,810	1,320	2,650	800
Available as food	12	868	724	528	1,060	320
Projected population	428,000	440,000	452,000	465,000	478,000	493,000
Protein requirement	25,680	26,400	27,120	27,900	28,680	29,580
Surplus (+) Deficit (-)	-25,668	-25,532	-26,396	27,372	27,620	-29,260

Source: Mara Region Socio-economic Profile June, 2003

The tables demonstrate that the Mara region is vulnerable to food deficits either as a result of poor crop yields due to rainfall inadequacies or land degradation leading to poor fertility soils or lack of proper agricultural extension services. The critical implication for the investment strategy is technology transfer and the provision of agricultural extension services.

4.2.3.2 Cash Crops

Kenya

In Kenya, the major industrial crops are tea, coffee, sugarcane, cotton, sunflower, pyrethrum barley, tobacco, sisal, coconuts, and bixa. Tea is the leading foreign exchange earner in Kenya after tourism and horticulture. The area cultivated with tea increased from 141,300 hectares to 147,080 hectares in 2006, but production dropped by 17,922 metric tons (5.5%) from 328,500 tons in 2005 to 310,578 tons in 2006. This drop was attributed to unfavorable climatic conditions, particularly frost, that affected some tea growing areas.

In exports, the industry recorded improved earnings with an increase of 11.8% to reach 47.3 billion KShs (665 million US dollars) in 2006 from 42.3 billion KShs (559 million US dollars) recorded in 2005. This was due to the increase in the price of black tea. The export volume however dropped by 10.3% from 349,700 tons in 2005 to 313,700 tons in 2006 as summarized in the following table. The local consumption increased by 18% to 16,500 tons in 2006 from 14,000 tons in 2005 and remains considerably low to date.

Table 4.24: Tea Production in Kenya, 2002-2006

Year		**2002**	**2003**	**2004**	**2005**	**2006**
Estates	**Area (Ha)**	44,400	45,100	48,800	48,600	51,300
	Production					
	Tons	111,200	112,900	132,100	130,800	119,401
	Yield (tons)	2.5	2.5	2.7	2.7	2.3
Small holders	**Area (ha)**	85,900	86,400	88,000	92,700	95,780
	Production					
	Tons	175,900	180,800	192,600	197,700	191,177
	Yields (tons\ha)	2.0	2.1	2.2	2.1	2.0
Total area (ha)		130,300	131,500	136,800	141,300	147,080
Total production (tons)		287,100	293,700	324,700	328,500	310,578
Price of Black Tea (per 100 kg)		11,639	11,793	12,696	11,824	14,642
Consumption (million kgs)		12.6	12.6	13.6	14.0	16.5
Exports (millions kgs)		272.4	269.9	333.8	349.7	313.7
Export (million Ksh)		34,306.3	33,394.1	43,446.7	42,862.9	47,297.4
Import (million Ksh)		175.9	180.3	553.2	571.2	-

Source: Economic Review of Agriculture, 2007 and Tea Board of Kenya Annual Reports, 2002-2006

The performance of these crops has been mixed and varied, with relatively good performance in tea and horticultural farming. In Kenya, tea is currently the most important cash crop accounting for approximately 20% of total foreign exchange earnings. Production has expanded considerably from 18,000 metric tons in 1963 to 294,000 metric tons in 2002.

The sugar cane industry also plays a key role in the agricultural sector, supporting over 200,000 small scale farmers directly and an estimated 6 million farmers indirectly. Sugar production has decreased from 516,803 tons in 2004 to 488,997 tons in 2005 and 475,670 tons in 2006. However, the area with sugar cane increased by 12% from 131,507 ha in 2004 to 144,765 ha in 2005 and 147,730 ha in 2006. The decrease in sugar production has been attributed to extreme weather conditions that hampered delivery to the factories for milling.

Table 4.25: Sugar Production in 2002-2006

Year		2002	2003	2004	2005	2006
Area (Ha)	Under cane	126,826	122,580	131,507	144,765	147,730
	Harvested	54,010	50,468	54,191	56,537	54,621
Sugar cane production		4,501,363	4,204,055	4,660,995	4,800,820	4,932,839
Yield of sugar cane (tons|ha)		70.7	69.2	73.8	71.5	70.89
Price of cane (Ksh|ton)		2,015	1,800	1,800	1,910	2,027
Sugar production (tons)		494,249	448,489	516,803	488,997	475,670
National consumption (tons)		652,129	663,780	669,914	695,622	718,396
Domestic price of sugar (Ksh\ton)		32,520	28,833	33,810	48,449	52,547
Exports (tons)		12,046	11,300	11,580	21,760	13,533
Imports tons)		129,966	182,225	164,020	167,235	166,280
Imports (million Ksh)		2,936	3,786	3,823	4,048	4,081

Source: Economic Review of Agriculture, 2007 and Kenya Sugar Board Annual Reports 2002- 2006

Pyrethrum production has shown steady decline over the last five years, dropping rapidly from 10,953 tons in 2002 to 762.7 tons in 2006. This reduction is attributed to the failure of the Pyrethrum Board of Kenya to pay the growers for deliveries made due to severe cash flow problems. The net effect was a shift by growers from pyrethrum to other profitable enterprises. The recent moves by the government to address farmer's fears and renewed interest and improvement in the world market have triggered a turn around in this sub sector. This has been demonstrated by an increase in the crop acreage from 4,522 ha in 2005 to 6,325 ha in 2006.

Table 4.26: Pyrethrum Production 2002-2006

Year	2002	2003	2004	2005	2006
Area (ha)	18,210	17,520	10,950	4,522	6,325
Production of Dry Flower (tons)	10,953	5,796	2,207	1,003	762,7
Price of dry flowers (Ksh|kg)	73.0	73.0	73.0	73.0	73.0
Yield (tons|ha)	0.6	0.3	0.2	0.2	0.2
Exports (tons of pyrethrum extract)	81	123	133	124	Na
Local value (Ksh millions)	1,271.5	781.9	305.7	158.1	133.1

NB: Dry flowers have 1.4% pyrethrum content.
Source: Ministry of Agriculture Economic Review and Pyrethrum Board of Kenya Annual Reports for 2002 -2006

Table 4.27: Tea Production 2006

District	Area (Ha)	Production (tons)
Transmara	180	270
Narok	4,042	11,432
Bomet	3,740	76,300
Nakuru	-	-
TOTAL	7,962	88,002

Source: Ministry of Agriculture Economic Review and Tea Board of Kenya, Annual Reports for 2002 -2006

Table 4.28: Pyrethrum Production, 2006

District	Area (Ha)	Production (tons)
Transmara	90	767
Narok	61	20
Bomet	270	5
Nakuru	2,666	767
TOTAL	3,087	1559

Source: Ministry of Agriculture Economic Review and Pyrethrum Board of Kenya, Annual Reports for 2002 -2006

Tanzania

The cash crops cultivated in Tanzania are mainly groundnuts, simsim, sunflower, cotton, coffee, pyrethrum, tea, tobacco, and cashew nuts. The areas under cultivation for each crop varied considerably over the 1998-2005 period. The area for cotton increased consistently from 105,600 hectares in 1998/99 to 357,260 hectares in 2004/05, an increase of 70.5% over seven growing seasons. The coffee cultivated area reduced slightly from 260,110 hectares in 2003/04 to 235,700 hectares in 2004/05, a decrease of 9.6%. The area under green tea cultivation also reduced slightly from 19,600 hectares to 12,860 hectares in 2004/05.

Table 4.29: Cash Crop Areas in '000' hectares, 1998-2005

Year	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Cotton	105.6	100.7	124.9	148.5	180.8	326.68	357.26
Coffee						260.11	235.70
Pyrethrum					0.65	5.05	8.37
Green Tea						19.96	12.86
Sisal			42.27	4.79	48.50	2,672.13	
Cashewnuts						288.52	161.38

Table 4.30: Cash Crop Production in '0000 tons, 1998-2005

Year	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Cotton						337.02	487.56	95.39		
Coffee		46.5	45.01	58.24	66.16	52.31	79.24	77.89		
Pyrethrum		0.7	1.90	1.80	3.44	0.35	2.70	3.11		
Made Tea	20.50	19.77	26.25	21.90	24.15	26.30	24.72	30.09		
Green Tea									46.01	24.15
Sisal					17.95	19.66	24.70	23.45	22.63	
Cashew nuts					121.2	122.0	55.0	81.7	92.81	89.98

Mara Region

In Mara region districts, cotton is the principal cash crop. The other cash crops of relatively minor importance are: coffee, tobacco, sunflower groundnuts, and tobacco. In 2002 approximately 29,936 ha were under production and more than 80% of the area was under cotton cultivation (District Integrated Agricultural Survey 1998/99 Survey Report, Mara Region).

Six years of cash crop data show two development patterns. During the first three years, the area under cash crops declined from 35,990 ha in 1996/97 to 13,548 ha in 1998/99. This was a result of a drought followed by severe rains thought to be linked to a strong El Ninio. The weather patterns improved in 1999/2000 and 2001/2002 and the production area increased. In general, 29,936 ha were under production for the six year period. More than 80% of the area was cotton. Other cash crops in the region were of minor importance. The production of these minor crops could improve if factors affecting them are addressed. Coffee could be a major crop in Tarime and parts of Serengeti, and tobacco could do well in Tarime. Diversification should be pursued.

The Mara region is not a major coffee producer. Coffee accounted for about 12% of cash crops between 1996/97 and 2001/2002. Coffee is generally grown on the highlands of Tarime, which produce about 90% of the coffee grown in the region. Coffee is also being tried in the Serengeti highland areas. Annual production over the last six years 1996 to 2002 shows instability. However, an annual average of 2,585 tons of coffee was realized over the period.

Groundnuts are an oil seed crop that could be grown more extensively, providing income supplement to farmers that currently depend on cotton or coffee. Groundnuts are grown mainly in Tarime district which accounts for about 73% of all production. Limited quantities of groundnuts are grown in the Musoma Rural and very negligibly in Serengeti District. Groundnuts account for about 4% of the total annual cash crop production in the region. (District Integrated Agricultural Survey 1998/99, Survey Report, Mara Report and Regional Commissioner's Offices in Musoma Rural and Serengeti Districts, 2002).

Sunflower is not a popular or significant cash crop. Sunflower is mainly grown in the Tarime District and to a smaller extent in the Serengeti District. Tarime accounted for about 78% of the crop grown between 1996/97 and 2001/02. Low prices to farmers and poor marketing arrangements could account for the crop's low popularity. Production for six years show significant fluctuations in quantities harvested (Regional Commissioner's Office, Mara, 2002).

Lastly, tobacco is principally grown in the Tarime District where 85% of the crop is produced. Tobacco production in Serengeti has not produced significant results. The problems faced in sunflower production have also been encountered by tobacco growers.

4.2.4 Selected Farming Systems and their Impacts on Land Degradation

4.2.4.1 Kenya

Small Scale Maize and Wheat Cultivation Systems

In Kenya, the small scale maize and wheat production systems are on farms ranging between 2-5 acres in the four districts Nakuru (Molo), Bomet, Narok, and Transmara. The area has gentle to steep slopes and flat savannah grasslands that are home to the greatest wildlife habitats. Both maize and wheat have similar agronomic requirements. The soils in these districts are fertile and the rainfall, ranging between 750 mm to 1200 mm annually, is adequate. However, the soils are prone to serious erosion, especially during the long rains season (March to May). The agricultural practices are mechanized and loosen the soil physical structure leading to land degradation and serious soil erosion.

The impact of land degradation is declining fertility (i.e., lowering of the production capacity and nutrient depletion). The rising population density and the customary inheritance laws have resulted in land sub-division into uneconomically small units, the reduction of fallow periods, and continuous cultivation leading to the rapid depletion of soil nutrients, declining yields, and environmental degradation.

Small-Scale Tea Production

Small-holder tea cultivation is only found in Ole Nguruone Division of the newly created Molo District. The soils and rainfall are most ideal for tea cultivation. The size of the tea farms are on the order of 2-5 acres and are mostly sited on the eastern slopes of the Mau escarpment. The small-holder tea cultivation involves the use of heavy equipment and machinery for bush clearing and ripping, which lead to lowering the physical capacity of the soils. This activity exposes the soils to land degradation and erosion.

Large Scale Maize and Wheat Production

Large-scale maize and wheat production is carried out on farms in excess of 50 hectares. The production process involves the use of heavy equipment and machinery. The expansion for this type of cultivation has led to the destruction of forested areas and encroachment into fragile lands, which in turn has led to land degradation and soil erosion.

Barley Cultivation System in Mau Narok

Barley cultivation is confined to the Mau Narok Division in the newly created Molo district. The agronomic conditions are suitable for barley. The cultivation process is wholly mechanized and is managed by Kenya Breweries Ltd. The land topographical conditions are undulating and some areas are on steep slopes. Support from Kenya Breweries Ltd. has established good soil and crop management practices that have reduced the impacts on land degradation in the area considerably. These soil and crop management practices include contour ploughing during land preparation and application of agro-chemicals for weed control. These practices have negligible disturbance on soils maintaining soil stability and reducing soil erosion.

Sugarcane Cultivation System in Transmara District

Sugarcane is cultivated on the western lower slopes of the district and covers parts of Kilgoris Division. The soils in this area are dominated by black cotton soils that are generally sticky when wet and very hard when dry, and are therefore difficult to manage. Farmers use heavy machinery to prepare the land, weed, and apply agro-chemicals. However, there is little negative effect on the land because of the nature of sugarcane growth with widely spread roots holding the soils together and reducing soil erosion. In addition, the leaves form a wide canopy which slows down rainfall intensity and corresponding soil erosion.

4.2.4.2 Tanzania

Small Scale Maize and Sorghum Production Systems

Maize is the most important cereal crop in Mara region, with the second largest planted area after cassava. The number of households growing maize in the Mara region during the long rains season was 77,336 (62% of the total crop growing households).The total production of Maize was 110,662 tons from a planted area of 91,804 hectares resulting in a yield of 1.2 tons/ha. There was a sharp decline in maize production from 106,000 tons in 1995 to 66,000 tons in 1996. This was followed by a gradual increase to 107,000 tons in 1999 after which the production remained more or less constant up to 2003. The average planted area with maize per household was 0.6 hectares. Tarime district had the largest area of Maize (39,273 ha), followed by Musoma Rural (19,326 ha), and Serengeti (17,490 ha).

Sorghum was the second most important cereal crop in the region in terms of planted area. The number of households that planted sorghum during the long rains season was 54,589. This represents 43.7% of the total crop growing households. The total production of sorghum was 54,506 tons from a planted area of 55,040 hectares, resulting in a yield of 0.99 tons/ha. The district with the largest area planted with sorghum was Tarime 22,060ha), followed by Serengeti (17,040 ha) and Musoma Rural (5,751 ha).

Small Scale Roots and Tubers Production Systems

The total production of roots and tubers was 161,111 tons. Of all roots and tubers, cassava production was the most important with a total production of 115,747 tons representing 71.6% of the total root and tuber crop production. This was followed by sweet potatoes with 43,234 tons (26.8%), Irish potatoes (1,781 tons, 1.1%), yams (277tonnes, 0.2%),and cocoyam (71 tons, 0.0%).

The number of household growing cassava in the Mara region during the long rains season was 138,982. This represents 75.4% of the total crop growing households in the region. The total production of cassava during the census year was 115,747 tons from a planted area of 115,743 hectares resulting in a yield of 1.0 tons/ha. The number of households growing sweet potatoes in the Mara region during the long rains season was 36,514 (19.3%). The total production of sweet potatoes during the census year was 43,234 tons from a planted area of 16,621 hectares, resulting in a yield of 2.6 tons/ha.

Small Scale Pulse Crop Production Systems

The total area planted with pulses was 14,438 hectares, out of which 11,726 ha were planted with beans (81.2% of the total area planted with pulses), followed by chick peas (2070 ha, 14.3%), cowpeas (278 ha, 1.9%), bambara nuts (256 ha, 1.8%), and mung beans (108 ha, 0.7%).

Oil Seed Crop Production Systems

The total production of oilseed crops was 1,459 tons planted on an area of 1,572 hectares. Groundnuts were the most important oilseeds crop with 1,338 ha (85.1% of the total area planted with oilseeds), followed by simsim (176 ha, 11.2%), Soya beans (38 ha, 2.4 %) and sunflower (21 ha, 1.3%).

Fruit and Vegetables Production Systems

The most cultivated fruit and vegetable crop was the tomato with a production of 3,890 tons (54% of the total fruits and vegetables produced), followed by cabbage (1,683 tons, 24%) and onions (907 tons, 10%). The production of the other fruit and vegetables crops was relatively small.

Annual Cash Crops Production Systems

An area of 20,587 ha was planted with annual crops, mainly cotton and tobacco. The area planted with annual cash crops in the short rains season was 18,628 ha which represents 15.5% of the total area planted with annual crops. The area planted with annual cash crops in the long rains season was 1,959 ha, representing 0.9% of the total area planted with annual crops.

Permanent Crops Production Systems

The area of smallholders planted with permanent crops was 16,835 hectares (5% of the area planted with annual and permanent crops in the region). The most important permanent crop in Mara region was banana with a planted area of 4,376 ha (i.e., 27% of the planted area of all permanent crops), followed by coffee (3,771 ha, 22%), mango (1,701 ha, 10%), orange (1,169 ha, 7%), pawpaw (991 ha, 6%), and sugarcane (383 ha, 22%).

Methods of Land Preparation

In all of the above production systems, ox plowing is the most common method of seed bed (land) preparation. Ox plowing is used on 144,491 ha which represented 66% of the total area cultivated, followed by hand hoe cultivation (72,166 ha, 33%), and tractor plowing (1,822 ha, 1%). These methods of land preparation have minimal soil disturbance and reduce the possibility of land degradation considerably.

4.2.4.3 Emerging Issues on Agricultural Production Systems

Kenya

The challenges facing maize and wheat production are low yields by small holders. The yields are as low as 20% of the potential. In the agricultural sector, the issues/challenges are numerous:

- **Low crop yields:**

Small holder framers in Nakuru, Bomet, Transmara, and Narok districts experience low crop yields for a variety of reasons, with low and declining soil/land fertility being the most important. This has been caused by land degradation, specifically rampant soil erosion, which has removed the top fertile soils in agricultural lands. The challenge has been exacerbated by inadequate soil conservation practices in these districts. To mitigate this, small holder farmers need to immediately undertake soil and water conservation measures by construction of conservation structures on steep farm areas. This will however require support from Government extension services on affordable technologies.

- **Unpredictable weather patterns:**

The southern districts of Narok and Transmara are arid and experience unreliable rainfall in most parts. The average annual rainfall is also low, between 500-900 mm. The moisture levels therefore cannot support good plant growth throughout the crop growing season. In one season out of five most crops fail due to unprecedented droughts. Small holder farmers are unable to rely on rain fed crop cultivation for sustainable food production. At other times, rainfall exceeds normal levels and results in floods. Thus, droughts and floods impact agricultural production in these districts and require Government interventions.

- **Poor rural infrastructure:**

In Nakuru district, specifically in Mau Narok and Olenguruone divisions, the rural access roads are poor and small holder farmers are totally unable to move their farm produce to the markets in Nakuru Town during the rainy season. This challenge is compounded by lack of cold storage facilities for vegetables and other perishable crops.

- **Agricultural extension services:**

In all four districts, Nakuru, Bomet, Transmara, and Narok, small holder farmers rely on agricultural extension services for technical advice including timing for land preparation, certified seed selection, planting ,weeding, harvesting to reduced crop losses, and crop marketing advice. Unfortunately, government support to extension services has been reduced, and this has negative impacts on the level of crop production in all districts.

- **Inadequate market information:**

Farmers need adequate market information in order to remain competitive in crop production. Such information includes horticultural crops prices as well as supply and demand for various food commodities in various cities and towns. This information is vital for farmers to diversify production, especially of horticultural crops. The impact of this is greater in Nakuru district which has large acreages dedicated to horticultural crops.

- **Lack of coherent land use policy:**

There must be a legislative framework and coherent land use policy to regulate agricultural expansion in light of increasing food demand and sustainable agricultural development. The issues that need to be addressed include:

- Destruction of the Mara catchments through human encroachment for agricultural expansion and production;
- Rangeland management where high livestock numbers exceed the land holding capacities;
- Farming on marginal areas;
- Forest depletion for charcoal burning and harvesting of building poles;
- Soil erosion as a result of poor crop cultivation and livestock herding practices;
- Disappearing /declining grazing land (threatening the survival of the Mara ecosystem);
- Human–wildlife conflicts; and
- High population densities in the high potential districts; and
- Land fragmentation into uneconomical units

Tanzania

In the Mara region, low production of both food crops and cash crops has been linked up with the following factors:

- **Climatic factors:**

In Musoma and Tarime districts, lowlands have unreliable rainfall patterns resulting in long periods of droughts and crop failures in some years.

- **Soil infertility:**

This is most common in sandy soils in some areas in Musoma and Serengeti districts.

- **Plant diseases:**

The outbreak of cassava mealy bags on the ‘90s affected cassava production negatively.

- **Inadequate utilization of arable land:**

The Mara region has arable land estimated at 2.5 million hectares but only 300,000 hectares is under crop production annually, representing approximately 20% of total arable land .The region’s potential is very large and can be cultivated to provide adequate food supplies in balance with the other land uses.

4.2.4.4 On-Going and Planned Mitigation Measures and Interventions

Table 4.31: On-going and Planned Interventions in Agricultural Production Systems

Crop Production Issues	Districts covered	On-going intervention	Planned interventions
Low Crop Yields	Nakuru Narok Transmara Bomet	Ministry of Agriculture Projects: • NALEP-Extension services and field visits • Farmer Field Schools • Safe Use of Agrochemicals Project	1. Promote drought/pest resistant crops. 2. Enhance capacity of research at KARI sub-station. 3. Expansion of pyrethrum, tea and coffee production.
Poor rural Infrastructure	Nakuru Narok Transmara Bomet	Road construction and upgrading Kenyan project through fuel levy fund. Rural electrification Ministry of Energy project.	Rural electrification. Provision of efficient road network.

Inadequate Marketing information	Nakuru	Intensification of cooperative member mobilization and management. GOK project. Ministry of Trade projects: • Training of Traders • Trade licensing • Provision of export facilities	Establish trading linkages, e.g., AGOA, COMESA. Establish a training center for traders. Streamline the management of cooperatives. Encourage cooperatives to add value to their produce.
	Narok	Ministry of cooperative development projects • Promotion of new societies • Education training and information	Rehabilitation of dormant societies. Formation of marketing groups.
	Transmara	Ministry of cooperative development projects • Promotion of new societies • Education training and information	Cooperative education and training.
Reduced effectiveness of Extension Services	Nakuru Narok Transmara Bomet	Land use planning and management WWF EARPO Project in Mara Basin. Development of Community Agriculture in ASALs Areas (CADSAL: Extension services. Promoting Farmer Initiative through FFS (through UNDP and FAO). This a new project that will cover districts such as Kilifi, Taita Taveta ,Nakuru, Bomet, Narok, Kitui, and Mwingi	Promote farm forestry and agro forestry practices.
	Nakuru	Irrigation demonstrations in public venues, e.g., Nakuru show. Department of Agriculture project.	Promotion of efficient and appropriate irrigation technologies.
	Narok	Department of agriculture projects • Integrated and sustainable soil fertility management on farm demonstration and distribution of clean planting materials. • Promotion of drought escaping crops	Closer collaboration with existing NGOs. Increase on farm demonstration.
	Bomet	National Agriculture livestock extension program. NALEP.	Increase on farm demonstration and research.
Unpredictable Weather patterns	Nakuru Narok Transmara Bomet	Monitoring of weather patterns for planning by meteorological stations. Irrigation.	Rehabilitation of water supplies in Bomet, Nakuru and Transmara districts. Develop district profile on irrigation and development.
	Narok	Establishment of irrigation schemes e.g., Mulot and Mosiro irrigation	Irrigation Development. Training farmers on

		schemes.	irrigation systems and techniques. Community mobilization for groups based horticulture.
Slow adoption farming as a business.	Nakuru Narok Transmara Bomet	Horticulture project, e.g., fruit tree introduction and expansion in Transmara district. Banana growing in Kilgoris and pirrar.	Encouraging the community to diversify crops.
	Narok	Promotion of high value fruits in central Olokurto and Mulot divisions. Department of Agriculture project.	Establishment of floriculture district wide. Promotion of high value fruits.
	Nakuru	Extension services. NALEP project.	Establishment of horticulture production centers in Bahati, Molo, and Naivasha.
Farming on marginal areas	Nakuru Narok Transmara Bomet	Extension services. NALEP project Group and individual small-holder irrigation and drainage in Nakuru, Transmara and Narok District.	Provide technical guidance, assistance to potential individual small-holder irrigation drainage farmers.
	Narok	Department of agriculture projects. • Promotion of drought resistant crops • Integrated and sustainable soil fertility management	Establishment of sericulture to promote alternative cash crops in ASAL. Water harvesting for crop production
Inadequate use of fertilizers and agrochemicals	Nakuru Narok Transmara Bomet	Extension services. National Agriculture and Livestock Extension project. The National Accelerated Agricultural Inputs Access Program (NAAIAP), a project proposed to cover all districts in Kenya with funding from the GoK.	Encourage farmers to use adequate amounts of fertilizers. Promote early sustainable fertilizer and agro-chemical use.
	Nakuru	Safe use project by Department of Agriculture.	Sustainable fertilizer and agro-chemical use.
Inadequate soil conservation practices	Nakuru Narok Transmara Bomet	Extension services. National Agriculture and Livestock Extension project.	Integrated soil and water conservation.
	Narok	Integrated and sustainable soil fertility management program. Department of Agriculture project.	Environmental awareness.

Lack of Coherent land use policy	Nakuru Narok Transmara Bomet	National land Policy. GoK project.	Establish adjudication sections. Survey and demarcation. Harmonization of various land acts. Introduction of policy on sub–division acreage. Sensitization and training on land use and ownership. Frequent site inspections to guard against unauthorized developments.

Tanzania

Crop production Issues	Districts covered	On-going intervention	Planned interventions
Climatic factors	Musoma Rural Serengeti Tarime	Bugwema smallholder irrigation development project	
Soil infertility	Musoma Rural Serengeti Tarime	Bugwema Smallholder Irrigation Development Project. Environmental conservation and protection of entire catchment. District Agricultural Development Program. Soil conservation	Encouraging the farming community to adopt organic farming.
Disease outbreak (Cassava mealy bug)	Musoma Rural Serengeti Tarime	Disease control District Agricultural Development Program.	Sustainable disease and pest control.
Inability to exploit arable land potential	Musoma Rural Serengeti Tarime	Mara Valley Smallholder Irrigation project. Extension services.	Extension services. Awareness through field demonstrations
Inadequate use of fertilizers and agrochemicals	Musoma Rural Serengeti Tarime	Extension services by Mara Valley Smallholder Irrigation project.	Encourage farmers to use adequate amounts of fertilizers. Educate farmers on safe use, storage, and disposal of Agro-chemicals.

In general, sustainable agriculture must address the important factors of population increase, high population densities, and poverty reduction. There must be a legislative framework and coherent land use policy to regulate agricultural expansion in light of increasing food demand. As will be discussed later in this chapter, legislation should also address rangeland management where high livestock numbers exceed the land holding capacities. The following intervention measures are recommended:

Kenya

(i) Intensify and support current Agricultural Extension efforts (by NALEP) in the four districts of Nakuru, Bomet, Narok, and Transmara districts.
(ii) Improve rural infrastructure (roads, electricity, and water supply) in Nakuru, Bomet, Narok, and Transmara districts.
(iii) Support farmer organizations in Nakuru, Bomet, Narok and Transmara districts to increase their capacity for credit, farm inputs and marketing.
(iv) Support adaptive research and development of new crop varieties for marginal areas, fertilizer use, and recommendations.
(v) Develop an appropriate policy framework for Kenya to promote a competitive agriculture sector.

Tanzania

(i) Intensify and support the agricultural extension services in Musoma Rural, Tarime, and Serengeti.
(ii) Support farmer organizations in Serengeti, Tarime, and Musoma Rural to increase their capacity for credit, agricultural inputs and Marketing.
(iii) Support research and development on new crop varieties for marginal areas, fertilizer use, and recommendations.

4.2.5 Crop Production Data Sheets for Selected Districts

Table 4.32: Small Scale Farming Systems in Mara Districts, Kenya

District	Farm Size (ha)	Food crops	Population in the agric sector (Persons)	Food Crop Area (ha)	Contribution to HH incomes (%)	House Holds	House hold size
Bomet	10	Maize, Beans, Irish Potatoes, Sweet Potatoes	136,500	45,777	62	76,493	5
Transmara	12	Maize, Beans, Finger Millet, Sorghum, Vegetables, Irish Potatoes, Vegetables	70%	1,720	38	35,700	5.1
Narok	4	Maize, Potatoes, Vegetables, Beans, Onions and Tomatoes	29,820	40,800		76,450	5
****Molo**	1	Maize, Beans, Irish Potatoes Vegetables	-	-	48	-	4

Source: Compiled from District Development Plans for 2002-2008

Table 4.33: Narok South Crop Production Trend 2004-2007

Crop/Year		2004	2005	2006	2007
Maize	Ha planted	19,220	21,916	21,400	22,480
	Yield in bags	25	25	20	20
	Production in bags	551,250	547,900	239,000	6,774,400
Beans	Ha planted	3,500	4,300	5,100	7,240
	Yield in bags/ha	6	6	5	5
	Production in bags	29,300	45,720	32,805	86,880
Wheat	Ha planted	34,500	34,500	34,500	35,200
	Yield in bags	30	30	25	25
	Production in bags/ha	1,035,000	966,000	862,000	879,000
Irish potatoes	Ha planted	-	990	940	1,081
	Yield in t/ha	-	12t	12t	12t
	Production in bags	-	11,830	11,180	10,788
Tomatoes	Ha planted	-	571	542	516
	Yield in bags	-	15	15	15
	Production in tons	-	10,059	8,472	9,720
Bulb onions	Ha planted	-	247	316	248
	Yield in bags	-	12	12	10
	Production in bags	-	3,400	4,380	292ss

Source: Verbal communication with District Agricultural Officer, Narok South District on 21/04/08 at District headquarters in Ololunga town

Table 4.34: Transmara District Small Farm Sector

Division	Farm area Sq. Km	Rural HH 1989	Household per Sq. Km.	Small Holdings Number	Main Food Product	Main Cash Crop grown	%HH with high value food crop	% with high value cash crop
Kilgoris	445	2588	6	2458	Maize Potatoes Beans Millet	Maize, Pyreth-rum, Tea	60%	40%
Kirindoni	632	6576	10	6313	Maize Beans Millet	Maize	86%	80%
Kenyan	467	4508	9	1803	Maize Beans Vegetables Millet Bananas	Maize Sugarcane Tobacco	40%	10%
Lolgorian	640	3605	7	2703	Maize Beans Vegetables	Maize Tobacco	80%	60%
Pirrar	404	4328	10	2596	Maize Beans Vegetables	Maize	80%	30%

Source: Annual Report for 2006, District Agriculture Officer, Transmara District, Kilgoris

Table 4.35: Six Year Average Area under Production by Crop and District (Ha), Mara Region (1996 to 2002)

Food Crop	Musoma Rural (Ha)	Tarime (Ha)	Serengeti (Ha)	Total (Ha)
Cassava	13,758	18,821	16,570	58,692
Sorghum	8,113	10,185	15,600	41,003
Maize	5,866	13,967	15,340	45,418
Sweet Potatoes	10,193	6,178	4,385	28,083
Finger Millet	660	2,942	3,638	8,692
Paddy	722	308	1,860	5,203
Beans	1,663	2,422	1,865	7,432
Total food crops	40,975	54,823	59,258	194,524
Cotton	7,175	40	2,894	24,559
Coffee	162	3,942	80	4,185
Tobacco	-	238	-	238

Sunflower	60	64	79	208
Groundnuts	404	348	-	752
Total cash crops	7,801	4,633	3,053	29,937
Grand Total	48,776	59,456	62,311	224,461

Source: Regional Commissioner's Office, Musoma, 2002

Table 4.36: Estimated Area (Ha) Under Production of Major Food Crops in Mara Region, 1996 – 2002

Crop/year	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002	Yearly average	% of regional yearly crop area
Cassava	37,640	46,290	43,466	58,700	84,650	90,410	58,692	30
Sorghum	16,230	28,820	31,330	62,640	56,120	51,880	41,003	21
Maize	19,550	50,570	30,990	48,250	55,110	68,040	45,418	23
Sweet Potatoes	19,630	26,280	19,050	43,380	31,810	28,350	28,083	14
Finger Millet	5,520	3,390	11,190	8,980	11,880	11,190	8,692	5
Paddy	1,342	3,930	1,870	6,390	11,100	6,590	5,203	3
Beans	3,510	5,860	5,530	8,060	10,830	10,800	7,432	4
Total	103,422	165,140	134,426	235,400	261,500	267,260	194,523	100

Source: Regional Commissioner's Office, Musoma, 2002

Table 4.37: Estimated Area (Ha) Under Production of Major Food Crops by District, Mara Region, 2001-2002

Crop	Musoma	Bunda	Tarime	Serengeti	Total	% of total region crop area
Cassava	21,910	15,040	22,210	31,250	90,410	34
Sorghum	8,130	10,630	13,950	19,170	51,880	19
Maize	8,760	15,040	20,080	24,160	68,040	
Sweet Potatoes	7,840	5,830	7,570	7,110	28,350	11
Finger Millet	630	1,310	2,070	7,180	11,190	4
Paddy	720	1,570	560	3,740	6,590	3
Beans	2,310	2,260	1,610	4,620	10,800	4
Total	50.300	51,680	68,050	97,230	267,260	100
% of total crop area	19	19	26	36	100	

Source: Regional Commissioner's Office, Mara, 2002.

Table 4.38: Total Food Crop Production (tons) by District, Mara Region, 1996 – 2002

District	Estimated tons of food crop harvested 1996 - 2002	% of regional tonnage harvested
Musoma	443,790	24
Bunda	350,050	19
Serengeti	534,310	29
Tarime	494,010	27
Total	1,822,160	100

Source: Regional Commissioner's Office, Mara, 2002.

Table 4.39: Large Scale Farming Systems in Mara Districts-Kenya

District	Farm Size, (Ha)	Food crops	Population in the agric. sector (Persons)	Area under cash crops, Ha	% of HH income	House Holds	HH size
Bomet	15	Tea, Pyrethrum, Coffee	136,500	561	62	76,493	5
Transmara	100	Pyrethrum , Tea, Coffee, Sugarcane, Citrus Fruits, Bananas	127,449	18,700	38	35,700	5.1
Narok	80	Wheat, Barley, Potatoes, Vegetables, Onions, Tomatoes	29,820	68,000		76,450	5
Nakuru (Molo)	-	Tea, Coffee, Potatoes	-	-	48	-	4
TOTAL				87,261			

Source: Compiled from District Development Plans for 2002-2008

Table 4.40: Wheat and Maize Production Areas in the Mara Basin Districts (Nakuru, Narok, Bomet and Transmara) for 2006 Season

District	Wheat		Maize	
	Area	Production	Area	Production
Nakuru	12,366	547,000	65,670	1,626,750
Narok	62,950	1,880,500	34,800	696,000
Bomet	19	380	24,950	809,720

T-mara	-	-	38,000	850,000
TOTAL	75,335	2,239,594	181,948	4,082,470

Source: Compiled from District Agricultural Office annual reports, 2006 Nakuru, Bomet, Transmara and Narok Districts

Table 4.41: Six-Year Average Production Area by Crop and District, 1996-2002

Food Crop	Musoma Rural	Tarime	Serengeti	Total
Cassava	13,758	18,821	16,570	58,692
Sorghum	8,113	10,185	15,600	41,003
Maize	5,866	13,967	15,340	45,418
Sweet Potatoes	10,193	6,178	4,385	28,083
Finger Millet	660	2,942	3,638	8,692
Paddy	722	308	1,860	5,203
Beans	1,663	2,422	1,865	7,432
Total food crops	40,975	54,823	59,258	194,524
Cotton	7,175	40	2,894	24,559
Coffee	162	3,942	80	4,185
Tobacco	-	238	-	238
Sunflower	60	64	79	208
Groundnuts	404	348	-	752
Total cash crops	7,801	4,633	3,053	29,937
Grand Total	48,776	59,456	62,311	224,461

Source: Regional Commissioner's Office, Musoma, 2002

Table 4.42: Estimated Area (Ha) For Major Cash Crops, Mara Region, 1996-2002

Crop/year	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002	Yearly average	% regional crop area
Cotton	31,326	27,334	7,690	22,004	28,190	30,370	24,559	82
Coffee	3,714	30	4,069	4,677	413	413	4,185	14
Tobacco	70	80	200	200	n/a	n/a	238	Ins.
Sunflower	50	134	149	100	400	190	203	Ins.
Groundnuts	830	200	1,040	864	617	617	752	3
Total	35,990	27,778	13,548	27,885	29,570	31,943	29,937	100

Source: Mara Region Socio-economic Profile, June, 2003

n/a= data not available

Ins. =Insignificant

The tables indicate that in Kenya small-holder farm sizes are in the order of 1 to 10 hectares and large scale farms are 15 to 100 hectares. The food crops are maize and beans as well as other minor crops such as potatoes, sorghum, and rice. The cash crops are maize, wheat, tea sugarcane, pyrethrum, and horticulture, and are cultivated in large-scale farms. In Tanzania, the staple food crops are maize and cassava, and are cultivated by a large number of small holders in the Mara region. Cash crops are mainly cotton, coffee, tobacco, sunflower and groundnuts.

4.2.6 Irrigated Agricultural Production

4.2.6.1 Introduction

Agricultural productivity in sub Saharan Africa has not kept pace with the high population increase. Food security in the region is low, and the nutritional status of the population has deteriorated considerably in the last 30 years. In general, food production has achieved a growth rate of about 2.5% per year versus a population growth rate of 3% per year. An increase in the production area has been the solution; however, good arable land is becoming less available. To restore food security in the region, a significant increase of crop yield is needed. In this regard, both rain fed and irrigated agriculture will need to be intensified. Irrigated agriculture has a higher potential for faster crop yield increases.

Currently, the contribution of irrigated agriculture to total agricultural production in sub Saharan Africa is 10%. The irrigated land expansion has been negligible and has averaged 1.2% per year over the last 30 years. The expansion rate began falling in 1980s, is currently below 1% per year, and varies widely from country to country. Several attempts have been made to assess the irrigation potential for Africa including the following:

In 1987 the Food and Agriculture Organization (FAO) assessed the land and water resources potential for irrigation on the basis of river basins and countries. The study proposed natural resources based approach to assessing irrigation potential.

In 1997 the AQUASTAT program (conducted by FAO) used secondary information on water resources and irrigation collected from master plans and sectoral studies for each country.

The latest FAO assessment (1997) was based on a river basin approach and the potential using available information on land and water resources. The FAO Geographic Information System (GIS) facilities were extensively used.

4.2.6.2 Irrigation Potential

Kenya

In Kenya, irrigation based farming is still very limited. It is mainly developed in the form of small scale irrigation schemes and large scale irrigation of some crops such as rice and coffee. Individual farms have developed their own systems of irrigation especially for export crops such as coffee and horticultural produce. Large commercial farms account for 40% of irrigated land, while small holder farmers and government–managed schemes account for 42%and 18 % irrigated land respectively.

Kenya still has a significant potential for irrigation that remains unexploited. Out of 540,000 hectares of irrigable land, less than 90,000 hectares are irrigated. The development of irrigation has been hindered by a number of constraints such as low utilization of water, lack of efficient technologies, slow allocation of permits for the use of water, poor management of government irrigation schemes, weather changes and unpredictability that complicates irrigation planning, destruction of catchment areas, surface water degradation, uncontrolled exploitation of ground water that leads to declining ground water levels and increasing extraction costs, and low participation of irrigators in the management of irrigation schemes. Irrigation can play an important role in increasing Kenya's agricultural productivity per unit land, expand arable land, and stabilize the agricultural production in times of adverse weather conditions.

Tanzania

Irrigation Development in Tanzania consists of traditional irrigation which has been practiced in the country for many years particularly in Kilimanjaro and Mbeya regions. Modern irrigation was first introduced in the country in the 1930s (NIDP, 1994) by the Tanganyika Planting Company (TPC) near Moshi town for sugar cane plantations. After independence, the Government of Tanzania continued to develop irrigation projects through river diversion (river run-off schemes), as a means of stabilizing agricultural production and attaining self-food sufficiency. Some modern and traditional irrigation schemes were developed and improved during the post independence era. These comprised of schemes for smallholder farmers, parastatal owned estates for paddy and sugar cane production and privately owned plantations for tea and coffee production.

The National Irrigation Master Plan (NIMP) study was carried out from year 2000 to year 2002 under the technical and financial assistance from the Government of Japan, through the Japan International Cooperation Agency (JICA). The Plan reveals that the irrigation potential in Tanzania is 29.4 million hectares out of which 2.3 million hectares are high potential, 4.8 million hectares are medium potential, and 22.3 million hectares are low potential. Currently only about 264,388 ha are under irrigation that is about 2% of the cultivated area.

The table below provides estimates of the areas suitable for irrigation of rice and upland crops in Kenya and Tanzania.

Table 4.43: Soil and Terrain Suitability for Surface Irrigation in Kenya and Tanzania

Country	Total country area (Ha)	Soils suitable for irrigation of rice (Ha)	Soils suitable for irrigation of upland crops (Ha)	Total area suitable for surface irrigation (Ha)	% of total area suitable for surface irrigation(5/2) 100
Kenya	58,037,000	11,405,600	5,979,100	540,000	30
Tanzania	94,509,000	23,344,700	908,700	29,400,000	26
Total	152,546,000	34,750,300	6,887,800	29,940,000	28

Source: Irrigation Potential A Basin Approach, FAO 1997 Kenya Water Master Plan 1992 And Tanzania National Irrigation Master Plan (NIMP) Study, 2000

4.2.6.3 Irrigation Requirements

The FAO CROPWAT model has been used to calculate net crop water requirements for each of the basin units. The estimates have been compared with those available from individual countries and the calculations have shown reasonable correspondence and can be used to estimate crop water requirements for each basin in the African continent.

Table 4.44: Irrigation Water Requirements for Southern Kenya and Northern Tanzania

Cropping season	**Main crops**														
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Actual**	**Potential**
Wet	Vegetables				P	-	-	-	-	-	h			40	50
Wet	Rice				P	-	-	-	h					25	35
Wet	Cotton					p	-	-	-	-	h			15	15
All year	Sugarcane	-	-	-	-	-	-	-	-	-	-	-	-	10	10
All year	Arboriculture	-	-	-	-	-	-	-	-	-	-	-	-	5	5
	Total													95	95

Source: Irrigation Potential, A basin Approach for Africa, FAO 1997 Kenya Water Master Plan 1992 and Tanzania National Irrigation Master Plan (NIMP) study, 2000

4.2.6.4 Irrigation Potential

Table 4.45: Irrigation Potential, Water Requirements, and Irrigated areas in Kenya and Tanzania

Country	**Irrigation potential (ha)**	**Gross potential irrigation water requirement**		**Currently irrigated Area (ha)**
		per ha (m^3/ha per year)	**Total (km^3/year)**	
Kenya	540,000	10,500-12,000	0.576	90,000
Tanzania	2,940,000	12,000	0.013	264,388
Total for Kenya and Tanzania	29,940.000	22,500-24,000	0.589	354,388

Source: Kenya Water Master Plan 1992, Tanzania-The National Irrigation Master Plan (NIMP), 2002 and Irrigation Potential A basin Approach for Africa, FAO 1997

In the Mara region, comprising Musoma Rural, Tarime, and Serengeti districts, the surveyed irrigation potential is 2,192 hectares, but only 120 hectares (or 5%) are currently under production (FAO, 1997). The table below summarizes the irrigation potential and the water requirements for Kenya and Tanzania.

Kenya

The Kenya National Water Master plan (1992) identified an irrigation potential of 540,000 ha based on 80% dependable flow. Currently only about 90,000 ha are irrigated. The surveyed irrigation potential in the upper and middle Mara River Basin is approximately 2,937 ha distributed as follows: Nakuru (Molo) District 505 ha; Bomet District 2,264 ha; and Transmara District 168 ha.

4.2.6.5 Key Irrigation Issues

The development of irrigation and drainage is low as indicated by the small percentage of the exploited potential. In addition, most of the existing irrigation and drainage systems have dilapidated infrastructure, requiring frequent rehabilitation and performing below expectations. The development of irrigation is hindered by a number of constraints including the following:

- **Lack of a comprehensive irrigation/drainage development and management policy:**

In Kenya there is no such policy and this has hindered a sustainable approach to irrigation development. The water Act of 2002 does not address irrigation issues adequately and is the major cause of delays in water use permit allocations from irrigation water sources. As a result of this, Kenya farmers experience inadequate irrigation infrastructure, inadequate funding, inadequate effective support services (especially research and extension services).

- **Destruction of catchments areas:**

The destruction of the Mau forest complex has serious negative implications for availability of irrigation water downstream for the expansive agricultural lands in Nakuru, Bomet, Narok, and Transmara districts. The deforestation also has caused surface water degradation leading to increases in water abstraction and production costs. The negative impacts are far and wide and include over-exploitation of groundwater eventually leading to declining underground water levels.

4.2.6.6 On-Going and Proposed Irrigation Interventions

The following tables summarize on-going and planned interventions in both Kenya and Tanzania.

Table 4.46: On-Going and Planned Irrigation Interventions, Kenya

Issue	Districts covered	On-going intervention	Planned interventions
Lack of comprehensive Irrigation /drainage development policy	Nakuru Bomet Transmara Narok	Ministry of Agriculture Project: Develop small-holder irrigation and drainage groups.	Efficient water harvesting, storage and utilization for irrigation. Efficient and appropriate irrigation technologies.
Lack of organized irrigation schemes	Narok	Establish irrigation schemes, e.g., Mulot and Mosiro.	Irrigation Development Training farmers on irrigation systems and techniques. Community mobilization for group based horticulture.
	Transmara		Develop district profile on irrigation and drainage activities.
Inadequate irrigation infrastructure	Nakuru	Promote water harvesting and storage facilities. Small-holder irrigation farms mainly around Lake Naivasha.	Encourage individual farmers to develop their own water sources.
	Narok	Construction of intake works in Mulot division.	Mobilizing rural funds through formation of rural SACCOs. Encourage roads department and local authorities to provide needed infrastructure.
Inadequate extension support services	Narok Nakuru Bomet Transmara	Strengthen Agricultural Training Centers, the FTCs, funded by the GoK Extension services. NALEP project: group and individual small holder irrigation and drainage in Nakuru, Transmara, and Narok district. Agricultural sector research under KARI and agriculture research foundations supported by EEC/EDF, WB. Field Schools and promotion of farmers' innovators project. FFS *Njaa Marufuku* Kenya (NMK) covering 71 districts and directly supported by the GoK.	Enhance dissemination of information on best practices by training extension service providers.
	Nakuru	Irrigation demonstrations in e.g. In Nakuru A.S.K	

Lack of organized irrigation schemes	Nakuru Bomet Transmara Narok	Extension services NALEP project: group and individual small holder irrigation and drainage in Nakuru, Transmara and Narok District.	Community mobilization for groups based horticulture.
Destruction of catchments areas;	Nakuru Bomet Transmara Narok	World Agro-forestry center project. Water shed management.	Protect water catchment areas.
Over exploitation of ground water	Narok Nakuru Bomet Transmara	Rain water harvesting and storage.	Catchment areas protection Extension and rehabilitation of existing water supply.
Increase in production costs	Nakuru Bomet Transmara Narok	The National Accelerated Agricultural Inputs Access Program (NAAIAP), a project proposed to cover all districts in Kenya with funding from GoK.	Establish affordable and accessible credit facilities.
Poor irrigation under government management	Nakuru Bomet Transmara Narok	Kenya Agricultural Productivity Project (KAPP) With support from the world Bank covering 20 districts. National Agriculture Extension Program (NALEP 11) supported by Sida.	Closer collaboration with other stakeholders, e.g., community NGOs.
Unpredictable weather patterns	Nakuru Bomet Transmara Narok	Monitoring of weather patterns for planning by meteorological stations. Irrigation.	Micro-catchments damming for irrigated rice farming in the basin.
Surface water degradation	Nakuru Bomet Transmara Narok	Integrated Water Management. Project by LVEMP.	Enhanced surveillance and capacity building at the grassroots to protect water resources.

Table 4.47: On-Going and Planned Irrigation Interventions, Tanzania

Irrigation development Issue	Districts covered	On-going intervention.	Planned interventions
Lack of appropriate technologies	Musoma Rural Serengeti Tarime	Bugwema Smallholder Irrigation Development Project. Mara Valley Smallholder Irrigation.	Enhance dissemination of information on best practices by training extension service providers.

	Butiama in Musoma Rural	DADP project funded by UNDP: Use of electricity powered pumps.	No record of planned intervention.
	Saguti in Musoma Rural District	DADP project funded by UNDP Use of diesel powered pumps.	No record of planned intervention.
	Chanyauru in Musoma	DADP project funded by UNDP: Solar energy for irrigation pumps used for 7.5 Ha vegetable field.	No record of planned intervention.
	Bukima in Musoma Bugerea in Serengeti	DADP project funded by UNDP. Gravity intakes at water sources used to irrigate 20 Ha of rice fields.	No record of planned intervention.
	Nyabange wind mill in Musoma	DADP project funded by UNDP. Wind mill power use for irrigation of 5 Ha rice and vegetable fields.	No record of planned intervention.

Proposed irrigation Interventions

There is immense potential for irrigation to contribute to the economic recovery in both countries. The proposed strategies include the following:

Kenya.

(i) Enact a National comprehensive irrigation and drainage policy to facilitate effective irrigation development and enhance participation in all related sectors.

(ii) Rehabilitate the existing small-holder irrigation schemes in Narok district (Narosura and Mosiro irrigation schemes).

(iii) Invest in extension support for irrigation development in Nakuru, Bomet, Transmara, and Narok districts.

Tanzania

(i) Rehabilitate the existing small holder irrigation schemes in Musoma Rural (Butiama, Saguti, Chereke, and Ochuma irrigation schemes), Tarime (Minigo and Ryagubo irrigation schemes), and Serengeti (Bugere irrigation schemes)

(ii) Capacity Building Support (technical personnel) in farmer organizations to ensure full integration of small-holder farmers in irrigation and drainage development in Tarime Serengeti and Musoma Districts.

4.2.6.7 Data Sheets for Selected Districts

Tanzania

Table 4.48: Irrigation Schemes in Mara Region, Tanzania, 2002

District	Name of Area	Division	Surveyed Potential Area (Ha)	Area under irrigation (Ha)	Comments
Musoma	Butiama	Makogoro	300	Nil	Electrically powered pumping engines
	Saguti	Nyanja	1,600	Nil	Diesel powered pumps
	Saguti	Nyanja	5	5	Under production
	Maneke	Nyanja	40	-	Earth work ongoing for dam construction, water flow by gravity
	Busahili	Kingata	60	40	
Total			2,005	40	
Tarime	Minigo	Nyacha	12	Nil	Solar powered pumps
	Ryangubo	Nyacha	15	Under construction	Under construction wind mill power
	Ochuma	Luoimbo	60	40	Dam water gravity flow
	Chereke	Luoimbo	60	Nil	Dam under construction, gravity flow
Total			147	40	
Serengeti	Bugerea	Ngoreme	40	Nil	Dam under construction, gravity flow
Grand Total			2,192	120	5% potential area developed

Table 4.49: Musoma District Irrigation Scheme Status: April, 2008

No.	Scheme Name	Total Area (acres)	Currently irrigated area (acres)	Irrigation system	Source of water	Crops grown
1	Butiama	300	18	Furrow system	Storm water	Maize, horticultural crops
2	Bugwema	2,400	-	Furrow basin	Lake Victoria	Cotton, maize, beans and paddy
3	Chirolwe	100	46	Basin	Storm water	Paddy
4	Buswahili	164	128	Basin	Storm water	Paddy
5	Chanyauru	25	7	Basin	Lake Victoria	Paddy, horticultural

						crops,
6	Bukima	40	-	Basin	Lake Victoria	Paddy
7	Suguti	14	-	Furrow	Lake Victoria	Maize
8	Mugango	160	71	Basin	Lake Victoria	Paddy
9	Drip Irrigation	8	5	Drip system	Lake Victoria	Horticultural crops
10	Masinono	750	-	Basin	Storm water	Paddy
11	Kataryo	500	-	Basin	Storm water	Paddy
12	Suguti Basin	1,500	-	Basin	Storm water	Paddy
13	Mwikoko	120	60	Basin	Spring water	Maize
14	Maneke	100	60	Basin	Storm water	Paddy
TOTAL		6,181	335			

Source: District Irrigation Officer –Musoma

Kenya

Table 4.50: On-Going Irrigation Projects in (Narok, Nakuru and Bomet districts) Mara Region Kenya

No	District	Project name	Water source	Division	Pote. Area (ha)	Irrigated area (ha)	No. of farmers	Status of project	Source of funding	Crops grown	Remarks
1	Narok South	Elangata Enterit	Mabokoni River	Osupuko	50	35	50	Operational	GoK	Maize, cabbages and tomatoes	Rehab
		Nkoron Ole Polos	Naroosura river	Osupuko	60	30	50	Operational	GoK	Vegetables, tomatoes, onions, kales	Rehab
		Oloiborongoni	Naroosura river	Osupuko	60	40	50	Operational	GoK	Vegetables, tomatoes, onions, kales	Rehab
		Kanunka A	Kanunka river	Osupuko	80	40	50	Operational	GoK	Vegetables, tomatoes, onions, kales	Rehab
		Kanunka B	Kanunka river	Osupuko	90	50	90	Operational	JICA/ GoK	Vegetables, tomatoes, onions, kales	Rehab
		Koseka	Kanunka river	Osupuko	110	60	70	Operational	JICA/ GoK	Vegetables, tomatoes, onions, kales	Rehab
		Oloi ruwa	Olchoro	Osupuko	80	60	175	On going	GoK	Vegetables,	Rehab

			river						tomatoes, onions, kales	
		Entiapiri	Entiapiri River	Osupuko	15	5	30	Proposed	-	-	
		Olo lepo	Naroosura rive	Osupuko	60	30	50	On going	ALRMP	Vegetables, tomatoes, onions, kales	
		Naroosura	Naroosura river	Osupuko	120	68	160	operational	GoK/CDTF	Vegetables, tomatoes, onions, kales	Under rehabilitation
2	Narok North	Mosiro	Ewaso Nyiro	Mau East	100	10	126	Proposed	GoK/ ADB	Kales and tomatoes	Partially operational
		Meeyu	Olchoro Oiruwa	Narok Central	20	5	51	On going	GoK	For horticulture	Partially operational
		Enkare Narok	Enkare Narok river	Narok Central	60	10	55	Proposed	GoK	For horticulture	Partially operational
3	Bomet	Kaboson	Nyongores river	Sigor	300	Nil	150	On going	GoK, & BCC	For horticulture & food crops	BCC got funds from EU.
		Kapkures	Sesei river	Mutarakwa	200	Nil	150	Proposed	GoK, & BCC	For horticulture & food crops	At design stage
		Mulot/Lelaitich	Amala river	Longisa	400	Nil	300	Proposed	GoK, & BCC	For horticulture & food crops	At design stage

		Chebaraa	Nyongores river	Sigor	350	Nil	250	Proposed	GoK, & BCC	For horticulture & food crops	At design stage
		Cheluch drainage	Nyongores river	Sigor	300	60	30	Proposed	GoK, & BCC	For horticulture & food crops	At design stage
		Kapkemoi drainage	Nyongores river	Sigor	170	50	45	Proposed	GoK, & BCC	For horticulture & food crops	At design stage
4	Molo	Njoro Drainage)	N/A	Njoro	150	50	100	operational	GoK	Maize, beans	

Source: Bi-annual Report, Ministry of Water and Irrigation, 2008 (Provincial Irrigation Office, Rift Valley Province)

ALRMP-Arid Lands Resource Management Project
BBC – Bomet County Council
WV- World Vision
CDTF – Community Development Trust Fund
EU - European Union.

4.3 Livestock Production

4.3.1 Introduction

Kenya

Both farmers and pastoralists keep livestock for food and income generation. In the high rainfall areas under intensive and semi-intensive systems, farmers generally keep pure and crossbred animals for milk, eggs, red meat, and white meat. In areas where land availability is limited, farmers stall feed for the animals and cultivate the land. There are areas as in the Mara River basin where land is still large enough to allow free grazing.

Tanzania

In Tanzania, the livestock sector is the second most important contributor to the region's economy. Livestock numbers vary from one district to another and include: cattle, goats, sheep, and donkeys. Cattle are kept for meat, milk, and dowry. Cattle are also used for land preparation (ox-driven implements), crop transportation, and transportation of domestic goods from farms to residences and markets. Goats and sheep are kept for meat and are also dowry supplements.

4.3.2 Livestock Population

Kenya

Livestock population in Kenya is currently estimated to be over 60 million, comprised of approximately 29 million chicken, 10 million beef cattle, 3 million dairy and dairy crosses , 9 million goats,7 million sheep, 800,00 camels, 520,000 donkeys and 300,000 pigs. Animals include indigenous, exotic, and cross breeds.

In 1995, livestock population in the Mara Districts (Nakuru, Narok, Bomet, and Transmara) was 1,227,845 beef cattle and 486,421 dairy cattle distributed as follows: Narok District 36,772 dairy and 504,765 beef; Transmara 40,250 dairy and 362,250 beef; Bomet 191,950 dairy and 233,730 beef; and Nakuru 217,449 dairy and 126,200 beef. The data for all the livestock is provided in the tables below.

Table 4.51: Livestock Population, Nakuru District, 1993-1995

Type of Livestock	1993	1994	1995
Dairy Cattle	195,700	211,799	217,449
Beef Cattle	155,300	137,900	126,200
Sheep	150,270	155,250	158,050
Goats	71,176	74,754	71,088
Pigs	9,428	16,002	19,964
Poultry	907,472	1,168,865	1,273,483
Rabbits	13,872	15,469	21,169

Bee keeping (No. of hives)	7,997	9,288	8,036

Source: District Livestock Office, Nakuru, 1996

Table 4.52: Livestock Population and Trends, Bomet District, 1992-1995

Type of Livestock	1992	1993	1994	1995
Cattle Zebu (Indigenous breed)	371,623	354,550	354,556	233,730
Dairy Cattle Grade	194,336	194,530	194,530	191,950
Goats	133,785	64,636	133,785	75,800
Sheep	55,245	91,340	57,248	116,950
Beekeeping Long hives KTBH	6,750 778	8,359 713	8,410 863	7,474 907
Rabbits	190	884	884	1,780
Pigs	-	-	-	20
Donkeys	-	-	-	20
Poultry Exotic Local	5,775 200,000	5,302 391,770	4,322 754,033	19,590 348,800

Source: District Livestock production Office, Bomet, 1996.
KTBH=Kenya Top Bar Hive

Table 4.53: Livestock Population, Narok, District, 1991-1995

Type of Livestock	1991	1992	1993	1994	1995
Beef Cattle	843,000	843,570	826,224	494,500	504,765
Wool Sheep	1,420,000	1,364,227	1,336,942	489,500	498,660
Donkey	229,260	226,967	224,697	117,471	117,571
KTBH	1,475	1,575	1,654	1,058	1,100
TLH	17,000	17,170	17,342	9,778	9,818
Camel	-	23	30	110	120
Dairy Cattle		64,394	65,038	36,722	36,772
Dairy Goat	-	783	797	270	1,061

Source: District Livestock Production Office, Narok, 1996
TLH= Total Longstroth Hives

Table 4.54: Livestock Population, Transmara District, 1991- 1995

Type of Livestock	1991	1992	1993	1994	1995

Dairy Cattle	30,210	31,720	33,300	35,000	40,250
Beef Cattle	272,100	285,700	300,000	315,000	362,250
Wool Sheep	29,940	31,430	33,000	35,000	40,250
Goats	25,940	27,240	28,600	30,000	34,500
Poultry (Layers)	2,000	25,000	450	500	600
Poultry (Local)	150,200	157,700	165,600	174,000	20,000
Donkeys	136	143	150	180	210

Source: District Livestock Production Office, Kilgoris, 1996

Tanzania

In 2002, it was estimated that the region had 1,291,576 cattle; 620,748 goats; 179,018 sheep; and 9,860 donkeys. Tarime has the highest number of cattle and accounts for 31% of the region's population. Thirty two percent of sheep were in Tarime. Cattle population increased from 969,766 in 1984 to 1,291,576 in 2002, an increase of approximately 33%. Goats increased by 65 %, while sheep decreased by 17% over the same period (Regional Commissioners office, Musoma, 2002). The cattle population density increased from 45 per km^2 in 1984 to 58 per km^2 in 1998 and 66 per km^2 in 2002.

Table 4.55: Livestock Population Density by District, Mara Region, 2002

District	**Land area km^2**	**Cattle Population**	**Cattle per km^2**	**Goats**	**Sheep**	**Donkeys**
Musoma	1,957	363,108	186	143,331	33,119	3,024
Tarime	3,885	401,800	103	133,447	57,033	4,874
Serengeti	10,942	273,749	25	237,762	56,398	769
Total	19,566	1,291,576	66	620,748	179,018	9,860

Source: Regional Commissioner's Office, Musoma, 2002

Table 4.56: Cattle Population Distribution in Mara Region 1984-2002

Year	Cattle	Goats	Sheep
1984	969,766	394,444	215,558
1998	1,272,537	510,190	194,000
2000	1,291,576	620,748	179,018

Source: Mara region Socio-economic Profile, June 2003

Table 4.57: Cattle Population Density by Districts, Mara region 2002

District	**Land area km2**	**Cattle population**	**Cattle per km^2**
Musoma	1,957	363,108	186
Tarime	3,885	401,800	103
Serengeti	10,942	273,749	25

Total	19,566	1,291,576	66

Source: Mara region Socio-economic Profile, June 2003

Table 4.58: Cattle Population and Density, Mara

Land area km^2	1984 cattle population	Density per km^2 1984	1994/95 cattle population	Density per km^2 1994/95	1998/99 cattle population	Population per km^2 1998/99	Change 1994 to 1999	
							Number	%
21,760	969,776	45	1,291,576	59	1,272,537	58	-19,039	-1

Source: Mara region Socio-economic Profile, June 2003

Table 4.59: Livestock Distribution by Type, Mara Region, 1984

Cattle		Goats	Sheep	Ranching dairy	% all cattle	Ranching cattle only
Improved dairy	All types of cattle					
3,173	969,766	394,444	215,558	8	7.8	5
Cattle number, Mara Region, 1998/99						
Households with cattle		**Cattle number**			**Cattle per house hold**	
98,418		1,272,537			12.93	

Source: Mara region Socio-economic Profile, June 2003

Table 4.60: Marketed Livestock by Type,Value, and District Mara Region, 2001

District	Livestock type	Number	%	Value (million TShs)	Average price per animal, TShs
Musoma	Cattle	15,828	26	1,266.2	79,997
	Sheep/Goat	4,560	21	34.2	7,500
Tarime	Cattle	16,703	28	1,837.3	109,998
	Sheep/Goat	12,833	58	154.0	12,000
Serengeti	Cattle	13,276	22	1,062.1	80,002
	Sheep/Goat	1,225	6	14.7	12,000
Total	Cattle	60,443	100	5482.8	90,710
	Sheep/Goat	21,998	100	228.6	10,392

Source: Mara Region Socio-economic Profile, June 2003

4.3.3 Rangelands and Livestock Production

Kenya

In Kenya, the rangeland conditions are satisfactory and the trend is currently stable. In marginal and agro pastoral zones of the Narok and Transmara districts, range improvements, particularly reseeding, continue to pose great challenges as a result of uncontrolled grazing and a poor land tenure system. Intervention measures for range rehabilitation are needed to improve reseeding and soil conservation. Range conditions are also depending on weather. A general increase in invader species of grasses and shrubs indicate deteriorating range conditions across the two districts. In rangelands, livestock are kept in a pastoral system or as developed ranching. Breeds in these systems are mainly the East African Zebu, the Boran cattle, and the Sahiwal cattle. Numerous varieties of sheep, goats, and camels are also found.

Overall forage production in the past two years has been normal both in quality and quantity, and it is associated with favorable weather (above normal rainfall). During the last two years, ranchers and pastoralists utilized standing hay, maize stovers, and wheat straws. Baled hay was available in commercial ranches especially in the Nakuru and Narok Districts.

The changes in land use practices in the rangelands continue to be a major concern, particularly in the Narok District where monoculture is fast taking hold. There is continued loss of biodiversity as more land is opened for wheat and horticulture in this district. The pastoral community livelihood is negatively impacted and seasonal migration is reduced causing land degradation. Overgrazing continues to be a major threat to sustainable range use in the Narok and Transmara Districts. Large flocks of sheep graze very low and do not allow for grass regeneration.

Tanzania

In Tanzania, the government has stopped the free supply of veterinary drugs and accaricides (veterinary drugs for control of ticks). Cattle owners are now required to purchase these for their livestock. Extension officers provide advisory services only. In rural areas, livestock owners go to market places (e.g., Minada and Mitera) to buy veterinary supplies from individual drug dealers at high prices. The region has 25 Veterinary Health Centers with eight in Musoma, eight in Tarime, and nine in Serengeti. Crushes (timber enclosures—pens—for holding livestock during vaccination campaigns) are also distributed in the following way: Musoma 9, Tarime 12, and Serengeti 10.

The lack of water for livestock is a common problem in many villages. Communities have not maintained charcodams constructed in the early 1930's to 1950's. Rainfall is available for only few months of the year, and rainwater has to be harvested through charcodams and other water reservoirs. During the dry season, livestock keepers migrate to other areas in search of water and pasture. Measures should be taken to ensure that livestock have access to adequate water supplies. Support is needed for charcodams and/or dam construction to harvest rainwater, since these have proven to be viable technologies for water distribution in the region.

Cattle ticks cause many livestock diseases and animal deaths. The common tick borne diseases in the region include East Coast Fever ECF, Anaplasmosis, Heart Water, and Babesiosis. Non tick-borne diseases are Foot and Mouth Disease and Contagious Bovine Pleural Pneumonia (CBPP). There are several livestock dipping facilities in the region. However, out of 113 cattle dips, only 49 are in good running condition and 64 are dilapidated. In addition, lack of accaricides is another problem facing cattle dipping.

Table 4.61: Distribution and Conditions of Cattle Dips in the Region, 2002

District	Working	Not working	Total Dips
Musoma	11	19	30
Tarime	16	32	48
Serengeti	12	9	21
Total	49	64	113

Source: Mara region Socio-economic Profile, June, 2003

Only 43 percent of the regions dips are in working condition. The worst dip situation is in Tarime District where only 33 percent are serviceable. Ideally, the region should have 125 working dips properly distributed for effective tick-borne diseases control. The region's dipping scheme is far from satisfactory as a result of many non-functioning dips and poor distribution of those in working order.

In the Mara region, where there are more than twelve ethnic groups with aggressive cultures and customs, cattle rustling (a common practice among pastoral communities of raiding and forcefully taking away others' livestock) is a common destructive practice that occurs regularly. The practice is often fatal, destructive and distributes poverty to victimized families. Traditional vigilante groups and courts (sungusungu and ritongo) are doing a commendable job in containing the situation.

4.3.4 Sheep and Goat Production

4.3.4.1 Introduction

Kenya

Many communities in the Mara region economically depend on sheep and goats as sources of red meat, milk, skins, and wool. Sheep and goats are highly adaptable to a broad range of environments and are found in all agro-ecological zones of the basin (i.e., from the cold high lands to the arid lowland plains). These livestock utilize a wide variety of plant species and are thus complementary to other livestock types. In certain areas of the basin, they provide the only practical means of utilizing vast areas of natural grasslands unsuitable to other forms of agriculture. Flock sizes vary by geographical zone. The larger flocks are found mainly among the pastoral communities in the ASAL areas while smaller flocks (sometimes numbering less than ten) are reared by mixed livestock/crop farmers. This resource is critical for household income as well as nutrition. Livestock are an important and secure form of investment and serves as a form of wealth.

The sheep industry has steadily improved, and the 2005 population represents a 7.8% increase over 2004. Although the major breed is the Red Masai, which is widely kept by pastoralists and generally grazed with cattle, Dorper sheep, Black Head Persian, and their crosses are also common (Ministry of Livestock Development Annual Report, 2007).

Table 4.62: Sheep and Goat Population Trends in MRB-Kenya

	2004				2005				2006			
District	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats
Nakuru	156,948	61,838	115,737	5,978	130,731	58,762	109,253	7,052	194,650	70,530	111,600	16,134
Narok	661,928	211,552	589,700	705	577,140	288,920	691,310	710	484,798	241,635	596,320	821
Trans Mara	73,399	-	51,848	93	76,550	0	57,625	102	78,400	0	59,000	150

Source: Ministry of Livestock Development Annual Report, 2007

Tanzania

Goat rearing was the second most important livestock activity in the Mara Region, Tanzania followed by sheep and pig rearing. In terms of total numbers, Mara ranked 9th of the 21 Tanzanian mainland regions with 5.4 percent of the total goat population.

Table 4.63: Number of Goats by Type and District, October, 2003

District	Indigenous			Improved for meat			Improved dairy			Total Goat	
	Number of households	Number of goats	%	Number of households	Number of goats	%	Number of households	Number of goats	%	Number of households	Number of goats
Tarime	31,871	235,607	99.1	0	0	0.0	528	2,103	0.9	31,871	237,710
Serengeti	9,164	103,574	100	0	0	0.0	0	0	0.0	9,164	103,574
Musoma	20,192	167,535	96.7	455	5,118	3.0	227	569	0.3	20,192	173,221

Table 4.64: Number of Sheep by Type and District, October, 2003

District	Number of indigenous		Number of improved mutton		Total Sheep	
	Number	%	Number	%	Number	%
Tarime	75,196	100	0	0	75,196	39
Serengeti	48,237	100	139	0	48,376	25
Musoma	40,132	99	230	1	40,362	21
Total	193,704	100	370	0	194,073	100

Table 4.65: Sheep by Type and District, October, 2003

District	Total sheep					
	Ram	Castrated sheep	She sheep	Male lamb	She lamb	Total
Tarime	19,724	5,165	33,610	6,964	9,732	75,196
Serengeti	10,124	7,172	21,122	4,503	5,456	48,376
Musoma	7,764	819	20,469	6,110	5,201	40,362
Total	43,318	13,781	91,890	21,090	23,995	194,073

4.3.4.2 Goat Production Systems

Kenya

Due to decreasing land sizes in the highlands and the medium lowlands, the small dairy goat industry is small but fast growing and contributing to better human nutrition. Dairy goats in peri-urban areas are also providing families with their milk needs. The demand for dairy goats is high. Nakuru and Bomet districts have shown the greatest dairy goat enterprises. The biggest problem until recently has been the absence of dairy goat breeders in the MRB. The region has therefore depended on supply from central and eastern provinces (particularly Nyeri and Meru) for their breeding stock.

Dairy supplies are grossly inadequate, overpriced and sometimes of questionable quality. The efforts of the Kenya Dairy Goat Breeders Association in collaboration with extension staff have helped particularly in Nakuru District where many farmers are now registering their animals for breeding. The government has continued to provide extension services for dairy goat production through livestock extension staff as well as sheep and goat production stations. However, these stations, (Naivasha, Marindas, Kimose, and Narok), have operated below their production capabilities due to inadequate funding. Other organizations involved in small stock extension services are the Catholic Diocese of Nakuru (CDN), Church Anglican Church, Farming Systems of Kenya, and various breeder organizations complementing the GOK extension services (Ministry of Livestock Development Annual Report, 2007).

Tanzania

The number of goat-rearing households in the Mara Region was 39% of all agricultural households (72,575) with a total of 634,044 goats and an average of 9 head per household. Tarime district had the largest number of goats (237,710 goats or 37.5 % of all goats in the region), followed by Musoma Rural (173,221 goats, 27.3 %) and Serengeti (103,574 goats, 16.3%). However Musoma Rural district had the highest goat density (109 head per km^2) (see table 4.55).

Thirty seven percent of goat-rearing households had herd sizes of 1-4 with an average of 3. About 84 % of goat-rearing households had herd sizes of 1-14 accounting for 56 percent of the total goats in the region and resulting in an average of 6 per households. The region had

1,405 households (1.9%) with herd sizes of the 40 or more (66,416 goats in total), resulting in an average of 47 per household.

Goats in the Mara Region were largely the indigenous breeds constituting about 99% of the total. Improved goats for meat and dairy constituted 0.8 and 0.4% of total goats, respectively.

The overall annual growth rate of the goat population from 1995 to 2003 was 0.3 percent. This positive trend showed eight years of population increase from 620,748 in 1995 to 634,044 in 2003. The number of goats decreased from 620,748 in 1995 at an annual rate of -1.7 percent to 578,900 in 1999. From 1999 to 2003, the goat population increased at an annual rate of 2.3 percent (see table 4.55).

4.3.4.3 Sheep Production Systems

Kenya

The Mara River basin has a great potential for wool production, especially in the cold highlands and vast lowlands. Kenya's history on wool sheep breeding dates back more than 100 years with merino, corriedale and Hampshire down. Corriedale and Hampshire down are mainly found in the highlands merino do well in the lowlands. The development of wool sheep production has been constrained by unstable market outlets as well as poor prices. For years sheep shearing was a management activity rather than a commercial undertaking; farmers sheared sheep but got no income from the wool. However, the situation greatly improved in the last two years with emerging local markets in RUPA mills. Eldoret re-opening the Kenya Farmers Association Wool Section in Nakuru four years ago also helped stabilize wool prices and hence wool sheep population in anticipation of improved wool prices. Munir-Ali and Spin Knit, both of Nakuru, purchased significant amounts of wool (Ministry of Livestock Development Annual Report, 2007).

Table 4.66: Wool Production (Kg)

Year/Districts	2004	2005
Nakuru	211,050	154,782
Narok	503,910	519,711
Total	714,960	674,493

Source: Ministry of Livestock Development Annual Report, 2007

Table 4.67: Wool Marketing

District	Quantity (Kg)	Average Price	Value (KShs)
Nakuru	154,782	KShs 25	3,869,550
Narok	574,123	KShs 50	28,706,150
Total	728,905		32,575,700

Source: Ministry of Livestock Development Annual Report, 2007

Despite the increased wool demand in local markets, production has not increased. The biggest challenge is lack of breeders. Wool marketing is better organized in Nakuru district than other wool producing districts, and better prices are correspondingly received. The main market outlets are Rupa Mills (Eldoret) and KFA wool unit (Nakuru).

Tanzania

The number of sheep-rearing households in Mara Region was 21,780 (12% of all agricultural households) with 194,073 total sheep and an average of 9 per household. The district with the largest number of sheep was Tarime with 75,196 (39% of total sheep in Mara region) followed by Serengeti (48,376 sheep, 25%), and Musoma Rural (40,362 sheep, 21%). However, Musoma Rural district had the highest sheep density (26 head per km^2). (See table 4.55).

Sheep rearing was almost exclusively indigenous breeds (99.8% of all sheep kept in the region). Only 0.2 % of the total sheep in the region were improved breeds. The overall annual growth rate of sheep from 1995 to 2003 was 1 %. The population increased at an annual rate of 2 % from 179,019 in 1995 to 194,036 in 1999. The sheep population remained fairly constant from 1999 to 2003 at around 194,000. (See table 4.55).

4.3.5 Pig Production

Kenya

Meaningful pig farming is only done in one district (Nakuru) in the basin out of the four districts. Most pigs kept by farmers are mainly crosses of landrace and large white breeds. The major constraints in pig production in the district pertain to traditions and cultural barriers against pigs and pig meat consumption by the majority of the communities, especially the pastoralists and also the high costs of commercial pig feeds.

Table 4.68: Pig Production Figures

District	Pig Categories					
	Sows	Boars	Gilts	Weaners	Piglets	Total
Nakuru	726	157	902	1927	2057	5,795
Bomet	0	0	0	0	0	0
Narok	NR	NR	NR	NR	NR	95
Trans Mara	25	7	NR	NR	55	87
Total	3218	91	292	459	620	27,211

NR – Not reported

Table 4.69: Number of Commercial Pig Farmers

District	Number	Breed	Number of Pigs
Nakuru	75	Crosses	5,795
Trans Mara	NR	NR	87
Bomet	0	0	0
Narok	NR	Large white, land races crosses	95
Total			27,211

NR – Not reported

Table 4.70: Pig Population Trends, 2002-2006

Year	2002	2003	2004	2005	2006
Total	33,755	25,506	39,810	28,298	27,211

Table 4.71: Pig Marketing

Type	Price Range (KShs)
Gilts	5000-7000
Serving Boars	7000-12000
Porker	5000-6000
Weaner	1500-3000
Pig Meat	140-180

Tanzania

Pig rearing is the least important livestock activity in the Mara region after cattle, goats and sheep. The region ranks 20th out of 21 mainland regions and had 0.2 % of the mainland total pigs. There were 328 pig-rearing households with 2,409 pigs for an average of 7 per household. The district with the largest number of pigs was Tarime with 2,129 pigs (88.4% of the total pig population in the region), followed by Serengeti (279 pigs, 11.6%). There was no pig rearing in the remaining districts. Tarime district had the highest density (0.6 head per km^2)

The overall annual decline rate of the pig population 1995 to 2003 was -9 percent. During this period, the pig population dropped from 5,139 to 2,409. The pig population increased from 5,139 in 1995 to 17,481 in 1999 at a rate of 36 percent, after which it decreased to 2,409 in 2003 (an annual rate of -39).

Table 4.72: Number of Pigs by Type and District, October 1, 2003

District	Boar	Castrated male	Sow/gilt	Male piglet	She piglet	Total
Tarime	631	0	258	496	744	2,129
Serengeti	140	0	140	0	0	279
Musoma Rural	0	0	0	0	0	0
Bunda	0	0	0	0	0	0
Musoma Urban	0	0	0	0	0	0
Total	770	0	398	496	744	2,409

Table 4.73: Number of Other Livestock by Type and District

District	Type of livestock				
	Ducks	**Turkeys**	**Rabbit**	**Donkeys**	**Other**
Tarime	8,963	5,782	1,333	1,071	2,522
Serengeti	4,826	6,955	419	272	4,733
Musoma Rural	40,623	0	34,865	819	9,498
Bunda	8,167	0	437	942	875
Musoma Urban	1,675	0	0	0	0
Total	64,254	12,737	37,053	3,104	17,629

4.3.6 Rabbit Production

Kenya

Rabbit production has never been taken seriously by farmers. This is another case where cultural and religious beliefs hinder an enterprise that could provide an inexpensive protein source. Most rabbits are kept by youth groups in schools (4-K clubs) and in rural areas as hobbies. The breeds kept are New Zealand White, Chinchilla, California White, French Ear Lopped, Kenya White and their Crosses.

Table 4.74: Rabbit Population, 2007

District	Total
Nakuru	29,930
Bomet	3250
Narok	4,200
Trans Mara	490
Total	89,712

Table 4.75: Rabbit Population Trend, 2002-2006

Year	2002	2003	2004	2005	2006
Total	73,912	70,458	71,365	68,220	84,849

4.3.7 The Beekeeping industry

4.3.7.1 Introduction

Kenya

Kenya, like other East African countries, relies heavily on agriculture. Seventy-five percent of the people live in rural areas and 60% live in absolute poverty. Kenya is a nation of small holders with over five million small-scale farmers and pastoralists. In recent years, cut backs in public services and the free market philosophy have hit rural communities very hard. Since this is unlikely to change, the future of rural communities will depend on developing their capacities from within (Ministry of Livestock Development Annual Report, 2006).

Beekeeping is an opportunity to harvest a local resource (floral nectar) to generate wealth and employment. The Ministry of Livestock Development estimates that current honey production levels are less than one fifth (1/5) of the country's potential estimated at 100,000 metric ton per annum. This potential translates into $100 million USD to the Kenyan economy. Beekeeping as an activity complements existing farming systems in Kenya; it is simple and relatively cheap to start, enhances the environment through the pollinating activity of bees, is completely sustainable, generates income, and requires a very low level of inputs (land, labor, capital and knowledge in its simplest form). Bee keeping is therefore an ideal activity for small scale and poor farmers (Ministry of Agriculture, Strategic Plan, 2006-2010).

Tanzania

Tanzania has had a National Beekeeping Policy since 1998. The objectives include developing and managing beekeeping and bee fodder resources. Several attempts have been made to modernize beekeeping practices by introducing top-bar hives that maximize honey and beeswax production. Other objectives include increased exports, sustainable development, and conservation natural resources (Forestry and Bee keeping Division, Ministry of Tourism and Forestry).

4.3.7.2 Production and Management Systems

Kenya

Beekeeping is widely practiced in the arid and semi-arid districts of the Mara River Basin including Narok, Bomet, Transmara and Nakuru. For years farmers have relied on livestock as their main source of income. In normal cropping seasons, farmers have boosted their income through beekeeping. Although there are few beekeeping projects in the region, there are many NGOs which support beekeeping and this explains the increase in numbers of "Langstroth hives", which currently dominate the sub-sector. The NGOs are currently engaged in farmer education and provision of technical extension services.

The major honey pot in the region is the Trans Mara District that produces high quality honey. However, due to poor road infrastructure the district has difficulties marketing its honey despite high demand. The Kenya Government intervention has been hampered by a lack of funds. Therefore, demonstration apiaries have been neglected and are under utilized. The NALEP SIDA project has developed a focal area approach in each district with at least one Common Interest Group (C.I.G) in Beekeeping. This approach promises enormous expansion of beekeeping in the four districts. (Ministry of Livestock and Fisheries Annual report 2006).

Table 4.76: Hive Distribution Trend in MRB Region

District	Langstroth			KTBH			Log Hives		
YEAR	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**
Bomet	1,026	1,622	1,631	1,665	1,942	1,955	9,100	9,559	9,649
Nakuru	52	60	120	7,143	7,164	8,590	10,499	2,281	9,520
Narok	228	252	282	1,934	2,214	2,315	29,085	29,285	29,664
Trans Mara	400	400	387	1,448	1,493	899	6,458	1,643	6,150

Source: Ministry of Livestock and Fisheries Annual Report 2006

Table 4.77: Honey Production Trends in MRB Region

District	Honey in Kgs			Beeswax in Kgs		
Year	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**
Bomet	40,736	140,989	129,687	No Data	No Data	No Data
Nakuru	146.000	120,000	120,000	73,000	71,000	62,00
Narok	249235	123,648	318,896	No Data	No Data	No Data
Trans Mara	37, 598	34,176	177,980	No Data	No Data	7,798

Sources: Ministry of Livestock; and Fisheries Annual Report 2006

Virtually all beekeepers rely on natural flora as sources of nectar and pollen and thus honey production fluctuates with weather patterns.

Tanzania

Honey production in Tanzania has been by smallholder beekeepers using traditional hives (typically hollowed-out logs or clay pots) and the African honeybee species, Apis mellifera, that is plentiful in the wild. Over 95 % of beekeeping is practiced in the forested woodlands of the Mara region. The remainder is carried out in banana and coffee plantations where trees are used for hanging hives. Beekeeping is attractive to poor households because it can be practiced by different people (including farmers, pastoralists and hunter-gatherers) and in different environments (such as forest, farmland, and peri-urban areas). Although the income generated is small, it can be significant for poor households. While traditional beekeeping is practiced widely, a combination of poor equipment, organization and production as well as underdeveloped markets means that local communities have not been gaining the full benefit of this potentially lucrative occupation (Earth report 3-Smart Hives, Tanzania).

An average of about 76 percent of beehives between 1999 and 2001 were of traditional design. However, the production of modern beehives is on the rise as noted in the table below.

Table 4.78: Number of Traditional and Modern Beehives Mara Region, 1999-2001

Year	Traditional	Modern	Total	% Traditional
1999	636	97	733	87
2000	860	148	1,008	85
2001	1,599	712	2,311	69
Total	3,095	957	4,052	76

Source: Mara Region Socio-economic Profile, June 2003

Table 4.79: Number of Traditional and Modern Beehives by District, Mara Region, 2001

District	Traditional Beehives	Modern Beehives	Total	% of total
Tarime	664	366	1,030	44
Serengeti	80	30	110	5
Musoma	44	44	88	4
Total	1,599	712	2,311	100

Source: Mara Region Socio-economic Profile, June 2003

Tarime district had the highest number of beehives and accounted for 91% of beehives in the region. Supportive services in production, processing, and marketing are virtually non-existent. The people in Mara region practice beekeeping in a traditional way that is not uniform and standard. Every beekeeper works independently on small-scale production. Beekeeping in the region is not major and contributes little to the nation's total bee products. The data below shows honey and beeswax production for Tanzania and the Mara region during 1997 and 1998. (Mara region Socio-economic Profile, June 2003)

Table 4.80: Bee Products in Tanzania and the Mara Region, 1997 and 1998

Year	Production in Tanzania Mainland		Production Mara Region	
	Honey (tons)	Beewax (tons)	Honey (tons)	Beewax (tons)
1997	13,544	902	2	0.1
1998	18,000	1266	6	0.5

Source: Mara Region Socio-Economic Profile, June 2003

The general trend in honey and beeswax production is highlighted in the table below from 1997 and 2001. Production is variable, and it depends on the weather rather than technology or beekeeper efforts.

Table 4.81: Beekeeping Products Harvested and Value in Mara Region, 1997-2001

Year	Honey		Beeswax	
	Kgs.	TShs	Kgs.	TShs
1997	1,935	1,161,000	100	70,000
1998	6,434	3,860,400	450	315,000
1999	9,258	5,554,800	502	401,000
2000	6,474	4,531,800	480	384,000
2001	10,775	7,542,500	807	645,600

Source: Mara Region Socio-economic Profile, June 2003

4.3.8 Poultry Production

4.3.8.1 Background Information

Poultry is the category of domesticated birds kept for meat, eggs, and feathers. Typically, poultry are members of the super order Galloanserae (fowl), especially the order Galiformes (which includes chickens and turkeys) and the family Antidae (in order Anseriformes), commonly known as "waterfowl" (domestic ducks and domestic geese). Poultry also includes other meat birds such as pigeons, doves, or game birds like pheasants. The term also refers to bird flesh. However, this report is limited to chicken, ducks, and turkeys (Dan L. Cunningham, 2005).

Table 4.82: Examples of Poultry Types

Bird	Wild Breed	Domestication	Uses
Chicken	Red Jungle fowl	India, c. 3000 BC	Meat, eggs, ornamental
Duck	Mallard	Various	Meat, feathers, eggs
Goose	Greylag Goose/Swan Goose	Various	Meat, feathers, eggs
Peacock	Various	Various	Meat, feathers, ornamental, landscaping
Swan	Wild Swan	Various	Veathers, eggs, landscaping
Turkey	Wild Turkey	Mexico	Meat

Source: Dan L. Cunningham, 2005.

4.3.8.2 Introduction

Kenya

Poultry production in Kenya is undertaken in a multitude of ways, utilizing different resources in a wide spectrum of social, cultural and economic conditions. Major poultry species kept include chicken, ducks, guinea fowls, turkeys, pigeons, quails, and ostrich, but chicken dominate the industry. The industry includes the much larger subsistence indigenous poultry and the fast growing commercial broiler and layer production. The indigenous poultry are found in most households where their meat and eggs enhance household food security in rural areas.

Of the total poultry population found in Narok, Nakuru, Bomet and Transmara districts, 87% are indigenous and are normally kept under free range management in most homesteads. With farmers becoming more and more commercial oriented, the emphasis is on improved productivity of indigenous birds through improved housing, feeding and better disease control. There is need for some form of selection and multiplication of indigenous birds, which have the best characteristics (Ministry of Livestock Development Annual Report 2007).

Table 4.83: Poultry Population in MRB Region, 2006

District	Indigenous	Layers (Exotic)	Broilers	Turkeys	Ducks	Geese	Ostriches	Others (Cockerel)	Total
Nakuru	739,960	166,930	109,131	32,591	9,497	4,181	61	1,000	1,063,355
Bomet	352,400	2,664	4,200	39	1,386	40	-	-	360,729
Narok	301 ,193	5,200	320	498	3,531	1,184	-	-	311,456
T/Mara	190,500	430	0	160	550		-		191,640

Source: Ministry of Livestock Development Annual Report, 2006

Tanzania

In Tanzania poultry keeping makes an important contribution to the most vulnerable rural households. Chickens, ducks, geese, and guinea fowl all provide a source of income, improve nutrition, and help meet family and social obligations. Poultry raised on family farms also make a significant contribution, along with the commercial sector, to meeting the rapidly growing demand.

According to the Sample Census for Agriculture 2002/2003 Report, the poultry sector in the Mara Region was dominated by chicken production. The region contributed 4.6% to the total chicken population of the Tanzania mainland. The number of households keeping chicken was 141,825, raising about 1,521,166 chickens. This gives an average of 11 chickens per household. In terms of the total number of chicken in the country, Mara ranked 11th out of 21 mainland regions (Sample Census for Agriculture 2002/2003 Report).

Table 4.84: Number of Chicken per District, October 1, 2003

District	Chicken Type			Number of chicken
	Indigenous	Layer	Broiler	
Tarime	585,180	536	268	585,983
Serengeti	246,871	4,607	798	252,277
Musoma Rural	443,135	7,872	0	451,007
Bunda	227,098	1,546	0	228,644
Musoma urban	1,675	0	117	3,255
Total	1,505,422	14,561	1,183	1,521

Source: National Sample Census for Agriculture 2002/2003

Table 4.85: Number of Households and Chicken Raised by Flock Size, October 1, 2003

Flock Size	Chicken Rearing Households		Number of Chicken	Average Chicken per Household
	Number	%		
1-4	36,629	26	103,477	3
5-9	42,208	30	278,665	7
10-19	41,850	30	535,628	13
20-29	14,714	10	325,261	22
30-39	3,088	2	98,709	32
40-49	1,511	1	63,439	42
50-99	1,646	1	94,714	58
100	178	0	21,273	120
Total	141,825	100	1,521,166	11

Source: National Sample Census of Agriculture 2002/2003

Poultry Population

The overall annual chicken population growth rate from 1995 to 2003 was 1.1%. The chicken population increased at a rate of 0.9% from 1995 to 1999 and at a rate of 1.2% from 1999 to 2003. Ninety nine percent of all chicken in Mara was the indigenous breed. The indigenous breed dominance makes the population trend similar to the total chicken regional trend (Source National Sample Census of Agriculture 2002/2003).

Table 4.86: Other Poultry per District

District	Ducks	Turkeys
Tarime	8,963	5,782
Serengeti	4,826	6,955
Musoma Rural	40,623	0
Bunda	8,167	0
Musoma Urban	1,675	0
Total	64,254	12,737

Source: National Sample Census of Agriculture 2002/2003

Poultry Development Policy

The Tanzanian government policy on poultry development includes:

- Government priority for development of traditional flocks to alleviate poverty, enhance income for women, and improve family nutrition;

- Government encouragement of private commercial poultry production in areas with attractive markets. Smallholder commercial poultry encouragement in areas with adequate input supplies, marketing facilities and support services;
- Poultry productivity improvement in the traditional sector. Rhode Island Red breeding stock encouragement in rural areas to upgrade indigenous poultry;
- Government encouragement of poultry processing plants by private entrepreneurs;
- Government encouragement of poultry farmer associations and privatization of all public hatcheries and farms. Besides enforcing hatchery regulations, the government will provide animal health extension services and monitor disease outbreaks.

(*Source:* Bureau of Statistics 1991 Agriculture Sample Survey 1987/88)

4.3.8.3 Production and Management Systems

Kenya

Commercial production

Commercial poultry keeping consists of hybrid layers and broilers in urban and peri-urban areas where higher demand is exists. Chicken feed availability has been one of the main production problems coupled with low quality and uncontrolled price hikes.

Table 4.87: Poultry Population Trend in MRB Region

Year	District	Layers	Broilers	Local	Others	Total
2005	Nakuru	168,200	253,000	832,300	38,700	1,292,200
	Bomet	2,700	4,200	352,400	1,500	360,800
	Narok	2,100	0	258,500	42,300	302,900
	T/Mara	300	NR	206,100	800	207,200
2006	Nakuru	NR	NR	NR	NR	NR
	Bomet	2664	4200	352400	1465	360729
	Narok	5200	320	301193	5213	311926
	T/Mara	430	-	190500	710	191640
2007	Nakuru	50300	60000	148000	0	258300
	Bomet	6330	8110	172350	0	186790
	Narok	320	5200	73135	0	78655
	T/Mara	0	430	186600	0	187030

Source: Ministry of Livestock Development Annual Report, 2007

Layer Production

For commercial chicken production in the Mara River Basin districts, farmers buy day-old chicks from hatcheries, located mainly within the major towns. The most common type used for commercial egg production is the hybrid and is obtained from specialized breeders (e.g. Kenchick, Muguku, Kenbrid, Sigma Suppliers and Western hatcheries). These breeders sell first crosses and multiple crosses to poultry farmers. These birds lay more eggs than the pure parents and are therefore generally used by producers. Day old chicks are normally ordered from reputed hatcheries for good quality and disease free birds. Vaccination for mareks disease is important at the hatchery (Ministry of Livestock Development Annual Report 2006).

Table 4.88: Number of Commercial Poultry Farmers in MRB Region

District	No. of farmers keeping layers	No. of farmers keeping broilers and other birds	Total
Nakuru	251	161	412
Bomet	14	10	24
Narok	NR	NR	NR
Trans Mara	NR	NR	NR
Total	266	171	436

Source: Ministry of Livestock Development Annual Report 2006

Table 4.89: Sources of Breeding Stock

District	Source	Breed/Type	Price (KShs) Day Old
Narok	Kenchick Muguku poultry farm	Broiler Layers	NR
Nakuru	Kenchick Kenbrid Muguku Sigma Feeds, Kims	Broilers Layers Cockerels	45.00 75.00 15.00
Bomet	Kenchic Kenbrid	No Data	No Data

Source: Ministry of Livestock Development Annual Report, 2006

Broiler Production

Broilers are hybrid birds for meat production, and they can be both males and females. They have a good feed conversion ratio (FCR) and are raised to reach market weight of 2kg in 6 to 8 weeks. The industry is rapidly developing and is considered an important source of animal protein. Broiler production is common in urban and peri-urban areas where a ready market exists for the finished product. Flock sizes vary from 100 to 500 birds for small scale producers, 1000 to 5000 for medium producers, and over 10,000 for established and contracted farms.

Indigenous Chicken (IC) Production

Indigenous chickens (IC) have been present for years where urban and rural human settlements exist; they are kept for various uses including income, inexpensive and quality animal protein, entertainment, manure production, kitchen waste disposal agents, biological clocks for telling time of day, gifts, funeral rights, spiritual cleansing and other cultural traditions. The IC day old chicks can be sourced from the National Animal Husbandry Research Station –Naivasha. Breeding cocks and pullets are also available at the center. Farmers can also source from other farmers (Ministry of Livestock Development Annual Report 2007).

In Kenya IC poultry production is about 70% of the total poultry and accounts for 50% of the eggs produced. However, the returns per bird are usually low due to poor management and low genetic potential (*Kibari J. Boki* , 2000, See Table 4.73).

Ducks

Ducks are best managed on free range at a density of about 400 ducks per hectare (200 per acre). An area should be provided for night sleep and shelter, and they should be confined in the morning to lay eggs in the same place. Duck houses should be cleaned out every week, and night shelters should be rotated to keep them clean. Swimming water is recommended, especially for broody hens, but it is not absolutely necessary.

Ducks start to lay eggs at 24 weeks. One drake is allowed for four ducks, and they should be put together one month before fertile eggs are required. The incubation period is 28-35 days, and the eggs require a high humidity and hence the need for bathing water. Ducklings should be left with the duck for at least 2 weeks after hatching. Ducklings should be fed on duck mash at least 4 times a day if under free range conditions. By the eighth week ducklings should be able to fend for themselves. The mash should be fed wet to make it crumble and only enough to be consumed in ten minutes. An adult duck will consume about 300gms per day, but it is more economical to keep ducks under locally available feedstuffs like sweet potatoes and vegetables. Ducks are not as susceptible to diseases as chickens. A possible explanation is that ducks have been accustomed to living in large numbers under rather unsanitary conditions. This unfavorable environment through the years may have resulted in a natural immunity against most diseases (Ministry of Livestock Development Annual Report, 2007).

Turkeys

Turkeys should be raised separately since they bully other birds, keep them away from feeders, and to avoid cross-infection of diseases. Turkeys should be kept within a fenced area. A small area should be thatched to protect them from rain. In the absence of trees, perches should be provided. Alternatively, movable pens of about 6 x 2 meters can be provided for one stag and its ten hens. The space requirement per bird varies with the sophistication of the house. For initial planning, a figure of $0.14m^2$ per bird for up to six weeks and $0.46\ m^2$ per bird at age of slaughter are suggested.

Turkeys are ready to breed after approximately 1 year and will lay about 20 eggs before going broody. A hen will make its own nest, but dark well-protected nests can be provided. One mating is normally adequate for the whole laying period. The eggs will hatch within 25-28 days, and they are the best hatched naturally although artificial incubators can be used.

Poults (turkey chicks) are susceptible to cold and dampness and should be confined with the hen for at least 1 week. Turkeys need ready access to food and clean water at all times .The ingredients and types of feed formulation are similar to those required for chicken. Turkeys, however, require a higher initial protein content of 27% from birth to six weeks, decreasing in stages to 18% over the latter stages of life. If a chick mash is used, it should be supplemented with a high protein source like fishmeal. Contrary to day –old chicks, day-old poults often have problems to locate their feed on arrival, especially when artificial brooders are used. The daily feed consumption of adult turkeys can go up to 0.350 kgs depending on their body weight. The most common disease is blackhead in young poults. The symptoms are loss of conditions and yellow diarrhea. Preferably they should be vaccinated against new castle diseases at three weeks of age (Ministry of Livestock Development Annual Report, 2007).

Tanzania

The poultry industry in Tanzania comprises commercial poultry production with broilers and layers, and the traditional poultry production, which is sometimes called the scavenging or scratcher production, made up of various types and sizes of birds. The total number of poultry estimated in the 1994/95 census of agriculture was about 30 million. Poultry production together with other small livestock contributes about 5.4% to the total GDP. Poultry are the most evenly distributed in Tanzania because:

- They are not affected by tsetse flies which limits other stock like cattle;
- They are accepted by most religious groups (unlike pork which is not consumed by the Muslim population);
- They multiply very fast;
- They are easy to dispose of (unlike cattle which if slaughtered for family use, need storage or refrigeration);
- They are easy to market and the income can be used for other purposes;
- Poultry manure can be used as raw material for feed formulations, fed directly to fish,
- Poultry manure is important for fertilizing soils and commonly used in gardens; and
- Poultry meat and eggs are good sources of protein. (National Sample Census of Agriculture 1994/95, Report)

Table 4.90: Number of Chicken and Other Poultry in Tanzania's MRB Region, 1994-1995

	Chicken			Other Poultry		
	Indigenous	**Broilers**	**Layers**	**Guinea fowl**	**Ducks**	**Geese**
Mara Region	1,369,810	20,820	1,395,050	640	101,170	7,880

Source: National Sample Census of Agriculture 1994/95 Report, Ministry of Agriculture and Cooperatives, Statistics Unit.

Commercial Chicken Production

The initial emphasis was for the government to run most poultry production, processing and marketing under a centralized economy. In this system, the day old chicks from the hatcheries were sold to small-scale poultry farmers keeping 100 to 2,000 birds, and only about 5% of the chicks were reared on large-scale farms with 5,000 birds or more (Bureau of Statistics 1991 Agriculture Sample Survey 1987/88).

The country has an approximate hatching capacity of 40 million eggs with current utilization of only about 30%. The poultry industry has been liberalized, and now the private sector commands 90% of market share of chick production as well as egg production and broiler meat. The layer population in Mara region decreased at an annual rate of -4.4% from 20,823 in 1995 to 14,561 in 2003. The number of improved chicken was most significant in Musoma Rural followed by the Serengeti district. The overall annual growth rate for broilers from 1995 to 2003 was -15.2% during which the population dropped from 4,226 to 1,183. The annual growth rate from 1995 to 1999 was 42.7%, which resulted in an increase of broiler chickens from 4,426 to 18,383. The broiler chicken population exhibited a decreasing trend at the rate of -49.6% per annum 18,383 chickens in 1999 to 1,183 in 2003 (National Sample Census of Agriculture, 2002/2003).

Indigenous/Traditional Poultry Production

Traditional or indigenous chickens are the most numerous of the domesticated chickens. According to the Sample Census of Agriculture 1994/95, there were 26,385,506 indigenous chickens, which supplied 100% of the poultry meat and eggs in rural areas and 20% of the poultry meat and eggs in urban areas. These birds are believed to have a low genetic potential for production but have the ability to survive under harsh conditions (scratch and scavenge to obtain their feed, poor housing, and poor husbandry including disease control). They are normally kept in the backyard or in the house, let out in the morning, and locked in during the night. The average carcass weight is between 0.6 and 1.2 kilograms. Egg production is between 40 and 60 eggs per annum. All these birds are kept by small holder farmers with flock sizes ranging from 10 to 30 birds per household.

Efforts to improve the production and productivity of the indigenous chickens through upgrading started in 1937 when exotic breeds were introduced. In 1943, other upgrading programs were initiated using cockerels imported from South Africa.

In 1982 the Food and Agricultural Organization (FAO) funded a program for rural poultry in Tanzania. The upgrading involved the imported Rhode Island Red and Barred Plymouth Rocks that were sold to farmers as a package including males and females in several stations. The program was implemented between 1982 and 1989. Rural poultry have played a very significant role in poverty alleviation and household food security in Tanzania. However, poultry production is disorganized (National Sample Census for Agriculture 2002/2003).

4.3.8.4 Poultry Products

Layers (Eggs and Manure)

A hen typically lays her first egg at 18 weeks, but timing varies based on the quality of birds and the level of management. Each hen lays on average 280 to 300 eggs for a period of 1 year. Egg production picks up steadily from 21 weeks to a peak of 85- 90% by 29 to 30 weeks. Then egg production gradually falls to 70% by the 56th week. This laying period can be extended by force molting the birds. When egg laying eventually falls to about 55% (by week 68-70) culling is recommended:

- Collect eggs 2 to 3 times a day;
- Separate broken and dirty eggs from whole eggs;
- Place eggs with the broad end up in the egg tray;
- Store eggs in a cool dry place; and
- Do not stack more than six trays.

Litter in the poultry house should be kept dry and removed regularly to reduce the parasite load. The litter can then be used as fertilizer for crop production, in fishponds and in biogas production.

Broilers (Meat and Manure)

Broilers attain market weight at an average age of 6 weeks with a live weight of about 1.6 kg. Litter in the broiler unit should be kept dry and removed before restocking to reduce the parasite load. The litter can then be used as fertilizer for crop production, in fishponds and in biogas production (Ministry of Livestock Development Annual Report 2007 and National Sample Census for Agriculture 2002/2003).

4.3.9 Factors Constraining Sustainable Livestock Production and Key Livestock Production Issues

Kenya

In Kenya, livestock production is seriously hampered and undermined by the following factors:

- Diseases brought by ticks, tsetse flies, or spread through livestock movement: In Kenya these diseases are the East Coast Fever, Trypanosomiasis, and Foot and Mouth disease. They are prevalent in areas of heavy tsetse flies infestation. In the Mara River Basin, such areas include group ranches lying adjacent to the Masai Mara Game Reserve and the Southern districts of Transmara and Narok South. The spread of these diseases have the profound negative impact on sustainable land use practices both for crop production and livestock rearing and limits use of some valuable land for both livestock and crop production. These diseases further limit the livestock production, movement, trade and overall returns to investment in the livestock industry.
- Lack of high quality breeding stock both for meat and dairy: This is common in all four districts and specifically for goats and sheep. This situation has degenerated to high incidences of in-breeding among the small stocks across the basin.
- Contagious Bovine Pleural Pneumonia (CBPP): There has been frequent out breaks of CPP in Narok and Transmara districts in the last three years. The inconsistent vaccine production in the National Vaccine Production center at Veterinary Laboratories in Nairobi has rendered control haphazard at times.
- Inadequate livestock extension services: In all the four districts, there is general lack intensified livestock extension especially to small holder livestock producers. There is inadequate training of extension staff on dairy goat production. This has resulted in general poor farmer management of dairy goats and high mortality rates of kids.

The major constraints affecting sheep and goat production are:

- Lack of high quantity breeding stock both for meat and diary goats (where available the prices are comparatively high);
- High incidences of in-breeding;
- High worm infestation;
- Frequent out breaks of contagious Caprine Pleuro Pneumonia (CCPP) and inconsistent vaccine production;
- Poor dairy goat census records maintained;
- General poor management of dairy goats by the majority of farmers with high kid mortality rates; and.
- Inadequate training of extension staff on dairy goat production.

The major constraints in wool sheep production, which have had adverse effects in the development of the wool sheep industry, are:

- Lack of good breeding stock for the wool sheep herds;
- In-breeding in most flocks;
- Lack of an organized market for wool;
- Poor management in many flocks; and
- Low market prices for wool.

A sustainable beekeeping industry in Kenya is greatly hampered by the following:

- Use of the wrong beekeeping technology and equipment;
- Poor harvesting techniques used by beekeepers generally leads to honey impregnation with smoke and other suspended particles that irreversibly destroy the color, smell, texture, and taste of the honey;
- Inadequate technical know-how;
- High cost of modern beekeeping equipment;
- Lack of funds allocated to beekeeping development;
- Lack of a streamlined marketing system;
- Low hive occupancy rates demoralizes farmers;
- Increased use of agrochemicals in farms is a major threat to beekeeping;
- Beekeeping is not being taken seriously as a business. Most producers treat it as a hobby, and hence, no management practices are undertaken; and
- Bee phobia among some people is a hindrance.

(Ministry of Livestock Development, Annual report 2006)

In Kenya poultry production is seriously hampered and undermined by the following factors:

- Poultry diseases and parasites. Most of the smallholder poultry are lost through diseases, mainly Newcastle disease, fowl pox, and chronic respiratory disease;
- High production costs resulting from high commercial feed costs, high electricity costs, poor physical infrastructure (i.e., road networks) and high taxes on poultry inputs;
- Poor management systems. Indigenous chicken are low producers in free range systems. For most smallholder poultry keepers, a handful of grains or kitchen waste is considered sufficient. The remaining requirements must be met through scavenging. This feed practice has contributed to low productivity of indigenous poultry even though studies show that under improved management systems production would be better;
- Weak links between research institutions. Research activities are carried out in public universities, particularly Egerton and Nairobi universities, as well as the Poultry Research Unit of the National Animal Husbandry Research Centre in Naivasha. However, research links between the institutions are weak, and hence little benefit to small holder poultry keepers occurs;
- High cost of veterinary drugs. Due to the high costs of veterinary drugs, most smallholder poultry farmers do not treat their chickens when they contract diseases. Most keepers use local traditional herbs, such as aloe, chilies, 'lumbi' (Kitaita) and many others;
- Lack of a well organized marketing system. This has resulted to low prices and price fluctuations;
- Difficulty in accessing credits; and
- Poultry vaccines available in the local chemist shops are packed in large doses (e.g., 1000 doses) making them uneconomical for farmers with small flocks.

There are a number of constraints in pig production in the Mara River Basin including:

- Lack of a stable and stratified market;
- High cost of commercial feeds;
- Lack of quality breeding stock;

- Inadequate credit facilities; and
- Cultural norms that restrict eating pork/bacon.

Table 4.91: Disease Prevalence by Region

Country	Region	Prevalent Disease
Tanzania	Serengeti Musoma Tarime	Anaplasmosis, Heart water, and Babesiosis are common in the Tanzania Mara Region. Other diseases present include: Contagious Bovine Pleuropnemonia (CBPP), East Coast Fever (ECF), Trypanosomiasis, Foot and Mouth Disease (FMD), Lumpy Skin Disease (LSD), African Swine Fever (ASF), and Newcastle Disease (ND)
Kenya	Nakuru Narok Transmara Bomet	Trypanosomiasis is more common in the Kenyan Mara sub-basin due to high tsetse fly infestation. Other diseases include: Rinderpest, Contagious Bovine Pleuropneumonia (CBPP), and Foot and Mouth Disease (FMD).

Table 4.92: Livestock Health: Tick-borne Disease and Control in Nakuru, Bomet, Transmara, and Narok Districts

District	Number of dips	No of spray races	Hand Sprays	Operational dips & spray races	Not operational dips & spray race	Remarks
Bomet	113	-	Several	94	19	-
Narok	127	NR	NR	32	95	There is need to repair some of the dips
Nakuru	154	17	Several	89	75	-
Trans Mara	40	-	Several	6	34	Same as last year

Source: Ministry of Agriculture and Livestock Development Data Base (2007), Kilimo House, Nairobi.
NR – Not reported

Tanzania

In Tanzania, livestock production is seriously hampered by the following factors:

- Prevalence of diseases: In all three districts; Musoma rural, Serengeti, and Tarime, cattle ticks cause many livestock diseases and thereby increase the numbers of animal deaths. The most common diseases in the region include tick borne diseases such as East Coast

Fever (ECF), Anaplasmosis, Heart water, and Babesiosis. There are two non-tick borne diseases with occasional outbreaks, namely, Foot and Mouth Disease and Contagious Bovine Pleural Pneumonia (CBPP);
- Cattle dipping facilities:

Table 4.93: Cattle Dipping Facilities

District	Working	Not working	Total Dips
Musoma	11	19	30
Tarime	16	32	48
Serengeti	12	9	21
Total	49	64	113

- The table shows that the operational status of the dipping facilities is poor. Investments are urgently required to rehabilitate the non-functioning facilities to and facilitate disease control;
- Inadequate veterinary services and high price of veterinary drugs: In the Mara Basin districts of Musoma Rural, Serengeti, and Tarime, smallholder farmers experience difficulties in accessing veterinary services. Farmers are therefore unable to control or treat animal diseases. This problem is compounded by the high cost of drugs when available. There is no financing scheme for the pastoral communities;
- Lack of reliable water sources: In the Mara region, the only reliable water source is the Mara River. Pastoral communities far from the river have unreliable water sources and suffer great losses during drought conditions; and
- Regular cattle rustling: There are more than twelve ethnic groups in the Mara region all with very aggressive cultures and customs. Cattle rustling is a destructive practice among these communities that occurs regularly. This practice is often fatal, destructive, and impoverishes the victimized families. Traditional vigilante groups and courts (sungusungu and ritongo) are doing a commendable job in containing the situation.

In Tanzania sustainable beekeeping is constrained by a number of factors including:

- Decreasing honey bee populations caused by deforestation and conversion of forest land to agriculture;
- Diseases and pests which invade the hives;
- Lack of modern equipment;
- Inadequate technical know-how leading to poor management;
- Lack of funds allocated to beekeeping; and
- Lack of a streamlined marketing system.
  (*Source:* Forestry and Bee keeping Division Ministry of Tourism and Forestry)

The major constraints facing poultry production in Tanzania include:

- Low productivity due to low genetic potential, disease, and poor management;

- Poultry diseases, in particular Newcastle disease, fowl typhoid, and infectious coryza cause heavy mortality and reduced production;
- Poor quality poultry feeds greatly limit productivity and adversely affect the quality and quantity of day-old chicks;
- Poor extension services;
- Inadequate credit facilities (particularly lack of collateral);
- Limited research services. There is a need to expand research programs undertaken to develop the sector;
- Lack of organized marketing and processing. There is no organized marketing and or slaughtering. Producers sell their products (eggs or live broilers) to consumers directly or through middlemen;
- Grading of broilers is done only in small processing plants, two of which are in Dar es Salaam and have a capacity to process 3,000 broilers each per day (Interchick, and Polo Italia).Another plant can process 1,500 broilers per day in Mbarali (Mbeya Region, ex-Chinese). There is no egg grading; and
- Tanzania is a very big country with very poor infrastructure (roads, telecommunications). Movement of products from one place to another is therefore a major problem. Similarly, marketing of poultry and poultry products in urban, peri-urban, and rural areas is a problem.

Bee Diseases in Kenya and Tanzania

The honeybee suffers attacks from a number of diseases. In the Mara region for both Kenya and Tanzania, the beekeeping industry is in its infant stage and not much research has been carried out on bee diseases. The most common diseases include:

Table 4.94: Common Bee Diseases

Type	**Common diseases**	**Causes**	**Symptoms**	**Control**
Brood diseases	American foul brood AFB	Bacillus larvae	Death of larva after it has been capped. The dead insect becomes brown. Drying of dead insect into a hard scale.	Drugs such as sulfathiazole and oxytetracycline terramycin can be used
	European foul brood (EFB)	Melissococcus pluton Bacteria	Drop in honey yield. Death of larva	Streptomycin, penicillin and terramycin drugs
	Chalk brood	Ascophaera apis Fungi	Chalky appearance of the dead brood	Information not available

	Sac brood	Virus	Death of larvae in their sealed cells. Affected larva becomes yellowish with tough skins.	Information not available
Adult bee diseases	Nosema disease	Nosema apis protozoa	Reproduction stops.	Giving the colony a new set of combs. Requeening the hive. Fumigillin (Fumidil-B) drugs
	Acarine disease	Microscopic mite (Acarapis woodii)	Hampers the bees flying ability. Bees crawl, and finally die.	Keep apiary clean. Avoid transferring infected combs from hive to hive. Disinfect old hive parts, as well as used apiary equipment. Avoid feeding bees with honey from a doubtful source.

Source: Stephen O. Adjare, 1990

General measures to prevent spread of bee diseases include:

- The apiary must be kept clean. Honeycombs, wax, propolis and other hive products must not be thrown away near the apiary;
- The beekeeper must not transfer infected combs from hive to hive or from apiary to apiary. Combs must be exchanged with great care;
- Old hive parts, as well as used apiary equipment bought or acquired from doubtful sources, must be disinfected;
- Unknown swarms should never be accepted when there is an outbreak of a bee disease; The beekeeper should set up a quarantine apiary four kilometers away from the nearest apiary, and make sure the swarm is disease-free before transporting it to the apiary;
- Bees should never be fed with honey from a doubtful source;
- If a colony dies of unknown causes, the hive should be closed pending an examination of a sample comb. The remaining stores in the hive should be protected from robber bees;
- Robbing must be prevented. Place syrup or food for a colony inside the hive or in a properly designed feeder to prevent robbing; and
- Brood combs should be regularly inspected for signs of disease.

(*Source:* H Herthoud, A. Imdorf, JD Charriere, Haueter, P. Fluri, 2005)

Common Poultry Diseases MRB

Table 4.95: Common Poultry Diseases

Common diseases	Causes	Symptoms	Mortality Rates	Control
Coccidiosis	Coccidian	Droopy, unthrifty look and raffled feathers, pale beaks and shanks	High and sudden.	Sulfur drugs and ensure dry litter
Fowl Cholera	Pasteurella avicida	Yellowish droppings, yellowish or greenish diarrhea. Droopiness, feverish, sleepiness. Birds sit with the head down or turned backwards, rested in feathers about the wing	High	Sulfur drugs. Ensure dry litter, cleaning and disinfection of the house. Birds with acute type should be destroyed and burned
New Castle Disease		Gasping coughing and sneezing in chicks, sitting on back hock joints, sudden decrease in egg production and respiratory symptoms in adults.	Varies from 0-100% depending on virulence of the organism	Vaccination after 3-4 weeks of age, at 16 weeks of age, and the 24th week. Thereafter vaccination when there is an outbreak in the area.
Fowl Typhoid	Salomonella gallinarum or shigella gallinarum.	Dullness, ruffled feathers, paleness of the head drooping comb, loss of appetite pale orange colored diarrhea.	Death occurs in 2 weeks	Vaccinate the birds at 7 weeks of age. Destroy all dead birds by burning. Do not allow visitors without disinfection.
Pullurum Disease	Salomonella Pullurum	Chicks utter squeaky chirps and appear drowsy and ruffle. Vent is smeared with fecal discharges.	Death occur in 3 weeks	Destroy all confirmed carriers of the disease. Clean and disinfect all the premises and incubators. Get chicks from hatcheries with good disease control program.
Fowl Pox		Pox lesions in the form of wart like scabs on the face, comb and wattles.		Provide footbath with disinfectant. Limit visitors to the unit. Workers should move from young to old flock in the units. Clean and disinfect the house and equipment at the end of each crop and rest it for 1-2 weeks

Source: Ministry of Livestock Development Annual Report 2007

Parasites

	Parasite	Damage	Symptoms	Impact	Control

	Type	to Poultry			
Ectoparasites:	Fleas Mites Ticks	Suck blood	Cause weakness leading to reduced performance	Reduced performance	Spray or dust the poultry and poultry house with recommended chemicals. Thorough disinfection of the poultry house before restocking. Replace litter at the end of each crop.
Endoparasites	Worms	Deprive the host its food	Cause weakness leading to reduced performance	Reduction in performance.	Provide proper sanitary conditions in the rearing units. Treat the flock by using recommended drugs from veterinary.

Source: Ministry of Livestock Development Annual Report, 2007

Other Vises

Vice	Control
Cannibalism Eating eggs	Have the correct stocking density Correct feeding and drinking space. Reducing light intensity De-beak the birds if the problem continues. Isolate cannibalized birds

Source: Ministry of Livestock Development Annual Report, 2007

4.3.10 On-Going and Proposed Interventions

Table 4.96: Ongoing and Planned Livestock Interventions, Kenya

Livestock Production Issue	Districts Covered	On-going Interventions	Planned Interventions
Prevalence of Livestock diseases Eg,ECF=East Coast Fever Foot and Mouth Disease Trypanasomiasis	Nakuru Bomet Transmara Narok	Veterinary department projects: Disease and pest control. Foot and mouth disease control. Tse Tse Flies. Community Based Initiatives of Siangiroi, Sigor, Ndanai project in Nakuru, Transmara, and Bomet districts.	Rehabilitation of cattle dips. Facilitate demand driven Extension Services in Nakuru Bomet and Transmara districts. Disease surveillance and sustainable Control.
Lack of high quality breeding stock	Bomet Nakuru Narok Transmara	Artificial Insemination A.I. Project. GoK project through Veterinary Department.	Public Extension Services
	Bomet	Extension services. Workshop/Field Day Bomet, Central Siongoroi Sigor, Ndanai, Tenwek Community Development (SICODO): Supports dairy goat improvement. Cattle improvement Project.	Rehabilitation of A.I. stations Ndarawetta and Kipleji Bomet Central Division.
Lack of reliable water sources;	Narok	Range water improvement. De-silting of water pans supported by ALRMP. Land, soil and water conservation project. Supporting farm planning enterprise diversification and use of farm manure to reclaim soil fertility.	Encourage more private sector participation in environmental conservation. Support in dam and water pan construction. Enhance household water security by promoting development of water pans at farm level
Declining Grazing land	Narok	Fodder and Pasture Conservation project. Use and conservation of wheat straw.	Promotion of fodder crops and water conservation.
Wild life –Human conflict	Transmara Narok Nakuru Bomet	Introduction of Wildlife Management Areas (WMAs) in the basin on a pilot basis.	Promotion of fodder crops and water conservation
Soil erosion due to poor livestock herding practices	Narok	Range Land soil and water Conservation project. Supporting farm planning enterprise diversification and use of farm manure to reclaim soil fertility.	Provision of technical support Establishment of More cattle dips and livestock watering points.

	Transmara Narok Nakuru Bomet	Ranch planning. Capacity building on PICD for natural resource management. National Agricultural and Livestock Extension Project.	Enhance dissemination of information on best practices by training extension service providers.
Lack of coherent land use policy	Bomet Narok Nakuru Transmara	ASAL – Based livestock and rural livelihoods support project.	Administer all categories of land to ensure proper and coordinated development.
Inadequate Livestock extension	Covering 22 Districts including Narok, Bomet, Nakuru, Transmara.	National Agricultural and Livestock Extension Project. Range fund extension and training Project. Field Schools and promotion of farmer's innovators project. Extension Services. PFI/FFS	Enhance dissemination of information on best practices by training extension service providers.
High incidence of inbreeding	Bomet Narok Nakuru Transmara	Artificial Insemination A.I. Project. GoK project through Veterinary Department	Livestock improvement
High worm infestation	Bomet Narok Nakuru Transmara	Meat inspection. National Agricultural and Livestock Extension Project: 22 Districts including Narok, Bomet, Nakuru and Transmara.	Effective disease and pest control, e.g., vaccinations and quarantines.
Frequent outbreak of Caprine Pleuro Pneumonia	Bomet Narok Nakuru Transmara	National Agricultural and Livestock Extension Project: The program has adopted a shifting focal area extension approach (FAA).	Effective disease and pest control, e.g., Vaccinations and quarantines. Improvement of livestock breeds.

Table 4.97: On-going and Proposed Interventions for the Beekeeping Industry in Kenya

Bee Production Issue	**Districts Covered**	**On-going Interventions**	**Activities**	**Planned Interventions**
Use of the wrong Beekeeping Technology and equipment	Bomet	SISE Crescent Integrated	Promote modern beehive production	Invest in modern beekeeping technology and equipment
	Bomet	Hive product processing by Tenwek Community Organization	Capacity building through demonstration apiaries	
	Nakuru	Baraka College of Agriculture	Capacity building through demonstration apiaries	

	Bomet	Catholic Diocese of Nakuru	• Agricultural extension • Assist farmer groups to procure KTBH	
Inadequate technical know-how	Narok Bomet Nakuru Trans mara	NALEP- SIDA funded project	Designed to develop and promote appropriate technologies on sustainable farming. Promote development and distribution of specific hives e.g. Langstroth hives.	Sponsor all officers in charge of beekeeping in their respective districts for a certificate course
	Trans Mara	KARI-Lolgorian	Capacity building through demonstration apiaries	
	Nakuru	Baraka College of Agriculture	Training of farmers	
	Trans Mara	Honey Care Cato	Training of farmers	
	Nakuru	Bee Development International	Training of farmers	
	Bomet	APS	Sponsors training of beekeepers thru CBOs	
High cost of modern Beekeeping equipment	Bomet	Tenwek Community Development	Equipment supply	Encourage local artisans to use locally available material to make hives and use modern equipment.
	Narok	Mara river Basin Association	Farmers training, equipment supply	
	Narok	ALRMP	Equipment supply. Facilitate farmers training	
	Narok	Friends of Conservation (Mara)	Environmental conservation. Facilitate equipment supply	
	Narok	Ewaso Nyiro South Development Authority (ENSDA)	Farmers training. Facilitate Equipment supply	
	Narok	Sanyati Ltd.	Give support in equipment supply	
Lack of funds allocated to beekeeping	Bomet	Honey Care Ltd	Beekeeping extension and provision of credit.	Ensure funds are allocated for beekeeping development activities to well selected districts
	Bomet Narok	Action Aid	Provides financial support to local CBOs. Facilitate equipment supply	
	Trans mara	WWF	Funding CBOs	
	Trans mara	ALRMP II	Training and Funding	
Lack of	Bomet	Honey Care Ltd	Marketing of honey	Encourage

streamlined marketing system	Trans Mara	Honey Care Cato	Marketing of honey	beekeepers to form "Marketing Federations"
	Bomet	Bomet Beekeepers Association (BBA)	Marketing of honey	

Source: Ministry of Livestock and Fisheries Annual Report 2006

Table 4.98: On-Going and Proposed Interventions for Poultry Production in Kenya

Poultry Production Issue	Districts Covered	On-going Interventions	Activities	Planned Interventions
Poultry diseases and parasites	Data not available	Data not available	Data not available	Intensify vaccinations against poultry diseases
High production costs	Data not available	Data not available	Data not available	Encourage formation of farmer organizations to address joint problems, including joint orders for economies of scale
Poor management systems	Nakuru, Bomet and Narok	Farmers Field Schools and Promotion of Farmers Innovators (PFI/FFS) NALEP	Technology development at field levels. Poultry management	Improved management to boost poultry production through proper housing, inexpensive supplementary feeds and other improved husbandry practices.
Weak linkages between research institutions	Data not available	Data not available	Data not available	Data not available
High cost of veterinary drugs	Data not available	Data not available	Data not available	Encourage formation of farmer organizations to address issues. Conduct more research on local herbs that have been used to treat poultry e.g., aloe, chilies
Lack of a well organized marketing system	Data not available	Data not available	Data not available	Encourage the formation of poultry marketing groups

Difficulty in accessing credits.	Data not available	Data not available	Data not available	Encourage formation of cooperative societies

Table 4.85: Ongoing and Planned Livestock Interventions, Tanzania

Issue	Districts Covered	On-going Intervention	Planned Interventions
Poor livestock production systems	Musoma Rural Serengeti Tarime	Government livestock extension services through District Agriculture Development Program 2007/08 plan.	2007/08 District agriculture development plan and budget to promote agricultural investment, Agricultural services and capacity building.
Prevalence of cattle diseases	Musoma Rural Serengeti Tarime	Participatory disease control Dips project: In Musoma there are 11 working Dips, Tarime 16, Serengeti 12 and Bunda 10. DAPS projects for rehabilitation. DASIP for dips/new construction and rehabilitation. Only 43% dips are working. In Tarime the year 2006/07 recorded 19,782 immersions in 43 dips. Spraying was done to 20,851 cattle, 1,042 goats. Vaccination Project against ECF, CBPP, Rabies and new castle; in the year 2007, 2,900 animals were vaccinated against CBPP, 7,010 dogs against rabies. Disease Treatment: The year 2006/07 in Tarime 13,656 cases were reported, 13,583 were treated, 11,138 recovered, 2,445 died. Meat inspection project: In Tarime 1421 cattle, 1337 goats, 295 sheep were slaughtered and inspected.	Introduce effective disease control measures. Procure veterinary drugs and accaricides. Only 43% of dips are in working condition, hence there should be a plan for dip rehabilitation.
Low rate of adoption of improved cattle breeds.	Musoma Rural Serengeti Tarime	Extension services DADPS for rehabilitation of dips and other livestock infrastructure	Promotion of agricultural extension services.
Lack of reliable water sources;	Musoma Rural Serengeti	Agriculture Sector Development plan ASDP which implements	Measures to ensure livestock access to adequate water supplies.

	Tarime	Charcodam construction and rehabilitation. Rain water harvesting.	Support for construction of charcodams.
Declining grazing land	Musoma Rural Serengeti Tarime	Utegi grazing area (5000 Ha) project formerly managed by Dairy Farming Company. Buhemba project formerly under the ownership of KABIMITA (defunct beef ranching company). BUGWEMA project formerly intended for irrigation farming.	Promotion of fodder crops and water conservation.
Wild life – Human conflict	Musoma Rural Serengeti Tarime	Wildlife Management areas.	Establishment of wildlife management areas WMA.
Inadequate veterinary services	Musoma Rural Serengeti Tarime	The government has withdrawn from provision of veterinary services. Mobilization of private sector communities to participate in disease control and extension services. Government project through Livestock sector.	Enhance dissemination of information on best practices by training extension service providers.
High cost of veterinary drugs	Musoma Rural Serengeti Tarime	Cattle owners purchase own veterinary drugs and accaricides. The region has 25 veterinary health centers: Tarime 8 Musoma 8 and Serengeti 9 Crushes are currently 9 in Musoma, Tarime 12 and Serengeti 10	Promote introduction of community veterinary drug stores at the village level.
Lack of coherent land use policy	Musoma Rural Serengeti Tarime	The sector constrains would be addressed by a coherent land use policy. Agriculture Sector Development strategy ASDS meant to create an environment for improving agricultural productivity.	Provision of a framework for restructured co-operatives. Improvement of livestock production and commercialization of livestock sector.
Regular Cattle rustling	Musoma Rural Serengeti Tarime	Traditional vigilante groups (Sungu sungu and Ritongo) are working to contain the situation.	No record of planned intervention.

Table 4.99: On-going and Proposed Interventions for the Beekeeping Industry in Tanzania

Bee Production Issue	Districts Covered	On-going Interventions	Activities	Planned Interventions
Decreasing honey bee populations caused by deforestation	Mara region	Information not available	Information not available	Establish bee reserves, both on village land and in government forest reserves
Diseases and pests	Mara region	Information not available	Information not available	More research on bee diseases and pests is required
Lack of modern equipment	Mara region	Information not available	Information not available	Invest in modern bee keeping technology and equipment
Inadequate technical know-how	Mara region	Gibaso and Kitawasi Bee Keeping Group.	Promotion of beekeeping.	Sponsor beekeeping officers in their respective districts for a certificate course
		WWF Mara River Basin Management Initiative	Facilitate training in organizational development, entrepreneurship etc The project trained 3 CBOs in Bukwaba ,Nyamatoke and Masanga villages in Bee Keeping between.2006 and 2007.	
Lack of funds allocated to Beekeeping	Mara Region	Information not available	Information not available	Apiculture Division should ensure funds are allocated for beekeeping development activities to districts and provinces
Lack of streamlined marketing system	Mara region	Information not available	Information not available	Encourage beekeepers to form “Marketing Federations”

Source: WWF Mara River Basin Management Initiative Report, 2006

Table 4.100: On-going and Proposed Interventions for Poultry Production in Tanzania

Poultry Production Issue	Districts Covered	On-going Interventions	Planned Interventions

Low productivity.	Musoma Serengeti Tarime	The current exercise undertaken by SUA on characterizing the different genotypes/ecotypes should be continued to improve indigenous breeds	After characterization, crossbreeding within the different genotypes superior for production should follow
Poultry diseases and Parasites	Musoma Serengeti Tarime	Current government veterinary services provided to treat and eliminate diseases and parasites	Vaccination against Newcastle disease should be given high priority followed by other regimes like control of helminths, typhoid, coryza, and nutritional deficiency
Poor quality poultry feeds	Musoma Serengeti Tarime	Current livestock extension services to improve the quality of animal feeds	Encourage farmers to buy feeds from reputable millers
Inadequate credit facilities	Musoma Serengeti Tarime	Attempts are currently underway to initiate cooperative credit facilities	Encourage formation of accountable cooperative societies
Limited research services	Musoma Serengeti Tarime	No data available on current efforts	Encourage research and development immediately
Lack of organized marketing and processing.	Musoma Serengeti Tarime	No data available on current efforts	Encourage the formation of poultry marketing groups
Poor infrastructure	Musoma Serengeti Tarime	No data available on current efforts	Improve rural infrastructure e.g. roads, electricity

4.3.11 Recommended Mitigation Measures

Mitigation should address the issues affecting livestock production in the Mara Basin in both countries. First, it is important to understand the concept of range management. Livestock production uses a pastoral system, semi-pastoral system, or developed ranching. All these systems have different constraints that need to be addressed separately. Biomass (animal feed), mainly pasture and water, and disease control are the leading issues. The interventions proposed below broadly address these issues.

Kenya

(i) Intensify and support disease control programs through the rehabilitation of cattle dips and increasing the vaccination programs in Narok South, Bomet, Nakuru, and Transmara districts.

(ii) Support the existing livestock extension projects (by NALEP) in Nakuru, Bomet, Transmara, and Narok districts

(iii) Rehabilitate and promote Artificial Insemination (A.I) services in Bomet district.
(iv) Rehabilitate existing water sources in Range lands, e.g., dams in Narok South and Transmara districts.
(v) Intensify and support existing fodder and pasture conservation projects in Narok South district.
(vi) Promote cross border security and conflict resolution to mitigate against cattle rustling.

The following mitigation measures address bee production in the Mara sub-basin in Kenya:

- Efforts should focus on improving the skills of beekeepers and providing practical training in the field. The majority of beekeepers have no help at present.
- There is a need to train farmers on modern beekeeping methods as most are still using traditional methods. Measures should also be put in place to improve the skills of those extension workers in contact with producers so that they become more effective.
- Producer capacity building components should be initiated including: workshops, developing networks and group affiliations, and developing a resource center for beekeepers;
- The beekeeping industry requires coordination of stakeholders in the industry. There is a need to foster links with the ministry of agriculture beekeeping officers, NGO extension workers, and church development agencies;
- More resources should be allocated to fully exploit the existing beekeeping potential;
- Awareness campaigns should be initiated promote and open markets for bee products. There is need to develop the under exploited local and regional markets;
- More carpenters and beekeeping equipment artisans should be trained to enhance equipment affordability;
- More resources both financial and personnel should be directed to research bee diseases and pests for better control;
- Marketing of bee products should not be limited to honey;
- Education on beekeeping is required for the industry to develop. There is a need to develop and disseminate production technology through field days and demonstrations;
- More field officers should be employed to work with farmers. There is need to collect, compile and disseminate market information on bees wax opportunities; and
- A credit scheme should be introduced to enable new beekeepers to get started.

The following proposed mitigation measures broadly address poultry production issues in Kenya:

- Productivity can be improved if vaccinations against poultry diseases are intensified. With the lack of electric power in most rural areas, new technologies such as thermo stable Newcastle vaccines should be introduced and sustained. There is need for an effective routine vaccination program;
- There is a need to sensitize farmers to link more closely to the laboratories for better disease control;

- Improved management of local poultry is needed for better production. Examples include more inexpensive home-made supplementary feeds for chicken kept under free range system as well as better housing and better disease control of indigenous chicken;
- Research activities on poultry need to be strengthened to benefit smallholder poultry farmers (e.g. genetic improvement of indigenous birds based on selection);
- There is need to encourage farmers to form groups/stakeholder organizations to address general problems; and
- There is need to strengthen extension services delivery to farmers.

Tanzania

(i) Intensify and support disease control programs through the rehabilitation of 19 cattle dips in Musoma, 32 in Tarime, and 9 in Serengeti which are not working, Provide funding for purchase of accaricides and for control of non tick borne diseases, support Vaccination Programs in the three districts.

(ii) Support existing efforts to promote private sector participation in livestock extension services in Tarime, Musoma, and Serengeti districts.

(iii) Provide additional support (financial/personnel) for the construction of charcodams through ASDP to improve water availability in Musoma, Tarime, and Serengeti districts.

(iv) Intensify and supports pasture and fodder conservation projects in Tarime, Serengeti, and Musoma districts.

The following mitigation measures address bee production in the Mara sub-basin in Tanzania:

- Modernize beekeeping practices by introducing top-bar hives which maximize honey and beeswax production;
- Invest in modern beekeeping equipment;
- Train more carpenters and beekeeping equipment artisans to enhance equipment affordability;
- Establish bee reserves, both on village land and in forests owned by central and local governments; and
- Improve the capacity of existing extension workers through training.

The following mitigation measures broadly address poultry production issues in Tanzania:

- Form producer and marketing cooperatives or associations;
- Conduct more research in traditional poultry;
- Upgraded indigenous birds using exotic breeds like the Rhode Island Red and the Barred Plymouth Rocks, to boost poultry production;
- Help alleviate poverty and ensure household food security through more donor support;
- Support vaccination against Newcastle and other common poultry diseases; and
- Preserve the present genotypes/ecotypes for future use and avoid genetic erosion.

5.0 Fisheries and Aquaculture

Fishing is a significant occupation in the Mara catchment area. Most fishing occurs in Lake Victoria, which is one of the most productive lakes in the world. The Musoma and Rorya (previously part of Tarime) districts are lacustrine and are involved in lake fisheries. Some fish is marketed outside these districts. Fish related activities also include the Mara Swamp and the Mara River catchment where pond and dam fisheries are found. Fish farms are prompted by high demand as a result of the rising population and external markets. This section gives a summary of fishery activities in Lake Victoria and the Mara Swamp, describes the status of aquaculture, and identifies fishery investment opportunities in these areas.

5.1 Lake Victoria Fisheries

Lake Victoria is the second largest lake in the world with a surface area of about 68,800 km^2 (Hutchinson, 1957). The lake leads in fish production in Africa, making it the most important protein source for an ever increasing population. Marked exploitation of Lake Victoria fisheries began with the introduction of gillnets around 1905 (Beauchamp, 1961). The major fish species exploited included tilapiine species [*Oreochromis esculentus*, *O. variabilis, Mormyrus* spp.*, Labeo victorianus, Bagrus docmac*, *Schilbe intermedius* (formerly *S. mystus*), *Protopterus aethiopicus, Clarias gariepinus* (formerly *C. mossambicus*)] and several haplochromine species. Some of these species ascend in masses to the upper river reaches to breed. They are the so-called "potamodromous" species that migrate from freshwater lakes to rivers to spawn (McKeown, 1984). They include *L. victorianus, S. intermedius, Brycinus spp., Mormyrus spp., Synodontis victoriae, S. afrofischeri, and Barbus spp.* To date, most of these species are rare and have become unimportant in the lake fisheries.

By the 1940s, the catch rate of *O. esculentus* had already shown signs of over fishing. The East African Fisheries Service recommended that 5-inch mesh gillnets be the minimum size used in the lake for sustenance of the tilapia fishery. However, smaller mesh sizes (2.5-3 inch) were later allowed to catch smaller fish (Beauchamp, 1956). As the population around Lake Victoria increased, the fish exploitation from the lake also intensified.

In 1948, the British government established the East African Fisheries Research Organization at Jinja, Uganda. This group was responsible for freshwater fisheries research in the whole of East Africa and recommended the introduction of other tilapiine species in the lake to make use of the apparently excess food and to supplement the declining population of *O. esculentus*. In addition, the group proposed that a predator, the Nile perch (*Lates niloticus*), be introduced to feed on the small, bony but numerous haplochromine species to obtain more economically viable fish. However, this proposal was not fully supported by all lake scientists (Fryer, 1960, and Corbet, 1961). In the early 1950s, four tilapiine species were introduced in the lake including *Tilapia zillii, T. rendalli, Oreochromis niloticus* and *O. leucostictus.* Notwithstanding protests from some scientists, the Nile perch was first introduced about the same time, and was openly introduced in the early 1960s.

Several natural and human-induced factors followed that changed the Lake Victoria ecology (Kudhongania and Chitamwebwa, 1995):

- A significant rise in the lake level brought about by very heavy rains in the early 1960s, causing submergence and eventual loss of the rooted fringing vegetation;
- Forest clearance for expanding agricultural activities and corresponding soil erosion;
- The use of agrochemicals for increasing crop production, and increasing loads of untreated domestic wastes;
- Intensive fishing activities, the use of destructive fishing gear, and the effect of the Nile perch predation.

As a result of these factors and practices, all indigenous species, including those of economic importance, have almost disappeared and new fisheries have evolved. Currently, fish species of economic importance are *L. niloticus, Rastrineobola argentea,* and *O. niloticus*. The *R. argentea* is the only important indigenous species remaining in the lake because it is a short-lived species and has a high turn-over rate enabling it to be resilient to predation. In the absence of competitors, this species has tremendously increased in stock size.

As fish populations declined, rivers became less important as breeding grounds for potamodromous fish. Some of these riverine species became so rare that they were feared extinct. The species fell victims of intensive fishing while aggregating at the river mouths prior to ascending up river to breed. The ecological changes in the lake altered the available food and favorable living and breeding conditions. Recently, there has been some resurgence of the indigenous riverine species (Mkumbo and Mlaponi, 2003). In the Mara River, these species have started to reappear (Sobo, 2002), although not in remarkable numbers as observed in Speke Gulf where they are caught and sold as far as Musoma Municipal Market. Although rare species (*L. victorianus, S. victoriae, S. afrofischeri and S. intermedius* (see Plate 5.1 at the end of the chapter)) are not caught in Musoma Bay where the Mara River empties, these fish have been observed all along the river, past Mara Swamp, to the Mau Forest upper reaches (Sobo, 2002; James Siameto, District Fisheries Officer, North and South Narok, pers. comm., April 2008). This anomaly has only been witnessed in the Mara River but the causes are unknown.

5.1.1 Status of Nile Perch Fishery

The Lake Victoria fisheries have been reduced from multi-species to the current three species for the reasons mentioned. Of these factors, Nile perch predation is most responsible for the indigenous population reduction (Barel *et al*., 1985, Witte *et al*., 1992). Due to the predominance of the Nile perch (Plate 5.2) since the early 1980s, Lake Victoria fish production increased from 85,914 tons per year to 567,660 tons in the 1990s, with Nile perch contributing over 70% of the total catch (Mkumbo *et al*., 2005). The Nile perch was at first disliked because of its different taste, predation of the most preferred local fish species, and stronger fishing net requirements. (The small-ply nets previously used to catch the indigenous species were too weak to retain these larger fish.) With time, however, the fish became accepted. The riparian population blessed the Nile perch calling it “mkombozi” or savior, since the price was affordable even to the poor (Reynolds and Greboval, 1988). The large amount of fish caught in the 1990s was more than the market could absorb. As a result, large quantities were processed by smoking which required large amounts of wood fuel. In turn, this increased the demand for firewood which increased deforestation at an alarming rate. To date, most Lake Victoria islands and shoreline are extensively deforested (see Plate 5.3). Post-harvest Nile perch losses were high, and due to the oily nature of Nile perch, fire accidents were common during smoking.

The Nile perch fishery brought about social transformations including specialized industries, permanent settlements at the landing sites, and the eventual creation of small towns. Fishery support services evolved for fishing gear, fishers, processors (smoking and frying), fish traders, and boat builders. With the exception of fishing and boat building, other activities were carried out by both men and women. Thus, the fishery also brought about gender role changes as it ceased to be a male monopoly.

Processing plants appeared around the lake and fish were processed into fillets and other products (Table 5.1). External markets brought in foreign currency. With time, the increased revenues and demand resulted in over fishing and the numbers started to decline (Table 5.2). The majority of fish processors and traders for local markets were eventually replaced by exporters for international markets due to higher external prices.

Table 5.1: Fishing Trends from 2000 to 2006 in Lake Victoria Tanzanian Sector

Number	**Year**			
	2000	**2002**	**2004**	**2006**
	55,985	80,053	77,997	98,015
Fishing craft	15,434	21,660	22,653	29,732
Motorized fishing craft	1,451	2,610	5,576	6,416
Fish transporting craft	639	1,082	769	1,320
Tot fishing gear*	2,441,228	5,081,529	3,691,519	4,593,921

*Combined number of gill nets and hooks

Source: IFMP National CAS (Catch Assessment Surveys) Working Group, Tanzania, Activity Reports

Table 5.2: Fishing Facilities in Musoma District in 2004 and 2006

Number	**Year**	
	2004	**2006**
Fishers	9,649	9,092
Fishing craft	2,711	2,512
Motorized fishing craft	516	554
Gill nets	41,429	57,278
Long lines	438,725	349,019
Landing sites	64	70

Landing sites with BMU leadership	43	47
Improved landing sites	3	1
Floating barges for off-loading	2	2
Landing sites with portable water	6	8
Landing sites connected to all-weather roads	32	17

Source: District Fisheries Office, Musoma, Annual Report, 2007

The main fishing methods used have been gillnets, hooks with long lines, hand lines to a lesser extent, and beach seines. Initially, gill nets of 6 to 12 inches were used to catch Nile perch. As demand increased, big fish were being fished faster than their replacement rate. Although the allowed fish size is 50 to 85 cm TL (Total Length), the modal length (the outstanding length frequency) of current catch falls between 40 and 50 cm TL. Increased demand has therefore not only reduced the stock size (Table 5.3) but also the capture size of the Nile perch (Figure 5.1). As noted, more than 75% of the catch does not exceed 50 cm TL. Fishers are now using smaller mesh sizes than the recommended minimum of 5 inches to catch more fish. Beach seines have been banned because of their destructiveness and non-selectivity with regard to the fish size caught. Beach seines are known to catch a greater percentage of immature than mature fish. Other prohibited gear includes trawls, gill nets less than 5 inches, monofilament nets, stake traps, and cast nets. Banned fishing methods include the use of poison and forcing fish into nets.

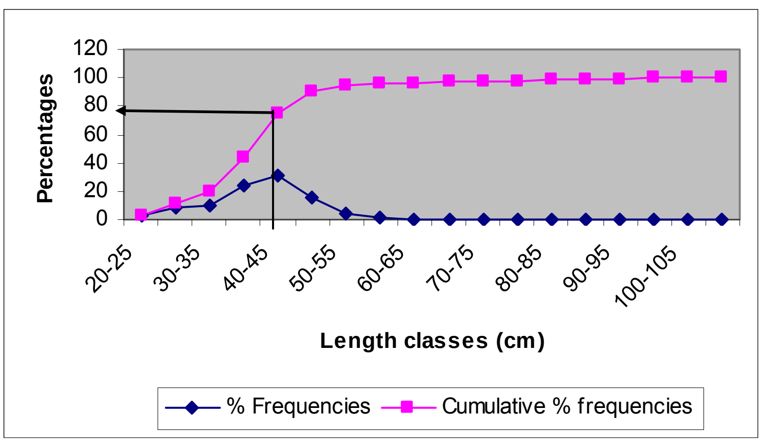


Figure 5.1: Nile Perch Size Distribution in Lake Victoria, 2007
Source: IFMP National CAS Working Group Report, 2007

Table 5.3: Hydro-acoustic Estimates of Fish Stock Sizes in Lake Victoria

Survey time	Stock sizes in metric tons	
	Nile perch	Dagaa
Aug-99	1,936,700	245,300
Feb-00	1,143,900	514,200
Aug-00	1,314,300	196,400
Feb-01	802, 500	875,900
Aug-01	1,240,000	552,800
Aug-05	614,000	495,400
Feb-06	750,000	1,100,000
Aug-06	600,000	890,000
Feb-07	722,000	1,251,000
Aug-07	314,000	869,000
Feb-08	375,700	1,381,700

Source: Regional Hydro-acoustic Working Group, 2008

As previously noted, Musoma and Rorya are the two districts bordering Lake Victoria and involved with its fisheries. The Rorya district has been formed recently (July 2007) and was formerly part of the Tarime district. Table 5.4 shows fish catch estimates for the Musoma district from 2004 to 2007.

Table 5.4: Estimated Annual Fish Catch in Musoma District, 2004-2007

Year	Annual fish catch (metric tons)
2004	39,360
2005	33,456
2006	30,110
2007	28,607

Source: District Fisheries Office, Musoma, Annual Report, 2007

In Musoma, there are two plants processing Nile perch fillets that are then sold either frozen or chilled to overseas markets. Many fishers from both Musoma and Rorya earn their living by selling Nile perch to these processing plants. Table 5.5 shows the fishery importance by income generated (includes processing and exporting) in the two districts. Table 5.6 gives monthly Nile perch catch and beach value as estimated during CAS operation in 2005 and 2006 (Catch Assessment Surveys).

Table 5.5: Weight and Value of Nile Perch Products from Musoma Processing Plants, 2005-2008

Fiscal year	Weight (kg) exported	Value (TShs)	Value (USD)	Royalty (TShs)
Jul 05-Jun 06	8,044,835	25 806,511,855	24,867,780	1,284,659,482
Jul 06-Jun 07	7,503,588	28,658,599,237	22,347,814	1,161,650,370
Jul 07-Mar 08	5,811,591	22,587,790,752	20,589,538	949,090,908

Source: MCS Regional Office, Musoma, Fiscal Year Reports

Table 5.6: Estimated Nile Perch Catch and Value in Musoma and Rorya Districts, 2005-2006

Month	Musoma District		Tarime District	
	Catch in million tons	Value in million TShs	Catch in million tons	Value in million TShs
Jul-05	1,666.4	1,815.1	1,326.5	1,444.8
Aug-05	1,718.3	1,910.7	1,368.0	1,521.1
Sep-05	1,886.3	2,097.5	1,384.7	1,539.8
Nov-05	1,881.9	2,104.0	638.2	713.5
Mar-06	844.0	746.2	404.0	357.2
Aug-06	1,199.0	859.2	997.0	714.4

Source: IFMP National CAS Working Group, Tanzania Data Brochure, 2007

5.1.2 The Status of Dagaa Fishery

Up to the mid 1960s, the dagaa fishery (*Rastrineobola argentea*) was almost unknown. It's lake population was low due to competition with other zooplankton feeders, especially the haplochromine species which accounted for more than 80% of all fish at that time (Kudhongania and Cordone, 1974). Dagaa are caught by first using light attraction with pressure lamps; then the fish are collected by a variety of methods (scoop nets, small beach seines, lift nets, and canoe seines), depending on the area and available gear. Only a small quantity of dagaa is eaten fresh, and the bulk is processed by sun-drying. The fish is spread on flat rocks when these are available, but in most cases it is spread on leveled sand beaches to dry in the sun (Plate 5.4). This method is unhygienic and yields poor quality product that cannot be accepted in international markets. Sun-drying is weather dependent, and the fish goes rancid or rots during rainy weather. Consequently, large post-harvest losses take place during the rainy seasons when, paradoxically, large fish catches are realized. Thus, under wet conditions, dagaa fishery is less profitable than if the processed product was weather independent.

Dagaa contribute more than Nile perch to the total landings (catch) from Lake Victoria, although in monetary terms, it is surpassed by the Nile perch. Table 5.7 presents the contribution of dagaa landings and beach value in the Musoma and Rorya districts. Sun-dried dagaa, on the other hand, are the only fish product widely distributed within Lake Victoria basin and beyond. The fish is therefore marketed in the Mara River catchment, providing cheap and affordable protein to the riparian communities.

Table 5.7: Estimated Catch and Value of Dagaa in Musoma and Rorya Districts, 2005-2006

Month	Musoma District		Tarime District	
	Catch in million tons	Value in million TShs	Catch in million tons	Value in million TShs
Jul-05	1,289.20	1,934	2,130	3,195
Aug-05	884.1	1,308	953.3	1,411
Sep-05	1,824.40	2,700	1,843.30	2,728
Nov-05	920.2	1,068	1,095.50	1,271
Mar-06	3,930	4,681	1,718	2,046
Aug-06	1,510	2,330	ND	ND

Source: IFMP National CAS Working Group, Tanzania Data Brochure, 2007

The biggest dagaa market (Plate 5.5) is at Kirumba, Mwanza, where thousands of bags from the Tanzanian side of Lake Victoria are off-loaded to both local and external fish traders. As mentioned, the dried dagaa is not optimal due to the sun drying method and lack of quality controls. Hygienic processing methods are highly recommended to improve the quality and market value. One straightforward technique is salting/brining the fish and drying on raised racks to eliminate sand and other solid contaminants. Better packaging would also improve quality control. Dagaa nutritional benefits are not only that the fish provides protein but also chewable bones that are a source of minerals to expecting mothers and infants. At present, substantial quantities are used in animal feed preparation for indirect consumption by people. Direct consumption is preferable where protein is a scarce and valuable commodity.

5.1.3 The Status of Nile Tilapia Fishery

Nile tilapia (*O. niloticus*; Plate 5.6) is the only tilapiine fish that has withstood the ecological changes and predation by the Nile perch in Lake Victoria. Both species were introduced into Lake Victoria from Lakes Albert and Turkana where they naturally co-exist. Therefore, it is not surprising that they should co-exist in Lake Victoria. The Nile tilapia is the third most important economically in the lake, and its fishery is based on gillnets and hooks operated as hand lines. The recommended mesh size is 5 inches. No hook size has been officially recommended, but hooks numbers 10 and 11 seem to be ideal for catching adult fish within the recommended capture size (of not less than 25 cm TL). Since the tilapia prefer shallow and protected bays, Musoma Bay is ideal, supporting a flourishing fishery (Plate 5.6). The Nile tilapia is presently one of the most preferred table fish from Lake Victoria. Since most Nile perch is processed for export, tilapia is discouraged from export so that it is availed for local consumption. Tilapia is mainly sold fresh in markets near the lake, but wider ice availability would help transporting and marketing to interior markets that are currently supplied with smoked and fried forms. Table 5.8 shows the estimated tilapia contribution and value for the two lacustrine districts.

Table 5.8: Estimated Catch and Value of Nile Tilapia in Musoma and Rorya Districts, 2005-2006

	Musoma District		**Tarime District**	
Month	**Catch in million tons**	**Value in million TShs**	**Catch in million tons**	**Value in million TShs**
Jul-05	241.9	118.1	185.1	90.4
Aug-05	247.8	110.5	198.6	88.6
Sep-05	268.1	119.6	204.6	91.3
Nov-05	851.2	405.6	386.0	183.9
Mar-06	329.0	166.2	349.0	176.3
Aug-06	141.0	84.6	1585.0	951.0

Source: IFMP National CAS Working Group, Tanzania Data Brochure, 2007

5.1.4 Management of the Lake Victoria Fisheries

The Lake Victoria fisheries are shared resources between the three lacustrine countries: Kenya 6%, Tanzania 51% and Uganda 43%. Prior to establishing a partnership under the East African Community (EAC) (which later became the Lake Victoria Fisheries Organization (LVFO)) for the common management of lake resources, each country separately managed its portion. Each country used what is known as a “control and command approach” which puts responsibility with each respective government. However, resource access is open. Stakeholders regarded the resources as belonging to separate governments without their individual ownership. Experience has shown separate management of an open-access resource is not effective unless stakeholders realize resource ownership (Geheb and Kamuturaki, 2005, Onyango, 2005). Ownership adds a sense of responsibility for management and sustainability.

To improve lake management, Beach Management Units (BMUs) were established under the Lake Victoria Environmental Management Program (LVEMP) in Tanzania, then in Kenya, and lastly in Uganda. The aim of BMUs was to co-manage lake resources with the governments and the main stakeholders, in accordance with the Food and Agricultural Organization (FAO) Code of Conduct for Responsible Fisheries (CCRF).

BMUs were initially regarded as government units run by local people. The role of BMUs was not well defined, and the relationship with federal governments was vague. As a result, conflicts between out-posted fisheries staff and BMU members arose. The BMUs had no legal status to perform their duties, and membership was limited to a committee. Fishers and other beach stakeholders were not included in BMU management. BMU members encountered challenges from fishers who trespassed. Thus, the expected high level of compliance with fisheries laws and regulations was not attained (Tables 5.9 to 5.11). Additionally, the BMUs were not harmonized in their formation and operation across the partner states. As a result the BMU structure and role in natural resource management was changed.

Table 5.9: Illegal Gear Impounded During Monitoring, Control and Surveillance (MCS) Operations

Year	District	Beach seines	Monofila-ment nets	Illegal Fishing Gear			
				Gillnets > 5" mesh	Dagaa seines	Hooks	Pressure lamps
2004/05	Musoma	629	374	790	342	0	16
	Tarime	391	261	977	408	4321	4
2005/06	Musoma	230	52	14	5	0	0
	Tarime	98	203	546	1	3	0
2006/07	Musoma	142	630	324	4	0	0
	Tarime	51	381	219	1	0	0

Source: Mara Region MCS Task Force Unit, Musoma Annual Reports July 04 to June-07

Table 5.10: Boats and Vehicles Impounded During MCS Operations

Year	District	Craft	Outboard engines	Bicycles	Vehicles	Fresh fish (kg)	Dried dagaa (kg)
2004/05	Musoma	19	7	29	0	2380	0
	Tarime	17	9	6	0	61,625	0
2005/06	Musoma	22	1	14	7	13,963	9,700
	Tarime	11	0	0	0	5,890	4,500
2006/07	Musoma	36	0	17	0	8,758	0
	Tarime	9	0	5	3	12,595	0

Source: Mara Region MCS Task Force Unit, Musoma Annual Reports July-04 to June-07

Table 5.11: Legal Action Taken During MCS Operations

Fiscal Year	District	Offenders Apprehended	Prosecutions Made	Cases Judged
2004/05	Musoma	90	42	36
	Tarime	108	33	22
2005/06	Musoma	55	18	17
	Tarime	25	17	8
2006/07	Musoma	66	15	6
	Tarime	37	11	6

Source: Mara Region MCS Task Force Unit, Musoma Annual Reports July-04 to June-07

The LVFO was established to further harmonize the policies and legislation systems for managing Lake Victoria. Currently, the Nile perch is widely fished due to its economic importance in external markets. The local market demand is also high for other lake species.

Realizing the importance of co-management and stakeholder involvement, LVFO has improved BMU operation.

In the present set up, the BMU membership includes committee members and beach stakeholders (boat owners, crew members, managers/supervisors, artisan fish processors and traders, fishing gear and equipment dealers/repair and boat makers), provided that they are vetted by the local authority/fisheries officer at inception. Non-citizens may also become members if they possess valid Immigration Department working permits and comply with non-citizen requirements in the National Fisheries Acts. An assembly democratically elects the BMU Committee composed of a chairperson, vice-chairperson, secretary, treasurer, and committee members numbering 9 to 15. The representation of the BMU committee is roughly 30% boat owners; 30% crew; 30% other stakeholder groups (including fish processor, boat makers, local gear maker/repairs, fishing equipment dealers and managers); and 10% fishmongers/traders.

The detailed BMU structure is described in the Guidelines for Beach Management Units on Lake Victoria (LVFO, 2007). BMUs are now legally operated units with specific guidelines for responsibilities of members and officers. There are sub-committees for special tasks. Figure 5.2 presents a BMU organizational chart. BMUs have been given ways to generate income and acquire assets, including the fish handling infrastructure (Plate 5.7). Generated revenues are used to run day to day activities in an accountable fashion. BMUs have therefore achieved ownership and capacity building with governments and stakeholders.

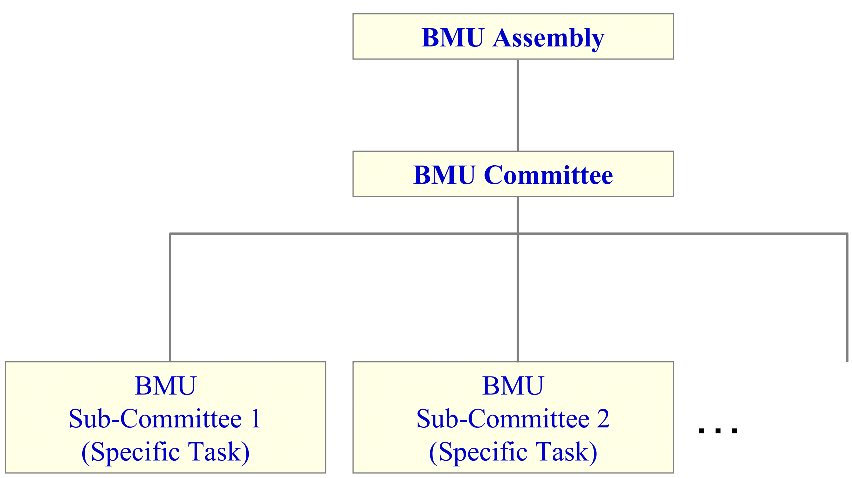


Figure 5.2: BMU Organogram
Source: Guidelines for Beach Management Units, LVFO, 2007

For greater effectiveness, BMUs within a certain area form networks linking them to higher level committee formation at ward/county, district, national, and regional levels. The networks are further linked to other co-management committees within defined administrative areas. With various incentives and all networks involved, BMUs are expected to co-manage the Lake Victoria fisheries with other stakeholder agencies. However, this organizational structure is still new and its success has yet to be demonstrated.

5.2 Wetland Fisheries in the Mara River Basin

The Mara River forms an extensive wetland about two kilometers before it flows into Lake Victoria. The wetland first originated when heavy rains of the 1960s raised the lake level and caused the riverbanks to spill, forming permanent flood pools. The flood pools were eventually colonized by fish and macrophytes, especially papyrus reeds, and formed an extensive swamp. During floods, the papyrus swamp slowed down the flow causing siltation, reduction of the river depth, and further spread of flood waters. In turn, these conditions were favorable for further papyrus swamp development. Currently, the swamp area is several thousand hectares. The swamp is an ideal habitat for the lungfish and catfish, both of which are adapted to living in low oxygen environments because they are able to breathe aerial oxygen. Papyrus swamps are most favorable breeding ground for lungfish (Goudswaard *et al.*, 2002, Greenwood, 1958).

A subsistence-level hook fishery for lungfish and catfish therefore exists in the Mara River Swamp (see Plate 5.8. The lungfish is the dominant fresh fish (followed by catfish) sold in village markets within the Mara basin. Chitamwebwa (2007) estimated that at least 25 metric tons of the lungfish were caught annually. However, this is thought to be an underestimate based on fish sales at the monthly cattle market at Kyagata, Musoma Rural District. More likely daily catch numbers range between 50 and 500 kg. In any event, the fishery is an important contributor of fish protein. This fishery is rather unique in that it is naturally self-regulatory. The size of the swamp is a function of natural precipitation and river flow. At times of floods, the swamp extends and provides more space for fish. During droughts, the swamp shrinks, and the lungfish aestivates in the dry swamp areas. That is, it buries itself in the mud surrounded by a cocoon and becomes inactive until the area is again flooded when it resumes normal life. Under the swampy conditions, the fish are not exposed to many enemies, and even fishing activities are checked. Hence, the population of the fish is sustained.

At the time when the swamp was being established, it became colonized by some fish lake species. These included the cichlid species of the tilapias: *Oreochromis niloticus, O. leucostitus, O. Esculentus, Tilapia zillii* and *T. rendalli* and some haplochromine species. The flood-pool lakes have provided subsistence for the riparian community fisheries. They have also acted as a refuge for some species thought to be lost through various factors, including Nile perch predation. For example, until recently when very severe droughts caused the flood-pool lakes to dry out, the Kirumi swamp was one of the few satellite Lake Victoria lakes where *O. esculentus* was found (Katunzi, 2000). Satellite lakes were able to support this species because they contained the alga, *Aulacoseira*, on which the fish feeds but which is almost absent from the main lake. In this way, the Mara Swamp acts as a reserve for some fish species. Other tilapia species also exist together with haplochromines and the swamp species. BMUs have been formed around the Mara Swamp to take part in managing this fishery.

5.3 Aquaculture in the Mara River Basin

The Mara River Basin is represented by four districts in Tanzania. They are Musoma Rural, Rorya, Serengeti and Tarime. In Kenya, four districts also fall within the basin: Bomet, North and South Narok, and Transmara. Among these districts, only Musoma and Rorya border Lake Victoria.

Aquaculture is practiced in all districts within the Mara Basin, but fish eating habits differ by district. Fish is eaten in most Tanzanian communities. However, in parts of Kenya, especially among the Masai, fish consumption is uncommon. Publicity to inform the Masai of fish eating benefits is on-going. The approach begins with informing the older generation first who are resistant to change. In North Narok, for example, the District Fisheries Officer, a Masai, has campaigned very effectively for young Masai to consume fish and also to fish in stocked dam areas (*O. niloticus and C. gariepinus*). Fish consumption in these areas is slowly taking root.

5.3.1 Aquaculture in Musoma District

The main fish source in Musoma is Lake Victoria, but the entire district does not have easy lake access. A good alternative for obtaining fresh fish is from aquaculture. The district has aquaculture potential where rainwater can be retained for more than six months. In 2000, under the LVEMP project, 14 ponds were constructed in Kongoto along the Mara River and were stocked with *O. niloticus*. Elsewhere, about 18 ponds were distributed as follows: Butiama Ward (8), Buhemba (5), Nyambono (3), and Kukirango (2). The following five dams are stocked with *O. niloticus* seeds obtained from Nyegezi, Mwanza: Bukabwa, Bwiregi, Kwisaro, Kitaramanka, and Kiarano. However, pond culture in the district has been discouraged by droughts that cause ponds to dry. Educational campaigns and readily available fingerling stocks would help encourage pond culture on a seasonal basis.

5.3.2 Aquaculture in Rorya District

Most of the Rorya District gets low rainfall (600 to 800 mm per year). However, the communities are significant fish consumers and therefore are eager to culture fish. A Non Governmental Organization (NGO), Heifer International, is assisting local communities to culture fish in groups and individually. Through this assistance, about 40 ponds were stocked between November 2006 and April 2007. However, ponds yield data are currently unavailable.

5.3.3 Aquaculture in Serengeti District

Aquaculture in the Serengeti district started in 1993 (District Fisheries Officer, Report ya Mabwawa, undated). This was done through the Evangelical Lutheran Church of Tanzania (ELCT), Arusha Diocese, which organized fishpond construction and provided fingerlings for stocking from the Nyumba ya Mungu Dam. The fingerlings were mainly tilapia (most likely *O. esculentus*). Further campaigns and stocking took place in 2004, 2005, and 2006. The ponds are distributed in 13 villages as shown in Table 5.12. The production output of these ponds is not known.

Table 5.12: Pond Distribution in Serengeti District Villages

Village	No. of ponds
Mosongo	19
Rung'abure	10
Kemgesi	7
Iharara	7
Mugumu	6
Kwitete	4
Maburi	4
Natta/Bugerera	4
Gantamome	2
Gusuhi	2
Bonchugu	2
Ngrawani	1
Nyichoka	1

Source: Repoti ya Mabwawa, District Fisheries Office, Serengeti District, undated

Fingerlings from the wild (Nyumba ya Mungu Dam) are not considered quality seed, because they could be composed of a mixture of species with widely varying growth rates. Therefore, obtaining stocking seeds from a known source is preferable. Good quality seed include *O. niloticus* which is best among the tilapias.

There are several dams in the district for water storage for both domestic and cattle watering. These dams are potentially suitable for fish stocking as well (see Plate 5.9).

Aquaculture development in the Serengeti district faces the following problems:

- Few trained personnel;
- Lack of working gear and transport;
- Lack of funds for educational campaigns, follow up, and supervision;
- Weak response by the local communities; and
- Little coordination between aquaculture experts and stakeholder institutions.

On the other hand, aquaculture benefits include:

- Better land use since ponds occupy small areas and yield substantial fish output;
- Pond activities reduce wildlife poaching in the National Park; and
- Quality seed would encourage pond culture and fish available for home consumption and sale.

Pilot ponds are now available for demonstration, e.g., at Rung'abure.

5.3.4 Aquaculture in Tarime District

Tarime is favorable for aquaculture due to the relatively high rainfall (1000 to 1200 mm per year) and its numerous springs. Furthermore, the high altitude and slightly cooler climate result in lower evaporation than other Tanzanian districts. Fish pond production was estimated at 1,960 kg/ha in 2004 (A. Shoko, pers. comm.). By focused campaigns and under the availability of good seeds, higher production and more farmers are attainable.

Polyculture involving fish, poultry, and vegetables can also be practiced. In one example, Nile tilapia *O. niloticus* and catfish (*C. gariepinus*) are cultured in ponds. Poultry droppings serve as direct food for the fish and also fertilize ponds for better algal growth. Pond water can then be used to irrigate the vegetables. This method can enhance both vegetable and fish production (see Plate 5.10).

5.3.5 Aquaculture in Bomet District

Bomet District is active in small scale aquaculture. Table 5.13 summarizes the aquaculture status. The district gets reasonably high rainfall and is situated at a high altitude with cool weather. As a result water is usually available. The district however faces problems in terms of a fisheries labor force. At present, there is limited staff to serve the district extension services. The main species cultured is the Nile tilapia whose seeds come from the departmental ponds in Kapsimotwo, other fish farmers, and LBDA nurseries at Borabu, Kegati KMFRI station, and Kisii. No catfish culture exists, but there are plans to introduce this species.

Fish production from pond culture does not satisfy demand. Fish is brought from Lake Victoria and sold as summarized in Table 5.14. Aquaculture expansion can and should be encouraged in the district.

Table 5.13: Summary of Aquaculture in Bomet District, 31 December, 2007

Description	Division				Total
	Bomet Central	Longisa	Sotik	Konoin	
No. of fish farmers	30	2	33	31	96
No. of ponds operating	33	4	33	41	111
Area of ponds (m^2)	1,706	235	3,448	3,110	8,499
No. of inactive ponds	10	Nil	2	2	14
Area of inactive ponds (m^2)	570	Nil	140	260	970
No. of new ponds	4	Nil	6	Nil	10
Area of new ponds (m^2)	380	Nil	620	Nil	1,000
No. of ponds stocked	6	1	6	Nil	13
Area of ponds stocked (m^2)	821	300	680	Nil	1,801
No. of fingerlings stocked	1,127	100	700	Nil	1,027
Value of fingerlings stocked (KES)	5,135	300	3,450	Nil	8,885
No. of ponds harvested	8	Nil	3	Nil	11
Area of ponds harvested	656	Nil	360	Nil	1,016

No. of fish harvested	293	Nil	150	Nil	443
Wt. of fish harvested	56	Nil	37.5	Nil	94
Value of fish harvested (KES)	8,275	Nil	7,500	Nil	15,775

Source: Bomet District Fisheries 2007 Annual Report

Table 5.14: Fish Estimates Sold in Bomet District Markets, 2007

Fish species	**State of fish**	**Quantity (kg)**	**Value in KES**
Tilapia	Fried/smoked	6,416.90	962,520
Dagaa/Omena	Sundried	26,510.40	1,127,856
Nile perch	Fried/smoked	9,420	487,152

Source: Bomet District Fisheries 2007 Annual Report

5.3.6 Aquaculture in North and South Narok Districts

Communities in both the North and South Narok Districts largely belong to the Masai tribe. The Masai normally consider fish consumption a taboo. As noted, the District Fishery Officer (DFO), who is the person responsible for fisheries activities in both districts, is a Masai and has encouraged fish consumption within the tribe. Acceptance has been wider among the young who are also learning how to fish.

Extensive aquaculture is done in these districts. This aquaculture includes fish stocking in dams used for water supply. Fish growth is enhanced by cattle feces and urine that help fertilize the water and stimulate plankton growth. One pond, Maji ya Moto of South Narok, *O. niloticus* reached a harvestable size within about 8 months.

Pond culture is also being undertaken by women who work singly or in groups. Most ponds have been constructed along permanent rivers (Narok and Enkare Ngusur). A constraint is limited district staff. One fisheries officer is the only support for both districts.

5.3.7 Aquaculture in Transmara District

The Transmara has good aquaculture potential with regard to water availability, although fish consumption is not very popular among the residents due to their customs. Fisheries information could not be obtained because all staff is located in the neighboring district of Gucha. The potential for Nile tilapia and catfish culturing exists, but inadequate staffing is a serious limitation. The current fisheries staff is not adequate to provide seeds and supervise pond management.

5.3.8 Aquaculture Prospects in the Mara Catchment

Kenyan aquaculture is presently more extensive than in Tanzania. Several stations for producing quality seeds/fingerlings for pond stocking exist. *O. niloticus* seeds are raised in

Kisumu and Sangoro. Trials to produce *C. gariepinus* seeds are taking place (Maroko, 2005). In Tanzania, stations for quality seed production do not yet exist. There is an *O. niloticus* seed pond at Nyegezi Freshwater Fisheries Institute and some ponds at the TAFIRI Centre, Mwanza. However, these locations do not produce seeds but serve as reserve ponds where intermittent seed collection takes place.

In terms of water potential, Tanzania receives less rain than Kenya. Consequently, water supply for feeding ponds is more available in Kenya, which also has a higher altitude and cooler climate. The Tarime District has a comparable climate to Kenya; Musoma, Rorya and Serengeti receive moderate rains but have pronounced dry periods during which most ponds go dry. While year round culture may be carried out in most parts of Kenya, seasonal culture is the option in Tanzania. Therefore, quality seed centers are more needed on the Tanzania side where fish are harvested before the ponds dry out. In contrast, most ponds in Kenya retain water throughout the year so that once stocked, the ponds can be self-sustaining.

In Kenya, the resident communities are less enthusiastic to fish culture since they are not ardent fish consumers. Induction to fish consumption is a prerequisite for fish culture campaigns. On the Tanzania side, most communities have a natural preference for fish. Thus, higher market potential exists in Tanzania, but more aquaculture potential is available in Kenya.

5.4 Summary of Issues and Potential Investment Opportunities

Hereunder we summarize issues, causes, impacts, ongoing intervention measures, and potential investment opportunities.

Issues	**Causes**	**Impacts**	**On-going interventions**	**Investment Opportunities**
1. Over-fishing of Nile perch stocks (>50%).	Overcapacity, illegal gear and fishing methods.	Diminishing catches.	Banning of illegal gear and fishing methods.	Local gear manufacturing to control illegal gear importation.
2. Post-harvest losses of up to >50% in dagaa and 10-20% in Nile perch.	Lack of handling facilities at landing sites; weather-dependent processing methods.	Fish deterioration of fish; low prices of fish; loss of much needed protein.	Icing done by fish collectors at landing sites, not by fishers on the lake.	Ice plants at landing sites; processing dagaa into quality and directly human-consumable products.
3. Live bait collection from the wild; almost 100% dependence on natural sources.	Demand from Nile perch hook fishery.	Interference with recovering indigenous fish stocks; seasonal availability of bait.	Prohibition of live bait collection from the wild. Campaigns to raise the bait in ponds.	Fish culture for live bait (catfish).
4. Population pressure.	High birth rates (>3% among	Higher fish demand than	Campaigns by governments and	Fish farming for both local and external

	fisher communities annually).	natural sources can provide.	NGOs on aquaculture practice.	markets; manufacture/provision of fish feeds and other aquaculture inputs.
5. Deforestation.	Timber and wood fuel demand.	Environmental degradation; high prices of wood products.	Afforestation campaigns by governments and NGOs.	Manufacture of non-wood products, e.g., canoes, furniture, etc.
6. Changing lake levels.	Alternate droughts and exceptional precipitation.	Loss of fringing vegetation; loss of inshore fish stocks.	Global concern over the world's changing weather patterns.	Construction of floating jetties at important fish landing sites.
7. Poverty*: Over 70% of ordinary fishers are below poverty level.	Ignorance of the best ways of exploiting available resources.	Low standards of living among fisher communities.	Poverty alleviation schemes of SACCOS and soft bank loans.	Investment in education: basic, technical, and professional levels. Various investments for provision of jobs and services.
8. HIV/AIDS* and water-related diseases with prevalence levels of 5-40%.	Life style; working in parasite infested waters; drinking impure water.	HIV/AIDS transmission; Weakness and disability to work; low life expectation; death.	Education and services given by governments and NGOs, e.g., AMREF.	Manufacture of life prolonging drugs in the area so as to render services as nearer to the victims as possible; investing in medical services.

*Although some of these issues transcend the fisheries sector are mentioned here because they are part and parcel of life, touching all people, fisher folk included.

5.5 Discussion of Investment Opportunities in Fishery Ventures

Investment opportunities are significant in fisheries in the Mara River Basin. These include: construction of fishing crafts; dagaa fishing and processing; Nile perch frame processing; lake transport; fish handling facilities; gear manufacturing; lungfish processing; ornamental fish; aquaculture development; and wetland related investments. These opportunities are described next.

5.5.1 Construction of Fishing Craft

Virtually all fishing craft on Lake Victoria are constructed from wooden planks logged from natural forests. In Tanzania, the preferred tree species has been "mninga" (*Pterocarpus angolensis*) because it can last up to ten or more years with occasional repairs. The tree has become scarce since it is also the most common wood used in furniture making and door and window frame construction. In general, wooden planks of suitable sizes and durability are becoming hard to find and increasingly expensive. Deforestation is becoming unmanageable. Fabrication of boats/canoes from alternative materials is greatly needed. Manufacturing of light, reasonably priced, fiberglass canoes could relieve some of the current deforestation problems and bring additional income to the region.

5.5.2 Dagaa Fishing and Processing

Dagaa (*Rastrineobala argentea*) is a small pelagic fish found throughout Lake Victoria. Most fishing is in relatively inshore waters, and the open offshore waters are still little exploited. Better motor boats are needed for deep waters. Lack of capital prohibits local fishers from exploiting the offshore dagaa stocks.

At present, dagaa is processed by sun drying on sandy beaches, and where they are available, flat rocks (such as those found at Kibuyi in the Rorya District). Sun drying is weather dependent, and, during the rainy season, dagaa drying suffers heavy post-harvest losses. As a result, most of the sundried dagaa is currently processed into animal feed. This is not the most efficient use of this resource when human food sources are limited.

Thus, investment opportunities exist in deep water dagaa fishing and dagaa processing using weather independent methods for higher and better quality yields.

5.5.3 Nile Perch Frame Processing

In processing Nile perch, the residual fish frames are largely disposed of in the bush. To date, very little, if any, fish frame processing is undertaken. Thus, the opportunity exists for fish frame processing into animal feed to replace the use of the more nutritional dagaa. This would also help reduce environmental pollution caused by the rotting dumped fish frames.

5.5.4 Lake Transport

Ever since the evolution of the Nile perch fishery in Lake Victoria, the population of fishers and service providers around the lake and its numerous islands has increased tremendously. Because of poor and unsafe craft used in transporting passengers and goods, accidents are quite common. Thus, investment is needed to provide for safe and reliable lake transport. These include the construction of reliable jetties for safe passenger boarding/landing and commodity loading/unloading, especially in densely populated fishing landing sites which have become permanent settlements.

5.5.5 Fish Handling Facilities

Fish handling poses limitations in the marketability of Nile perch and other Lake Victoria fish because the catch is not chilled immediately. Ice facilities are needed to preserve catches. Dagaa cannot be sold fresh in distant markets because it deteriorates quickly. Prices for fresh dagaa fall rapidly once caught. In the absence of ice, the fish is sold and dried as soon as possible to prevent spoiling. Ice availability would greatly improve the marketability of dagaa and other fish. Ice production at fish landing sites is another potential venture for investment.

5.5.6 Gear Manufacturing

Usage of illegal fishing gear is rampant, and regulating the type of imported gear becomes difficult. Thus, fishing gear manufacturing in the Lake Victoria region would increase the ability to survey and regulate the gear used and would minimize the use of illegal mesh sizes and gear types. Investing in recommended gear manufacturing locally is a promising opportunity.

5.5.7 Lungfish Processing

In the Mara swamp, the lungfish stock could support a small filleting plant to hygienically process fillets. Fillets could then be sold to hotels in Musoma, Serengeti, and Tarime. They could also be turned into more gourmet products such as fish balls, cakes, pie, samosas, and sausages.

5.5.8 Ornamental Fish

Another investment area is ornamental fish export. Lake Victoria, as the other two great lakes of Africa, Nyasa and Tanganyika, is known as a cichlid lake and formerly harbored more than 300 species, mainly haplochromines (Greenwood 1956). Although Lake Victoria cichlids are not as colorful as those from Lakes Nyasa and Tanganyika, there are some unique species found in rocky shores such as *Pundamilia* spp. which are of interest to tropical fish enthusiasts.

5.5.9 Aquaculture Development

Lake Victoria is remote from most districts, and the infrastructure connecting them is relatively poor. Especially in Tanzania, fresh fish hardly reach interior towns. An alternative to transporting fresh fish is to raise them in ponds. Pond culture business opportunities exist in setting up seed farms. Farmers could obtain Nile tilapia (*O. Niloticus*) and catfish (*C. gariepinus*) seeds for stocking. Catfish cultures require expertise since the fish must be bred artificially; catfish are artificially induced to spawn by hormone injection; and eggs are fertilized artificially, an involved process for an ordinary local farmer.

The culture of C. *gariepinus* as live bait for Nile perch and other purposes is very promising (Maroko, 2005). To date, most live bait comes from the wild, especially from Lake Victoria and its river systems. Live bait collectors have a thriving trade of selling to fishers. In Tanzania, a piece of juvenile *C. gariepinus* costs from 100 to 200 TShs at landing sites. On the other hand, collecting *C. gariepinus* from the wild for live bait is discouraged as it interferes with the natural fish breeding cycle in river flood pools. Bait fish are collected while still in their juvenile stage and have a total length between 8 and 25 cm TL. Bait fishing therefore poses a threat to the species population, growth, and survival, and it is prohibited. When cultured in ponds, the fish attain 8 to 10 cm TL in about 40 days. A farmer who cultures *C. gariepinus* may opt to sell the fish as fingerlings for pond stock or as live bait to Nile perch hook fishers after attaining bait size. Pond farmers may also allow fish to grow to market size for human consumption. A number of Ugandan farmers have taken up this business (J. Kamanyi, pers. comm.). Juveniles are sold to Nile perch hook fishers in Uganda, Kenya, and Tanzania, while market size fish can be smoked and sold to Rwanda and Burundi. If large fish quantities could be cultured, the threat imposed by live bait collection from the wild would be greatly minimized. Fish culture is a good opportunity for investors who are willing to invest in facilities, equipment, expertise, and overhead costs.

Another practice, known as cage culture, is being considered by some investors for Nile perch and Nile tilapia in Lake Victoria. However, some scientists and managers in the three East African partner states are critical of this practice. The fear is that inshore land acquisition would limit free access to riparian communities. The question has yet to be resolved.

Lastly, to encourage pond culture, a seed-producing center should be availed in a given district to shorten the distance between the seed source and the ponds to be stocked and reduce mortality during transportation.

5.5.10 Wetland Related Investments

Papyrus reed is an aquatic plant covering an extensive area of the Mara Swamp, including the river estuary and parts of the lakeshore within Musoma Bay. The reed is a good craft-material that can be woven into a number of useful objects, including mats, chairs, and sofas. The reed is widely used in Kenya by the Luo communities around the Nyando wetland. In the Mara wetland, only crude mats are made from reeds. There is thus the opportunity to train local communities to profitably utilize the swamp as an alternative income generator to fishing. Alternative resources would reduce the present fishing pressure on the fish stocks. There is also the possibility to utilizing reeds in producing fuel briquettes, which would abate deforestation. The work above could be sponsored by NGOs and Community Based Organizations (CBOs) for empowering the local communities toward increased income generation and poverty alleviation. Such activities are possible in Tanzania where the papyrus reed is readily available.

Plate 5.1: Potamodromous Species: *Labeo victorianus* (L), *Schilbe intermedius* (Si), *Synodontis afrofischeri* (Sa) and *S. victoriae* (Sv) caught from Speke Gulf, Lake Victoria

Plate 5.2: Nile Perch

Plate 5.3: Deforestation in Juma Island, Lake Victoria, as a consequence of fuel-wood demand for smoking Nile Perch during its boom period

Plate 5.4: Sun-drying of dagaa on a sandy beach. The dried dagaa is contaminated with sand and grit that adheres to the fish, making it both unhygienic and inconvenient to eat. Sun-drying in the open air is also subject to weather conditions.

Plate 5.5: Mwanza Fish Market. Thousands of bags of sun-dried dagaa are brought here for sale.

Plate 5.6: Nile tilapia (*Oreochromis niloticus*) at Nyarusurya landing site, Musoma caught from Musoma Bay.

Plate 5.7: Fish handling infrastructure at Kijiweni, Sengerema District. Such services belong to and are run by BMUs all round Lake Victoria

Plate 5.8: Lungfish (*Protopterus aethiopicus*) (left) and catfish (*Clarias gariepinus*) (right). These species form the fishery of Mara River Swamp

Plate 5.9: The Manchila Dam in Serengeti, completed in 2007, is the source of water for Mugumu Town. It is suitable for multi-species fish stocking, potential candidates being *Oreochromis niloticus* and *Clarias gariepinus*

Plate 5.10: Poly-culture practiced by a farmer in Tarime. Note the chicken cage in the pond and various plants grown around the edge of the pond

6.0 Environment, Ecosystems, and Tourism

This chapter describes environmental resources and major ecosystems for the Mara River Basin. The significance of wildlife and tourism in the greater Serengeti-Mara Ecosystem towards sustainable development is also discussed. The status of two major wetlands, various forests, and wildlife species are highlighted with respect to their conservation challenges. Wildlife within the basin, ecology, and tourism activities are presented along with tourism investments and the associated positive and negative impacts. Lastly, possible investment proposals are provided.

6.1 State of Environmental Resources

The Mara River, shared by Kenya and Tanzania, is of profound environmental and biodiversity conservation interest. The river has a catchment area of about 13,750 km^2, with an upper basin area of about 8,941 km^2 (65%) in Kenya and a lower basin area of about 4,809 km^2 (35%) in Tanzania. The human population, livestock and wildlife depend on this environment for survival and well being. In addition, the basin environment is of global significance due to its unique ecosystems and biodiversity.

The increasing use of resources within the basin has had impacts on the environmental health and resilience here. Eighty years ago, the Serengeti-Mara area was under-populated with respect to both humans and wildlife. In the last fifty years, however, tourism, cattle and agriculture have all expanded significantly, competing for the same land. This expansion has created serious problems, and, if allowed to continue unchecked, it threatens the long-term viability of the ecosystem. Unsustainable use of environmental resources poses a danger to the development of the region, and potentially compromises the ecological, economic, and social needs of all inhabitants.

6.1.1 Biodiversity

The Mara basin encompasses a very rich biodiversity of fauna, flora and a variety of habitats. The basin has a wide array of large and small mammals, birds, reptiles, arthropods, microbes, fish, and unique plant species. However, some of these fauna, floral species and habitats are threatened. The variety of habitats, ecosystems, and diversity of flora and fauna has made the Mara basin a regional and international attraction site.

Agro-biodiversity is represented by various food and cash crops as well as livestock. Agro-biodiversity is important because it provides security against drought, crop diseases, and animal diseases. Different crops and animals resist disease occurrences to varying degrees, hence enhancing food security. Loss of agro-biodiversity in terms of traditional food crops is very real in the basin.

Biodiversity and the ecosystems of the Mara River basin present a variety of benefits to the local communities. These benefits accrue from domestic consumption as well as inter-household and distant trade to various parts of Kenya and Tanzania. Almost 80 % of all inhabitants derive their livelihoods from agricultural activities, contributing about 75 % to the regional economy.

Key biodiversity issues in the basin include:

- Natural resource use conflicts;
- Deforestation and habitat destruction;
- Human population increase and subsequent encroachment into wildlife habitats;
- Pollution of river systems;
- Human-wildlife conflicts;
- Illegal activities of wildlife poaching and over harvesting of medicinal plants;
- Recurrent droughts; and
- Impacts of climate change.

6.1.2 Forests

Forests are among the most important natural resources in the Mara River basin. They conserve water and soils, regulate gaseous balance in the air (carbon sequestration), and provide biological diversity. The forests provide both tangible and intangible products for the local communities and the region. The basins' forests include Bwiregi, Nyabasi, Mogabiri, Tarime, Mukendo, Musoma, Bisumwa, Buruma, Bariri, Malambika, Salama, Rigo, Ring'wani, Machira, Kuruya, Bwiri and Rorya in Tanzania and Olenguruone, Kirengeti, Emperua, Mau, and Chepalungu in Kenya. These forests are both indigenous and exotic plantations. The forests are home to monkeys, elephants, buffaloes, abundant avian life, and other species.

These forests and their biodiversity are under severe threats due to various illegal activities that include exotic plantings, encroachment, political interference, over-exploitation, low reforestation, and lack of sustainable forest management. Sustainable forest management, aiming to increase the quality of life for local communities through employment and provide raw forest products for domestic and industrial use, should be an integral component of the overall development.

6.1.3 Wetlands

The two main wetlands in the basin are the Enapuiyapui and Masurura swamps in Kenya and Tanzania, respectively. These wetlands are productive ecosystems providing environmental goods and services including water storage, flood control, water filtration, water recharge and discharge, nutrient cycling, pollution control, wildlife habitats and landscaping. In addition, they provide non-use existence value benefits. Much like other sensitive ecosystems, the wetlands are under threat from agro-chemical pollution and soil erosion. Forest encroachment and destruction for farming are also threatening these wetlands. Deliberate efforts are needed to protect the wetlands and their biodiversity and to sustain the goods and services they offer.

6.1.4 Agriculture

Agriculture is the livelihood for a large proportion of the basin's population. There are three major agricultural activities: crops, livestock, and fisheries. However, these activities exploit environmental resources such as land, water, and forests. The growing food requirements due to population increase and accessibility to more markets is driving the demand for more cultivated land, settlement space, and more livestock products. An analysis of cultivation pattern in the Mara region from 1975-2000 indicate a general in crease in land under farming (Sitati, 1997 and 2000; Table 6.1)

Table 6.1: Expansion of Cultivation in the Mara Region

Region	Year	Area (km^2)	% change
Koyiaki-Lemek_olkinyei	1975	74	
	1984	154	108
	1991	245	59
	1996	309	26
Siana-Maji-Moto-Naikara	1975	0	
	1984	17	
	1991	70	312
	1997	81	16

Source: Sitati, 1997 & 2000

Agricultural expansion has resulted in conversion of wetlands and wildlife rangelands to farmlands. Massive deforestation has occurred both in the upper and lower basin. Soil erosion has increased as a result of cultivating steep slopes and river banks. Soil erosion on farms due to water and wind has lead to water pollution and siltation of dams, water pans, swamps, and rivers. In addition, sedimentation and eutrophication of water bodies has led to emergence and sustenance of notorious aquatic vegetation such as water hyacinth. Air pollution as a result of dust from exposed and/or bare farms is also common. Other areas prone to erosion include cattle tracks, road reserves, and gullies. Erosion has led to reduced soil fertility and higher incidences of bare hills. Since a great part of the basin is within the Arid and Semi-arid Lands (ASAL), the pastoralists have tended to overstock their livestock resulting in land degradation and emergence of invasive species such as wire grass.

The expansion and intensification of agriculture (Figure 6.1), made possible by irrigation, has increased erosion; pollution of surface water and groundwater from agricultural biocides; deterioration of water quality; and increased nutrient levels. Use and mishandling of agrochemicals and fertilizers have also contributed to environmental pollution.

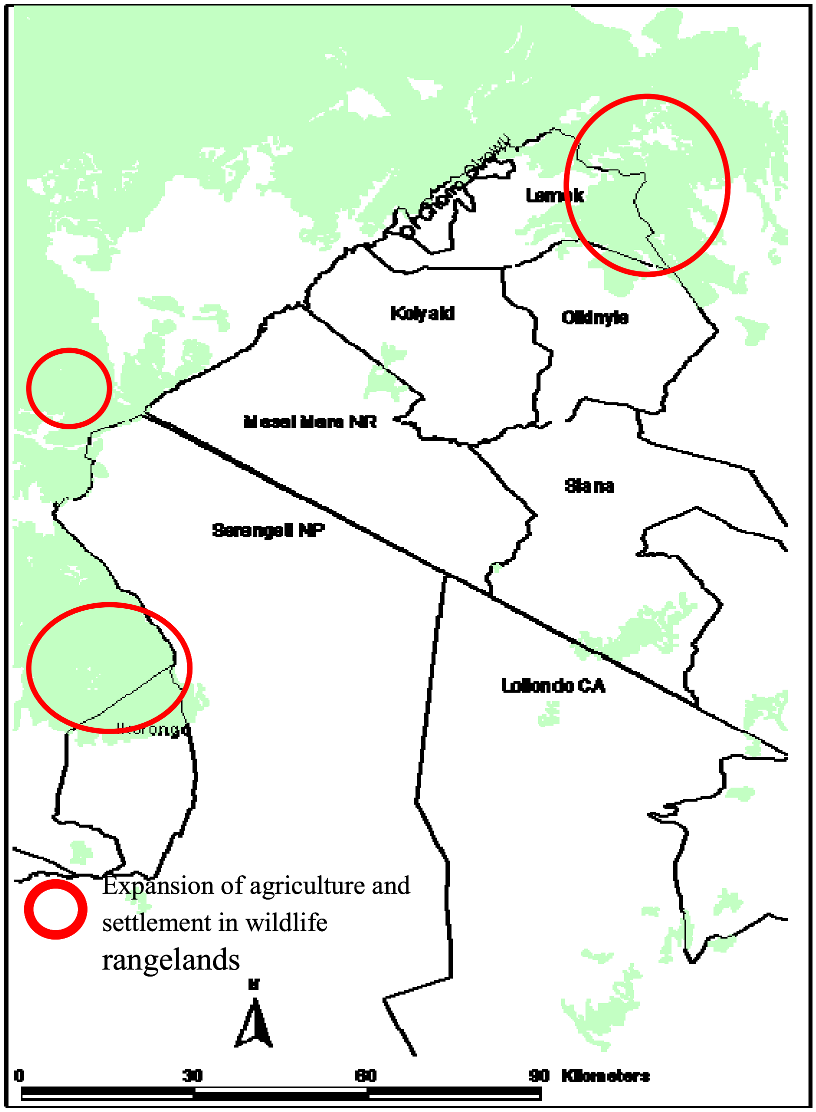


Figure 6.1: Expansion of Agriculture and Settlements over the Last 5 Decades

Residual chemicals from farms and agro-industries eventually runoff into streams, swamps, and rivers. Household chemical containers are poorly disposed of and may cause human and environmental health risks whose impact has not been documented. Elimination of dry season die-back and the creation of a more humid microclimate could potentially increase agricultural pests and plant diseases.

6.1.5 Human Encroachment and Land Use Changes

Human settlements are mainly concentrated in high agro-economic regions and urban centers. Common settlement types include circular, manyattas, crescent, linear, dispersed, and urban. As a result of human population increases, people have encroached on forests, wetlands, and wildlife rangelands. Dilapidated sites and mushrooming market centres near parks degrade the aesthetic value of the environment where they occur.

Major land uses include agriculture, small scale farming, large scale wheat production, irrigation farming, livestock production, forestry, and wildlife and wetlands conservation. Land use changes within the basin have affected the Mau Forest, the northern Masai Mara wildlife rangelands, and the agricultural western periphery of the Serengeti National Park (SNP). Over the last four decades, the human population and areas under agriculture have increased dramatically. Consequently, the following land use changes have been observed in the basin:

- Forest clearing for agricultural and settlements in the upper and lower catchment;
- Opening wildlife rangelands for agriculture, especially wheat and maize farming;
- Human settlements and construction of schools, roads, market centres.

Based on 1986 satellite imageries, about 69 % (9,594 km^2) of the land was under natural pasture as savannahs, grasslands, or shrub lands and was mostly used for grazing livestock and/or wildlife reserves (Mati, *et al.* 2005). However, by 2000, these rangelands had been reduced by 24 % to 7,245 km^2 due to agricultural encroachment, with the agricultural area increased by 55 % (Mati *et al.* 2005). The natural vegetation has been declining as forests declined by 23 %, due to forest clearing for tea and timber harvesting (Mati, *et al.* 2005).

These land-use changes impact the ecology and affect biological diversity through modification and degradation of natural resources. The low, erratic rains and droughts could be a result of the extensive forest cover reduction. Habitat reduction and fragmentation can also reduce the diversity of wildlife species. Permanent settlements and cultivation in the wildlife migratory routes threaten the future migratory patterns and wildlife distribution. Genetic diversity is being reduced, increasing the species vulnerability to disease outbreaks. Increased use of heavy chemicals such as fertilizers, pesticides, and herbicides has contaminated water supplies and harmed not only the aquatic species but also wildlife and livestock that rely on these water sources. Although water quality monitoring is inadequate, evidence of pollution is provided in the Monograph Chapters 3 (Water Supply and Sanitation), 4 (Agriculture), and 5 (Fisheries).

Land use changes have contributed to:

- Loss of Biodiversity
- Reduced wildlife and livestock ranges
- Competition over wildlife and livestock pasture and agricultural land;
- Blockage of wildlife migratory corridors and breeding grounds
- Human-wildlife conflicts;
- Loss of water catchments areas
- Water use conflicts; and
- Inequitable resource use and benefit sharing among the major stakeholders (community ranches, wildlife conservation associations, tour/hotel operators, large agricultural farmers and local governments).

6.1.6 Energy Needs

Energy supply is vital for the operation of other sectors. The majority of residents (about 80%) rely on wood fuel as the energy source. To meet energy needs, trees are harvested extensively causing large scale deforestation. Deforestation has exposed bare land, promoted soil erosion, and reduced soil fertility. Deforestation also affects the livelihood of the communities through wood scarcity and micro-climate change.

6.1.7 Environmental Pollution

Human settlements are the main sources of pollution to land, air, and water. The main environmental pollution types related to anthropogenic activities in the basin include:

- *Water and land pollution* through contamination by chemicals, agrochemicals, siltation, solid wastes (garbage), plastics, organic wastes, effluents, oil, agricultural and mining runoff, and spills;
- *Air pollution* through aerial sprays (large scale farms), smoke (farm fires), and dust and odour from decaying organic matter;
- *Agrochemical poisoning* through skin contact and ingestion leading to adverse health effects to human, livestock, and wildlife; and
- *Global warming* accelerated by deforestation and green house gases released through farm fires and combustion of organic fuels.

Environmental education as well as implementation and effective use of the existing environmental regulations may reduce these pollution sources in the basin.

6.1.8 Water Resource Use

Adequate and safe water is essential for all life and for sustained economic development in the Mara River Basin. Human communities, domesticated animals, and wildlife all depend on water for their well being. Water sources in the Mara Basin include the Mara River and its tributaries; surface water storage facilities such as dams and water pans; ground water resources (accessed through boreholes and wells); wetlands; and springs. The main water uses in the basin include:

- *Domestic use* characterised by households, hotels, institutions, and livestock;
- *Agricultural use* characterised by small and large scale farmers along the Mara River and main wetland areas;
- *Industrial use* including mining companies and small industries; and
- *Wildlife use* has drinking water and as a vital habitat.

Available data (Chapters 2 and 3) indicate a decline in water quantity in the main sources attributed to deforestation, vegetation cover clearance, increased water abstraction for human and agricultural use, and other activities (e.g., river bank cultivation). Most open water sources in the basin are polluted bacteriologically as a result of topsoil erosion, poor farming methods, sewage discharge, agrochemical discharges, and fertilizer leaching into water resources (Chapter 4).

The pressure currently placed on water resource in the basin has resulted in various environmental impacts such as:

- Increased water demand as a result of population increases;
- Increased human activities in the basin leading to water degradation (of both quantity and quality) through illegal logging, increased farming activities, charcoal burning, and encroachment;
- Water pollution arising from poor farming technologies (soil erosion, siltation, and agrochemical contamination);
- Increased resource conflicts arising from shared water sources by livestock, wildlife, and humans;
- Increased water-borne and water related diseases (e.g., malaria, typhoid, amoebiasis) due to pollution and substandard sanitation;
- Loss of important wildlife resources such as salt licks and dry season grazing; and
- Loss of wildlife habitat and blocked wildlife corridors from traditional routes.

The implications of these environmental impacts on local communities include increased poverty, loss of human life, and destruction of human property. Unfortunately, these impacts serve to increase negative community attitude towards environmental conservation.

There is evidence that the Mara River basin has experienced environmental degradation leading to poor water quality and quantity and biodiversity loss (Gereta *et al.* 2003, Dwasi 2002, and Campbell 1993). This degradation limits efforts to reduce poverty, improve health, improve food security, increase economic development, and protect natural resources. There is significant loss of forest cover in the upper catchment and along the Mara River caused by unsustainable expansion in irrigated farming, fast population growth, poor planning of water resource use, and pollution loads (romp farming, urban centers, and tourist facilities). All these factors hinder sustainable conservation of the biodiversity and landscape. Other important contributing factors are weak legislation and institutional framework, lack of environmental education and awareness, and alternative means of livelihood that promote environmental conservation.

All stakeholders should be actively involved in planning and implementation of environmental management activities. There is need for Kenyan and Tanzanian Governments to coordinate existing environmental regulations, policies and all environment-related sectors to be able to address the common challenge of sustainable environment.

6.2 Unique Ecosystems in the Basin

An ecosystem is a dynamic and complex community of flora, fauna, and micro-organisms, interacting with their physical environment including soil, water, climate, and the atmosphere as a functional unit (Briggs *et al.,* 2005). The Mara River basin has a wide array of ecosystems that including forests, wetlands, open savannahs, and woodlands, which are home to a diverse flora and fauna assemblage. These ecosystems and the biodiversity they hold are important environmental and economic resources. However, the basins' ecosystems are currently threatened by multiple adverse human activities that include expanding agricultural activities, deforestation, settlement expansions, and increased tourism facilities.

6.2.1 Forests

6.2.1.1 Upper Catchment Forests

The forests of the Mau Complex when combined cover an area of over 400,000 ha and it is the largest remaining closed canopy forest block in Eastern Africa. It forms upper catchments of all, but one, rivers that drain west of the Rift Valley, including Nzoia, Yala, Nyando, Sondu and Mara, which drain into Lake Victoria. It is also the main catchment of critical lakes and wetlands in the Rift Valley, including lakes Baringo, Nakuru, Naivasha, Natron and Turkana. The forest complex is rich in flora and fauna. Despite their importance, these forests are highly threatened mainly by settlements and logging for charcoal, timber, posts and poles.

Vegetation species richness and structure in this forest complex is typical of a montane forest. The vegetation pattern has broad altitudinal zonation from west to east. Lower montane forests below 2,300 meters give way to bamboo thickets and Arundinaria alpines mixed with forest and grasslands. Characteristic trees include *Aningeria adolfi-friedercii* and *Strombosia scheffleri*. However, this zone has been heavily logged and cleared areas are dominated by pioneer species such as *Tabernaemontana stapfiana*, *Syzygium guineense,* and *Neoboutonia macrocalyx*. Pockets of less disturbed forest hold *Olea capensis*, *Prunus africana*, *Albizia gummifera,* and *Podocarpus latifolium* (Mutangah *et al*., 1992).

The fauna of the forests has been documented well. Notable mammal species include the rare yellow-backed duiker, *Cephalophus silvicultor*, the little known African golden cat, *Felis aurata,* and the sparsely distributed mountain fruit bat, *Stenonycteris lanosus*. Remnant populations of the African elephant, *Loxodonta Africana,* and the giant forest hog, *Hylochloerus meinertzhageni,* are still sighted, while the bongo, *Tragelaphus euryceros,* may have become extinct. Four primate species, the black-and-white colobus monkey, *Colobus guereza,* the blue monkey, *Cercopithecus mitis*, the red-tailed monkey, *C. ascanius* and the potto, *Perodicticus pott,* occur here. The butterfly, *Capys cupreu,* is endemic to the Mau escarpment. There is little information on other fauna (Bennun & Waiyaki 1992; Bagine *et al*., 1992; Davies *et al*, 1992; Mutangah *et al*., 1992). Except for the Masai Mau, forest birds have been studied in detail, with 49 of Kenya's 67 Afrotropical Highland biome species recorded here. In addition, Mau Forests have a rich highland bird community. Avifauna species of regional conservation concern include Ayre's hawk eagle, *Hieraaetus spilogaster*, African crowned eagle, *Stephanoaetus coronatus,* African grass owl, *Tyto capensis,* cape eagle owl, *Bubo capensis,* red-chested owlet, *Glaucidium tephronotum,* least honey guide, *Indicator exilis,* grey-wingled robin, *Sheppardia polioptera* and purple-throated cuckoo-shrike *Campephaga quiscalina*. Regional species such as Hartlaub's turaco, *Tauraco hartlaubi*, the restricted-range Hunter's Cisticola, *Cisticola hunteri* and Jackson's Francolin *Francolinus jacksoni* are also found (Bennun & Njoroge 1999).

As shown in Figure 6.2 and described below, there are four main forest catchment areas for the Mara River that fall into three different protection regimes.

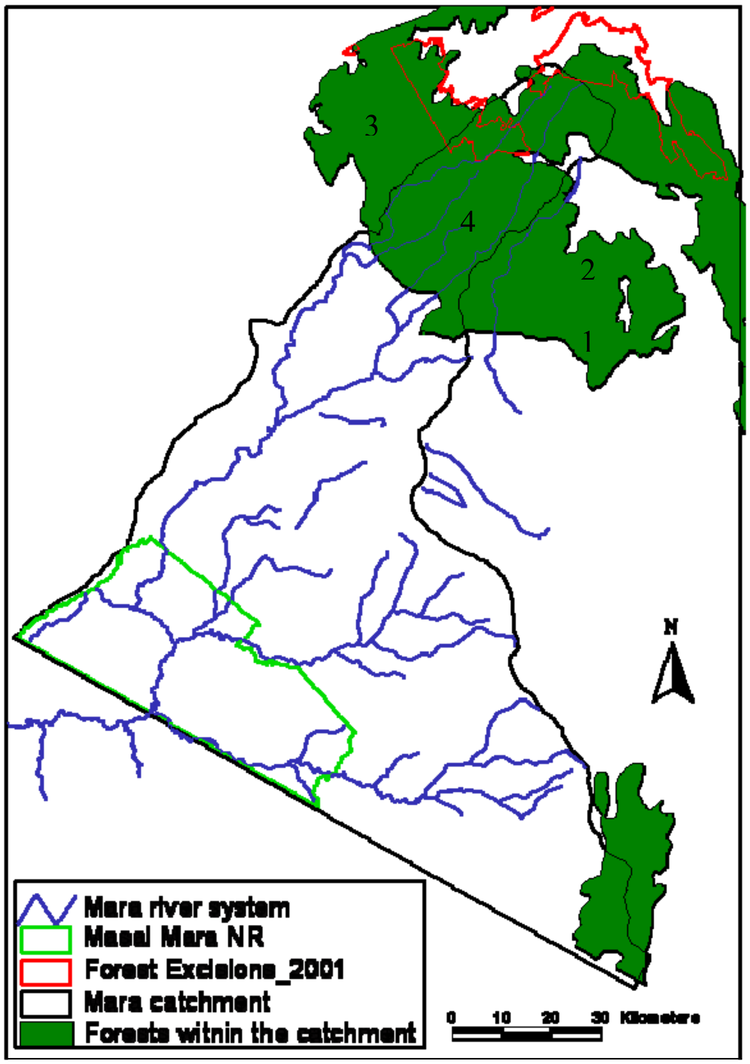


Figure 6.2: Forest Catchment Areas for the Mara River

1. **Maasai Mau Forest:** This is a Trust Land Forest managed by the Narok County Council and covers approximately 45,794 hectares (ha). In the latest Rapid Aerial Assessment Report by KFWG (2008), this forest was found to be under intense pressure from human settlements and Podo tree logging.

2. **Ol Pusimoru Forest Reserve:** This is gazetted forest managed by the Kenya Forest Service (KFS) and originally covered 36,832 ha of which 20,000 ha degazetted were

for settlement and 16,832 ha for undeveloped forest. During the aerial reconnaissance of 2008 by KFWG, the area had increased settlements.

3. **South West Mau Forest Reserve:** This is a gazetted forest reserve managed by KFS and covers about 81,000 ha. A large section of this forest was de-gazetted in 2001 and is almost completely settled. During the 2008 aerial survey increased settlements were noted.

4. **Transmara Forest Reserve:** This is a gazetted forest managed by KFS and covers an area of about 35,270 ha. The 2008 aerial reconnaissance indicated encroachment by forest fires, tea plantations, and limited Podo logging.

6.2.1.2 Lower Catchment Forests

There are six gazetted forests on the lower Mara River Basin in Tanzania, covering an area of about 3,092 ha as summarized in Table 6.2 (URT 2003b). Another 28,555 ha of forests are proposed in Musoma, Tarime, and Serengeti Districts (Table 6.3). These forests are under intense deforestation pressure from the local communities. The inhabitants depend on these forests for firewood and charcoal as their main source of cooking fuel, which seriously encourages tree cutting. In addition, there is widespread logging to acquire building materials, construction of anti-livestock theft “bomas” (figure 6.3), and bush burning to clear forests for agricultural farmland expansion. These forests have minimal fauna due to intense hunting and livestock grazing, and hence, they can be appropriately called “empty forests”.

Table 6.2: Gazetted Forest Reserves in Tanzania within the Mara River Basin

District	Name of Forest Reserve	Hectares	Regime
Musoma	Kyanyari	2,765	Central Government
	Kyarano	175	Central Government
Tarime	Bwiregi	87	District Council
	Nyabasi	17	District Council
	Mogabiri	6	District Council
	Tarime	42	District Council
Total		3,092	

Source: URT, 2003b

Figure 6.3: Wood Harvesting for Theft-Proof Cattle Boma in the Serengeti, Tanzania

Table 6.3: Proposed Forest Reserves in Tanzania within the Mara River Basin

District	Name of Forest Reserve	Hectares	Regime
Musoma	Mukendo	5	District Council
	Musoma Ranges	8,000	District Council
	Bisumwa	200	District Council
	Buruma	50	District Council
District Total		**8,255**	
Serengeti	Rigo	4,000	District Council
	Ring'wani	6,000	District Council
	Machira	800	District Council
District Total		**10,800**	
Tarime	Kiruya	4,000	District Council
	Tarime B	1,000	District Council
	Bwiri	500	District Council
	Rorya	4,000	District Council
District Total		**9,500**	
Total		**28,555**	

Source: URT, 2003b

Forest resources are important for the local communities. Some of the forest products and non-material benefits (as described by district officials, 2008) are indicated below:

- Timber and Poles
- Fuel wood
- Herbal extracts
- Fodder
- Honey
- Vegetables
- Game meat
- Cultural heritage
- Recreation

6.2.2 Main Wetlands

Wetlands can be describes as "areas of land permanently, seasonally or occasionally waterlogged with fresh, saline, brackish or marine waters including both natural and man made areas that support characteristic biota" (GoK, 2002). They are typically areas that are inundated with or saturated by surface or ground water at a frequency and duration sufficient to support vegetation typically adapted to saturated soil conditions.

There are two major wetlands in the Mara River Basin, the Enapuiyapui in Kenya and Masurura swamps in Tanzania. Their difference is their physical location, with the former situated in the upper Mara River catchment and the later at the mouth of the Mara river as it enters Lake Victoria.

6.2.2.1 Enapuiyapui Swamp

The Enapuiyapui Swamp is located in the Kaptunga Forest at the border of Narok North and Molo Districts. The swamp is shared between the Ogiek and Masai communities in the Molo and Narok Districts, respectively. The swamp has declined in size over the last three decades by 70% to the current size of about 15 ha. There are four streams emanating from the swamp, two of which flow westwards joining to form the Amala River which eventually joins the Mara River. The other two outlets flow eastwards and join the Njoro River. However, apart from the broad catchment area, the swamp has no inlet rivers or streams. According to the local forest department office, 5.3 ha of the swamp contain water throughout the year, although the water levels fall during dry seasons. The most important indigenous tree species in the forest around the swamp used to be the Cedar species which are now depleted. According to Okeyo-Owuor (2007), except for color changes and increased siltation in the swamp, the water is still fresh and poses no threat to aquatic organisms, wild animals, and livestock that use it frequently.

Biodiversity

The floral components found around the swamp include over forty key plant species such as *Olea Africana, Junipera procera*, *Ficus capensis*, *Hagenia abyssinica*, *Rapnus prinoides*, *Schefflera volkensis*, *Dombeya quitsinii*, and *Pinus patula*. The most important indigenous tree species in the forest around the swamp are *Fagala macrophyila, Croton macrostachyns, Croton miglocripus, Aningeeria adlfi-troedeoo, Podo species, Albizia gumasifeza, Polysias* *kiknyuensis, Hagemia abyssinica,* and *Syzygium guineense*. Lower plant species common in the swamp are water lily, *Typha* spp, star grass, moss, ferns, and sedges such as *Pycraeus nitidus*.

The fauna within the swamp includes more than six species of mammals, notable among which are the bush buck, *Tragelaphus scriptus,* common duikers, *Sylvicapra grimmia, black* and white colobus monkey, *Colobus guereza,* and tree hyrax *Dendrohyrax dorsalis*; and more than six species of birds including the crown bird, *Grus pavonina,* Houtoub turocos, *Tauraco hartlaub,i* grey heron, *Ardea cinerea,* Houga bassard, *Buteo augur,* Adada ibis, *Bostrychia hagedash* and stilt *Himantopus himantopus* . Numerous arthropods dot the swamp with most conspicuous among them being grasshoppers, honey bees, crickets, termites, tsetse flies, butterflies and moths. The swamp waters have a total of 606 benthic macro-invertebrate fauna from 12 taxa (Okeyo-Owuor, 2007). The main swamp reptiles are snakes and frogs. In addition, other seasonal wildlife visit the swamp at different times for grazing or watering including buffalos, *Syncerus caffer,* antelopes, African hare, *Lepus microtis*, hyenas, *Crocuta crocuta*, and leopards, *Panthera pardus*.

The ecological and biodiversity status of Enapuiyiapui Swamp has changed considerably over the last 30 to 50 years. For instance, the local community estimates that the swamp size has declined from the previous 50 to the current 15 ha (Okeyo-Owuor, 2007). The vegetation cover of the Kaptunga Forest, which forms the immediate catchment of this swamp, has declined by a factor of 80% over the last 30 years (Okeyo-Owuor, 2007). This decline may have led to the decrease in wetland biodiversity. In both the Ol Pusimoro and Kiptunga forests that encase the swamp, bamboo forests and valuable shrubs have been destroyed over the years and indigenous forest vegetation has been replaced with plantations including exotic vegetation of *Punus patula, Americana spp,* and *Eucalyptus spp*. These exotic species (especially the pines and the water thirsty eucalyptus) have adversely affected the regeneration of other indigenous, slow growing tree species and their undergrowth biodiversity. Furthermore, both licensed and unlicensed saw millers harvest mature exotics and indigenous trees. Arguably, such activities generate income to both government and loggers, but do not benefit the indigenous Ogieks and Masai communities. In recent times, the swamp water level recedes in the dry seasons and large parts dry up leaving only isolated bogs in the river channel. At these dry times the water color is grayish, highly silted, and used largely for watering livestock (Okeyo-Owuor, 2007).

Ecological and Socio-economic Functions

The swamp has diverse functions and values ranging from material (products) to non-material (services). These can be categorized as follows:

Ecological functions or services

- Water purification through nutrient and toxin retention;
- Biodiversity conservation;
- Sediment trapping;
- Groundwater recharge; and
- Erosion prevention.

Social services

- Providing water for households, livestock, and wildlife;
- Grazing ground during the dry spells;
- Source of herbs and the giant coreid bug which are traditionally used in enhancing courtship and maturity among Morans and young girls;

Economic services and products

- Income generated from the sale of honey, artifacts, wild fruits, and vegetables;
- Sources of raw materials or natural products for community use or trade, including *herbal* medicine (e.g., *Rapnus prinoides* and *Clematis hisurta* used to treat malaria and flu, respectively), thatching grass, and building poles.

Threats to Wetland Sustainability

The on going forest destruction resulting from expanded farmlands around the swamp have caused severe biodiversity loss, declining water quality, and reduced water levels. Over the last three decades, 70% of the wetland was converted into agricultural fields and the present swamp occupies only 15 ha (Owuor, 2007).

Degradation of the wetland caused by oil spills from heavy machinery used for logging and farming may cause heavy metal pollution in the swamp. Although fecal coliform counts are negative in the swamp, a downstream outlet which connects the swamp with the Amala River shows positive fecal coliform values (Okeyo-Owuor, 2007), and with increased human population and degradation in the forest catchment, the swamp ecological function for water purification is compromised.

Other constraints to sustainable utilization of the wetland include:

- Unpredictable and increasingly longer dry seasons;
- Inadequate sensitization of stakeholders;
- Limited awareness about sustainable management of wetland resources;
- Limited alternative livelihood activities for the poor;
- Lack of wetlands ownership since they are held in trust by the government and are therefore considered common property;
- Political interference in the enforcement of management of trust lands.

6.2.2.2 Masurura Swamp

The Masurura Swamp is an extensive wetland that lies within the floodplain of the Mara River before emptying into Lake Victoria at the Mara Bay. The swamp is surrounded by 17 villages in the three districts of Musoma, Tarime, and Serengeti (Munishi, 2004). The swamp is about 59 km^2 (Chitamwebwa, 2007) and is bordered by three districts of Musoma, Tarime, and Serengeti and surrounded by 17 villages. A number of activities conducted by the local communities adjacent to the swamp are socio economically important but some may have negative impacts on the swamp and its biological resources. Main activities based on utilization of the swamp include fishing, harvesting the typha plant, livestock grazing and dry season agriculture. According to the communities adjacent to the swamp, livestock grazing ranks the first most important socio economic activity followed by farming, fishing and harvesting of other wetland products (Munishi, 2004).

However, Munishi (2004) and Yanda & Majule (2004) report high cultivation pressure on the swamp edge associated with crop production during the dry season and may lead to land degradation and hence soil erosion with subsequent water pollution in the swamp. Fertilizers, herbicides, insecticides and fungicides from agricultural activities end up into the swamp, which may modify the hydrology of the swamp with negative impacts on the existing biodiversity. Grazing pressure has greatly increased in the swamp as a result of increased livestock numbers, resulting to soil degradation and erosion that has further increased sedimentation and modified microhabitat in the swamp and especially affect the spawn fish. In addition, over fishing in the swamp has been reported and is driven by market demand while reported use of chemicals in fishing will eventually have negative impacts on fish biodiversity (Munishi, 2004).

Biodiversity

The major floral diversity includes *Cyperus papyrus* and *Typha domingensis*. Other plants in different microhabitats include sedges, such as *Pycreus elegantus, Scirpus confusers* and *Ludwiga abyssinica.* Water hyacinth is also present. On the edge of the swamp, where the swamp grades into terrestrial conditions, several plant species occur such as *Acacia xanthopholea, A. drepanolobium, A. tortilis, A. albida,* and *A. brevispica*. Other common species are *Solanum incanum, Cisus spp, Cynodondactylon, Lantana Camara, Ipomea spp, Achiranthes aspera, Ocimum suave, Tagetus minuta, Bidens pilosa, Ricinus communis, Schlerocarya birea spp cafra, Limpestrumlipens, Acacia tortilis, Leonitis spp, Grewia bicolar, Euphorbia cabndellubrum and Aloe spp.* On the adjoining farm lands, several species of *Sena spectabilis, Grevillea robusta and Psidium guajava* dominate. Grasses such as *Themeda triandra* is also present (Munishi, 2004).

The swamp fauna include different types of fish, mammals, amphibians, reptiles, birds, and a variety of insects. About 14 fish species are known to exist at different abundances. Some of these fish species are of socio-economic importance to the local communities, and they include *Claris spp,* African lung fish, Nile Tilapia *Oreochromis nilotica,* Nile Perch *Lates nilotica*, *Cynodontis afrofishery,* and *Clarius aluwardi*. About 32 wildlife species are reported to inhabit the swamp at different periods of the year including the common hippopotamus *Hippopotamus amphibious,* Nile crocodile *Crocodilus niloticus,* Sitatunga *Tragelaphus spekii*, olive baboon *Papio anubis,* and vervet monkey *Cercopithecus aethiops*. Others include the warthog *Pharcochaerus aethopicus*, spotted hyena *Crocuta crocuta,* spotted neck otter *Lutra mauricollis,* and waterbuck *Kobus ellipsiprymus*. While not all of these species are strict wetland residents, the wetland has a connection with their existence during different seasons for food, water or shelter, especially during the dry season. A total of 33 waterfowl bird species in 13 families have been recorded, of which 27% are migrants (9% northern migrants, 6% African migrants, and 12% both African and northern migrants). An additional 72 terrestrial bird species in 28 families have also been recorded, among which 5 species are crop pests (Munishi, 2007).

Ecological and Socio-economic Factors

The Masurura Swamp is an important fish breeding site for Lake Victoria. After spawning, fish use this wetland as nursery grounds where young fish grow away from predators and are protected by wetland vegetation (Chitamwebwa, 2007; Munishi, 2007). Other functions include:

Ecological services

- Microclimate regulation;
- Recreation;
- Shore stabilization;
- Biodiversity conservation;
- Nutrient retention;
- Flood control;
- Water purification through sediment trapping.

Social services and goods

- Cultural and aesthetic values;
- Provision of water for livestock, households, and wildlife use;
- Livestock and wildlife grazing;
- Fishing.

Economic services and goods

- Income from the sale of fish and other products;
- The swamp is a main source of raw materials for artifacts and other products like *Cyperus papyrus* used for mats, *Typha spp* used for house thatching/roofing, herbal medicines, and firewood. .

Threats to Swamp Sustainability

Agricultural and livestock grazing around the swamp have contributed to pollution and soil erosion that impair the wetland functions. Vegetable farming on the edges of the swamp as well as other intensive agricultural activities in the basin make use of agrochemicals (herbicides, insecticides, fungicides, and fertilizers) which end up into the swamp and resulting to eutrophication. Mining wastes from upstream areas will cause further decline in swamp biodiversity values if not checked.

There is evidence that crop and vegetable cultivation of the swamp banks is expanding, especially during dry seasons to enhance output (Yanda & Majule, 2004). Furthermore, the swamp attracts large herds of livestock during the dry season which overgraze extensive adjacent areas and degrade the soil causing bank erosion. As a result, sensitive fish species (such as tilapia, lung fish, catfish, and Nile perch) are threatened due to high sedimentation of their nesting sites. In addition, the swamp receives heavy silt and pollution loads from the Mara River that further affect fish spawning and threatens its biodiversity (Yanda & Majule, 2004; Minishi, 2007).

Fishing is ranked the third most important socio-economic activity adjacent to the swamp with 80% of the population being fishermen. Fishing is carried out both for subsistence and commercial purposes. Ready fish markets have caused over fishing which threatens available resources (Yanda & Majule, 2004; Minishi, 2007). As mentioned above, use of chemicals has intensified and might be detrimental to various fish species. There has also been unsustainable exploitation of raw materials for different wetland related products such as mats and wildlife hunting (e.g. Sitatunga, hippos, wild pig, and warthog). Lastly, deforestation for construction purposes, firewood, and illegal charcoal burning also threaten the environment and the ecology of the Masurura swamp.

Other constraints to sustainable wetlands utilization:

- Encroachment due to population growth;
- Unpredictable and increasingly longer dry seasons;
- Limited awareness about sustainable management of wetland resources;
- Inadequate sensitization of stakeholders;
- Limited alternative livelihood activities for the poor;
- Lack of wetlands' ownership since they are held in trust by the government and are therefore considered common property;
- Inadequate legal provisions and constraints imposed by the land tenure systems.

6.2.3 Savannahs and Open Woodlands

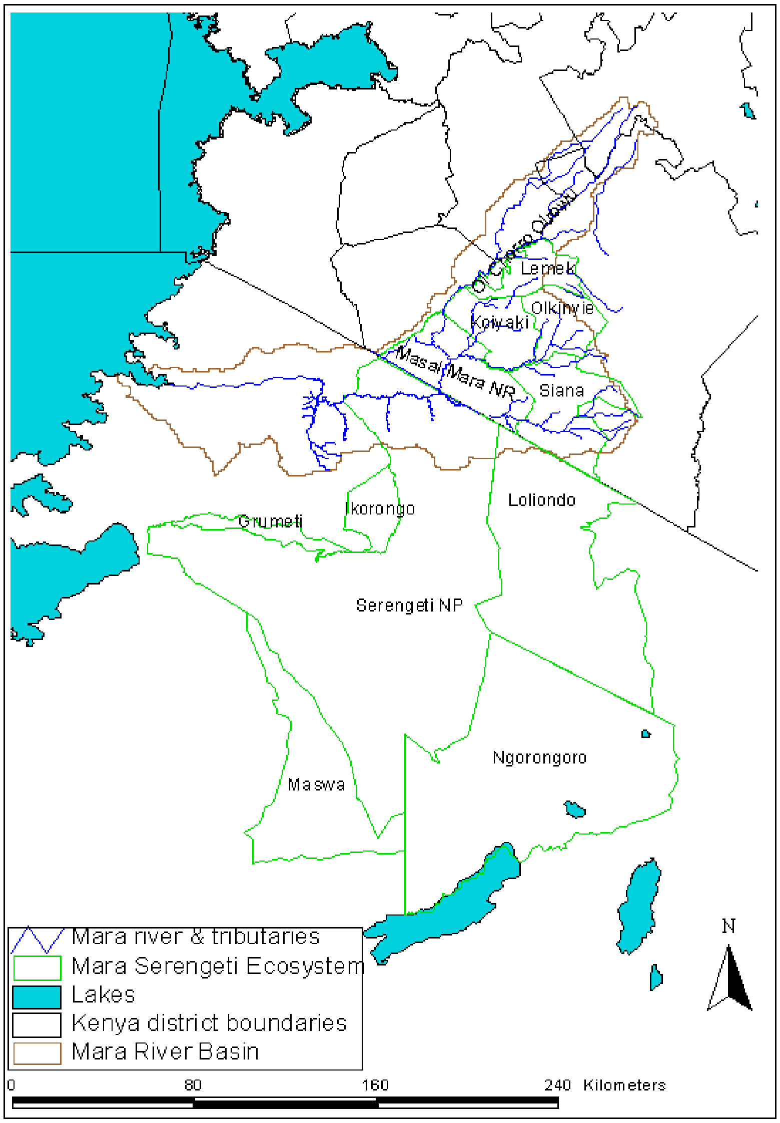
The savannahs, grasslands, and open woodlands cover about 39 % of the basin and include the protected areas of the Serengeti National Park (northern zone of Tanzania) and Masai Mara National Reserve (Kenya). The pastoral group ranches in Kenya form part of this ecosystem and are important dry season dispersal areas. The entire Serengeti Mara Ecosystem covers an area of about 25,000 km^2, defined by the migratory wildebeests.

Common grass species here interspersed with other grasses and shrubs include the red oat grass, *Themeda triandra*, favored by grazers in its early growth stages. The grassland supports an enormous mass and diversity of grazing herbivores. Each herbivore has a unique feeding strategy, which brings about grazing succession. Acacia woodlands are dominated by *Acacia brevispica*, *A. drepanalopium* and *A. xanthophlea*. The riverine forests are mainly along the Mara River system and its tributaries. The forests are home to a wide variety of mammals and birds, quite different from the savannah species. The riverine forests are vulnerable to fires and destruction by elephants.

6.2.3.1 Masai Mara

The Masai Mara area is comprised of the Masai Mara National Reserve and the adjoining pastoral group ranches (Figure 6.4). The Reserve was established in 1961. The national reserve extends over an area of 1,523 km^2 and is a formal conservation estate where land use is restricted to wildlife and tourism. The pastoral group ranches are privately owned lands where the main activity has been livestock herding. The ecosystem here is a tapestry of grassy savannah, shrub land, and riverine forest. The area is drained primarily by seasonal watercourses, with the Mara River being the only permanent river. The Talek, Sand, and Olare-Orok Rivers, the main tributaries of the Mara River, are largely seasonal. The Mara River receives an annual rainfall of about 600 mm in the southeastern parts, rising up to 1200 mm at the northwestern edge (Norton-Griffiths *et al.*, 1975). The Masai Mara forms an important dry season habitat for migratory herbivores.

Figure 6.4: A Map of the Serengeti-Mara Ecosystem



About 65 large mammals and over 50 bird species have been recorded from the Masai Mara Reserve and pastoral group ranches. However, over the last 4 decades, herbivore populations declined by about 70%, with non-migratory herbivores declining by about 58%. The decline ranged from 49% in small brown antelopes to 72% in medium brown antelopes (Ottichilo, 2000; Cheruiyot, 2007). Over the same period, the population sizes of the elephant and ostrich remained constant, while that of the hippopotamus increased by over 400% (Kanga *et al.,* in prep). There is direct correlation between the wildlife population decline and the expansion of agriculture and settlements into prime wildlife rangelands.

6.2.3.2 Serengeti

The Serengeti National Park (SNP) was first established as a reserve in 1929 and later as a park in 1940, covering an area of about 14,763 km^2, nearly 10 times larger than the Masai Mara National Reserve. With a biome of tropical and subtropical grasslands, savannahs and shrub lands, the park forms a major component of the Serengeti Ecosystem (WWF, 2001), protecting about 50% of the entire ecosystem. Other ecosystem portions in Tanzania are the Ngorongoro Conservation Area, Muswa Game Reserve, Grumeti Game Reserve, Ikorongo Game Reserve and the Loliondo Game Control Area (Figure 6.4). A significant portion of the northwestern and western boundary of the Serengeti NP directly border growing human populations of farming and herding communities. These “hard edge” areas are negatively impacting the ecosystem. The Serengeti is drained by the Mbalange, Gurumeti, and Mara Rivers all flowing westwards to Lake Victoria, but the Mara River is the only permanent river and drains only the far north of the Serengeti. Climatically, the area experiences maximum temperatures between 24-27 ^{0}C and minimums of 15-21 ^{0}C with mean annual rainfall ranging from 1,050 mm in the northwest to 550 mm in the southeast (Sinclair et al., 2000, Sinclair & Arcease, 1995). The long rains peak between March and May.

6.3 Wildlife Dynamics

6.3.1 Regional Perspective

Wildlife populations are increasingly subjected to negative pressures by human population growth and encroachment. The long-term preservation of many wildlife species will depend on the management of protected areas, which requires a sound understanding of ecological factors and interdependencies.

The Serengeti-Mara Ecosystem (Figure 6.4), an area of about 25,000 km^2 straddling the Kenya and Tanzania border (34° to 36° E, 1° to 3°30' S), is defined by movement of the migratory wildebeest *Connochaetes taurinus*. The eastern boundary is formed by the Crater Highlands and the Rift Valley. The "western corridor" stretches west almost to Speke Gulf of Lake Victoria. The remaining western boundary is formed by dense cultivation. The northern boundary is formed by the Isuria escarpment and the Loita plains in Kenya. The southern and southwestern boundary runs along an area of rocks and dense woodland. The ecosystem covers several different conservation and administrations areas. In Tanzania, these areas include the Serengeti National Park (14,763 km^2), Ngorongoro Conservation Area (8,288 km^2), Maswa Game Reserve (2,200 km^2), and Grumeti, Ikorongo, and Loliondo Game Controlled Areas. In Kenya, the ecosystem areas include the Masai Mara National Reserve (1,523 km^2) and adjoining Community Group Ranches (4,000 km^2) in Kenya. Although the ecosystem may be large enough to ensure sustainable conservation of biodiversity in general, the increasing human settlement and agricultural development just adjacent its protected areas may have adverse impacts.

The ecosystem has three distinct types of land use: (1) the formal protected conservation areas of the Serengeti National Park, Masai Mara National Reserve, and Maswa Game Reserve; (2) the multiple land use area of the Ngorongoro Conservation Area, in which the interests of both wildlife and pastoral Masai are of equal importance; and (3) the extensive pastoral rangeland and agricultural areas in Masai Mara, in which the interests of the landowners and/or land users are paramount. Wildlife, both resident and migratory, is found on all of this land. The migratory wildlife is of specific concern and is the focus of national, regional, and international conservation efforts.

The main features of the Serengeti-Mara Ecosystem include the varied land use types, diverse habitats ranging from savannah grasslands and woodland to riverine vegetation, and swamps with *Acacia* woodlands dominating the area with extensive grass plains, and high biological diversity (over 1000 plant, 500 bird, and 25 large mammal and reptile species). However, little is known about the diversity of the ecosystem's smaller flora and fauna.

Wildlife population dynamics are driven by changing climatic and environmental conditions, trophic interactions, and anthropogenic influences. Rainfall influences population dynamics through vegetation growth and surface water availability. Rainfall also influences ungulate population dynamics. Human population growth and land transformations influence ungulate populations through the destruction and loss of their natural habitats. The long-term viability of wildlife populations in the Serengeti-Mara Ecosystem, where landscapes are shared by wildlife, humans, and livestock is threatened by land transformations due to 1) rapid human population growth; 2) rapid demographic, socio-cultural, economic, political, and institutional changes; 3) expansion of settlements and agriculture; and 4) transition from semi-nomadic pastoralism to a sedentary lifestyle and from communal to private and corporate land tenure. These transformations are concurrent with habitat alteration, declining woodland cover, increasing competition between wildlife and livestock, harassment and displacement of wildlife, and illegal harvesting resulting in marked declines in wildlife numbers.

The Serengeti-Mar Ecosystem is famous for harboring internationally important species, supporting the largest herds of migrating ungulates, and supporting one of the highest concentrations of large predators in the world. Estimates put the migrating ungulates at 1.2 million wildebeests, 200,000 plain Zebra, *Equus burchelli,* and 400,000 Thomson's gazelles, *Gazella thomsoni*. The migration is characteristically seasonal and primarily dependents on rainfall variability and spatial distribution. There are numerous herds of topi, *Damaliscus korrigum*, eland, *Taurotragus oryx*, kongoni, A*lcelaphus buselaphus*, and giraffe, *Giraffa camelopardalis*. Flocks of impala, *Aepyceros melampus*, are found in patch bushes while Grant's gazelles, *Gazelle granti*, congregate with Thomson's gazelles on the plains or in their own small groups. Large herds of elephants, *Loxodonta africana*, some hundreds strong, keep close in the riverine forests but spread out over the ecosystem during the rains. The hilly grounds are favorite sites for klipspringer, *Oreotragus oreotragus*. The oribi, *Ourebia ourebia*, and chanler's reed buck, *Redunca fulvorufula*, are rare. The plains have several large herds of buffalo, *Syncerus caffer*, while waterbuck, *Kobus defassa*, are seen in groups of 6 to 20 almost anywhere within a mile of water. Warthogs, *Phacochoerus aethiopicus*, are numerous. Ostriches, *Struthio camelus*, may be found as single birds or in groups.

Hyenas are the most numerous of the large carnivores at about 7,500, followed by lions, *Pantera leo* at about 2,500. The Cheetahs, *Acinonyx jubatus* have drastically declined in numbers with the Mara holding only 45 individuals. Bat-eared foxes, *Otocyon megalotis*, are rare while the three species of jackal, *Canis*, are well represented. Schools of hippopotamus, *Hippopotamus amphibious*, are numerous along the river drainage systems, and crocodiles, *Crocodile nilotica*, are common basking along the rivers. Spotted neck otters, *Lutra maulicollis*, are seen towards the flood plain. Olive baboons, *Papio anubis*, and vervet monkeys, *Cercopithecus aethiops*, are the most common primates.

The population of the endangered black rhinocerous, *Deceros biconis*, has steadily declined. The greater kudu, *Strepsiceros strepsiceros*, and roan antelope, *Hippotragus equines*, have completely disappeared from the Masai Mara area but some may still be found on the Serengeti side. The wild dogs, *Lycaon pictus lupinus*, have been wiped from the Mara except for one pack commonly sited in the Loita Forest while sporadic sighting on the Serengeti side have been from the Gol Mountain area. The small mammalian fauna of rats, *Thyronomys, Pelomys,* striped mice, squirrels, *Paraxerus*, rock hyrax, *Heterohyrax brucei*, and shrews, *Crocidura*, are present. A list of the medium and large mammals present in the ecosystem is given in Appendix 6A.

The ecosystem has a diverse avifauna that includes 12 species of *Cisticola* and 53 birds of prey. Grassland birds are well represented while large numbers of palearctic migrants winter in the area, including the Caspian plovers, *Charadrius asiaticus* and white storks, *Ciconia ciconia*. Unusual birds include the rock cisticola, *Cisticola aberrans,* rufous-bellied heron, *Ardeola rufiventris,* Denham's bustard, *Neotis denhami,* black coucal, *Centropus grillii,* pale wren warbler, *Calamonastes undosus*, Tabora cisticola, *Cisticola angusticauda,* Icterine warbler, *Hippolais icterina,* green-capped eremomela, *Eremomela scotops* and magpie shrike, *Urolestes melanoleucus*. The grasslands are the strongholds of the threatened migratory corncrake, *Crex crex* and the near-threatened, restricted-range Jackson's widowbird, *Euplectes jacksoni*. The woodlands hold the threatened, restricted-range gray-crested helmet-shrike, *Prionops poliolophus*. The riverine forests provide a habitat for a sharply defined group of birds such as the turacaos, *Corythaeola,* trogons, *Trogon violaceus,* and bulbuls, *Pycnonotous*.

6.3.2 Endangered and Threatened species

The Serengeti-Mara Ecosystem has several threatened wildlife species listed on the International Union for Conservation of Nature (IUCN) red list database (http://www.redlist.org) and as shown in Table 6.4. This number may increase especially if small mammals and invertebrates are further studied.

Table 6.4: Threatened species of the Serengeti-Mara Ecosystem

Species	IUCN Threat Category	Site
Black Rhinoceros, *Diceros Bicornis*	CR	MM/SNP
Wild Dog, *Lyacon pictus*	EN	Loita Forest (MM)/SNP
Madagascar Pond-heron *Ardeola idea*	EN	MM/SNP
Lion, *Panthera leo*	VU	MM/SNP
African Elephant, *Loxodonta Africana*	VU	MM/SNP
Cheetah, *Acinonyx jubatus*	VU	MM/SNP
Common Hippopotamus, *Hippopotamus amphibious*	VU	MM/SNP
Lesser Kesrel, *Falconaumanni*	VU	MM/SNP
White-headed Vulture, *Trigonocaps accipitalis*	VU	MM
Karamoja Apalis, *Apalis karamojae*	VU	SNP
Blue Swallow, *Hirundo atrocaerulea*	VU	SNP
Lesser Flamingo, *Phoenicopterus minor*	NT	SNP
Pallid Harrier, *Circus macrourus*	NT	SNP
Great Snipe, *Gallinago media*	NT	SNP
Jackson's Widowbird, *Euplectes jacksoni*	NT	MM
Grey-crested Helmet-shrike, *Prionops poliolophus*	NT	MM/SNP
Corncrake, *Crex crex*	NT	MM
White Rhino, *Ceratotherium simum simum*	NT	MM
Leopard, *Panthera pardus*	LC	MM/SNP

MM: Masai Mara; **SNP:** Serengeti National Park

The categories of the listed threatened and endangered species are defined as follows (IUCN):

Extinct (EX): A taxon is extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitats, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Extinct in the Wild (EW): A taxon is extinct in the wild when it is known only to survive in cultivation, captivity, or as a naturalized population outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitats, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR): A taxon is critically endangered for an observed, estimated, inferred, or suspected population size reduction of ≥ 90% over the last 10 years or three generations, whichever is longer, where the causes of reduction are clearly reversible AND understood (see www.iucnredlist.org, Section V on threat categories). Under these conditions a taxon faces an extremely high risk of extinction in the wild.

Endangered (EN): A taxon is endangered for an observed, estimated, inferred, or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is longer, where the reduction or its causes may not have ceased, OR may not be understood, OR may not be reversible (see www.iucnredlist.org, Section V on threat categories.). Under these conditions, a taxon faces a very high risk of extinction in the wild.

Vulnerable (VU): A taxon is vulnerable for an observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations, whichever is longer, where the reduction or its causes may not have ceased, OR may not be understood, OR may not be reversible (see www.iucnredlist.org, Section V on threat categories). Under these conditions, the taxon faces a high risk of extinction in the wild.

Near Threatened (NT): A taxon is near threatened when it has been evaluated against the criteria but does not qualify for critically endangered, endangered, or vulnerable now, but it is close to qualifying or it is likely to qualify for a threatened category in the near future.

Least Concern (LC): A taxon is least concern when it has been evaluated against the criteria and does not qualify as critically endangered, endangered, vulnerable, or near threatened. Widespread and abundant taxa are included in this category.

6.3.3 Population Status of Selected Wildlife Species

The Serengeti-Mara ecosystem has been monitored using aerial surveys since 1957 and estimates of migratory wildebeest and zebra populations are available since that time. Other large herbivores have also been monitored, and the first full elephant census was carried out in 1961 using the Total Count (TC) technique, and in 1971 it was expanded to include buffalos. However, it was not until the 1980s that regular and comprehensive survey programs using both TC and Systematic Reconnaissance Flight (SRF) techniques were adopted. The available wildlife time series data from the 1980s are summarized in Tables 6.5 and 6.6.

Both the total aerial counts and the Systematic Reconnaissance Flight (SRF) techniques (Norton Griffins, 1978), are have consistently been used in the ecosystem to count wildlife numbers. Both methods make use of a fixed wing aircrafts along defined transect lines. The pilots recorded the beginning and end points of each transect using Global Positioning System (GPS) and flight lines drawn on maps with coordinates written out for pilots to follow and use GPS for navigation and marking waypoints of species counted. Flights are maintained at an average height of about 350 feet above the ground.

Total Count: Covers the entire sampling area and is conducted along 1km interval transects that follow East-West or North-South orientation. The sampling crew is composed of a pilot, front seat observer (FSO) and two rear seat observers (RSO). Each RSO observe a strip of 500 meters on either side of the aircraft. A GPS is used to navigate and well as storing wildlife count waypoints. All crew members spot, identify, and count all target wildlife along the 1 km strip. When a herd is too large, the pilot circle above it to enable observers to get an accurate count.

SRF Count: The sampling area is systematically searched along transects spaced 5 km or 10 km apart. The total area searched is usually between 3-10% of the total area surveyed. Each transect is divided into Sub- units defined by thirty-second flying time, which is approximately 1.8 km long on the ground. At the beginning of each Sub- unit the front seat observer (FSO) announced the change of sub- unit and records the radar altimeter to the nearest 10ft. Rear seat observers (RSO) records onto cassette recorders the sub–unit identification with all counts of large mammals, birds and human activities sighted within each of the sub–units. These recordings are transcribed onto data sheets after each flight.

Laboratory Work: Census data are entered in computers and analyzed using various techniques developed for each method. For SRF, wildlife population estimates are calculated using Jolly's Method of 2 unequal sized units (Jolly 1969). The species distribution maps are created using appropriate software.

6.3.3.1 Masai Mara

Aerial wildlife counts in the Masai Mara have been carried out by the Kenya Wildlife Service (KWS) since 1984 targeting the larger herbivores (elephant, buffalo, elands, and giraffe). Other species (i.e., wildebeest, zebra, warthog, Grant's gazelle, Thomson's gazelle, hartebeest, hippo, water buck, topi, rhino, and ostrich) have only been incorporated into these counts from 2007 (Table 6.4). Other organizations that have also been involved in wildlife counts in the Mara include the Department of Resource Survey and Remote Sensing (DRSRS), WWF and International Livestock Research Institute (ILRI). The elephant population has shown to be stable over the survey period. A steady buffalo population was recorded between 1984 and 1992 but a massive population decline of 50% ensued in 1996. The overall buffalo population has since been recovering but is affected by the sporadic long dry seasons and seems to be declining in the pastoral areas. Giraffe and eland seem to be dominant in the dispersal areas, probably due to the availability of scrublands.

Table 6.5: Wildlife population estimates for key wildlife species in the Masai Mara, 1984 – 2007

Year/Institution	**1984**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2005**	**2006**	**2007**	**84/07**
Species	**No. Counted**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**Trend**
Buffalo	13988	12895	3220	2555	1885	2472	3079	3172	2557	2607	3480	4247	3264	3302	Decline
Eland									1182	432	576	538	735	1194	Stable
Elephant	1029	1621	1487	1551	1232	1492	1537	1487	1889	1791	2116	1696	1701	1558	Stable
Giraffe	- -	- -	- -	- -	- -	- -	- -	1256	540	509	789	725	532	568	Decline
Grant's Gazelle	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1080	?
Hartebeest/Kongoni	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	523	?
Hippos	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1205	Increase
Waterbuck	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	122	?
Warthog	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	298	?
Wildebeest	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	131053	Decline
Zebra	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	34114	Decline
Thomson's Gazelle	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7064	?
Topi	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	2915	?
Hyena	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	34	?
Impala	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	4431	?
Jackal	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	5	?
Leopard	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1	?
Lion	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	94	Decline
Ostrich	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	238	?
Rhino	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	10	Decline
Baboons	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	18	?

Note: Kenya Wildlife Service (KWS) has been conducting total aerial census of larger herbivores in the Masai Mara since 1984, but has adopted a count of *all* large wildlife only since 2007 (Kuloba *et al*., 2007).

6.3.3.2 Serengeti

Wildlife population trends in the surveyed area of the Serengeti are presented in Table 6.5 for 15 species. Most of the species show stable trends compared to the most recent census and buffalo have increased; however, Grant's gazelle, giraffe, kongoni/hartebeest, and wildebeest had significant declines.

Table 6.6: Wildlife population estimates for key species in the Serengeti, 1991 – 2006

Year	**1996**	**2001**	**2003**	**2006**	**2003/06**
Species	**Estimate**	**Estimate**	**Estimate**	**Estimate**	***Trend***
Buffalo**	61,905	67,025	104,087	133,475	*Increase*
Eland	11,736	20,015	15,912	17,965	*Stable*
Elephant**	5,603	8,954	10,900	10,710	*Stable*
Grant's Gazelle	126,419	47,182	55,109	35,552	*Decrease*
Giraffe	6,166	14,228	10,552	5,248	*Decrease*
Hippo**	963	1,251	3,542	1,974	*Stable*
Impala	70,651	92,628	91,490	72,191	*Stable*
Kongoni/Hartebeest	11,122	15,405	16,184	7,206	*Decrease*
Reedbuck	324	365	348	279	*Stable*
Thomson's Gazelle	229,887	119,759	175,548	241,417	*Stable*
Topi	49,959	46,333	39,333	35,059	*Stable*
Waterbuck	1,559	3,532	1,196	1,085	*Stable*
Warthog	4,943	2,637	3,769	3,372	*Stable*
Wildebeest##	135,282	6,668	57,425	34,286	*Decrease*
Zebra	150,834	166,303	185,434	161,049	*Stable*

Source: TAWIRI, 2006

** These populations are better estimated from the results of the total counts.
Refers to resident wildebeest only. Migratory wildebeest are better estimated from the results of the areal point surveys.

6.3.3.3 Trends and Spatial Distribution of Elephants

Serengeti

Systematic Reconnaissance Flights are not reliable at estimating elephant numbers. Populations of elephants are better estimated using Total Counts (TAWIRI, 2007). The estimated population of elephant in the Serengeti ecosystem from the SRF in 2006 is 10,900 ± 1285 (Table 6.5).The SRF appear to be overestimating the population of elephant when compared to the 2,617 elephant counted in the May 2003 total count (TAWIRI, 2007). Most elephants are confined in the wooded northwestern part of the ecosystem and in Maswa (Fig. 6.5). High densities are in the northern parts of SNP. The majority of elephants in this SRF census were in SNP (50%), Maswa Game Reserve (27%), and about 22% were found outside protected area (PA) boundaries.

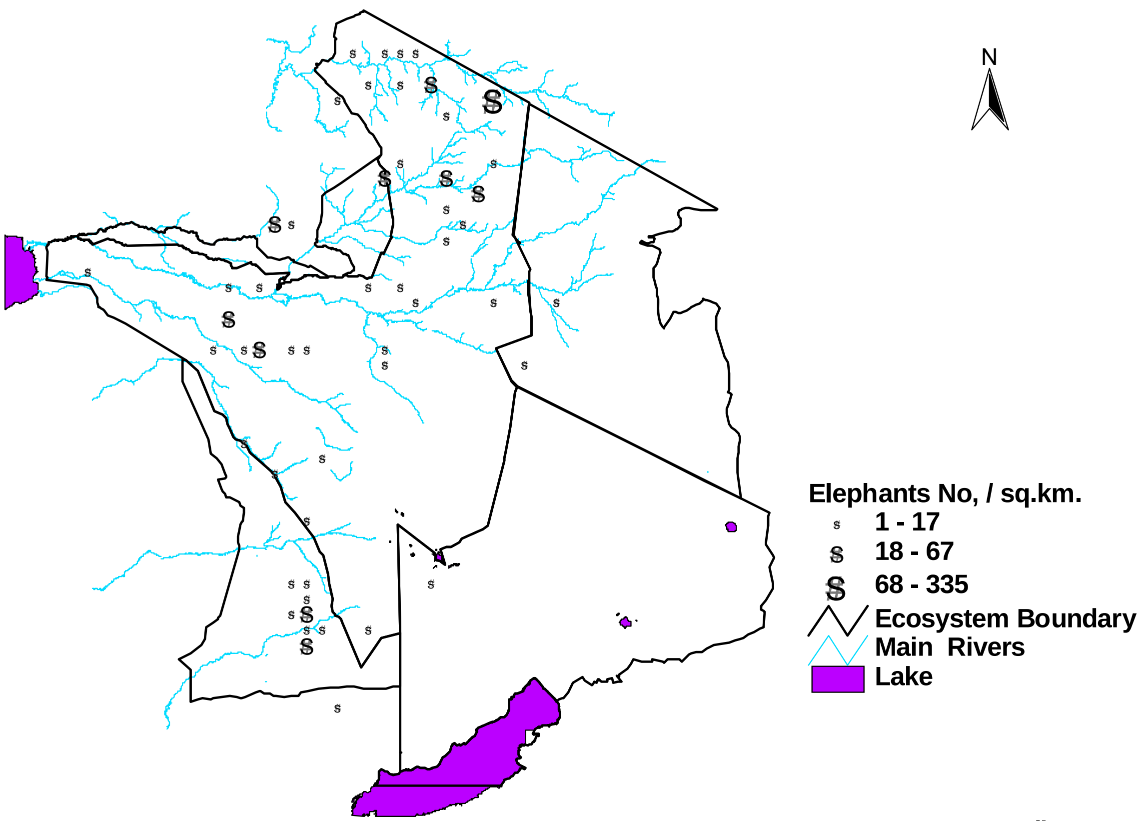


Figure 6.5: Density and Distribution of Elephant in the Serengeti Ecosystem, April 2006 (*Source:* TAWIRI, 2007)

Masai Mara

Elephants are dispersed throughout the area, although several concentrations were identified along the river valleys (Mara, Talek, and Sand River), Siana hills shrublands, and Lemek forest (Fig. 6.6). On average, the elephant population in Masai Mara doubled over the last 20 years, from 1,029 in 1984 to 2,072 in 2007. The dispersal areas have had a four-fold increase, while the reserve has an increase of only 28%. Increased elephants in community lands have led to increased human elephant interactions and corresponding conflicts.

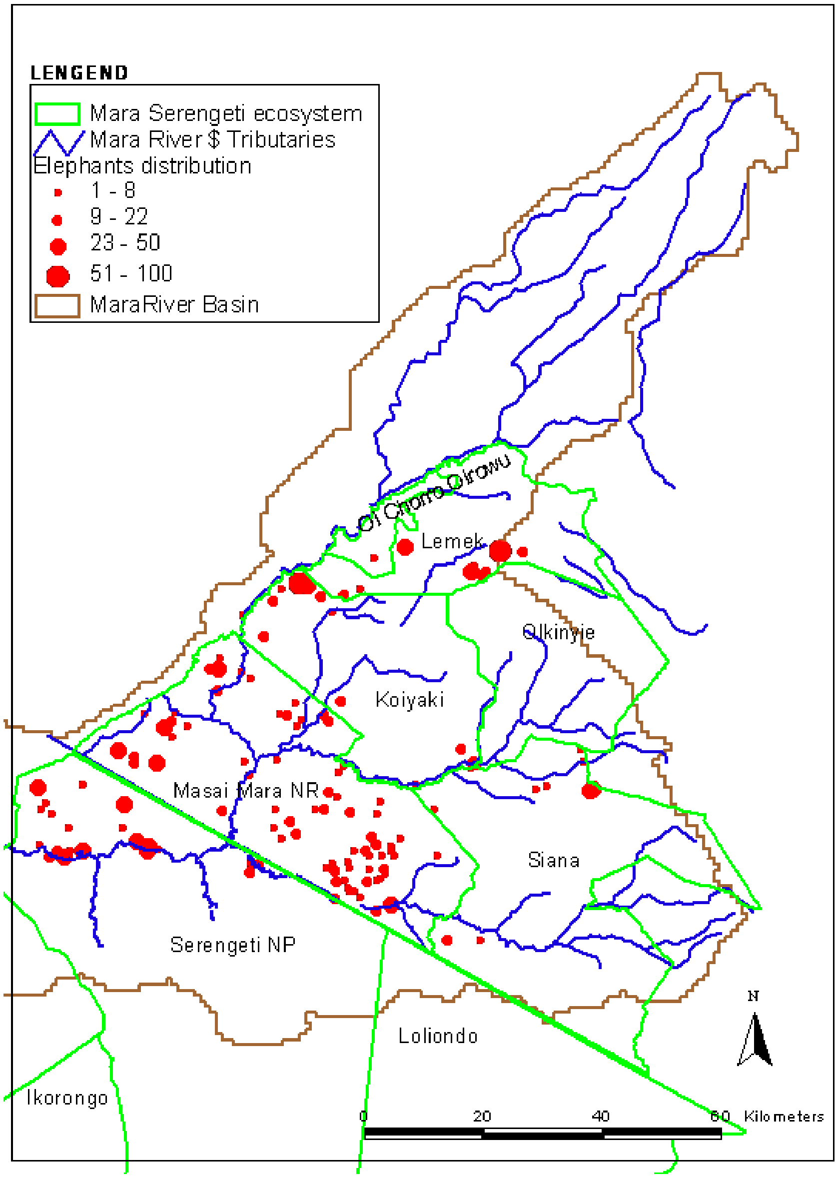


Figure 6.6: Density and distribution of elephant in the Mara ecosystem, April 2006 (*Source:* Kuloba et al., 2007)

6.3.4 The Migration Phenomena

The Serengeti-Mara ecosystem experiences one of the worlds' spectacular annual migrations of wildebeest, zebra, and Grant's gazelle. Hundreds of thousands of herds cross from the Serengeti plains in Tanzania to the Masai Mara in Kenya. The movement traverses climatic and territorial borders in making an annual round trip. This migration is the defining characteristic of the Serengeti-Mara Ecosystem.

The foraging movements and behaviors of the migrants are significantly related to environmental heterogeneity (Etzenhouser *et al*., 1998), and depend on the spatial distribution of food and nonfood items. Complex environments hinder their moving speed, and low velocities characterize areas of abundant forage. The routes taken between feeding stations are made along least energy cost pathways (Gross *et al*., 1995) and maximize energy intake potential, preferring short green grass (Wilmhurst *et. al*., 1999). The inter-species competition coupled with intra-species interactions affect dispersal and influence movement trigger times. Linda (1975), Ottichilo et al. (2001), Wolanski & Gereta (2001), and Wolanski et al. (1999) cite the main causes of this migration as (i) search for food supply, which is dependent on uneven distribution of rainfall; (ii) a search for specific nutrients in forage coupled with inter-specific competition among the herds; and (iii) the herd's response to complex environments and, at some point, search for surface water during the western trek.

In an annual cycle, as revealed by radio collar tracking, the herds begin migration from the Serengeti southern plains where they usually reside from January to April (wet season). This part of the ecosystem includes extensive short grasslands on saline and alkaline soils, dominated by *Sporobolus ioclados, S. kentrophyllus, S. fimbriatus, Digitaria abyssinica, D. macroblephara,* and *Kyllinga nervosa* grasses.

At the onset of the dry season (May to July), the herd moves west, occupying a transitional range in the western part of the ecosystem. This range is wooded and broken by extensive plains on which *Themeda triandra, Panicum coloratum, Chrysochloa orientalis,* and *Eriochloa fatmensis* are common grass species. Taller grasses (such as *Panicum maximum* and *Echinochlol hapoclada)* occur in swampy areas. Rainfall is more evenly distributed here through the year, averaging 900 to 1,000 mm per annum. From July to August the migration turns east into the western corridor.

From August to November (late dry season), the herds move northwards into their dry season range in the northwest Serengeti NP, spilling over into the Masai Mara National Reserve and surrounding pastoral group ranches that protect essential dry season grazing resources. The area is characterized by thicket patches in open, relatively tall grasslands with scattered *Acacia* trees. Common grass species here are *Themeda triandra, Setariasphacelata, Sporobolus fimbriatus, Pennisetum mezianum,* and *Digitaria macroblephara*. This dry season range has a comparatively high annual rainfall of 1,000 to 1,200 mm, often with appreciable rainfall in the dry season.

During the rainy season (December to January), the herds embark on the southern trek back to the Serengeti plains and the time spent by the herds throughout the ecosystem has been well document by Thirgood, *et al*., (2004; table 6.7) (Figure 6.7).

Table 6.7: Time Spent by Migrating Herds in the Serengeti-Mara Ecosystem

Protection Level	Area	Days per year	% of the year
Well protected	Serengeti NP	155	42
	Masai Mara NR	44	12
	Ngorongoro	130	36
	Total	**328**	**90**
Less protected	Muswa	0	0
	Grumeti	4	1
	Ikorongo	5	1
	Total	**9**	**2.5**
Unprotected	Loliondo	10	3
	Masai Mara Ranches	11	3
	Ikoma	7	2
	Total	**28**	**7.5**

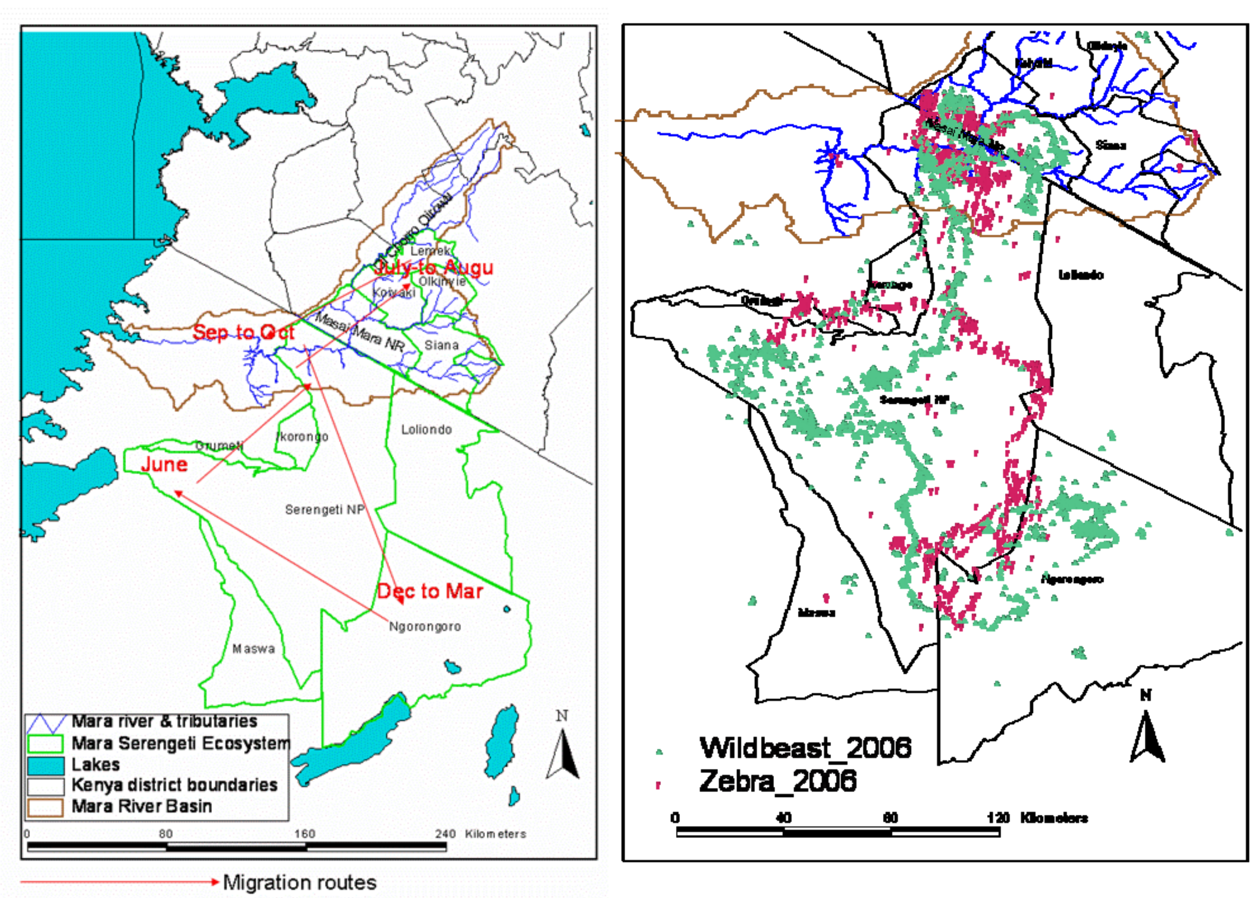


Figure 6.7: Migration routes of wildebeest and zebra in the ecosystem Gazelle (*Source* from Kanga et al., in prep)

6.3.5 Wildlife Veterinary Health

Understanding the population dynamics of wildlife diseases is crucial for pathogens that infect both wildlife and domestic species, particularly since economic, health, and political factors are impacted. Determining the most cost-effective and least damaging ways to control pathogens enhances the ability of wildlife managers to control diseases. Pathogens are an important ecological factor in natural populations, but current knowledge is limited, and the association between pathogens and their wildlife hosts is poorly understood (Munson and Karesh, 2002).

Various wildlife disease outbreaks are documented for the Serengeti-Mara Ecosystem since the mid-1950s riderpest outbreak (Sinclair, 1979; Dobson, 1995; SNP, 2004). The ecosystem is served by wildlife veterinary facilities, based in both the Serengeti National Park and Masai Mara National Reserve. However, sporadic diseases have been a major threat in the ecosystem. Wildlife populations have suffered major declines due to disease epidemics (Table 6.8)

Table 6.8: Summary of Wildlife Health/Disease in the Ecosystem

Disease	**Species affected**	**Impacts**
Rinderpest	Ungulates	Wiped out more than 95% of buffalo and wildebeest populations
Pleuro-pneumonia	Ungulates	In conjunction with rinderpest of 1880-1890, these diseases claimed 95% of all ungulates in the ecosystem
Canine Distemper Virus	Lions and hyenas	Claimed about 67% of lions in the ecosystem
Rabies	Bat eared fox, wild dog and silver backed jackals	Claimed almost all wild dog parks in Mara
Anthrax	Zebra, Baboon, elephants and impala in Serengeti and buffaloes in Mara	Moderate
Tuberculosis	Eland and Giraffe, wildebeest and lion	High
Foot and mouth disease	Wildebeest	High
Trypanosomiasis	Human and cattle	12 people were infected. High
Malignant Catarrhal Fever	Cattle	High
Sycorptic Mange	Thomson's gazelle, cheetah, lion, goats and domestic dogs	Minimal
Bovine tuberculosis	Lions	Minimal
Brucellosis	Ruminants	High

Source: SNP, 2004; Hoare & Fyumagwa, 2006; Dominic, 2008

Rinderpest

Rinderpest is a viral disease that can reach pandemic proportions in wild ruminates and livestock. Rinderpest epidemics were recorded from the 1880s through mid 1950s, claiming about 95% of wild ruminate populations, especially buffaloes and wildebeest. A recent cattle outbreak in the Serengeti in 1990s was controlled by vaccination. Routine sero-surveillance is carried out, and the latest screenings show no evidence of exposure.

Pleuro-Pneumonia

Pleuro-Pneumonia can be devastating. In 1880s to 1890s there was a pleuro-pneumonia epidemic which together with a concurrent rinderpest epidemic claimed more than 95% of wild herbivore populations.

Canine Distemper Virus

An outbreak occurred in 1994 in Serengeti and claimed about 67% of the lion population. Hyenas also suffered some mortality in the 1994 epidemic. There is an annual serological survey conducted in Serengeti NP to monitor this disease.

Sycorptic Mange

Sycorptic mange is an ecto-parasite that affects cheetah, lion, domestic dog, and Thomson's gazelle. The impact of this condition is unknown. From March 2007 to March 2008, two cases of mange infection were treated in the Mara on cheetah and Thomson's gazelle.

Rabies

Rabies is a severe viral disease that potentially kills any mammal and is a dangerous zoonosis. Cases have been reported intermittently within and around the ecosystem over the last 15 years. The disease claimed some wild dog packs in the ecosystem , but it is not clear if it was the only reason for their extirpation in the early 1990s. Cases on bat-eared foxes were reported in the late 1980s and early 1990s. The most resent case was suspected in a silver backed jackal in 2007 in the Masai Mara. However, results to support this incidence are yet to be released. In the Serengeti NP, records and large amount of data show that despite high prevalence of rabies in areas surrounding the park, there is little evidence of significant mortalities in wildlife inside the park. Dog vaccination programs are active.

Anthrax

The anthrax bacterium is one of the oldest pathogens known to mankind. Anthrax is a fatal zoonosis and occurs sporadically in a number of wildlife species, particularly herbivores, where acute deaths can occur. The following outbreaks have been recorded:

- 1975 in the Masai Mara where buffaloes were mostly affected;
- sporadic cases in the Serengeti affecting zebra, baboon, elephant and occasionally impala;

- 2006 in the Ngorongoro Conservation Area where many livestock succumbed and three pastoralists died;
- a zebra in the Serengeti NP was positively diagnosed recently.

Malignant Catarrhal Fever

This disease is associated with wildebeest calves for the first 3 months after birth. The disease is rapidly spread into cattle typically on common grazing grounds. This infection has no vaccination, and the only protective measure used by the pastoralists is to avoid contaminated grazing grounds during the wildebeest calving months of infection risk. The disease is common in the pastoral rangelands in the Masai Mara and occurs annually with the wildebeest migration.

Trypanosomiasis

Trypanosoma Mansonii, are protozoal blood parasites transmitted by tsetse flies *Glossina* spp. (vector). Diseases associated with trypanosome causes mortality in humans and livestock while wildlife maintenance hosts are asymptomatic. Between 2000 and 2001, twelve human infections of sleeping sickness were diagonised in the Serengeti. Trypanosomosis is an economically important disease. Tsetse fly control programs are active in the Serengeti, with impregnated targets (treated nets) set along tourist routes and around habitations about every 6 months.

Foot and Mouth Disease

This is an acute and non-fatal condition that erupts sporadically and disappears again without severe long-term damage to livestock. Buffalos are the most important wild maintenance hosts. Many different strains of the highly infective virus exist, but the exact distribution and epidemiology is not well understood. An outbreak occurred in Serengeti wildebeest in 1999 and positive clinical diagnoses in cattle west of Serengeti NP were detected in 2006.

Tuberculosis

Tuberculosis (TB) is a chronic bacterial disease of mammals that can be a serious problem if it becomes established in wildlife populations, as it is difficult to eradicate the infection in free-ranging animals. TB prevalence in the Serengeti is very low despite a potential infection source at the livestock-wildlife interface. However, in 1994, TB was detected in Serengeti initially in eland and giraffe and later in wildebeest. In 2006, a buffalo in Serengeti was also positively diagnosed. Sero-surveys on lions in Masai Mara showed that they had been exposed to TB, suggesting an infection route via their prey species. The disease is circulating in the ecosystem, but its impact on wildlife populations is currently unknown.

Brucellosis

Brucellosis or "*contagious abortion*" is a bacterial infection that causes reproductive problems in ruminates. The disease is an economic problem for the livestock industry and zoonosis. In 2004, this disease was positively diagnosed in wildebeest and buffalo in the Serengeti NP with a prevalence rate of 17 to 22% in both species.

Physical injuries

Apart from diseases, wildlife in the Mara ecosystem suffers from physical injuries arising from various human-wildlife conflict issues. Injuries in wildlife on the Mara side are on the rise due to the increase in human-wildlife interactions. From March 2007 to March 2008, 71.4% of the total wildlife health cases attended were due to physical injuries.

6.3.6 Human-Wildlife Interactions

The Serengeti-Mara ecosystem is internationally famed for its pristine beauty and annual wildebeest migration. However, the migration across the Kenya-Tanzania border poses conservation challenges. The ecosystem is characterized by resource competition between wildlife, livestock, and people. Due to drastic land use changes over the last five decades, multiple ecosystem threats exist. The major threats are loss of wildlife habitat to crop farming and the subsequent escalation of human-wildlife conflicts. These threats are more pronounced on the Kenyan side (Wasilwa, 1997). Similarly, the Serengeti experiences conflicts related to wildlife hunting and farmland expansions due to high human population along protected area boundaries (Campbell et al., 2001).

Long-term data on human-wildlife conflicts in the Masai Mara and Serengeti National Parks are summarized below.

6.3.6.1 Masai Mara

Trends in Human-Wildlife Conflicts
From 2001 to 2007, there was an increase in human-wildlife conflicts in the Masai Mara at a rate of 14.28% per annum (Figure 6.8). Human population growth and associated infrastructure and agricultural expansions have disrupted the wildlife migration corridors and ecological balance of the Serengeti-Mara ecosystem. As a result, the wildlife ranging area has decreased, and conflicts between wildlife and pastoralists, agriculture, physical structures, and conservation authorities have increased (Sitati, 1997).

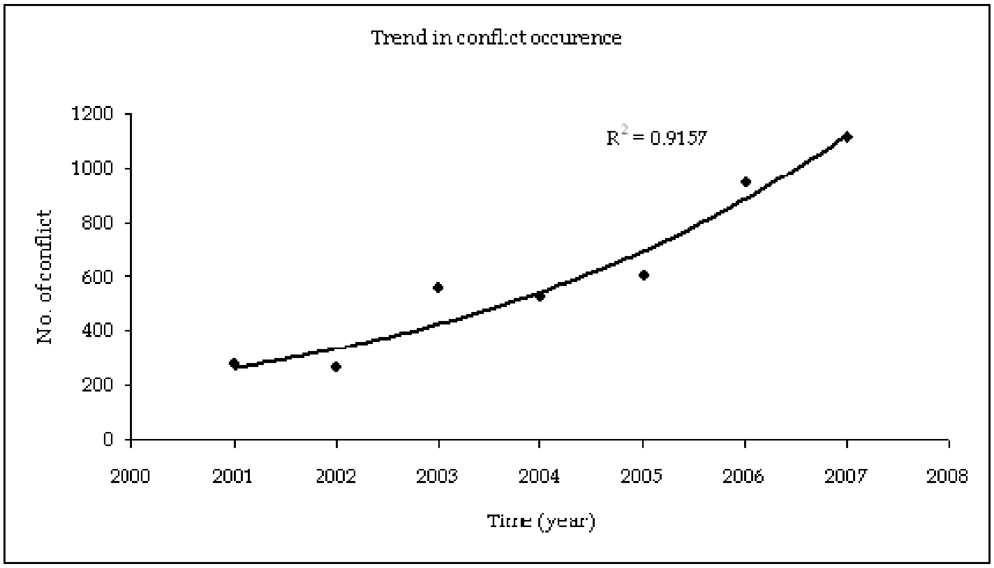


Figure 6.8: Trend of Human-Wildlife Conflicts in Masai Mara (Kiambi, 2006)

In addition the following are other reasons advanced for the raising conflicts

- Changes in land use;
- Population growth and encroachment on wildlife habitats:
- Loss of wildlife grazing and breeding grounds due to large scale farming extending to the Loita Plains;
- Blockage of wildlife migration corridors and breeding grounds;
- Prolonged droughts forcing pastoralists to move livestock in search of greener pastures and watering points; and
- Increased numbers of livestock competing for grass and space with wildlife.

Annual Pattern of the Human- Wildlife Conflicts in Mara

Conflict occurrences in the Masai Mara are seasonal, with the most intense period being April through September (Figure 6.9). This period coincides with the wet seasons' crop cultivation and harvesting, especially for wheat and maize. The same pattern has been identified in studies by Sitati (1997) and DEAP (2001-2006).

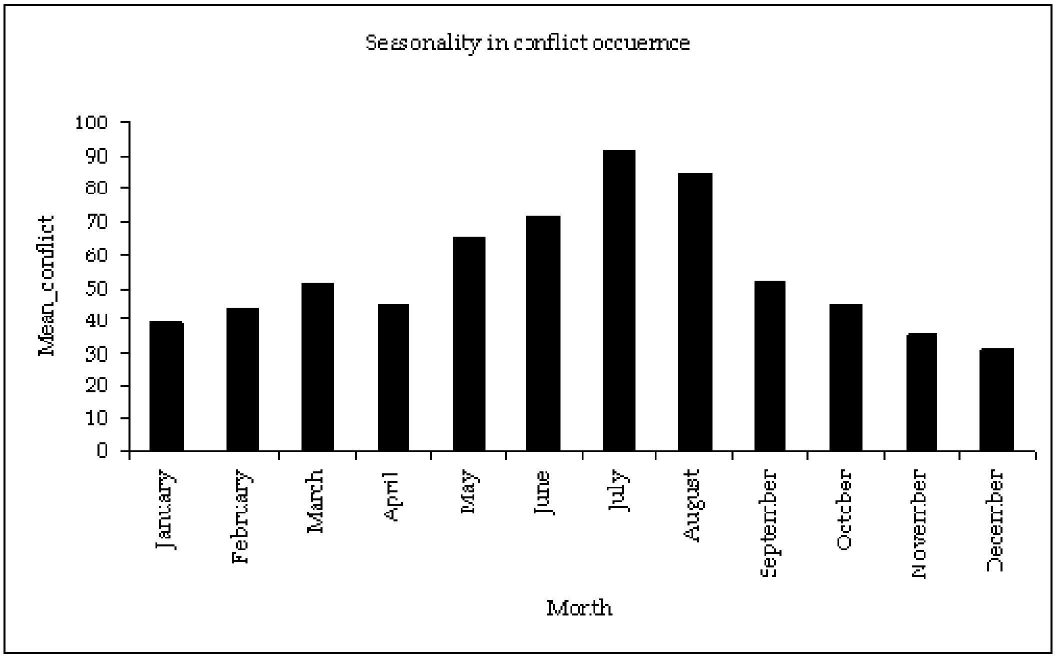


Figure 6.9: Pattern of human-wildlife conflict across the year in Mara (Kiambi, 2006)

From 2000 to 2008, crop raids, installation destruction, and insecurity reports increased in the Mara. Conversely, human deaths and injuries declined, and predation remained fairly constant. The increase in crop raids and insecurity was mainly due to changes in land use from livestock husbandry to crop farming around Masai Mara National Reserve. This also explains the constant levels of livestock predation. The increase in installation destruction correlates with the rise in infrastructure such as fences, water dams, and crop stores (Sitati, 1997, Wasilwa, 1997).

The elephant is the most problematic animal in the Masai Mara, responsible for roughly 68% of human deaths and ranks high on account of other incidences of human injury, crop raids, installation destructions and insecurity. In order of severity, buffalo, leopard, lion, and hyena are other animal species inflicting human death. Predation is largely by the leopard with more than 52% of the reported cases. Lion are second in predation followed by hyena and primates. Crop raiding species include elephants, zebras, primates, buffalos, wildebeest, and warthogs. Increases can be explained by increased human encounters with the wildlife as a result of wildlife range reduction and obstructed migration patterns (Campbell *et al.,* 2001; Wasilwa, 1997)

There has been illegal harvesting of wildlife using snares, dogs and weapons (such as spears). Snaring has been reported as a serious threat to wildlife in the Mara. Between 2001 and 2004, there were 1,201 snare and 278 poachers recorded in the Mara Triangle alone. There is a link between snaring wildlife and poverty levels and this peaks during the dry or drought periods (Table 6.9).

Table 6.9: Number of Arrested Poachers and Snares Collected in the Mara Triangle (Mara Conservancy) between 2001 - 2004

Month	2001		2002		2003		2004	
	Arrest	Snares	Arrest	Snares	Arrest	Snares	Arrest	Snares
January					10	11	0	84
February			1	0	11	5	9	76
March			13	95	9	8	4	0
April			6	0	12	12	1	0
May			10	80	4		1	0
June			12	33	2	44	1	22
July			6	10	10	25	2	
August	10	60	17	113	6	2		
September	0	140	26	107	9	20		
October	3	68	5	0	10	31		
November	7	17	30	64	22	53		
December	4	0	1	12	4	9		
Total	**24**	**285**	**127**	**514**	**109**	**220**	**18**	**182**

Source: Mara Conservancy

6.3.6.2 Serengeti

Crop Raids and Associated Wildlife in Tarime, Serengeti

From 2001 to 2007, sorghum was the leading crop destroyed by wild animals with an average of 20 acres raided per season (Figure 6.10). Maize and finger millet crops were 7 and 6 acres, respectively. Other crops raided include cassava and potatoes. Hippopotamus accounted for about 31% of all crop raids, and hippos and elephants collectively accounted for more than half of the cases. Baboons and monkeys also had significant adverse impacts. Of all cases reported, buffaloes contributed least to crop raids. The findings are supported by data in the western Serengeti (location of the Tarime district) where large resident wildlife populations and dense human settlements exist adjacent to the park (Campbell *et al*., 2001, Hofer *et al*., 1996).

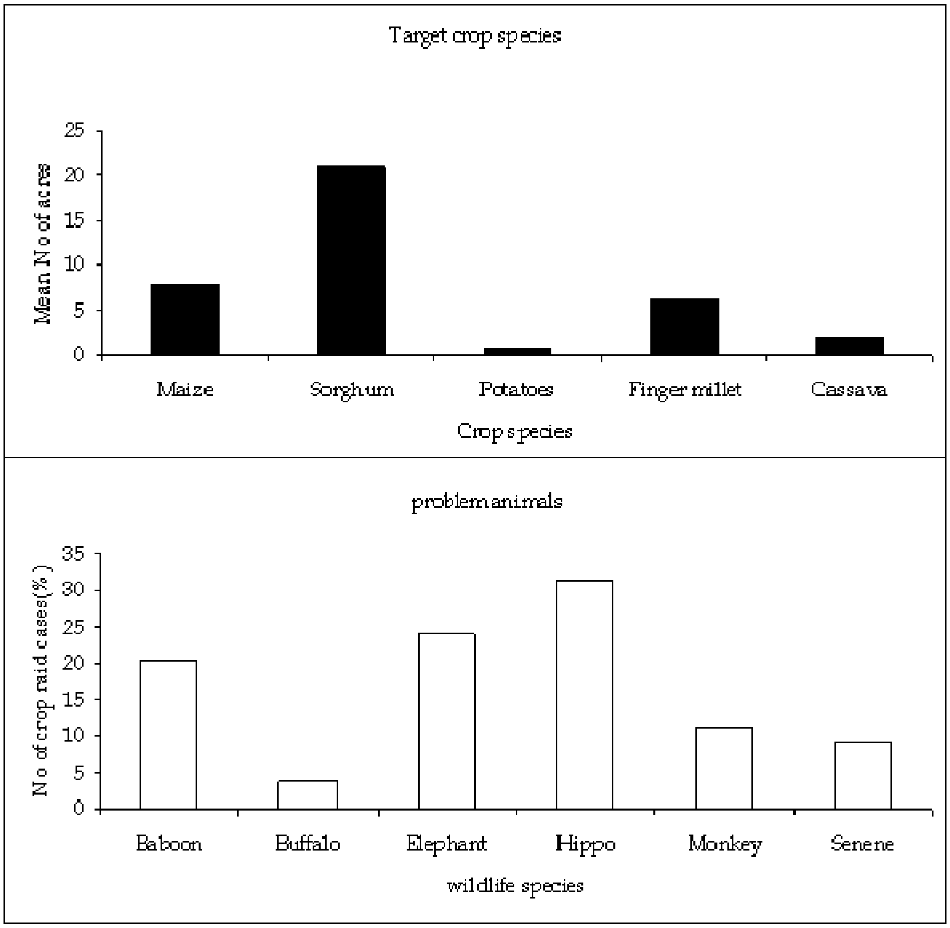


Figure 6.10: Levels of Target Raid Crops by Animals, Tarime District, Tanzania (unpublished data, Wildlife Office Tarime)

Hunting in the Serengeti

Wildlife hunting is a significant issue in the Serengeti. Hunting is carried out for both subsistence and commercial purposes and the same has destroyed large wildlife populations in Serengeti NP (Campbell *et al.*, 2001). In addition, illegal poaching of wood products, livestock encroachment, and fishing are other major issues (Table 6.10). These problems can be attributed to high poverty levels in the adjacent areas and inequitable sharing of the park benefits.

Table 6.10: Conflict Type and Magnitude in the Serengeti NP

Conflict Type	Frequency	% Total
Hunting	400	80.65
Pouching of wood products	46	9.27
Livestock encroachment	25	5.04
Fishing	11	2.22
Cultivation	4	0.81
Mining	4	0.81
Collecting thatch grass	2	0.40
Collecting medicine	1	0.20
Collecting water	1	0.20
Hiding/refuge	1	0.20
Honey harvesting	1	0.20
Total	**496**	**100**

Source: Campbell *et al.,* 2001

6.4 Tourism

Tourism in the Serengeti-Mara ecosystem has been economically successful with more than 300,000 annual visitors. Recognition of the ecosystem as one of the 7th modern wonder of the world is likely to further boost tourism. Tourist numbers have been increasing each year correlating with income gains. The ecosystem contributes to Kenya's and Tanzania's gross domestic product (GDP). In 2000, the Tanzanian government earned more than 740 million US dollars in foreign exchange from the tourism industry. Tourism accounts for nearly 10% of the Tanzanian GDP, representing 40% of total foreign exchange earnings (SNP, 2004). In 2005, Kenya generated revenues of almost 49 billion Kshs (700 million US dollars) from tourism and directly employed 176,000 people (10% of all jobs).

6.4.1 Tourism in Masai Mara

Tourism surpassed coffee as the largest single earner of foreign exchange for Kenya in 1987. The Mara area accounted for 18% of all visits to national parks and generated 8% of gross tourist revenues. The industry is successful as seen by tourist numbers increasing at a rate of 3.8% per annum from 1980 to 2007 (NCC data 2008; Wasilwa, 1997). Economic competition in the private sector has led to excellent tourist facilities and government supported infrastructure. Most revenue is generated from accommodation tariffs, park entry fees, game drives, ballooning, camping, and transport. For instance, from 1977 to 1987, the Narok County Council (NCC) earned over 75 million KShs from visitor accommodation tariffs in the reserve. There have also been significant benefits to the local people. Much of the tourism revenue is used to enhance public health, education, and animal husbandry throughout the district. For example, in 1988 the NCC earned about 25 million KShs from the reserve, while the adjacent wildlife group ranches received about 2.78 million KShs (Hamilton *et al.,* 1990). The group ranch income represents only 1% of the gross earnings of the Masai Mara, but these ranches provide wildlife grazing areas and scenic beauty for tourists. Tourism in the Masai Mara is lucrative but more of the revenues should support the local people who share their land with wildlife. Tourism income could make a greater contribution to improve living conditions in the pastoral area and to general conservation efforts.

Masai Mara has experienced a high tourist influx resulting in congestion, with accommodation facilities have been built in the reserve and community dispersal areas (Wasilwa, 1997). Currently, the Mara has more than 70 tourist lodges and camp facilities as summarized in Table 6.11. Most of these facilities are within neighboring group ranches as compared to the reserve itself. Masai Mara has been the most important area for the tented safari operators, who largely utilize the Koyaki, Lemek, and Siana group ranches.

Table 6.11: Accommodation Facilities and Capacities in the Masai Mara

Tourism Enterprise Name	No. of Tourists Accommodation Facilities	Bed Capacity
Koiyaki Lemek Wildlife Trust	25	1146
Siana Masai Mara Conservancy	22	1040
Masai Mara Game Reserve	9	570
Oloololo Group Ranch	2	120
Mara Conservancy	6	284
Olaro Orok Conservancy	3	36
Majimoto Group Ranch	1	12
Olderkesi	2	28+
Olkinyei Conservancy	1	12
Total	**71**	**3248**

Source: Transmara & Narok county councils, 2008; Wasilwa, 1997

There have been three periods of visitor growth in Kenya: the late 1960's, 1976, and the mid 1980's. Overall visitor growth has been 5.7% per year while earnings have been over 15% per year. In the recent past (2005-2007), there was an increase in visitors and especially from July to August as shown in Figure 6.11 when the migrations occur. The Masai Mara area has attracted tourists more rapidly than any other park or reserve in the country, with visitor entries rising by 9%, and bed nights by 12% annually.

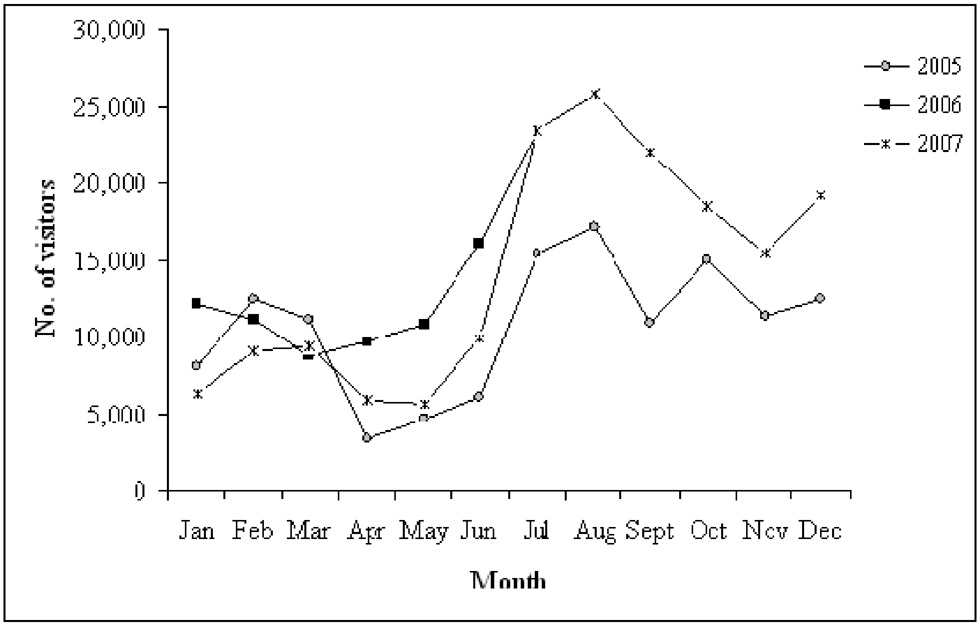


Figure 6.11: Tourism Trends in the Masai Mara National Reserve, 2005 – 2007
(*Source:* Mara Conservancy & Narok County Council)

Wildlife survival, and by extension the tourism industry, hinges on the local community. Local participation through Community Based Wildlife Management (CBWM) is needed to sustain the industry. The Masai Mara dispersal area is an integral component of the Mara ecosystem. The adjacent group ranches and communities have developed wildlife conservancies, focused on ecotourism potential, and enhanced wildlife conservation. The local communities also sell Masai cultural products.

While pastoralism has co-existed with wildlife and water resources, the Masai are undergoing dramatic changes in their lifestyle. Population growth (5.3%) and a less nomadic lifestyle have increased natural resource pressures. Immigration and cultivation among the Masai have further accelerated the changes. An integrated management plan is needed to guide long-term conservation and development for the Mara.

6.4.2 Tourism in Serengeti

The Serengeti area has a number of accommodation facilities distributed both inside and outside the park as summarized in Table 6.12. In addition, there are two planned campsites (Mbuzi, Mawe, and Mbalageti) in the western corridor. The lodges and luxury tented camps are managed by private investors, while the ordinary camps, youth hostel and the guest houses are managed by the Serengeti National Park (SNP, 2004). .

Table 6.12: Lodges and Permanent Tented Camps in the Serengeti National Park

Name	Type	Capacity	Owner	Location
Facilities within the Park				
Seronera Wildlife lodge	Lodge	150	TAHI Ltd	Seronera
Lobo Wildlife Lodge	Lodge	150	TAHI Ltd	Lobo
Sopa Lodge	Lodge	154	Sopa Hotels Ltd	Moru
Serena	Lodge	144	Tourism Promotion Tanzania Ltd	Seronera
Serena Kirawira	Luxury permanent tented camp	50	Tourism Promotion Tanzania Ltd	Kirawira
Nsasiata Migration Camp	Luxury permanent tented camp	42	Halycon	Lobo
Grumeti River Camp	Luxury permanent tented camp	20	Conscorp Tanzania Ltd	Kirawira
Kusini Camp	Luxury permanent tented camp	18	Abercombie& Kent	Southeast NR Maswa
Facilities outside the Park				
Ndutu	Lodge	80	Gibbs farm / Ndutu	NCA,Ndutu
Ikoma	Permanent camp	26	Swala Safaris	Outside Park, Ikoma gate
Kijereshi	Permanent camp	54	Manjis Sandhu	Outside Handajega
Kleins	Luxury permanent tented camp	16	Conscorp/ Arechers	Outside , Lobo
Serengeti Stopover	Permanent bandas	20	Private partnership	Outside Ndabaka
Speke Bay Lodge	Permanent bandas and campsite	34	Speke Bay Lodge Ltd	Outside Lake Victoria

Source: SNP, 2004

The three main focal areas of tourism in Serengeti are Seronera, Lobo, and Kirawira (Grumeti). In addition, there are numerous other areas of interest, especially during the migration. These areas include the Gol, Naabi, and Ndutu. Game viewing track networks are extensive in Seronera, Lobo, and Naabi-Barafu-Gol Kopje areas. However, the Barafu Kopjes are out of bounds for visitors.

Visitor offences from 1999 to2002 are summarized in Table 6.13. Off-road driving is the most common offence, followed by camping without paying the associated fees. However, these incidences are minimal compared to the 150,000 visitors entering the park annually.

Table 6.13: Visitor Offences in the Serengeti National Park, 1999-2002

Offence	**Incidences**	**%**
Off road driving	35	26.3
Camping w/o paying	27	20.3
Entering park w/ o paying	24	18
Speeding	17	12.8
Disturbing animals	12	9.0
Entering at Ndutu	11	8.3
Others	5	3.8
Night	2	1.5

Source: SNP, 2004

From 1992 to 2002, visits to the Serengeti National Park increased nearly four fold at an average growth rate of 27% per annum (Table 6.14). Similar to the Masai Mara, the peak tourism season is from July to September and coincides with the wildebeest migration. Such tourism growth potentially contributes to the Tanzanian and regional economy.

Table 6.14: Number of Visitors to Serengeti National Park, 1992 – 2002

Month	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2002**
January	7,592	11,136	14,456	12,016	12,938	11,441	12,116	18,837	27,845	30,149
February	8,156	8,223	10,593	9,709	10,381	8,635	9,060	15,531	24,290	26,345
March	5,966	6,291	6,585	6,732	7,164	5,177	5,362	11,593	20,112	21,926
April	4,488	3,908	3,987	4,378	4,669	2,542	2,587	8,677	17,056	18,730
May	4,082	4,082	4,024	4,463	4,783	2,685	2,759	8,878	17,285	18,988
June	6,277	6,277	3,656	6,055	6,450	4,426	4,574	10,768	19,249	21,027
July	12,730	10,091	10,355	37,188	40,615	41,624	44,805	54,032	65,546	70,356
August	13,301	10,506	10,506	13,124	14,038	12,533	13,200	19,913	28,913	31,209
Sept	6,313	6,932	6,932	7,495	7,984	6,056	6,299	12,588	21,165	23,036
October	5,891	5,890	5,890	7,031	7,480	5,510	5,712	11,961	20,496	22,328
Nov	6,466	7,107	7,107	7,579	8,111	6,224	6,510	12,840	21,459	23,373
Dec	9,339	10,911	10,911	11,010	11,784	10,140	10,668	17,240	26,102	28,257
Total	**90,601**	**91,354**	**95,002**	**126,780**	**136,397**	**116,993**	**123,652**	**202,858**	**309,518**	**335,724**

Source: SENAPA, 2006

The concentration of tour vehicles in wildlife sensitive areas is considered to be an issue in the following areas: Seronera (Masai Kopjes, Sixteen, and Vidimbwini), Simba, Gol, Ndutu, and Naabi. The problem is most serious in the Seronera area where key attractions and facilities are located. However, during migration periods, congestion can also be acute in the Gol/Moru Kopjesl. With the continued increase in park visitors, dispersal of visitors to other areas through provision of visitor centers, balloon operations, non-vehicle based activities and an improved game viewing road network is needed.

Animal harassment occurs almost daily, with more than ten cars crowding into a given area. Radio communication between tour vehicles has aggravated the problem and undermines park patrols. Punishing offending drivers is therefore nearly impossible. Seasonally limiting bookings and adding an extra fee for the high access areas (such as the Gol) would help alleviate congestion.

Waste management systems throughout the park are generally poor, with the exception of some hotels such as the Serena Lodges. Existing systems for park facilities and staff are rudimentary and improved low impact systems are needed. One solution is to install an incinerator, but waste disposal should be further evaluated.

Key tourism issues and challenges in Serengeti include:

- Loss of wilderness;
- Mushrooming town centers;
- Encroachment of villages into reserves;
- Water scarcity;
- Wildlife poaching;
- Wild fires;
- Agricultural expansion and blockage of wildlife migratory routes;
- Forest destruction;
- Large scale farming;
- Human – wildlife conflicts;
- Pollution of the Mara River;
- Individual land ownership;
- Livestock and human diseases;
- Poor management of ranches and Community Based Organizations (CBOs).

6.5 Cross-border and Regional Concerns

The border between Kenya and Tanzania is closed along the Serengeti-Mara at Sand River gate. Opening the border could relieve congestion in the Masai Mara, stimulate tourism in the northern Serengeti, and help suppress poaching. The economic potential of both Serengeti and Masai Mara would increase if security and infrastructure (roads, camps, and park facilities) improved. (Incidences of poaching, tourist attacks, and cattle rustling have been reported in northern Serengeti.) Conservation and marketing would increase the tourism potential in the Serengeti-Mara ecosystem.

The migratory wildebeest define the Serengeti-Mara ecosystem, and they have an important role in modifying the natural vegetation, damaging food crops, and competing for grazing alongside other wildlife and livestock. At present, the wildebeest population appears to have stabilized, but any land use change on either side of the border is bound to affect both sides. Additional regional concerns include the protection of the water catchments, spread of wildlife diseases, spread of dry season fires, flow of tourist, and law enforcement (cattle rustling and poaching). These concerns apply equally to the entire ecosystem irrespectively of national boundaries.

The advantages of regional co-operation in ecosystem management are obvious. Neither the Serengeti nor the Masai Mara can be considered in isolation. Benefits would accrue from a regional approach to tourism, ecological research, monitoring, environmental protection, and public education. A regional strategy should seek to harmonize the Kenyan and Tanzanian political, social, and economic frameworks.

6.6 Issues, Causes, Impacts, and Interventions

These are summarized in the table below:

Table 6.15: Issues, Causes, Impacts, and Interventions

Issues	Causes	Impacts	On-going & Planned Intervention Measures	Potential Investment Areas
Deforestation in Mara region	**1**. Introduction of Agricultural activities; **2**. Forest clearing for tea; **3**. Increase in timber harvests which have increased opened land by 82 %; **4**. Illegal logging; **5**. Lack of law enforcement; **6**. Politics; **7**. Unclear forest boundary; **8**. Ownership conflicts.	Land degradation and erosion. Between 1986 and 2000, 204km^2 (23%) of Closed Forests was cleared for tea growing. Increase in Tea/open forest by 875 km^2 (82%). Increase in agricultural land by 886km^2 (55%) Decrease in shrub and grassland by 2349 km^2 (24%). Almost 80 % of all region inhabitants in both countries derive their livelihoods from agricultural activities. Agriculture contributes directly and indirectly about 75% of the economy of the region. The Mau forest originally covered 45,000 hectares. About 50 % has been lost due to unclear boundaries between the private farms and the forest.	**WWF-Integrated MRB Program for the protection of Mau forest complex:** Involvement of key stakeholders in the management of natural resources through the new concept of Participatory Forest Management (PFM) as envisaged in the new Forest Bill of 2005. **Forest Department Projects:** Establishment of forest plantation. Protection of Mau Forest complex. Fire break boundary clearing.	**1**. Comprehensive biodiversity assessment of all the MRB forest resources to identify level of forest destruction, encroachment and excision. **2**. Indigenous community involvement. **3**. Clear boundaries need to be established and marked. **4**. Deal with illegal settlements and cancel fake title deeds. **5**. Develop strategies to reduce land use conflicts in the areas affected.
	Fuel wood extraction-13,200m3 of fuel wood	Loss of valuable forest products (no hard data	A WWF Project component is dedicated to	Strengthening capacity of NGOs and CBOs to

	annually between 1964 and 1999.	available).	the protection and restoration of the Mau forest complex ecosystem.	educate communities on sustainable forest resources utilization practices.
	Establishment of Nyayo tea zone between 1986 and 1988.	Loss of 15,000ha of forest cover in Southwestern/Transmara forests during that period.		
		Act as buffer against encroachment (no data available).		**1**. Establish and enforce buffer zone against encroachment. **2**. Extend Nyayo tea zone to protect (and buffer) against encroachment.
		Increase acreage under tea (23%) of Closed Forests was cleared for tea growing. Increase in Tea/open forest by 875 km^2 (82%).	Forest Department Projects: Establishment of forest plantation. Protection of Mau Forest complex. Fire break boundary clearing.	Agro-forestry Extension Program.
		Provide employment (no data available)		
	Transfer of ownership of gazetted forests to government.	This resulted to Haphazard and uncontrolled forest resource utilization leading to Loss of fuel wood, building material, food, fodder and other non timber products, valued at 750,000,000 KShs.	Political commitment for forest conservation at national and local levels of governance. A concise and integrated national land use policy. Establish appropriate forest policies that will strengthen communities' commitment to conserve forests, i.e., policies that are inclusive and will	**1**. Develop a resource management policy for forest and other resource users. **2**. Develop participatory land use policy (Resource Management Policy).

			recognize traditional institutions, rights, and skills of forest dwellers. Include public participation in the decision process related to delineation and management of state forests.	
	Annual wood fuel extraction by forest adjacent communities.	Destruction of ecological biodiversity due to loss of fauna and flora habitats. Estimated at over 13,200 cubic meters of which only 5% is licensed. No specific data on loss available.	WWF-EARPO responsible for project implementation.	Support community initiatives. Build CBO capacity to tackle community empowerment.
Soil Erosion	Cultivation on steep slopes.	Data show that 49% of farmlands are free of erosion; 41% had moderate erosion; 4% had some erosion; 1% had very high degree of erosion.	SIDA funded NALEP is responsible for soil and water conservation. LVEMP-Integrated Soil and Water Management Component. Land Management capacity building through Serengeti-Luangwa Ecosystem Management Project.	Degraded areas lack a more focused approach and designs for soil and water conservation structures. Integrated soil and water management.
	Gullies.	Data show that 57% of farmlands had no gullies; 30% had some gullies.		
Land Fragmentation	Population pressure on available land.	Average holding became 46.0 ha; Minimum size 0.6 ha; Maximum size 630 ha.	No planned intervention measure.	Population control project including birth control.
	Change in Population growth rate of Nakuru	Land fragmentation causing a change in population	Planned intervention: Check population growth	1. Additional support for the population control

	District between 1989 and 2002 to 4.85% annually.	density from 118 persons/km^2 in 1989 to 218 persons/km^2 in 2002.	through intensification of family planning campaigns.	project. 2. Establish a better land use policy.
	Change in population growth rate of Bomet District between 1989 and 2002 to 3% annually.	Land fragmentation causing a change in average population density from 167 to 240 persons/km^2 between 1989-2002.	Planned intervention: Check population growth through intensification of family planning campaigns.	1. Additional support for the population control project. 2. Establish a better land use policy.
	Change in Population growth rate of Narok District between 1989 and 2002 to 6.26% annually.	Land fragmentation causing a change in average population density from 15 to 32persons/km^2 between 1989-2002.	Planned intervention: Check population growth through intensification of family planning campaigns.	1. Additional support for the population control project. 2. Establish a better land use policy.
	Change in Population growth rate of Transmara District between 1989 and 2002 to 4.1% annually.	Land fragmentation causing a change in average population density from 47 to 104 persons/km2 between 1989-2002.	Planned intervention: Check population growth through intensification of family planning campaigns.	1. Additional support for the population control project. 2. Establish a better land use policy.
Soil and Water pollution	Non-judicious and uninformed use of chemicals resulting into 41% fertilizes and 35% chemicals use in MRB cropping systems.	Shortened fallow periods. Polluted agricultural lands. Polluted river waters. Destruction of flora and fauna in the Mara Basin.	Planned intervention: Safe use of agrochemical project.	Upscale the safe use of agrochemicals project *basin wide*.
Unregulated water extraction				
Encroachment into forested areas	Political rewards; Illegal logging; Commercial Logging; Shortage of agricultural land; Greed and corruption; Ignorance by the community; Fuel wood demand; Population pressure.	Destruction of ecological biodiversity due to loss of fauna and flora habitats (no specific data on loss available).	WWW-EARPO project.	Institutional strengthening; Capacity building for CBOs to empower communities to protect the surrounding natural resources.
Biodiversity Loss	Conversion of natural	Mara part of Mara	Wildlife conservation	Establish balance between

	forests into agricultural land. Expansion of wheat farms into wildlife habitats. Droughts occurring every seven years (on average), and a severe droughts occurring every twenty years (on average) in the Serengeti. Poaching. Threat: Potential climate change due to the increased Greenhouse effect. Population pressure.	Serengeti has lost 70% of its wildlife between 1976 and 1996. Non-migratory wildlife species in Masai Mara ecosystem declined by 58% in the last 20 years. The decline ranged from 49% in small brown antelopes, to 72% in medium brown antelopes. In individual species, the decline ranged from 25% in Grants gazelle to 88% in the warthog. During a drought, 20% to 80% of the migrating wildebeest die. At 50% die-off, the wildebeest population may take twenty years to recover. At 80% die-off, there may be no recovery of the wildebeest population, signifying the end of the great migration.	project by WWF and KWS	wildlife conservation and alternative land use. Integrate wildlife conservation and livestock keeping. Establish anti-poaching activities. Veterinary support. Habitat protection.
Decline in the Quantity and quality of water in Enapuiyapui swamp	Increase in the number of animals in the swamp over the last 30 years. The numbers of elephants have increased from 1, 30 years ago to the current 3 as of April 2007. Increase in Elands from 1 to 2, Warthogs from 2 to 3, Wild	The quantity of water in the swamp which was previously very high in wet season and high in dry season has declined to medium. Color of the water has changed from clear to red. In terms of quality, the	WWF-MRB-dialogue Project for the restoration of Enaspuyipui swamp biodiversity status.	Encourage the protection of wetlands by educating farmers on sustainable agricultural use of wetlands, e.g., planting of wetland friendly crops.

	pigs from 2 to 3, Bush backs from 1 to 3, Buffaloes from 1 to 2, Duikers from 1 to 2, Columbus monkey from 1 to 3, Zebras from 1 to 3, Thompson gazelles from 2 to 3 porcupines from 2 to 3 and monkeys from 1 to 3.	water has changed from fresh to dirty. In the wet season, water velocity has changed from the previous fast to low and in the dry season from low to almost zero. The faucal coliform counts were measured and found to be negative in the swamp. But in the site which connects the swamp with the outlet to River Amala and frequently used for washing and watering livestock, the coliform values ranged between 50-100 colonies forming units/100ml of water sampled.		
Negative impacts of socio-economic activities around Enapuiyapui swamp.	Charcoal burning.	Deforestation of the catchments. Soil compaction and degradation. A study carried out in the swamp shows that there has been a decline in vegetation cover from the previous approximately 80% to now less than 20%.	WWF-EARPO-Project Protection of Mau forest complex and Enaspuyipui swamp.	Education and awareness creation on wise use of resources. Sustainable management of resources during the process of conservation.
Rapid Droughts.	Caused by destruction of water catchments areas.	Lack of food and water leading to emaciation and finally death of wildlife livestock and people In the year 2000, for instance, pastoralists lost	Agriculture Sector Development plan ASDP which implements Charcodam construction and rehabilitation in Tanzania.	Fodder crops growth and conservation. Support in dam and water pun construction. Technical guidance and assistance to potential

		35% of their cattle due to drought, while over the last 20 years; there has been a decline in wildlife of over 50%.in Mara region.	Rain water harvesting. Range Land soil and water conservation project by ALRMP in Kenya NALEP project Group and individual small holder irrigation and drainage in Kenya.	individual smallholder irrigation farmers.
Loss of Indigenous plant species	Replacement of plantation forests with exotic species and tree felling by saw millers who hardly follow the laid down guidelines on logging.	Exotic forest species now occupy more than 10% of forested areas in Mau. The preferred use of exotic species such as pines and the water thirsty eucalypts adversely affects the regeneration of certain valuable indigenous slow growing tree species and their undergrowth biodiversity. Indigenous forest vegetation has over time been replaced by government sanctioned plantations largely comprising exotic vegetation now 85% (largely Punus pistula plantations, 20%, Cypress Americana, 55%, and Eucalyptus spp, 10%.	WWF project for the conservation of Mau forest complex.	Avoid water demanding species (e.g., eucalyptus) close to springs and water courses.

6.7 Summary of Potential Investment Areas

Table 6.16: Investment Areas in Biodiversity, Environment, Ecosystems, Wildlife, and Tourism

Area	Investment Program/Project	Objective
BIODIVERSITY	**1**. Develop a comprehensive biodiversity assessment of all the Mara River Basin (MRB) forest resources.	To identify the level of forest destruction, encroachment, and excision.
	2. Develop a comprehensive biodiversity assessment of all the MRB wetland resources.	To identify the level of wetland destruction, encroachment, and excision
	3. Develop a comprehensive biodiversity assessment of all the MRB Savannah grassland resources.	To identify level of wild life habitat destruction.
	4. Develop a comprehensive biodiversity assessment of all the MRB wildlife resources.	To identify the level of wildlife resources destruction.
	5. Develop a comprehensive natural resource management policy to forestall the unsustainable natural resource use in the MRB.	To regulate natural resource utilization in MRB including deforestation and habitat destruction.
	6. Establish a transboundary early warning system to forestall the recurrent drought.	To provide adequate timeframe to prepare mitigation measures against droughts.
	7. Enact natural resource management legislation to control illegal natural resource activities, wildlife poaching, and over harvesting of medicinal plants.	To regulate natural resource utilization in MRB including deforestation and habitat destruction.
ENVIRONMENT	**8**. Establish regular monitoring of MRB rivers, wetlands, springs, and groundwater to monitor and assess pollution levels.	To monitor and control surface water and groundwater pollution levels.
	9. Develop a comprehensive natural resource management policy to forestall unsustainable natural resource utilization in the MRB.	To regulate natural resource utilization in MRB including human-wildlife

		conflicts, water use conflicts, pasture, and agricultural land.
	10. Develop a comprehensive land use policy to forestall unsustainable land use in MRB.	To reduce the inequitable resource use and benefit sharing among the major stakeholders.
	11. Enforce water use regulations in the MRB.	To regulate increased water demand.
	12. Initiate health programs and construct health clinics to deal with increased water-borne and water related diseases.	Disease control and prevention.
	13. Initiate education programs on management and utilization of MRB wetlands.	Sensitization on wetland economic value and management.
ECOSYSTEMS	**14**. Develop comprehensive inventory of MRB ecosystems.	To identify sectors with high economic value and important political constituencies.
	15. Carry out resource surveys and mapping of wildlife.	To assess, monitor, and manage ecosystems.
	16. Develop MRB poverty maps at various scales.	To assess the extent of poverty in the MRB at various scales.
	17. Establish a MRB Poverty Analysis Unit at MRB Project headquarters in Musoma, Tanzania.	To monitor poverty levels project socio-economic impacts.
	18. Harmonized land use policies and legislations in Kenya and Tanzania.	To regulate land use in MRB.
WILDLIFE	**19**. Develop a comprehensive wildlife management policy to forestall unsustainable natural resource utilization in the MRB.	To reduce human wildlife conflicts.
TOURISM	**20**. Develop a comprehensive tourism policy to regulate all components of and improve the industry.	To improve the community involvement in the industry.
	21. Promote ecotourism in the MRB especially in the dispersal areas.	To encourage local community participation and benefit sharing.

7.0 Energy and Hydropower Development

The energy sector in the Mara River basin is progressively growing fuelled by the growing population and socio-economic activities. In Kenya, hydroelectric power (HEP) is the major source of electricity. The current major sources of electrical power generation include hydropower, contributing 51.2% of the national grid, thermal oil at 30.8%, and geothermal at 17.7%. Hydropower and geothermal energy resources will continue to be developed in the country to meet the ever increasing demand.

Hydroelectric power is also the main source of electricity in Tanzania, although the hydropower contribution to the Tanzanian national grid has been dropping. Specifically, in 2005, Tanzanian hydropower contributed 60% of the total energy generation. In 2007, the hydropower contribution declined to 48%. Currently, the thermal power contributes 52% to the national Tanzanian grid. The relative hydropower contribution is expected to decline further as large-scale electricity production from natural gas continues to develop.

The Mara River basin has significant hydro-power potential which has only partially been exploited. This chapter describes this potential and the energy sector in general, including energy sources and use patterns; electricity generation, transmission, distribution; and rural electrification.

7.1 Energy Sources, Types, and Use Patterns

The prevalent energy source in the Mara River basin is fuel wood. Most people live in rural areas and use firewood for cooking, heating, and tea drying. In urban areas, charcoal is the prevalent fuel source for cooking. Electricity use is limited to the district headquarters, where it is mostly used for lighting and in the Masai Mara hotels and lodges that use electric generators. Electric power has not yet reached most rural market centers, tourist lodges, and households in the Mara River basin. However, the Kenya Government has initiated a nationwide rural electrification program to electrify all regions in the country.

A similar situation exists in Tanzania. In the Mara basin more than 95% of the households use firewood for cooking and heating, while less than 4% of households use charcoal. The majority of the households in rural areas have no access to electricity. Use of electricity is limited to urban areas. At the national level, the main source of primary energy supply is biomass-based fuels particularly fuel-wood (charcoal and firewood), which are the main source of energy to both urban and rural areas. Biomass-based fuel accounts for more than 90% of primary energy supply. Commercial energy sources, i.e., petroleum and electricity, account for about 8% and 1.2% of the primary energy used, respectively. Coal, solar, and wind account for less than 1%.

7.2 Energy Sources

Kenya

Sources of fuel wood include (1) on-farm exotic trees and indigenous trees in non-protected areas and (2) the protected forest reserves. Information on the volume of fuel wood consumption in rural areas and the actual demand is not easily available. In urban centers, small traders (selling wood for cash) supply fuel wood from the rural areas. Traders also supply charcoal in urban areas as a business commodity. Charcoal demand is always high in urban areas as many of the families living there have no other cooking fuel option. However, the high profits realized in these urban charcoal markets promote the cutting down of trees and illegal logging. Thus, the widespread use of charcoal and fuel wood as energy sources threatens the Mara River basin forests.

Emerging and expanding urban centers and towns in the Mara River basin are increasing the demand for electric power. The need to make electricity accessible to more households and market centers in the basin is great and so are the environmental benefits:

- Reduced pressure on forest resources;
- Support of small-scale (jua kali) industries which provide alternative economic activities not depending on the use of natural resources;
- Promotion of poverty eradication efforts;
- Reduced environmental pollution associated with burning wood fuel.

The energy consumption of the Mara districts in Kenya for cooking and lighting purposes is illustrated in Table 7.1a,b.

Table 7.1: Energy Consumption in the Mara River Basin, Kenya

(**a**) Percentage distribution of households by main source of cooking fuel

District	Electricity	Paraffin	Firewood	Charcoal
Kenya	0.6	13.2	68.3	13.3
Rift Valley	0.5	7.0	70.2	19.3
Bomet	-	0.4	96.7	2.7
Nakuru	2.1	14.3	41.7	37.0
Narok	-	2.0	74.6	19.9
Transmara	-	0.5	92.1	6.1

Source: Kenya Integrated Household Budget Survey, 2005/06

(**b**) Percentage distribution of households by main source of lighting fuel

Region/District	Electricity	Paraffin	Solar	Firewood
Kenya	15.6	76.4	1.6	4.5
Rift Valley	11.3	75.9	1.5	10.6
Bomet	3.1	94.7	2.1	-
Narok	1.7	83.8	3.1	10.6
Transmara	0.7	93.3	0.5	5.5
Nakuru	24.8	73.3	0.9	0.1

Source: Kenya Integrated Household Budget Survey, 2005/06

Tanzania

In the Tanzanian part of the Mara basin, energy sources include electricity, kerosene/paraffin, firewood and charcoal. Table 7.2a shows the extent to which these energy sources are used in rural areas and demonstrates that firewood is the most prevalent energy source in rural areas. In all three districts, 95% - 97% of the households use firewood for cooking and heating, followed by 2% - 4.3% of households using charcoal. Table 7.2b shows the percentage distribution of households by source of energy used for lighting in rural areas. The table shows that the main sources of energy for lighting are wick lamps followed by hurricane lamps. The majority of the households in rural areas have no access to electricity. Use of electricity is limited to urban areas.

Table 7.2: Energy Consumption in Rural Areas of the Mara River Basin, Tanzania

(a) Percentage distribution of households by sources of energy for cooking

District	Electricity	Kerosine/Paraffin	Firewood	Charcoal
Musoma Rural	0.1	0.6	95	4.3
Serengeti	0.0	0.1	97	2.8
Tarime	0.0	0.2	97	2.4

Source: The United Republic of Tanzania, 2003 population and housing census

(b) Percentage distribution of households by sources of energy for lighting

District	Electricity	Hurricane Lamp	Firewood	Wick Lamp	Pressure Lamp
Musoma Rural	0.5	22.3	2.9	73.3	0.73
Serengeti	0.04	16.3	4.1	79.0	0.15
Tarime	0.09	20.4	2.4	76.4	0.4

Source: The United Republic of Tanzania, 2003 population and housing census

Table 7.3a shows the extent to which various sources of energy are used in the urban areas of the Mara districts, indicating that firewood and charcoal are of equal importance. Firewood was used by 48% of the households followed by charcoal which was used by 47% of the households. About 3% of the households use kerosene, and a very small portion of the households use gas or electricity. Table 7.3b shows the percentage distribution of households by source of energy used for lighting in urban areas. The table shows that the main sources of energy for lighting are hurricane lamps, wick lamps, and electricity.

Table 7.3: Energy Consumption in Urban Areas of the Mara Basin, Tanzania

(a) Percentage distribution of households by sources of energy for cooking

District	Electricity	Kerosine/Paraffin	Firewood	Charcoal
Musoma Rural	3.1	2.5	60	34
Serengeti	0.2	3.5	43	53
Tarime	0.8	3.3	41	54

Source: The United Republic of Tanzania, 2003 population and housing census

(b) Percentage distribution of households by sources of energy for lighting

District	Electricity	Hurricane Lamp	Firewood	Wick Lamp	Pressure Lamp
Musoma Rural	26.4	33.8	1.3	37.4	0.8
Serengeti	2.0	61.2	1.1	33.4	1.3
Tarime	15.0	42.0	1.2	39.0	1.3

Source: The United Republic of Tanzania, 2003 population and housing census

Owing to the low level of economy and technological development in Tanzania, most of the Tanzanians have no access to electricity and rely mainly on biomass as their source of energy. Electricity coverage in rural areas is practically non-existent with less than 1% of the rural population connected to the electric grid. The coverage of urban areas is better with 15% - 25% of the households having electricity access (Table 7.4).

Table 7.4: Percentage of households with electricity

District	Rural Areas	Urban Areas	Total
Musoma Rural	0.5	24.7	1.4
Serengeti	0.3	2.5	0.5
Tarime	0.2	15.2	2.7

Source: The United Republic of Tanzania, 2003 population and housing census

Apart from fuel wood energy, there is a growing use of fossil fuel (oil, gas, and coal) for various domestic, industrial, commercial, and mining purposes. The use of solar energy is hindered by the high initial costs of the associated equipment (solar panels and batteries). This option is thought of as the best alternative source of energy particularly for rural communities. Scattered use of solar-powered projects in the basin is indeed observed particularly for projects in remote areas where diesel, petroleum, and electricity are not easily available.

7.3 Energy Supply and Demand

Kenya

In Kenya, commercial energy is dominated by petroleum and electricity as the major movers of the economic sector, while wood fuel provides energy needs of the traditional sector including rural communities and the urban poor. At the national level, wood fuel and other biomass account for about 68% of the total primary energy consumption, followed by petroleum at 22%, electricity at 9% and other sources including coal at less than 1%. Electricity is the most sought after energy source by the Kenyan society and access to electricity is normally associated with rising /high quality life. However, electricity consumption in Kenya is still very low at 121KWh per capita equivalent to a national access rate of 15% which indicates extremely low levels of national penetration relative to an average of 32% for developing countries. A few countries in sub-Saharan Africa have a penetration rate well above the global average for developing countries; e.g. South Africa 67%, Ghana 45% and Zambia 42%. The challenge, therefore, is to ensure growth in electricity supply to meet increasing demand, and to improve national electricity access to levels comparable with emerging African economies and other developing countries.

Table 7.5 provides details on electric energy supply and demand balances for the period 2002 to 2006. Nationally, total electricity supply grew by 6.3% from 5,547.0 x 10^6 KWh in 2005 to 5,894.9 x 10^6 KWh in 2006. The table indicates that all consumer categories recorded increased demand in electricity except the off-peak category that declined by 15.7% between 2005 and 2006. Electricity for export nearly doubled in 2006 from 24.4x 10^6 KWh in 2005 to 46.7x 10^6 KWh in 2006. The increase in electricity consumption by street lighting category is attributed to the street lighting rehabilitation program by the city councils (Nairobi, Mombasa, and Kisumu) and other major towns in country. The electricity consumption by rural electrification category rose by 17.0% from 175.8 x 10^6 KWh in 2005 to 205.6 x 10^6 KWh in 2006 due to the ongoing reforms and extensions in rural electrification. The transmission losses and unallocated demand accounted for 18.6% of the total demand in 2006, and this is partly explained by the high increase in thermal generation.

Table 7.5: Electricity Energy Supply and Demand Balances, 2002 - 2006 (Million KWh)

Demand	**2002**	**2003**	**2004**	**2005**	**2006**
Domestic & Small Commercial	1,262.9	1,325.5	1,416.6	1,507.7	1,572.4
Medium & Large (Commercial & Industrial)	2,277.9	2,368.8	2,587.0	2,753.5	2,919.8
Off-peak	60.5	55.6	66.8	52.9	44.6
Street Lighting	6.4	7.3	7.2	8.5	10.0
Rural Electrification	134.3	153.2	156.5	175.8	205.6
Sub-total	3,742.0	3,910.4	4,234.1	4,498.4	4,752.4
Exports to Uganda				24.4	46.7
Transmission losses & unallocated demand	943.8	941.2	960.3	1024.2	1095.8
Total demand = Total supply	4685.8	4851.6	5194.5	5547.0	5894.9
Imports from Uganda and Tanzania	238.4	189.4	161.9	27.9	10.8

Net generation	4,447.4	4,662.2	5,032.6	5,519.1	5,884.1

On oil products, petroleum oil is imported in form of crude oil for domestic processing and as refined products. Petroleum accounts for about 20% of the total primary energy consumed in the country, while coal contributes less than 1% (used in the cement industry).

The supply and demand balances for petroleum products are shown in Table 7.6. The table shows that the total domestic demand for petroleum products maintained an upward trend in the period 2002 to 2006. The increases were fuelled by increased economic activities in the country.

Table 7.6: Petroleum Supply and Demand Balances 2002 – 2006 (x 10^3, tonnes)

User Demand	**2002**	**2003**	**2004**	**2005**	**2006**
Agriculture	73.8	57.0	58.1	35.7	34.8
Road transport & retail pump outlets	1208.2	1061.1	1269.0	1344.5	1542.4
Rail transport	21.6	24.2	20.8	17.9	20.5
Tourism	8.0	8.4	8.5	8.7	8.9
Marine (excluding Naval Forces)	48.4	0.5	7.5	1.3	0.9
Aviation (excluding Government)	459.6	486.4	520.9	549.4	594.5
Power Generation	208.9	151.5	204.2	319.3	386.6
Industrial, Commercial and others	310.0	280.3	291.2	362.4	405.9
Government	7.5	11.9	39.9	57.8	31.2
Balancing Item	(40.1)	47.4	(45.4)	10.4	12.5
Total	2305.9	2128.7	2374.6	2707.5	3038.2

With specific reference to the Mara River basin, the energy supplies in the basin are inadequate both in quantity and diversity. The lack of diverse energy sources indicates a general lack of economic diversity. The area relies mainly on subsistence economy and lacks investment in the energy sector that could stimulate economic growth. As population increases and most of the land area is turned into agricultural land for the production of food and cash crops, the supply of fuel wood will diminish and will be unable to meet demand. High population growth rates portend higher energy demands which are presently met by fuel wood. If the current situation persists, there will be uncontrollable destruction of the Mau Forest, the water catchment area for the Mara river system.

Tanzania

The main source of primary energy supply in Tanzania is biomass-based fuels, particularly wood-fuel (charcoal and firewood), which are the main source of energy to both urban and rural areas. Biomass-based fuel accounts for more than 90% of primary energy supply. Commercial energy sources, i.e., petroleum and electricity, account for about 8% and 1.2%, respectively, of the primary energy used. Coal, solar, and wind account for less than 1% of energy used.

Approximately half of the petroleum is consumed in the transport sector, 25% in manufacturing, and the remainder is split evenly among households, agriculture, fisheries, and other services. Recently, the oil industry has been deregulated, and oil companies can import their oil products directly, a task which was previously the responsibility of TPDC alone.

Table 7.7 provides a load forecast of electricity for the anticipated needs of the population and economy of Tanzania to 2031 under the base case assumptions mentioned below:

- Base year for the forecast: calendar year 2006.
- Forecast period: 2007 to 2031.
- Historic period used: 1986 to 2006.
- Customer categories retained.
- Tariff increases based on a cost of service recovery scenario.
- Assumed growth in GDP:
  - Agricultural component: 4% to 5%
  - Industrial component: 9% to 10%
  - Services component: 6% to 7%
- Load shed in 2006: 25% of demand in all categories.
- Accelerated electrification: 375,000 new customers added by 2013 (three quarters of the accelerated electrification program target).

Table 7.7: Load Forecast for Tanzania under Base Case Assumptions

	2006	2006	2016	2031
	Actual	Unconstrained		
National Sales (GWh)	2,784	3,400	8,600	23,100
National Losses (GWh)	806	1,100	2,100	4,000
National Generation (GWh)	3,590	4,600	10,700	27,100
National sum of peak demands (MW)		800	1,700	4,800

Source: Power Systems Master Plan Study, Final Draft Report, 2008

The existing electrical power generation in Tanzania consist of both hydro and thermal generation units. The hydro capacity is comprised of six TANESCO hydro plants with a total nameplate capacity of 562 MW (545 MW available capacity). The thermal installed capacity of the Tanzanian grid totals 690 MW (or 605 MW available capacity), for a total nameplate capacity of 1,252 MW.

7.4 Hydropower Generation

7.4.1 General Overview

The power sector in Kenya falls under the Ministry of Energy, which is responsible for the overall management, policy development, and implementation functions. The Electricity Regulatory Commission (ERC) is an autonomous entity mandated to regulate power development and cost. The Kenya Electricity Generating Company Limited (KenGen), a majority government-owned company, is responsible for electric power generation and provides about 80% of the annual electricity demand. The Kenya Power and Lighting Company Limited (KPLC), which has 52% private sector shareholding, is currently the sole electricity transmission and distribution company. KPLC purchases bulk power under Power Purchasing Agreements (PPAs) with KenGen and other Independent Power Producers (IPPs). The utility company also has an energy purchase and sale agreement with the Uganda Electricity Transmission Company (UETCL) on a non-firm basis (which is the third revision of the original 1957 contract when the two power grids were interconnected).

In Tanzania, the Ministry of Energy and Minerals is responsible for all energy related matters, while the Energy and Water Utilities Regulatory Authority (EWURA), established under the EWURA Act, 2001, has the responsibility for energy regulation. A state owned Tanzania Electric Supply Company (TANESCO) Limited, is currently responsible for electricity generation, transmission, and distribution. However, recent reforms allow private companies to engage in the generation of electricity.

7.4.2 Hydropower Potential in the Mara River Basin

Kenya

Some of the Mara tributaries in Kenya have potential for mini and micro-electric hydropower generation at various waterfall sites. For example, the Tenwek Mission in Bomet district is exploiting the potential of the Nyangores River by generating its own hydropower for use in the Mission Hospital. The Tenwek power generation has a firm capacity of 5 MW. However, to sustain the hydropower generation potential, there is need to intensify the conservation of the South West Mau Forest which is the major water catchment for the district.

In addition, the Ewaso Ngiro South basin, which is riparian to and located to the east of the Mara, has been identified as a potential hydropower development site. The hydroelectric potential of the Ewaso Ngiro South has been recognized for many years and has been the subject of a number of studies since 1980. In 1993, a detailed feasibility study proposed schemes at Oletukat, Leshota, and Oldoko on the main Ewaso Ngiro South with an inter-basin water transfer tunnel in the head waters to provide additional generation flow. The combined installed capacity would be 180 MW.

Further studies were undertaken between October, 1998, and June, 2000. This comprised a program of site investigations, environmental studies, a pre-feasibility study for a rangeland irrigation scheme, and, the development of tender stage designs and drawings for the three hydropower and the river transfer schemes. The installed capacity was reviewed and it was noted that a capacity of 260 MW provided the least cost development. However, a capacity of 220 MW was recommended to limit the impact of releases downstream of each scheme.

The water transfer scheme would consist of a 2.6 m^3/s mean flow water transfer from the Amala River to the Nosagami River which is a tributary of the Ewaso Ngiro South. Maximum water transfer was not to exceed 6 m^3/s.

The significant feature of the proposed Ewaso Ngiro hydropower development is the transfer of water from Amala River into the headwaters of the Ewaso Ngiro. The arrangement would enhance the yields of all three hydropower plants. However, the increased flow in the Ewaso Ngiro and the seasonal regulation imposed by the storage reservoirs on the cascade would alter the inflows into Lake Natron downstream. This raised cross border issues with Tanzania and possible concerns over the changes to the ecology and water balance at the northern end of the lake. The location of the Ewaso Ng'iro River and Lake Natron in relation to the Mara River basin is depicted in Figure 7.1.

A study of options for preventing the Amala transfer flows from reaching Lake Natron was undertaken and a pre-feasibility study to assess the viability of irrigating some 6,000 ha of rangeland downstream of Oldorko was completed in January, 2000. It is, however, recommended that further work need to be undertaken, but it appears feasible that a rangeland irrigation scheme of the proposed size could redress the impacts of the upstream projects on the inflows into Lake Natron. The proposed irrigation scheme would additionally provide an important source of grazing for Masai livestock.

However, in 2000, KenGen, the electric power generating company in Kenya dropped the Ewaso Ng'iro project from its portfolio of Least Cost Power Development Plan and decided not to pursue it any further until such time as its costs would justify inclusion in any future least cost plans.

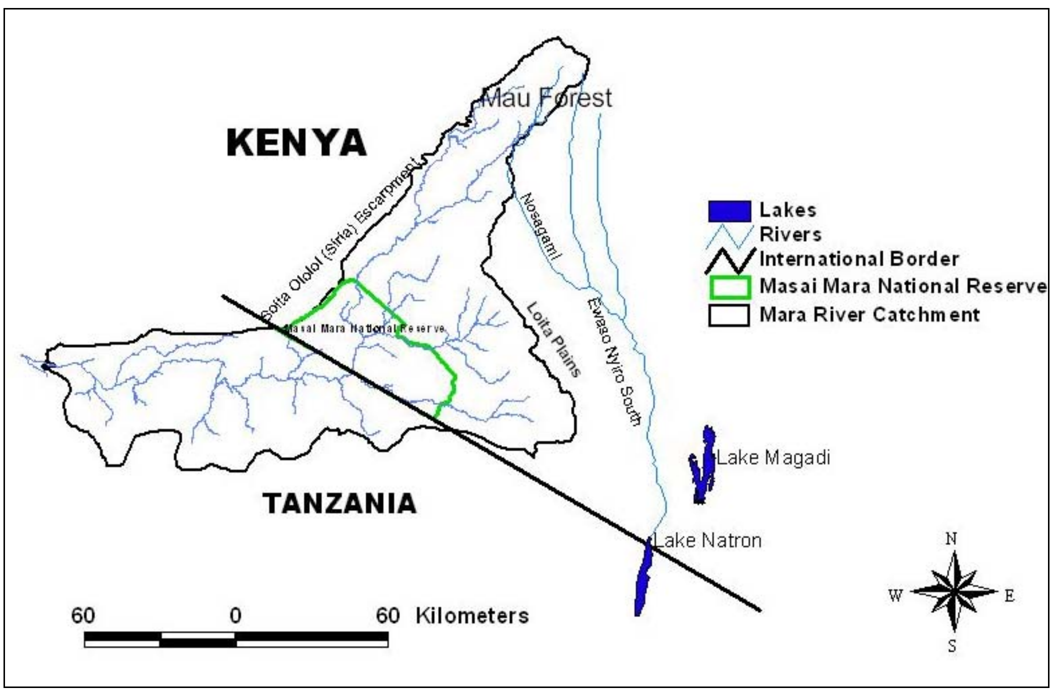


Figure 7.1: Location map for River Ewaso Ng'iro South

Tanzania

In Tanzania, the potential for hydropower generation in the Mara Basin has been identified at the Mara mine location taking advantage of the 304.8 meters head between the Kenyan border and the Mara mines. This head has been estimated to produce an estimated of 380 million KWh of electric power. However, no feasibility study has been carried out on this project. Implementation of this project would involve building a reservoir across the Mara River and would require a comprehensive regulation plan. The regulation plan would need to address several upstream and downstream issues including sedimentation in the reservoir, inundation of the land upstream of the dam embankment, constraining fish habitants, and maintaining the downstream Mara wetland, among others.

7.5 Electricity Generation, Transmission and Distribution

Kenya

In Kenya, electricity is generated from a number of sources including hydropower, geothermal, thermal, and wind. Details of installed capacity of electricity for the period 2002 to 2006 are presented in Table 7.8. The total installed capacity increased slightly in 2006 from 2005 as a result of commissioning a co-generation plant with an installed capacity of 2 MW by the Mumias Sugar Company and an Emergency Power Producer (EPP) with a thermal installed capacity of 80 MW. However, thermal oil installations with a generating capacity of 61.5 MW were decommissioned.

Details of generated electricity are presented in Table 7.9. The generated electricity stood at 5,894.9 GWh in 2006 compared to 5547.0 GWh in 2005. The increase was due to improved electricity production from thermal oil and geothermal units which rose by 20.7% and 4.4% respectively in 2006. Hydro electric power generation declined slightly from 3,038.9 in 2005 to 3,024.8 GWh to account for 51.3% of electricity generation in 2006. The drop was attributed mainly to the drought experienced in the country during the first quarter of 2006.

Geothermal and thermal sources accounted for 17.7% and 30.8% of generated electricity in 2006. During the same year, Independent Power Producers (IPPs) produced 942.4 GWh of electricity while the Emergency Power Producer (EPP), which was commissioned in June 2006 due to a shortfall in supply, generated 331.6 GWh of electricity. Co-generation by the Mumias Sugar Company produced 5.6 GWh.

Table 7.8: Summary of Installed Capacity in Kenya, 2002 - 2006

Year	Installed Capacity (MW)				
	Hydro	Thermal oil	Geo-thermal	Co-generation	Total
2002	677.2	407.0	58.0	-	1142.2
2003	677.2	407.0	58.0	-	1142.2
2004	677.3	392.8	128.0	-	1198.1
2005	677.3	351.3	128.0	-	1156.6
2006	677.3	369.8	128.0	2.0	1177.1

Table 7.9: Generated Electricity in Kenya, 2002 - 2006

Electricity Generation (GWh)								
Hydro	Thermal oil				Geo-thermal	Co-generation	Wind	Total
	KenGen	IPP	EPP	Total				
3070.9	279.8	887.5	-	1167.3	447.2	-	0.4	4685.8
3432.8	345.3	574.7	-	920.0	498.4	-	0.4	4851.6
3169.2	416.4	621.8	-	1038.3	986.6	-	0.4	5194.5
3038.9	580.2	926.0	-	1506.2	1001.6	-	0.3	5547.0
3024.8	544.6	942.4	331.6	1818.5	1045.7	5.6	0.3	5894.9

On transmission and distribution, the Kenya Power and Lighting Company (KPLC) own and operate the two systems. As of June 2006, the transmission system consisted of 1,323 km of 220 kV lines, 2,035 km of 132 kV lines, and 600 km of 66 kV sub-transmission lines. The distribution system consisted of 58 km of 40 kV, 5,973 km of 33 kV, and 15,267 km of 11 kV distribution lines. The corresponding substation transformer capacities were 2,602 MVA for the 220/132/66/33 kV, and 1,384 MVA for the 66/33/11 kV distribution system. Distribution transformer capacity for the 33/0.415 kV and 11/0.415 kV network totalled 2,801 MVA and is recorded to have increased at an average annual growth rate of 6.2% in the last five years. A major project to upgrade and reinforce the distribution network is currently being implemented as part of the larger Energy Sector Recovery Project (ESRP) co-ordinated by the Ministry of Energy and being implemented over a four year period.

In the Kenyan part of the Mara basin, electricity grids of 33 kV and 11 kV mainly serve the major towns such as Bomet, Narok, Ololulunga, Kilgoris, Mulot, and Longisa. The current program is to ensure the availability of electric power in the rural market centers, schools, and health facilities.

Tanzania

Electricity is generated from a number of sources including hydropower, which contributes about 45% of the total installed capacity of power production in Tanzania, and the rest is from thermal sources such as gas, diesel, and Heavy Fuel Oil (HFO) (Table 7.10). The major fossil fuel used in power production is diesel oil used by generators in major towns. The recent discovery of natural gas along the southern Tanzania coast has contributed to power production by gas-powered generators.

Table 7.10: Existing Power Production Capacities by Source, Tanzania

Source	**Installed Capacity (MW)**
i) Hydropower	562
ii) Thermal	
- Diesel	80.00
- Gas turbines	463.00
. – HFO	147.00

Total thermal	690.00
Total installed capacity	**1252.00**

The power networks in the country develop based on demand and generally follow political administrative regions. These networks cover a total of 22 regions on the mainland of which 14 are connected to the main grid and 6 form isolated systems. Zanzibar is composed of two main islands (Unguja and Pemba). The region of Unguja in Zanzibar is connected to the TANESCO grid, while Pemba is supplied by an isolated power plant.

The main grid is supplied by six hydroelectric power plants (two more awaiting rehabilitation), and six main thermal power plants. The five main hydroelectric power plants feed at 220 kV and 132 kV levels. Smaller power plants are connected at 66 kV and 33 kV levels. The main load centres and the power plants are interconnected at 220 kV. Tanzania considers 33 kV and 11 kV to be the medium voltage distribution, while there are plans to phase out the 66 kV voltage level. In the medium term, long distance transmission will continue to be at 220 kV and 132 kV. The coastal stretch to the north of Dar Es Salaam is supplied at 132 kV.

TANESCO imports between 5 MW and 10 MW of bulk power from Uganda for the Kagera region, while Sumbawanga town in Rukwa region and Tunduma and Vwawa (Mbozi) township in Mbeya region are supplied by the neighbouring Zambia.

The Musoma region is connected to the National Electricity Grid from Mwanza. Two transformers of total capacity of 24 MW serve this region. The consumption of electricity in the Mara region ranges from 3,000,000 to 4,000,000 Kwh per month. The maximum regional demand is estimated at 9 MW.

Regional Initiatives

At the regional level, the East African Community member countries have continued to pursue integration of their power grids to enable increased power trade, improved reliability and optimised operation and development. The Governments of Kenya and Tanzania obtained funding for the implementation of a 330 kV transmission line project between Arusha, Tanzania, and Nairobi, Kenya. The project is expected to be completed in 2009. Ethiopia and Kenya are undertaking a feasibility study for an interconnection scheme financed by the African Development Bank, the Development Bank of Southern Africa, the French Development Agency, and KfW of Germany. The line would enable transfer of electricity from identified Ethiopian large hydropower projects that are more economic than hydro sites in Kenya. Implementation of this project will catalyze development of the Ethiopian hydro generation projects and enable Kenya to access cheaper power.

A 21-month study also commenced in February 2006, under the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) of the Nile Basin Initiative, for a second Kenya-Uganda Interconnection, among others. The study will cover pre-feasibility, feasibility, detailed design, and preparation of tender documents on four interconnection projects.

7.6 Rural Electrification

Kenya

The rural electrification program in Kenya started in 1973 as part of the basic infrastructure to stimulate socio-economic growth and stem rural-urban migration through the creation of social amenities and employment opportunities at close proximities to the rural population. The Kenyan government has intensified this program under the Kenya Rural Electrification Program (REP) to promote rural development by providing affordable electrical energy to more people living in the rural areas. Under the current Kenya policy, the goal is to provide electricity to 20% of the rural population by 2010 and increase to at least 40% by 2020. This program is of particular importance to the districts within the Mara River basin. This policy accelerates the pace of rural electrification through grid extension and off-grid projects.

The Government has established the Rural Electrification Authority to manage the rural electrification program and privatization or concessioning of isolated systems.
The electrification of the districts in the Mara basin falls under the mandate of the Rural Electrification Authority and a program to improve the electric power availability in the Mara basin is ongoing. Table 7.11 presents ongoing and proposed electrification projects to connect some rural markets, schools, and health centers in the basin to the national grid.

Table 7.11: Rural electrification projects in the Mara River Basin, Kenya

District	**Project**	**Status**
Bomet	Mulot market and Do's office	Construction in progress
	Kaboson Market	Construction in progress
	Kapkwen Market	"
	Goitabsilibwet Secondary School	"
	Mengwet Secondary School	"
	Kipkegei Secondary School	Construction on-going
	Makimeny Market and Secondary	Up-coming
	Kongotik Girls Secondary School	Up-coming
	Tegat Health Centre	Up-coming
	Siwot market/Dispensary/Secondary School and Aisaik Secondary School	Up-coming
	Kiplokyi Secondary School	Up-coming
Nakuru/Molo	Kapsimbeiywo Secondary School	Construction on-going
	Amalo Water Supply	Construction in progress
	Chemaner Health Centre	

	Langwenda Market; Kiptende water Supply; Kaplamai Health Centre; Ambusket Market and School	Up-coming
Transmara	Kararo Market	Construction in progress
	Osinoni Market	Construction in progress
	Shankoe Market	Up-coming
	Osupuko Market	Up-coming
	Emurua Dikirr,Murugan and Kapolecho Markets	Up-coming

Tanzania

Energy services have an impact on all rural economic activities including agriculture, business, social services, gender equality, and poverty. Addressing energy requirements in rural areas is in line with the provisions contained in the Tanzania Development Vision 2025. About 85% of the total energy is consumed in the rural areas where the majority of the Tanzanians live. Biomass, particularly wood fuel, constitutes 90% of rural energy consumption, which has significant impact on the process of environmental degradation. The balance of 5% is met by other options such as kerosene, diesel, biogass, solar, wind, and other renewable energy sources. The rural population with access to electricity is only about 1%. The low consumption of commercial energy has suppressed economic growth, which is manifested in low levels of agricultural mechanisation and industrialisation.

The national energy policy (2003) emphasizes the importance of rural electrification:

(i) Rural electrification is needed to make electricity available for economic activities in rural areas, townships and commercial centres; This is a pre-requisite for a balanced socio-economic growth.

(ii) Reaching rural households with electricity would provide energy supply to replace kerosene used for lighting, improve the efficiency of wood-fuel use, improve the standard of living, and reverse deforestation.

Currently, there are several programs of rural electrification for the whole of Tanzania being implemented by TANESCO and the Government with strong support from development partners. The program of TANESCO is to add 3,000 to 5,000 rural customers per month. The government program is more ambitious—electrify 100,000 urban, peri-urban, and rural customers per year over the next five years (PSMP, 2008).

The districts in Mara River Basin are connected by the following grids:

i) Tarime feeder (33 kV) – supplies electrical energy 550,000 kwh per month to 51 villages;
ii) Butiana Feeder (33 kV) – supplies electrical energy 350,000 Kwh per month to 33 villages;
iii) Makoko feeder (11 kV) – supplies electrical energy 1,000,000 kwh per month to 33 villages.

7.7 Electric Power Tariffs

Kenya

In Kenya, electricity is supplied to slightly more than 15% of the total population. The access rate in rural areas is estimated at 4%. This supply is predominantly to the middle and upper income groups. The Energy Regulatory Commission (ERC) is responsible for reviewing and approving electricity tariffs proposed by the Kenya Power and Lighting Company before they become effective.

The current retail electric power tariffs came into operation in July, 2008. There are five consumer categories, namely:

- Domestic consumers (DC)
- Small Commercial consumers (SC)
- Interruptible supply (IT)
- Street lighting (SL)
- Commercial/Industrial consumers

The tariff structure comprises an energy charge, a capacity charge, and a demand charge. Automatic charges intended to cushion the utilities against oil price and foreign exchange rate fluctuations are also applicable. Besides the gazetted KPLC tariffs, consumers pay value added tax (VAT), as well as Electricity Regulatory Commission and Rural Electrification Program (REP) levies. The automatic adjustments, i.e., Fuel Oil Surcharge (FOS) and Foreign Exchange Rate Fluctuation Adjustment (FOREX), fluctuate from one billing period to the next, depending on the cost of fuel and the prevailing exchange rate relative to the base value. The following is a summary of these taxes and levies while Table 7.12 (a) and (b) show the current electric power tariffs, effective from 1st July, 2008.

Taxes and other levies included in the tariffs comprise the following:

- Fuel Oil Surcharge (FOS) which fluctuates every month due to increase/decrease in the price of fuel used in power generation. This will be the most expensive charge due to the continuing increase in the price of fuel locally and at the global market.
- Foreign Exchange Rate Fluctuation Adjustment (FOREX).
- VAT at 16% of standing charge and taxable value of electricity energy consumed with the exception of the first 200 Units under domestic consumption.
- Rural Electrification Programme (REP) Levy at 5% or Revenue from unit sales
- Energy Regulatory Commission (ERC) Levy at cents 3/kWh.
- Power Factor surcharge for any installation whose power factor is less than 0.9 lagging.

Table 7.12: Approved Electricity Tariffs and Rates, Kenya

(a) Tariffs for Domestic, Small Commercial, Interruptible and Street Lighting Customers

Tariff	Supply voltage (V)	Consumption /Month (kWh)	Fixed charge (Kshs/month)	Consumption/Month (kWh)	New Cost/kWh (Kshs)
Domestic Consumer (DC)	240 or 415	≤15,000	120.00	0 – 50 51 – 1500 >1500	2.00 8.10 18.57
Small Commercial (SC)	240 or 415	≤15,000	120.00		8.96
Interruptible (IT)	Off-peak metered at 240 or 415	≤15,000	120.00 240.00 when used with DC or SC		4.85
Street Lighting (SL)	Metered at 240V		120.00		7.50

Source: The Kenya Power & Lighting Co. Ltd

(b) Tariffs for Commercial/Industrial Customers

Tariff	C1	C12	C13	C14	C15
Fixed charge	800.00	2,500.00	2,900.00	4,200.00	11,000.00
Voltage	415V	11kV	33/40 kV	66 kV	132 kV
Charge/Unit (kWh) (Kshs)	5.75	4.73	4.49	4.25	4.10
Demand (Kshs/KVA)	600.00	400.00	200.00	170.00	170.00
Units Consumed	> 15,000	> 15,000	> 15,000	> 15,000	> 15,000

Source: The Kenya Power & Lighting Co. Ltd

Tanzania

In Tanzania, TANESCO is responsible for the distribution of electricity in the country including the definition of its customer categories, and EWURA is responsible for reviewing and approving electricity tariffs proposed by TANESCO. Electricity tariffs vary depending on the category of electricity customers. TANESCO has defined its customers into four customer categories.

According to the new recommended electricity tariffs and connection charges applicable in Tanzania mainland, which became effective since 1st January 2008, there are significant differences of customer tariffs (Table 7.13). The domestic low voltage customers, for example, do not pay basic service charge and are charged 49 TShs per kWh of electricity utilized. However, for those exceeding monthly usage of 50 kWh, any extra 1 kWh is charged at 156 TShs. Industrial customers (T2 and T3) are charged a monthly basic charge and a flat rate of 85 TShs per 1 kWh of electricity consumed.

Table 7.13: Electricity Tariffs in Tanzania

Tariff Category		**Tariff Block (kWh/month)**	**Tariff in (TShs)**
Code	**Type**		
D1	Domestic Low Usage	0 – 50	40 per kWh
		Over 50	128 per kWh
T1	General Usage, including residential, commercial and industrial use, with average monthly usage over 275 kWh	All kWh	106 per kWh
		Service charge	1,892 per month
T2	General use, but exceeding 7500 kWh per month, demand not exceeding 500 kVA	All kWh	70 per kWh
		Demand charge	7,680 per kVA
		Service Charge	7,012 per month
T3	High voltage tariff, metered at 11 kv or above	All kWh	65 per kWh
		Demand charge	7,123 per kVA
		Service Charge	7,012 per month

Source: Standardized Small Power Purchase Tariffs for Tanzania, 2007

Currently the two countries of Kenya and Tanzania set their electricity tariffs separately. It is, however, noted that the current tariffs in Kenya are much higher than the tariffs in Tanzania.

7.8 Potential Sources of Energy

Apart from biomass, fossil fuels, and electricity there exist a number of other potential energy sources yet to be developed. These include:

- Solar energy;
- Wind energy;
- Bio-gas;
- Medium-scale hydropower on Mara Mines.

Renewable energy sources, including solar and wind, are environmentally friendly, and their development can create employment opportunities, improve the quality of life, and reduce poverty. Solar energy can be harnessed for water heating, cost effective crop drying, and electricity generation for households and telecommunication facilities in isolated locations. Solar energy is currently widely used for crop applications and fish and wood drying through direct sun exposure (which affects product quality). In view of the Mara River basin location, solar energy is available throughout the year. Unfortunately, developing solar energy is still expensive making it less favorable than other energy sources.

Following is a brief description of potential energy sources.

7.8.1 Solar Energy

The potential for solar energy in Kenya is estimated at 4 to 6 KWh per m^2 per day of insolation, which translates into approximately 250 million tons of oil equivalent per day. However, only a minute fraction of this resource has been harnessed.

Solar energy applications are diverse and include solar heating and drying, solar photovoltaic (PV) lighting, water pumping, refrigeration, and telecommunications. Solar PV is widely used for provision of low power electricity in off-grid rural and depressed urban areas. It is estimated that up to 4 MW of PV power is currently installed in Kenya. The Government recognizes the great potential of this source of energy and will encourage the development and utilization of appropriate technologies. The challenge is to develop fiscal and regulatory frameworks that would create an enabling environment to accelerate the development and utilization of these technologies.

In Tanzania, a study was conducted through the Tanzania Rural Electrification Study (TRES) to assess the potential of solar as a source of energy. The study revealed that there is good and stable solar potential in Tanzania. The monthly average insolation was determined to range between 4.5 – 5.3 kWh/d. However, one of the major constraints with regard to development of solar energy is lack of dissemination of information on PV systems. High initial costs constrain the development of this energy source. The Government of Tanzania in collaboration with the development partners has initiated a number of projects aimed at creating an enabling environment for developing solar energy in the country. The projects are targeted at raising awareness in the use of solar energy, building capacity by developing curriculum for training technicians in vocational training centers, and demonstrating the use of solar in schools, health centers, and dispensaries. Other projects are aimed at removing market barriers to use solar energy.

7.8.2 Wind Energy

Wind energy has been used in Kenya primarily for water lifting since the beginning of th19th century but its use declined with the advent of the more flexible and easy to use oil fired internal combustion engines. However, with rising oil costs, the exploitation of wind energy is becoming increasingly more attractive, particularly in remote areas away from the power grid and oil supply outlets. To promote investment in wind energy generation, the Ministry of Energy has recently completed preparation of a broad National Wind Atlas. The national statistics show that more than 50% of the country has more than a fair chance of harvesting wind energy. But these resources are spatially distributed depending on terrain, climatic, and seasonal factors.

In addition, the Kenyan Government is promoting the development of wind-diesel hybrid systems for electricity generation under the rural electrification program in areas remote from the national grid.

The challenge in developing this energy source is to attract private sector investments in the fabrication of wind power systems.

In Tanzania studies have been under way for a number of years, sponsored by the Ministry of Energy, TANESCO, TaTEDO (Tanzania Traditional Energy Development and Environment Organization) with technical and financial support from RISO (Denmark National Laboratory) and DANIDA. The global climate data indicates that Tanzania is located in a generally low wind tropical area. However, there are local phenomena due to high mountains and escarpments, which have wind speed effects. Studies have revealed observations of good wind speed along the rift valley escarpment in Tanzania of about 9.4m/s. At some locations, spot measurements have been observed as high as 12 m/s.

There are a number of wind resources assessment initiatives being undertaken in the country, whereby more new sites are being proposed for assessment of their wind resources. There are also plans to develop a wind map across the country. Meanwhile, investors have shown interest in developing grid connected wind farms in the surveyed areas (Singida) to generate 50 – 100 MW.

7.8.3 Small Hydropower

In addition to the identified economically significant hydroelectric sites with at least 30 MW potential, it is estimated that there exists at least 3,000 MW of hydroelectric power potential in the whole of Kenya as small and micro to pico hydro projects that are currently considered uneconomic to exploit. However, it is probable that pre-feasibility studies of these projects may establish economic viability for a host of applications including community based electricity production. The Kenya Government is encouraging development of such projects by communities and investors alike through mobilization resources for undertaking pre-feasibility and feasibility studies for those of high economic merit order ranking. There is need to undertake reconnaissance and pre-feasibility and feasibility studies on the resource potential in all river drainage basins.

In the Mara River basin, some of the Mara tributaries in Kenya have potential for small and micro-electric hydropower generation at various waterfall sites in the upper catchment. For example, the Tenwek Mission in Bomet district is exploiting the potential of the Nyangores River by generating its own hydropower for use in the Mission Hospital. However, to sustain the hydropower generation potential in this region, there is need to intensify the conservation of the Mau Forest Complex which is the water catchment area for the Nyangores and Amala Rivers.

Tanzania's total technical hydroelectric energy potential is reported to be in excess of 5,000 MW installed capacity. Of this potential installed capacity, only about 12% has actually been developed. Tanzania has nine river basins, of which hydroelectric capacity has been developed in two river basins namely Pangani and Rufiji. A compilation of information in year 2002 by TANESCO lists more than 60 potential sites in various capacities in the range of 45 kW to 80 MW (MoEM, 2007). These sites have been studied to various levels of detail, but most are only identified and a conceptual study has been conducted with the available maps and river flow/rainfall data. Of the total hydroelectric energy potential assessed so far in Tanzania, the total potential for small hydro-power (capacity < 10 MW) is reported to be about 315 MW. However, there are no reports indicating any assessment that has been carried out on small hydropower in the Mara River Basin on the Tanzanian side.

7.8.4 Bio Diesel

Bio diesel is not currently used in Kenya. However, production potential from locally grown trees and crops exists. There is need for research and development on the potential for the exploitation of this energy supply option, learning from other countries that have succeeded in the implementation of this technology.

However, given the shortage of arable land in Kenya, climate variability, high dependence on rain-fed agriculture, and inadequate food production, the challenge is to develop biotechnologies for production of bio-diesel crops in low and medium potential lands.

In Tanzania, bio-diesel can be produced from jastropher and palm trees. Currently, the Government of Tanzania is keen on implementing a project to prepare the policy, legal, regulatory, and institutional framework aimed to prepare a sound ground for the production of bio-diesel in the country toward energy sustainability. It is anticipated that the growing of plants for the production of bio-diesel will take into consideration national interests as far as employment, land, environment, and food security. Since 2005, about 8 companies have been issued licenses to invest in bio-diesel production.

7.8.5 Power Alcohol

Power alcohol was introduced in Kenya as a fuel blend for gasoline in 1983. However, its use was discontinued in 1993 due to production related problems leading to unsustainable pricing. This blend which was used as a substitute for premium gasoline (93 octane)) had a volume composition of 65% super petrol, 10% alcohol, and 25% ordinary or regular petrol. The Kenya Government is planning to reintroduce power alcohol as a motor fuel in its long-term economic policy to enhance security of supply and redress the trade imbalance arising from petroleum imports. The challenge is to redress the management and pricing problems which led to the loss of its competitiveness in the market place and the eventual withdrawal there from.

There is a potential for the production of power alcohol in Tanzania from sugar cane. A number of companies have shown interest to invest in this sector. As mentioned for the case of production of bio-diesel, the Government of Tanzania is implementing a project to prepare the policy, legal, regulatory, and institutional framework aimed to prepare a sound ground for the production of bio-fuels including power alcohol in the country.

7.8.6 Biogas

Despite its potential benefits, the penetration rate of biogas technology is still very low in Kenya. Research has shown that about 30% of the 800 biogas digesters introduced in the1980s have fallen into disuse (Kenya, Sessional Paper No.4 on Energy, May, 2004) The main problems are poor management, high initial capital costs, high maintenance costs, limited water supply, and weak technical support.

The challenge is to redress these constraints with a view to improving system management and level of awareness so as to enhance wider acceptance and adoption of the technology. The Government plans to provide technical support in the form of research, development, and demonstration projects.

In Tanzania, the use of biogas as a source of energy is also still very low as is the case for Kenya. The main problems in developing this technology are also similar and include poor management, high initial capital costs, high maintenance costs, and lack of technical support.

7.8.7 Municipal and Industrial Waste Energy

With the appropriate management of municipal waste, it is possible to generate electricity using different technologies, the sale of which could generate revenues sufficient to cover the costs of waste collection and treatment by local authorities. For the large cities in Kenya that continue to experience serious waste management problems, the use of waste for electricity generation is a unique solution to their revenue problems as well.

The challenge is to improve waste management, including sorting to identify waste suitable for electricity generation. Further, there is need to identify appropriate technologies with potential for electricity production using municipal waste as feedstock. From April 2008, the Kenya Government has introduced a new *feeding tariff* which guarantees the purchase of power developed from such sources by the Kenya Power and Lighting Company.

In Tanzania there is a potential to generate energy from industrial wastes to meet the increasing power load. Typical examples are power plants using bagasse (waste sugar cane), rice husk, timber industry waste, municipal waste, and any other material which is bio-degradable. Tanzania has two power plants which use industrial waste and the plants have capacity to deliver to the grid:

i) A 7 MW surplus capacity (partly installed, but not yet fully commissioned) at the TPCL (sugar industry), using bagasse (waste sugar cane). The industry has an operational power plant to serve its own internal requirements.
ii) A 2.5 MW capacity at TANWAT company installed in 1995, which previously served the mini-grid in the area and was recently connected to the main grid.

There is considerable interest in Tanzania to develop power plants by burning waste from coconut and sisal plantations, timber, industrial waste, and municipal waste.

7.9 Challenges in the Energy Sector

Developing economies require sufficient energy supplies and affordable electricity services for economic development. Availability of adequate electrical energy is crucial for the economic development of Mara River Basin. However, development of the power systems faces many challenges:

- Lack of accessibility to affordable electricity services due to a combination of low consumer incomes and high electricity tariffs. Currently about 15% of the Kenya population has electricity which is low due to the high costs of consumer connections and network expansion particularly in rural areas and among the urban poor. In the rural areas, where access is about 4%, the scattered nature of human settlements further escalates the supply costs. About 10% of the population in Tanzania currently has access to electric power supply while in the rural areas access is only about 1%.
- Lack of financial resources to invest in expansion of transmission and distribution of electricity network in rural areas.
- Low household income in the urban and rural areas of the Mara River basin and high electricity tariffs bar people from using electricity services.
- The high initial costs of developing solar energy applications limit the use of this important and abundantly available renewable energy source.
- Lack of financial resources, technology, and human capacity comprise major constraints in developing the use of bio-gas.
- Least-cost energy sources appropriate for both urban and rural areas in the Mara River basin have not been adequately evaluated.
- Detailed feasibility studies to evaluate hydroelectric power projects and least-cost power options have not been carried out.
- High electricity tariffs.
- High cost of undertaking feasibility studies and resource development.
- Inappropriate credit schemes and financing mechanisms.
- Unavailability of small hydro systems and accessories on the local market.
- Lack of domestic manufacturing capacity for hydro systems of all sizes.
- Obsolete and inefficient technologies in old hydro plants.
- Deforestation, destruction of water towers, and climate variability make hydropower investments appear risky.
- Inadequate hydrological data.
- Inadequate policy, legal and regulatory frameworks to support exploitation of the natural resource.
- Inadequate financial resources to modernize the power transmission and distribution infrastructure for reliable and cost-effective electricity supplies.

The issues raised in the provision of energy in the Mara River basin as in the rest of the two East African countries are summarised in Table 7.14.

Table7.14: Issues Matrix on Energy and Hydropower Development in the Mara River Basin

Issues	Causes	Impacts	On-going and Planned Intervention Measures	Potential Investment Projects
Low countrywide electricity access	-Low consumer incomes. -High electricity tariffs. -High cost of consumer connections.	-Major hindrance to socio-economic development in the country. The level and intensity of commercial energy use in a country is a key indicator of the degree of economic growth and development.	-The Kenyan Government has formulated an Energy Access Scale-up Program through which 1 million households will be connected with electricity between 2008 and 2012 at an estimated cost of 84 million KShs. The program which will be financed by the Government as well as development partners will target connecting all major trading centres, secondary and primary schools, community water supply works and health centres in the country. This is intended to increase electricity access in the rural areas currently at 4% to 12% by the year 2012. -In 2007 the government of Tanzania has established an agency to promote accessibility of sustainable energy in rural areas by providing subsidies to both private and public sector and also to assist investors to	Promoting renewable energy alternatives.

			prepare projects concerning provision of energy to the rural areas. The government of Tanzania has also established a fund to promote rural electrification.	
Weak power transmission and distribution infrastructure	-Lack of financial resources to invest in expansion of transmission and distribution networks	Low electricity coverage and high production losses due to power outages.	The government has continued to finance extension of electricity supply in the rural areas as part of the basic infrastructure to stimulate economic growth and employment.	
Lack of solar energy	-High initial costs of developing the resource.	-Low socio-economic development.	-Under the Vision 2030, the Kenya Government intends to spend 180 KShs million to provide solar electricity generators to 74 public institutions including boarding primary and secondary schools, health centres and Dispensaries. Narok South district is one of the districts to benefit from this program. -The Government of Tanzania in collaboration with the development partners have initiated a number of projects aimed at creating an enabling environment for developing solar energy in the country. The	

			projects are targeted at raising awareness in the use of solar energy, building capacity.	
Over-dependence of bio-mass as a source of energy	i) Low income levels to afford alternative sources. ii) Non availability of alternative sources in rural areas.	i) Cutting down of trees for firewood and charcoal making. 95 – 97 % of households in the rural areas use firewood as source of energy for cooking and heating. In urban areas 48% and 47% of households use firewood and charcoal respectively for cooking and heating. ii) Cutting down of trees enhances erosion and flooding.	i) Manufacturing of stoves which minimize the use of biomass. ii) Promoting planting of trees to meet requirements for firewood and charcoal. iii) Implementation of mitigation measures by District councils and NGO's.	Support a long term tree-planting program. Research to design stoves efficient/economical in using biomass.

8.0 Land, Water, and Air Transport

8.1 Introduction

This chapter presents the general infrastructure development in the Mara basin including, road network, airports and ports. Road transport is the most common mode of travel, although the road network is generally not well developed and maintained. Most roads in the Mara basin are earthen and become almost impassable during the rainy season.

Air transport is widely used in Kenya by tourists visiting the Masai Mara National Reserve and large-scale wheat farmers who use small planes between farms and the major towns. On the Tanzanian side, air transport is used to link the Mara Region and its district headquarters with other regions.

There is no railway transport in the catchment area. Water transport is not viable since the Mara River, the only permanent river, is not navigable. Water transport is practiced in Lake Victoria in Tanzania.

8.2 Land Transport

The road transport system plays a central role in the economy and promotes local and national linkages. The road network varies widely in its characteristics.

Kenya

The roads in Kenya are classified into the following main categories:

- Class A comprises international trunk roads;
- Class B connects administrative provincial headquarters (i.e., national trunk roads);
- Class C connects district headquarters (primary roads);
- Class D is local access roads (secondary roads);
- Class E is minor roads; and
- Class F is special purpose roads.

In Kenya, the Mara River basin roads are class B through class F. The primary transboundary transport is the class B road from Nairobi – Mai Mahiu – Narok – Bomet - Kisii town. From Kisii, the class B road joins the class A road through Migori to Isebania at the border of Kenya and Tanzania. The Mai Mahiu to Narok road section is currently under reconstruction. The road network is shown on Figure 8.1.

The remaining network is gravel and earthen roads. In general, the roads are in very bad condition and people walking long distances lose productive time. The poorly maintained surface roads and feeder roads linking trading centers make it very difficult for farmers and merchants to transport and market produce and materials, especially during the rainy season. Poor road access hinders productivity and thereby promotes poverty levels.

In the Narok district, the total classified and unclassified road network is approximately 1,150 km and 3,200 km respectively (Narok District, DDP 2002-2008). While this network supports economic activities, most of these roads are earthen and impassable during the rainy seasons. The Mara Game Reserve roads are currently maintained by the local authorities and are in fairly good condition.

The Bomet district has about 120 km of paved roads. Included is the newly constructed Narok-Kaplong road. Another approximately 590 km are gravel and 350 km are earthen roads (Bomet District, DDP 2002-2008). The road network in Transmara district is comprised of approximately 10 km bitumen roads, 170 km murram /graveled roads and 270 km earth roads (Transmara District, DDP 2002-2008).

Tanzania

In Tanzania, the road network is classified into four main grades:

- Trunk (national/international) roads connecting regional centers and providing access to border posts and ports;
- Regional roads connecting centers to trunk roads;
- District roads connecting different areas within the districts; and
- Feeder roads linking villages and centers within the wards.

The total road network in the Mara basin is about 2,280 km. Of the total, about 310 km are trunk, 600 km are regional, 655 km are district, and 715 km are feeder roads. The 315 km of trunk roads are dominated by the Sirari - Tarime - Makutano - Bunda - Mwanza Highway. Table 8.1 presents in summary the road network by grade and district.

Table 8.1: Road Network by Grade and District, 2002

District	Grade (km)				
	Trunk	Regional	District	Feeder	Total
Musoma Rural	96	196	265	327	884
Tarime	139	273	215	270	897
Serengeti	79	131	174	117	501
Total	314	600	654	714	2282
% of Total	14	26	29	31	100

Source: National Bureau of Statistics and Mara Regional Commissioner's Office (2003) Mara region socio-economic profile.

The road network is also classified by road surface type. The network includes about 140 km of tarmac and 420 km of gravel. The remaining 1,720 km are earthen. Most earthen surface roads are in district and feeder roads. Road classification by surface type and district is presented in Table 8.2.

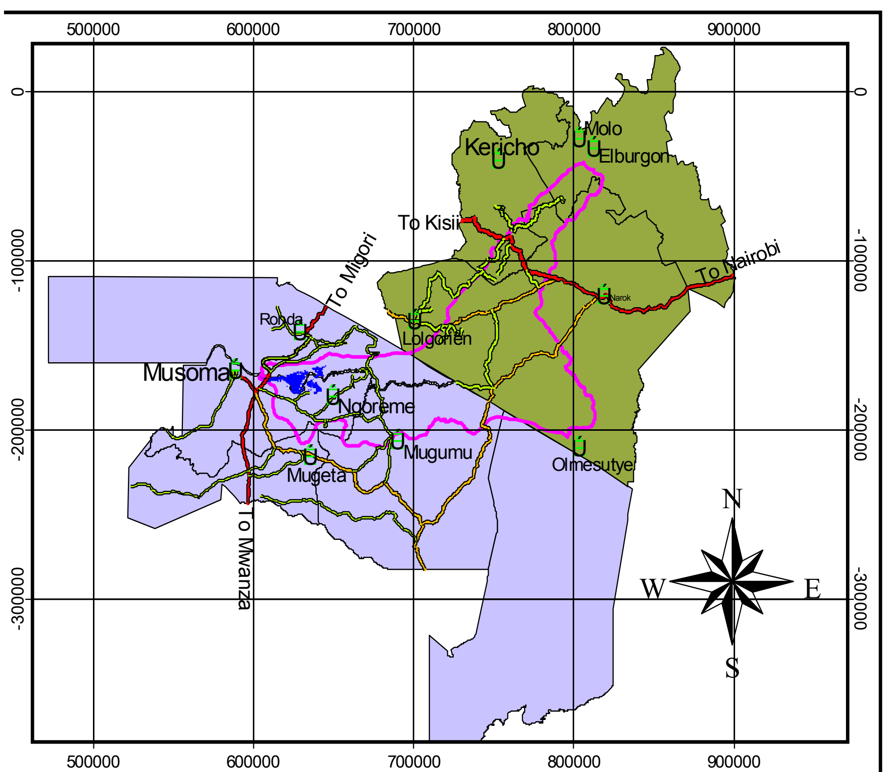
Table 8.2: Road Network by Surface Type and District, 2002

District	Type of surface (km)			
	Tarmac	Gravel	Earth	Total
Musoma Rural	64	170	650	884
Tarime	79	124	694	897
Serengeti	0	127	374	501
Total	143	421	1718	2282
% of Total	6	18	75	100

Source: National Bureau of Statistics and Mara Regional Commissioner's Office (2003) Mara region socio-economic profile

Based on Table 8.2, approximately 75% of the roads are earthen. Furthermore, up to 40% of the roads in Serengeti become impassable during the rainy season.

Motor vehicles in the Mara River Basin include passenger buses, mini-buses, light and heavy trucks, tankers, pick-up trucks, cars, and motorcycles.



Note: Trunk roads (red); mixed gravel-tarmac trunk roads (yellow); regional road (green)

Figure 8.1: Mara Basin Road Network in Kenya and Tanzania

Another type of public transport is the bicycle taxi, popularly known as "Boda-Boda". These bicycles together with motorcycles are found in all towns and rural centers, and they significantly contribute to the employment of young people. The bicycle is now a major, informal mode of transport including border crossings where smuggling occurs. However, bicycle transporters are often unwilling to follow traffic rules, suffer high accident rates, and lack traffic regulation training.

8.3 Water Transport

The Mara River is not navigable. The river channel is characterized by non-uniform channel slope and depth, low water levels, and extensive wetlands which are densely vegetated. These features limit the use of the river for navigation. Water transport is practiced in Lake Victoria in Tanzania.

Musoma town centers (i.e., Kinesi and Shirati) and communities located on Lake Victoria are well served by water transport. Musoma town has been an important port linking the Mara region to Mwanza, Bukoba, Kemondo Bay, and Ukerewe Island through passenger and cargo ships. Musoma town is also an important fishing landing site. Small passenger and fishing boats operate informally and serve the Lake Victoria communities. However, the marine services offered by the Tanzania Railway Corporation (TRC) have deteriorated and are currently limiting the use of the Musoma Port.

TRC's services notwithstanding, future prospects are bright for Musoma Port to be a major fishing landing site and a trading hub, connecting the market centers in Mara Basin to other lake regions within Tanzania and to Jinja and Kisumu in Uganda and Kenya.

8.4 Air Transport

Air transport plays a great role in the Mara River Basin especially in the Kenyan Narok and Transmara districts. The region has a number of airstrips, used mainly by tourists visiting the Masai Mara National Reserve hotels and lodges and by some large scale farmers. Bomet district has one airstrip that is occasionally used by small aircrafts mainly delivering drug supplies to the Tenwek Mission Hospital.

On the Tanzanian side, the Mara Basin is connected to air transport through the Musoma airport. The Musoma airport services both commercial and non-commercial flights for passengers and cargo. At present, the Musoma airport is well connected to Dar es Salaam and Mwanza by Precision Air (which flies to Musoma four times a week). The air traffic to Musoma airport is expected to increase in the future as tourist activities in the Serengeti National Park increase. The Musoma airport is already a favorite destination of charter flights as a result of its proximity to the Serengeti National Park.

The disadvantage of the Musoma airport is that is has and earthen surface. When it rains heavily, flights are cancelled and passengers are ferried through Lake Victoria to Mwanza airport for flight connections. For light aircraft, small air strips serve Tarime town,

Kiabakari, Mugumu, Shirati Seronera, Fort Ikoma, and Nyabata. Some airports are expected to be upgraded when finances are available.
Beyond air transport for tourists visiting the Masai Mara and the Serengeti, the improvement of the existing airports in the Mara Basin will also bring increased commercial and trade activity, and it is thus a key investment opportunity.

8.5 Issues on Transport in Mara River Basin

Some of the pertinent issues raised in the above sections concerning transport in Mara River Basin are summarized in Table 8.3, highlighting the causes, impacts, intervention measures and investment opportunities.

Table 8.3: Issues matrix on transport in the Mara River Basin

Issues	Causes	Impacts	On-going & Planned Intervention Measures	Potential Investment Projects
1. Poor road infrastructure	Low investment to construct all weather roads.	Roads not passable for a considerable duration during the rainy season. About 75% of the length of the road network in Musoma Rural, Serengeti, and Tarime districts is made up of earth surface. Many of these roads become impassable during the rainy season; up to the level of 40% in Serengeti district. Lack of markets for agricultural products.	Mobilization of funds by governments in Kenya and Tanzania to construct all weather roads. Implementation of mitigation measures by governments responsible for infrastructure development.	Consolidate efforts to mobilize funds to construct all weather roads.
2. Poor air travel infrastructure	Low investment to construct airports.	Capacity to handle air traffic is limited. Musoma airport is still covered by earth surface. Under heavy rains, flights to Musoma are cancelled and passengers are ferried all the way to Mwanza airport to get flight connections elsewhere.	Mobilization of funds to upgrade Musoma airport and other airfields to serve the districts. Implementation of mitigation measures by Ministry of Infrastructure.	Consolidate efforts to mobilize funds to upgrade Musoma airport and other airfields to serve the districts.

9.0 Population, Social Development, and Public Health

This chapter presents the basic demographic characteristics of the Mara River basin districts. These demographic characteristics include population, population densities, education, and health. Access to good facilities including schools, medical centers, water, and sanitation determines the welfare and quality of life. Limited access to such basic services impedes poverty eradication efforts.

9.1 Demographic Characteristics in the Mara River Basin

9.1.1 Population Density and Other General Statistics

Kenya

The Mara River basin has experienced high growth rates for both people and livestock over the last few decades. An approximate 1.1 million people live within the Mara catchment. Of this total population, about 775,000 live in Kenya. At the current annual growth rate (3.3 %, 2.7%, and 2.3% in Narok, Bomet, and Transmara districts respectively), the population will almost double in 20 years to 1.980 million (Mara area Master Plan, 2006-2036).

High population densities exist in the upper and middle basin reaches, while the lower and middle reaches are sparsely populated. The lower population density is due to the semi-arid nature of the lower catchment, the Masai Mara Game Reserve, and the Serengeti National Park. Downstream of the Serengeti National Park in Tanzania, the population density again increases.

According to the National Population and Housing Census (1999), Bomet district is the most densely populated with an average density of about 200 people per square kilometre. The Transmara and Narok districts have approximately 60 and 20 persons per square kilometre, respectively.

Table 9.1 presents some demographic characteristics of the districts in the Mara River basin compared with the national and the Rift Valley Province statistics. Analysis of the statistics leads to the following observations:

1. The literacy rates in the three districts (Narok, Bomet, Transmara) are comparable to the national rates.
2. Infant mortality rates are generally lower in the Mara Basin districts, except in Transmara district which require more concerted efforts in public health awareness. It is the same case with the under five mortality rates where the levels in Transmara district still remain high, indicating a major health challenge.

3. The poverty levels in Narok and Nakuru districts are much lower than the national average indicating a higher production in these two districts. The two districts are major wheat and barley producers in addition to livestock rearing.

Table 9.1: Socio-Demographic Characteristics in the Mara Basin, Kenya

Region/District	Total area Km^2	Population (2002)	Average Population density (2002)	Literacy rates %	Infant mortality rate (per 1000 live births)	< 5 yrs mortality (Per 1000 live births)	Poverty incidence %
Kenya			56***	79	77**	115**	46
Rift Valley Province			45***	73	61**	77**	49
Narok (Narok S.)	15,088	403,812	18	59.5	-	48*	27
Bomet	1,462	415,091	201	73.4	35*	94*	59
Transmara	2,932	182,070	63	50.7	67*	116*	52
Nakuru	7,242	1,312,555	181	71	42*	96*	38

Source: District Development Plans 2002-2008: Narok, Transmara, Bomet and Nakuru
**Source:* Rift Valley Provincial Statistics Office, 2003
***Source:* Kenya Demographic and Health Survey, 2003
****Source:* Ministry of Health; Report on the Performance Status 2003 and 2004
Source: Basic Report on Well-being in Kenya

Table 9.2 presents the population distribution by divisions in the districts within the Mara River basin in Kenya. The projected population for 2008 in the Mara River basin districts in Kenya is estimated at 1,112,060. The population density in Bomet is much higher than in the other districts due to its high agricultural potential and production.

Table 9.2: Population Growth by Division in Mara River Catchment

Narok South District							
Division	**Area (Km^2)**	**1999**		**2002**		**2008**	
		Population	**Density**	**Population**	**Density**	**Population**	**Density**
Ololulunga	1,511	54,378	36	64,952	43	78,546	52
Mara	4,496	40,468	9	44,964	10	58,453	13
Mulot	724	68,771	95	75,286	104	91,935	127
Loita	1,711	15,402	9	17,113	10	22,247	13
Olokurto	1,208	44,707	37	48,332	40	59,207	49
Total/Average	9,650	223,725	37	250,646	41	310,388	51
Bomet District							

Division	Area (Km²)	Population	Density	Population	Density	Population	Density
Bomet Central	337	120,759	359	133,326	396	153,976	457
Longisa	257	75,550	294	83,412	324	96,331	374
Siongiroi	249	61,116	246	67,476	271	77,927	313
Sigor	208	43,583	210	48,119	232	55,571	268
Tinet Forest	444	2,234	5	2,466	6	2,849	6
Total/Average	1,882	382,794	203	417,868	246	488,089	284
Transmara District							
Division		**1999**		**2002**		**2008**	
	Area (Km²)	**Population**	**Density**	**Population**	**Density**	**Population**	**Density**
Kirindon	663	56,197	85	60,121	91	68,811	104
Lolgorian	1,106	25,553	23	27,337	25	31,289	28
Total/Average	2,846	170,591	60	87,459	58	100,100	66
Nakuru District (Part of Molo District)							
Division		**1999**		**2002**		**2008**	
	Area (Km²)	**Population**	**Density**	**Population**	**Density**	**Population**	**Density**
Keringet	492	59,863	122	66,193	135	81,293	165
Olenguruone	172	32,030	185	35,417	205	43,496	253
Elburgon	436	65,314	150	72,220	166	88,695	203
Total/Average	**1,101**	**157,207**	**152**	**173,830**	**169**	**213,484**	**207**

Source: District Development Plans for Narok, Bomet, Transmara and Nakuru Districts, 2002-2008

Tanzania

According to the 2002 Population and Housing Census, about 1,000,000 inhabitants lived in the three districts of Musoma Rural, Serengeti, and Tarime as summarized in Table 9.3. The average population density for Tanzania according to the 2002 population and housing census was 38 people per km^2. The population density of Musoma Rural and Tarime are above the National average.

Table 9.3: Population Size and Density in Mara Basin, Tanzania

National/District	Land area (km²)	1988		2002		2012 (Projected)	
		Population	Density	Population	Density	Population	Density
Musoma rural	1957	248,268	127	330,953	169	399,000	204

Tarime	3885	333,888	86	492,798	127	662,000	170
Serengeti (Inc. Nat. Park)	10,942	111,710	28	176,609	45	233,000	59
Total		**693,866**		**1,000,360**		**1,294,000**	

Source: Mara Region Social-Economic Profile, 2003

A high Serengeti growth rate of 7.5% from 1978 to 1988 (Table 9.4) indicates a substantial migration into the district. However, this trend slowed down to 3.3% from 1988 to 2002, and it is projected to be 2.8% by 2012. The population growth rate for Musoma rural was 2.1% from 1988 to 2002, the lowest in the three districts. The annual growth rate for Tanzania according to the 2002 population and housing census was 2.9. The population growth rate for Tarime has been consistent at 2.8% for two decades (1978-1988 and 1988-2002), but it is projected to increase to 3.0% by 2012.

Table 9.4: Distribution of Growth Rates by District (%)

District	1978/88	1988/2002	2002/2012
Musoma Rural	1.7	2.1	1.9
Serengeti	7.5	3.3	2.8
Tarime	2.8	2.8	3.0
Average	4.0	2.7	2.6

Source: Mara Region Social-Economic Profile, 2003

Table 9.5 presents some of the important demographic characteristics in the Mara River basin in Tanzania. The literacy rates in all three districts are average compared to the national statistics. Both infant mortality and under 5 mortality rates for the three districts are relatively higher than the national averages. The population in Musoma Rural and Serengeti below the basic needs poverty line is higher than the national average, while in Tarime, it is comparable.

Table 9.5: Socio-Demographic Characteristics in the Mara Basin, Tanzania

National/District	Literacy rate %, 2002	Infant mortality rate (per 1000 live births), 2002	< 5 yrs mortality (Per 1000 live births), 2002	Poverty incidence %, 2000/01
Tanzania	71	95	153	36
Musoma Rural	76	115	191	64
Serengeti	67	109	181	61
Tarime	71	123	207	32

Source: Poverty and Human Development Report, 2005, and Tanzania in Figures, 2006

9.1.2 Population Distribution by Sex Ratio

The sex ratio refers to the number of males for every 100 females. This measure illustrates the age-sex structure pattern in a population. The age-sex distribution is an important parameter for evaluating potential gender issues. For example, the number of women and men in a country helps determine (1) the extent of equal access to social facilities (such as health and education),

(2) whether the population is old or young, and, (3) the presence or absence of sex bias at various ages.

Kenya

Figure 9.1 presents the distribution of population by broad age groups and region. The figure shows that all the districts in the Mara River basin have more than 40% of their population in the 0-14 age group. In particular, Narok and Transmara districts have over 50% of the population in the 0-14 age group. This shows large young population and leads to a high level of dependency in these two districts.

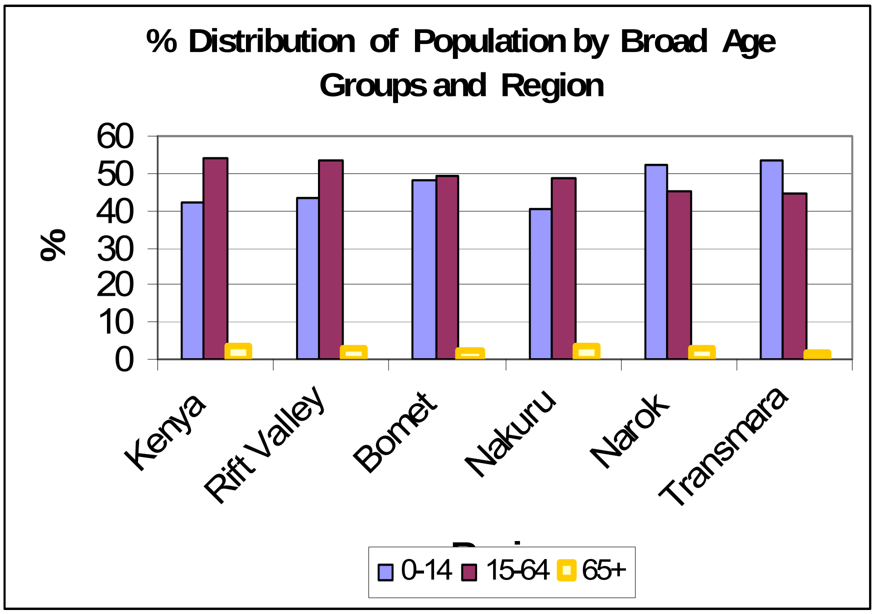


Figure 9.1: Percentage Distribution of Population by Broad Age Group and Region
Source: Kenya Integrated Household Budget Survey (KIHBS) 2005/2006

Analysis of the 1999 population census and the Kenya Integrated Household Budget Survey shows that females constituted over 50% of the total population across various age groups, except for a slight decrease at age 0-14 years.

The 1999 population census showed 102 males versus 100 females among children aged 0-14 years. An increase in females compared with males was observed in the older age groups. At age group 50-54 years, the number of females equaled males. From 75 years and above, the analysis showed a higher percentage of females. In summary, at birth and early life stages, males have better chances of survival than females, but at later age stages, females have better survival rates. This relationship is demonstrated in Figure 9.2.

The Kenya Integrated Household Budget Survey (KIHBS) of 2005/06 showed that Kenya had a sex ratio of 97 males per 100 females which is the same as the 1999 sex ratio. Table 9.6 which is also a summary of Figure 9.2 presents the gender distribution and sex ratios at the national, provincial (Rift Valley) and district levels for the districts within the Mara Basin. The gender distribution shows some dramatic changes between the 1999 and 2005/06 analyses, namely:

- The sex ratio at the national level has remained stable over the years.
- At provincial level, males increased relative to the females from 1999 to 2005.
- At district level, there was an increase of males relative to females in Bomet, Transmara, and Nakuru districts while there was a drop in Narok district.

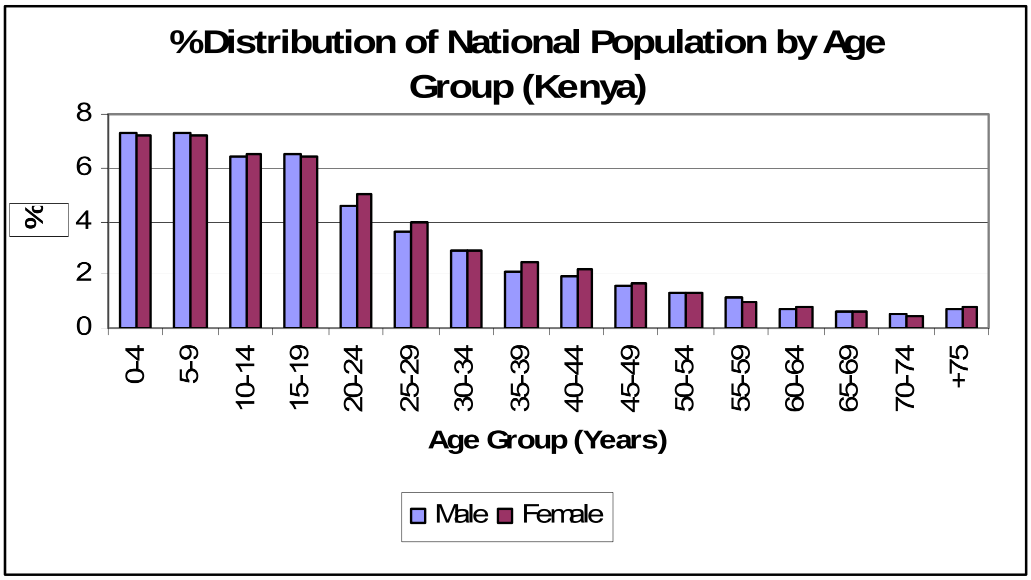


Figure 9.2: Percentage Distribution of Population by Age Group
Source: Kenya Integrated Household Budget Survey (KIHBS), 2005/06

Table 9.6: Gender Distribution and Sex Ratios for Selected Kenya Regions

Region/District	1999			2005/06		
	Males	Females	Sex Ratio	Males	Females	Sex Ratio
Kenya	49.3	50.7	97	49.3	50.7	97
Rift Valley Province	49.9	50.1	99	51.2	48.8	105
Bomet	48.5	51.5	94	50.2	49.8	102
Narok	50.1	49.9	101	49.5	50.5	98
Transmara	49.1	50.9	96	51.0	49.0	104
Nakuru	50.3	49.7	101	53.1	46.9	113

Source: Kenya Integrated Household Budget Survey (2005/06)

Tanzania

The recent census information indicates a consistent increase of males and females in the districts as shown in Table 9.7. District sex ratios for 1988 are relatively comparable to 2002. Overall, the sex ratio in all three Tanzanian districts increased in 2002. Nevertheless, the sex ratios of the three districts are lower than the national average of 96. The reason of having more women than men is that most likely women from other regions come to the districts in Mara Region to marry in view of the fact that the tribes in these districts practice polygamism, especially among the major Kurya tribe.

Table 9.7: Population Distribution by Gender Ratio (Male/Female) by District

District	1988			2002		
	Male	Female	Sex ratio	Male	Female	Sex ratio
Musoma Rural	109,795	123,543	88.9	159,323	171,627	92.8
Serengeti	52,692	58,997	89.3	84,263	92,346	91.2
Tarime	154,860	176,930	87.5	233,301	259,497	89.9

Source: Mara Region Social-Economic Profile, 2003

9.1.3 Household Size

Kenya

Nationally, the mean household size was estimated at 5 according to KIHBS 2005/06. In the Mara River catchment, the highest average household size recorded was in Bomet district at 6.1, followed by Narok district at 6.0. Nakuru had the lowest mean household size of 4.3. The distribution of households by size is summarised in Table 9.8.

Table 9.8: Percent Distribution of Households by Size

Region/District	Household Members				Mean Household Size
	1-2	3-4	5-6	7+	
Kenya	18.7	27.3	27.3	26.7	5.1
Rural	14.5	24.9	29.5	31.1	5.5
Rift Valley	17.9	25.1	27.0	30.1	5.3
Bomet	8.6	18.2	30.1	43.1	6.1
Narok	5.7	22.6	32.9	38.8	6.0
Transmara	9.5	17.6	34.3	38.6	5.9
Nakuru	26.7	32.7	25.3	15.4	4.3

Source: Kenya Integrated Household Budget Survey (2005/06)

Tanzania

In the 2002 census, the Serengeti district had the highest average household size of 5.5 persons per household. Musoma Rural and Tarime had the same average household size of 5 (Table 9.9). The average household size for Tanzania is 4.7.

Table 9.9: Percent Distribution of Households by Size

District	Mean Household Size
Musoma Rural	5.0
Serengeti	5.5
Tarime	5.0

Source: 2002 Population and Housing Census

9.1.4 Age Dependency

Age dependency ratio is defined as the proportion of population that is dependent on the working-age population. The age groups 0-14 and 65 years and above is taken to be the dependent population. The ratio of this population by the working population aged 15-64 years yields the dependency ratio.

Kenya

Table 9.10 presents the distribution of population by broad age groups and the resultant dependency ratio. Comparison of the dependency ratios of the Mara districts in Kenya and the national and provincial levels indicates that the ratios in Transmara, Narok, and Bomet are much higher than the national and provincial ratios. High dependency ratios can negatively impact on economic growth and increase poverty if opportunities for gainful employment are not created.

Table 9.10: Percentage Distribution of Population by Age Group, Age, Dependency Ratio, and Region

Region		Kenya	Rural	Rift Valley Province	Narok	Bomet	Transmara	Nakuru
Age-Group (%)	0-14	41.9	43.4	43.6	52	48.1	53.6	40.2
	15-64	54.2	52.2	53.2	45.1	49.4	44.7	56.7
	65+	3.6	4.2	2.7	2.8	2.1	1.7	2.3
Age Dependency (%) Ratio		**84.0**	**91.2**	**87.0**	**121.5**	**101.7**	**123.7**	**75.0**

Source: Kenya Integrated Household Budget Survey (2005/06)

Tanzania

Table 9.11 presents the distribution of population by broad age groups and the resulting dependency ratio in Mara River districts in Tanzania. Comparison of the dependency ratio between the three districts indicate the values are fairly comparable. Serengeti has a slightly higher value. The age dependence ratio for Tanzania is 93. The statistics for the three districts are above average for the country.

Table 9.11: Percentage Distribution of Population by Age Group, Age Dependency Ratio

Region		Musoma Rural	Serengeti District	Tarime District
Age-Group	0-14	48.00	50.85	48.49
	15-64	47.76	45.76	47.95
	65+	4.25	3.39	3.56
Age Dependency Ratio		**109.4**	**118.53**	**108.55**

Source: Tanzania 2002 Population and Housing Census

9.1.5 Family Planning Policies and Programs

Kenya

In 2000, the Government of Kenya launched the National Population Policy for Sustainable Development (National Council for Population and Development, 2000). The policy outlines the program from the 1994 International Conference on Population and Development in Cairo. Policy implementation is guided by the national and district action plans formulated by the National Council for Population and Development (NCPD).

The policy addresses issues of environment, gender, and poverty, as well as problems facing youth. The goals and objectives include full integration of population concerns into the development process; motivating and encouraging Kenyans to adhere to responsible parenthood; empowerment of women; and integration of the youth, elderly, and persons with disabilities into mainstream national development. The overriding concern is implementing policies, strategies, and programs that will shape the population growth to fit the available national resources and improving the quality of life.

Tanzania

The Government of Tanzania started providing Family planning services as a component of maternal and child health (MCH) in the mid-1970s. The Family Planning Unit (FPU), which is responsible for initiating and developing family planning standards and guidelines on service provision, training, and other aspects of quality care, became operational in 1986. The National Family Planning Program in Mainland Tanzania is the sum total of all family planning activities provided by various agencies in the country. It is a separate component of and coordinated by the Reproductive and Child Health (RCH) Unit of the Ministry of Health and Social Welfare. Family planning services currently are integrated into MCH clinics at dispensaries, health centers, district and referral hospitals, as well as in some private hospitals.

9.1.6 Fosterhood and Orphanhood

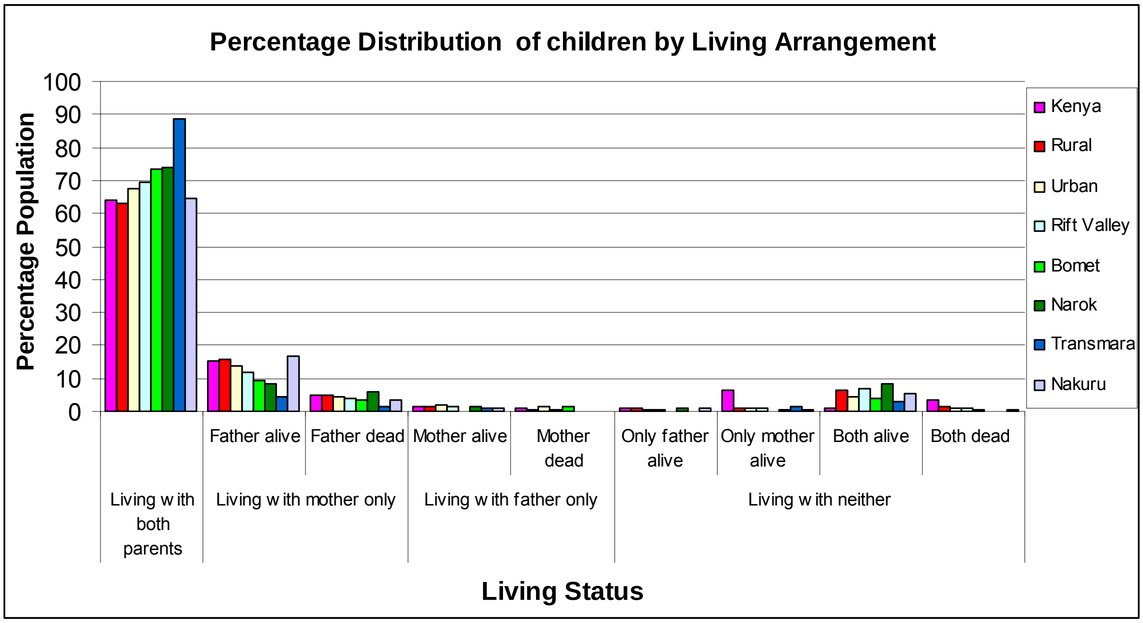
Kenya

Figure 9.1 illustrates the distribution of children aged 0-14 years by living arrangements, parental survival status, and region. The table compares the national orphanhood levels with those in the Mara River districts. Nationally, about 64% of children live with parents, 21% with their mothers but no fathers, and 2% with their fathers but no mothers. In comparison, children living with their parents in the Mara basin districts stood at 70%, 73%, 74%, 89%, and 65% respectively in Bomet, Narok, Transmara, and Nakuru. Further, in Bomet district, 9% of the children live with their mothers but no fathers, and 1% with their fathers but no mothers. Similar statistics for Narok, Transmara, and Nakuru are summarised in Table 9.12. The same statistics are also presented in bar form in Figure 9.3. This analysis shows that more children live with their parents in the Mara Basin districts than the national level.

Table 9.12: Percentage Distribution of Children (0-14 years) by Living Arrangements

Region or District	Living with both parents	Living with mother only		Living with father only		Living with neither		
		Father alive	Father dead	Mother alive	Mother dead	Father alive	Mother alive	Both dead
Kenya	64	16	5	2	1	1	1	1
Rift Valley	70	12	4	1	1	1	1	1
Bomet	73	9	4	0	2	0	0	0.3
Narok	74	8	6	2	0.1	1	0.5	0.2
Transmara	89	4	1	1	0.1	0	1	0
Nakuru	65	17	3	1	0.2	1	1	1

Source: Kenya Integrated Household Budget Survey, 2005/06



Source: Kenya Integrated Household Budget Survey (2005/06)

Figure 9.3: Distribution of Children (0-14 years) by Living Arrangement, Kenya

Tanzania

In the 2002 Population and Housing Census in Tanzania, data on survival of parents was collected to assess the extent of orphan hood in Tanzania. By definition, 'orphan' refers to a child less than 18 years of age whose mother *and* father are dead. Table 9.13 presents the percentage distribution of survival of parents for the children in the three Mara districts. It can be observed that above 80% of the children in the three districts had indicated to have both parents alive. The rate of orphans in Tarime is higher compared to the other districts. The national average statistic for orphan hood is 1.1%. The rate of orphan hood in the Kenyan districts are somewhat lower compared to the statistics for the Tanzanian districts. The percentages of children who indicated to have both parents alive are higher in the Tanzanian districts compared to those in the Kenyan districts of the Mara.

Table 9.13: Percentage distribution of children and survival of parents

Mother		**Alive**	**Alive**	**Dead**	**Dead**
Father		**Alive**	**Dead**	**Alive**	**Dead**
District					
Musoma Rural		89	8	1.86	1.00
Serengeti		84	13	1.81	1.17
Tarime		85	12	1.82	1.26

Source: Tanzania 2002 Population and Housing Census

9.1.7 Human Settlements, Urbanization, and Migration

Settlements in both rural and urban centers have important implications on the environment and the natural resources. Urban centers concentrate human activities and hence create high demands for natural resources, basic services and infrastructure (water supplies, sanitation, waste disposal, healthcare, roads, and public transport). Rapid urbanization and migration into urban areas often leads to urban decay, loss of environmental quality, health deterioration, and encroachment on fragile ecosystems. As expected, people move from low to higher economic potential areas.

Kenya

In Kenya, the Mara River basin is settled by different tribes and the majority of the population lives in the rural areas. The indigenous tribes include the Masai who are pastoralists, the Ogiek who are hunters and gatherers and live in the forests, and the Kipsigis who practice both agriculture and livestock rearing. The area has also attracted many immigrants who are mainly agriculturalists including the Kikuyu, Kisii, and Luhyas. The Masai mainly occupy the Narok and Transmara districts, while the Kipsigis are found in Bomet and Transmara. Immigrants are found in all the Mara districts.

The settlement patterns are greatly influenced by land use, land tenure, and urbanization. The main land use patterns are crop farming and livestock rearing. Settlements are dense in areas where favourable climate and fertile soils support agricultural activities. These areas include the Bomet and Nakuru districts and parts of Transmara (Pirrar, Keiyan, and Kilgoris divisions). In areas with large livestock populations, human settlement is sparse, as in Lolgorian and parts of Kirindoni in Transmara district.

In general, people tend to settle in and around towns and trading centres due to the availability of business, employment opportunities, and social amenities such as piped water and electricity. The main towns are slowly being urbanized. However, there is poor infrastructure to support urban migration. Overall, the urban centers in the Mara catchment lack physical development plans, water and sanitation services, and solid waste disposal. The absence of planning strategies poses the greatest challenge in improving the environmental conditions and sustainability of these growing towns.

Tanzania

In Tanzania, the majority of the population in Musoma Rural, Serengeti, and Tarime live in rural wards. The population within the town perimeters are urban and mixed (urban and rural). The urban centers include: Butiama, Mugango, and Nyambono towns in Musoma Rural district; Mugumu, Ngoreme, and Robanda towns in Serengeti district; and Tarime, Ronda, and Sirari towns in Tarime district. The total urban populations in the Mara River basin vary between the towns. According to 2003 estimated data, the urban population in the districts varies from 10,000 in Musoma Rural to 35,000 in Tarime (Table 9.14). This data indicates an increasing urbanisation trend in the three districts.

Table 9.14: Urban Population in Mara Region Districts

District	1988			2003 (estimates)		
	Total population	Urban population	% Urban	Total population	Urban population	% Urban
Musoma Rural	248,268	0	0	337,000	10,000	3
Serengeti	111,710	6,674	6	182,000	15,000	8.2
Tarime	333,888	15,590	4.7	508,000	35,000	6.9

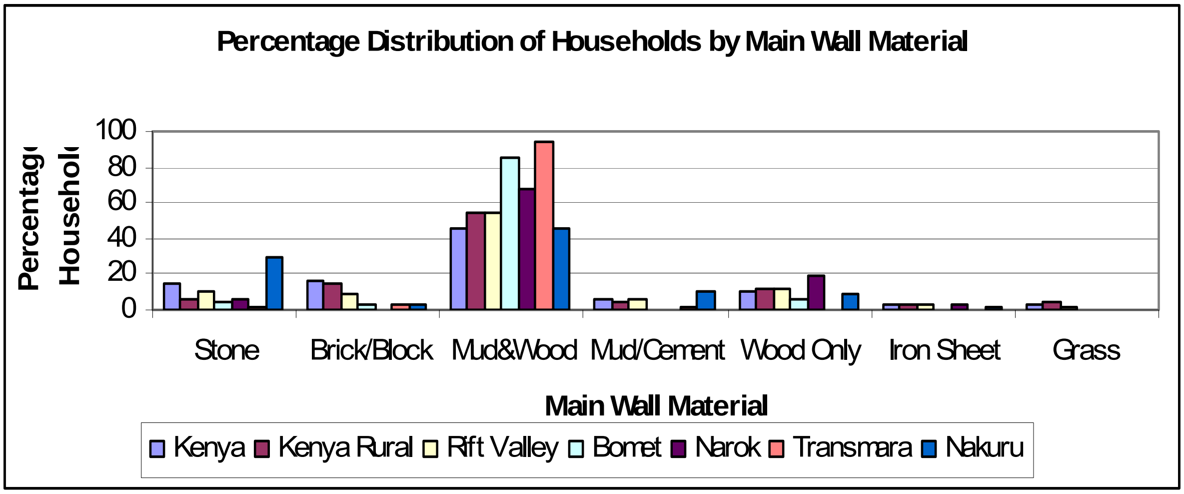
Source: Mara Region Social-Economic Profile, 2003

9.1.8 Housing Characteristics

The accessibility of housing, sanitation, water, and energy directly impact household welfare. Access to safe water and improved sanitation reduces water borne and infectious diseases and promotes better health. Conversely, poor housing conditions predispose communities to illness. Housing conditions are therefore useful to understanding the social and economic conditions, public health, and future resource needs.

Kenya

Wall construction materials used by the majority of rural households include mud/wood, mud/cement, iron sheets, stone and sand. The predominant wall materials used by Kenyan households are mud and wood. Nationally, 54% of rural houses are mainly made of mud walls, and 37.9% are stone. In the Mara basin, Transmara district has the highest proportion (94.2%) of mud and wood followed by Bomet district (85.8%). The high level of mud-made homes is a clear indicator of poverty in the Mara districts. The poor housing conditions expose people to the vagaries of weather and illness. Another contributing factor to the high levels of mud-walled homes (huts) is the pastoralism nature of the indigenous communities (Masai), whose major occupation is livestock keeping. Culturally, livestock ownership reflects the wealth of the community, but selling livestock is difficult and hence, in monetary terms, they remain poor. This situation will change as the open rangelands become occupied by farmers from other regions. Figure 9.4 shows the distribution of wall construction materials used at the national, province and at district levels.

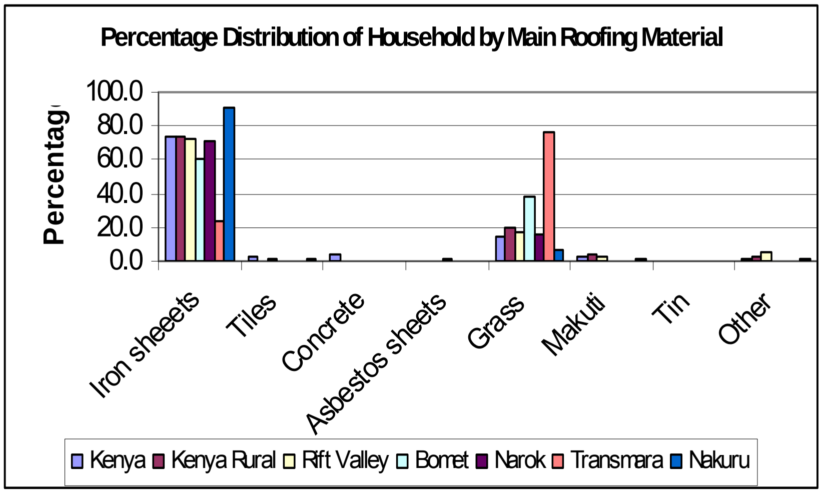


Source: Kenya Integrated Household Budget Survey (2005/06)

Figure 9.4: Percentage Distribution of Households by Wall Material, Kenya

For roofing materials, iron sheets, tiles, asbestos sheets, tin, and grass thatched roofs (*makuti*) are used. About two-thirds of Kenyan households (69 percent) live in dwellings with corrugated iron *(mabati)* roofs, and 22% have grass- thatched roofs. Urban-rural differences in roofing material are not as pronounced, with 73% of urban households having corrugated iron roofs, compared with 69% of rural households.

In Bomet, Narok and Nakuru districts, the majority of the households use corrugated iron sheets, while grassed roofs are widely used in Transmara district as shown in Figure 9.5. Figure 9.5 also shows that iron sheets and grass are the main roofing materials that are used in Kenya. However, as more land is put into agricultural production in the Mara basin districts, grass for roofing will become scarce and consequently, families using grass will be forced to use alternative materials. In Nakuru district, the use of iron sheets is higher than the national level. This is an indication of the level of development in this district which used to be the centre of operation in the Rift Valley during the colonial days.



Source: Kenya Integrated Household Budget Survey, (2005/06)

Figure 9.5: Percentage Distribution of Households by Roofing Material, Kenya

Information on the number of rooms used for sleeping provides a rough measure of household crowding. The survey by the 2003 KDHS showed that most households in Kenya (77%) have one to two persons sleeping together in a single room.

Tanzania

Wall construction materials used by the majority of households in Tanzania include stones, cement bricks, sun-dried bricks, poles and mud, timber, and grass. Table 9.15 presents the percentage distribution of households by wall construction materials. In Musoma Rural, 65% of the households use sun-dried bricks for wall construction followed by poles and mud (20%) and baked bricks (10%). The high level of sun-dried bricks is an indication of growth of sub-urban centres in the district. The pre-dominant wall construction materials for Serengeti and Tarime districts are poles and mud (70%) followed by baked bricks (15%) and sun-dried bricks. As in the case of Kenya, the high level of mud-made homes is Serengeti and Tarime is an indicator of poverty. The high levels of mud-walled houses in Serengeti and Tarime reflect the pastoralism character of the indigenous communities in these districts (Kurya).

Table 9.15: Percentage of Households by Wall Construction Materials, Tanzania

District	Stones	Cement Bricks	Sun-Dried Bricks	Baked Bricks	Poles and Mud	Timber	Grass	Other
Musoma Rural	0.37	4.52	65.19	9.74	19.81	0.01	0.23	0.11
Serengeti	0.25	1.61	9.43	15.91	72.57	0.07	0.13	0.03
Tarime	0.14	1.62	9.27	15.44	73.41	0.03	0.10	-

Source: Tanzania 2002 Population and Housing Census

Roofing materials used in Tanzania include iron sheets, tiles, concrete, asbestos, grass and grass/mud (Table 9.16). In the three Mara districts, between 55%-67% of the households live in houses thatched with grass. Families who live under roofs thatched with grass do so because of poverty, namely, their income cannot allow purchasing iron sheets as roofing material. Between 20% and 30% households live under corrugated iron sheet roofs. Such households have good income and, in most cases, they live in urban or sub-urban centres. Lastly, between 7% and 12% of the households live under grass/mud roofs.

Table 9.16: Percentage Distribution of Households by Roofing Material, Tanzania

District	Iron Sheets	Tiles	Concrete	Asbestos	Grass	Grass/Mud	Other
Musoma Rural	32.17	0.02	0.03	0.04	60.07	7.67	0.00
Serengeti	21.81	0.05	-	0.23	67.48	10.43	-
Tarime	31.70	0.06	-	0.06	55.74	12.43	-

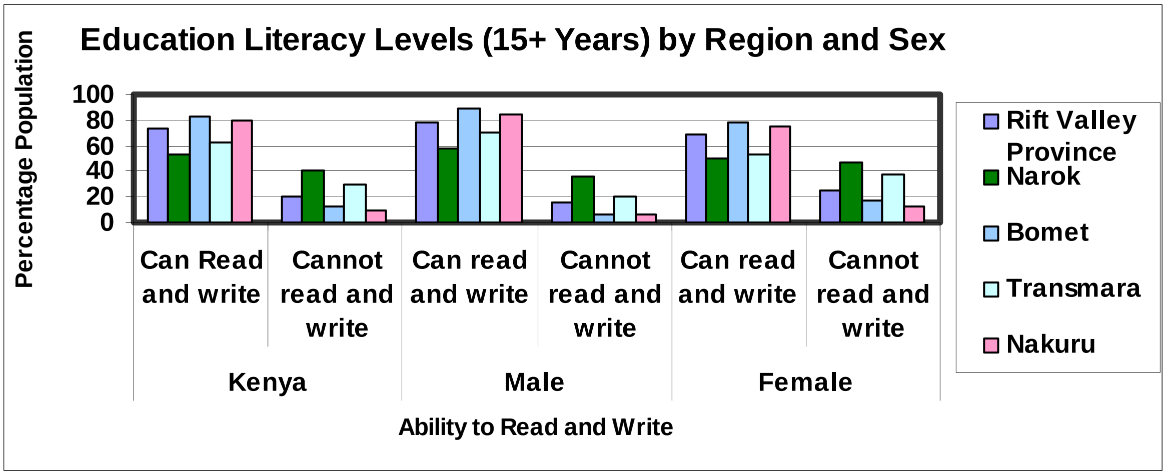
Source: Tanzania 2002 Population and Housing Census

9.2 Education and Literacy

9.2.1 Education and Literacy in Kenya

The formal Kenyan education system is categorized into primary (standard 1-8), secondary (form 1-4), and tertiary schooling (vocational and university education). As part of the Millennium Development Goals (MDGs) on Universal Primary Education (UPE), the government introduced the Free Primary Education Program in 2003. The key educational indicators include school attendance, highest grade completed, type of school attended, and literacy.

In 2008, the government introduced subsidized secondary school education to enable more students attain secondary school education. In Kenya, adult literacy is defined as the percentage of people aged 15 years and above who can, with understanding and ability, read and write simple statements in at least one language. The population meeting this criterion nationally stands 79%. The literacy levels vary depending on gender and among the urban and rural population. Over 90% of the urban dwellers can read and write compared to 75.7% of the rural population. In the Mara basin districts, Bomet has the highest literacy levels for both men and women at 89% and 77% followed by Nakuru district at 84% and 75% respectively. In Narok district, the literacy levels stand at 57% and 50% for males and females respectively, while in Transmara literacy levels are at 71% and 53% for males and females respectively. The conclusion is that the illiteracy levels for females in Narok and Transmara districts stand at more than 45% in each district. Major contributors to this low level of literacy in these districts are attributed to the communities' cultural practices of early girl child marriages and of reserving school opportunities mostly for male children. Figure 9.6 presents the literacy distribution for the population 15 years and above for the Mara River basin, Rift Valley Province, and for the nation.



Source: Kenya Integrated Household Budget Survey (2005/06)

Figure 9.6: Population Literacy Distribution 15+ Years; Kenya

School Enrolment

In addition to primary (standard 1-8), secondary (form 1-4), and tertiary schooling (vocational and university education), the formal Kenyan educational system also includes private secondary schools offering an extra two years study, beyond the usual four, allowing students to join universities outside the country, e.g., in Uganda. Table 9.17 shows the gender disparities in school enrolment for 1999. The data show more boys enrolled in schools than girls in all districts and across all educational levels from primary school to post graduate level. The major contributing factor to the low enrolment of females in secondary schools is the cultural tendency of marrying off the girls after initiation.

Table 9.17: School Enrolment by Gender, Kenya 1999

Region/District	Primary 1-8			Secondary 1-4			Form 5 to Post graduate		
	Male	Female	Gender Ratio	Male	Female	Gender Ratio	Male	Female	Gender Ratio
Kenya	51.2	48.8	95.2	53.2	46.8	88.0	53.9	46.1	85.5
Rift Valley	51.3	48.7	94.9	54.5	45.5	83.4	55.1	44.9	81.4
Bomet	50.3	49.7	98.8	60.7	39.3	64.8	61.4	38.6	62.8
Narok	56.1	43.9	78.4	62.2	37.8	60.9	62.3	37.7	60.5
Transmara	51.9	48.1	92.6	66.3	33.7	50.9	66.4	33.6	50.6
Nakuru	50.6	49.4	97.6	52.6	47.4	90.1	53.2	46.8	87.9

Source: Central Bureau of Statistics, Kenya: Analytical Report on Gender Dimensions, Vol. XI

The free primary school education program was introduced in Kenya in 2003 as a means to meet the Millennium Development Goals, namely, to achieve universal primary education for the Kenyan population. Table 9.18 shows the primary school enrolment in Narok South district from 2002 to 2007. The table shows that although the enrolment of girls has been lower than that for boys, it has been increasing steadily from about 79% (girls to boys) in 2002 to 85% in 2007. In Bomet district, a sample primary school enrolment in August 2005 and April 2006 is depicted in Table 9.19. Complete data similar to the Narok data was not available for analysis. However, even with this sample, it shows that while the primary school enrolment for girls in August 2005 was approximately 92% of the boys enrolment, the enrolment was 98% by April 2006. It is, however, important to note that unlike the Masai, who represent the majority in Narok and are generally pastoralists, the Kipsis, who form a major component of the population in Bomet and are mostly farmers, are more settled in the area and can afford to have more children (boys and girls) attend school. The results from Narok and Bomet districts also show the positive impact of the free education program towards the education of girls. Alternatively, without free education, some communities, including those in the Mara basin, would prefer to spend educational funds on boys rather than on girls. .

Table 9.18: School Enrolment in Narok South District (2002-2007)

2002		2003		2004		2005		2006		2007	
Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
21,809	17,155	25,674	21,581	29,951	23,857	31,873	25,905	33,239	27,065	34,235	28,932

Source: District Education Office, Narok

Table 9.19: Public Primary School Enrolment in Bomet District

August 2005		TOTAL	April 2006		TOTAL
Boys	**Girls**		Boys	**Girls**	
65,320	60,158	125,478	67,601	65,978	133,579

Source: District Education Office, Bomet

9.2.2 Education and Literacy in Tanzania

The Tanzanian education system is categorised into primary school (standard 1-7), secondary school (form 1 – 6), and tertiary schooling (vocational and university education). This section presents the status of primary and secondary education in the three Mara Basin districts.

Literacy level is the percentage of population aged 13 years and above who can read, write, and count. Table 9.20 presents the literacy levels in the three Mara River basin districts. In all three districts, the literacy level is above the 2010 national target of 80%. The national average statistic is 71.

Table 9.20: Literacy Levels by District, Tanzania

District	Population (Age 13+)			National Target (2010)
	Total	% of population with skills to read & write	% of population with no skills to read & write	
Musoma Rural	171,524	84%	16%	80%
Serengeti	102,796	87%	13%	
Tarime	178,472	89%	11%	

Source: District Education Offices: Musoma Rural, Serengeti and Tarime

Primary Education, Distribution, and Enrolment

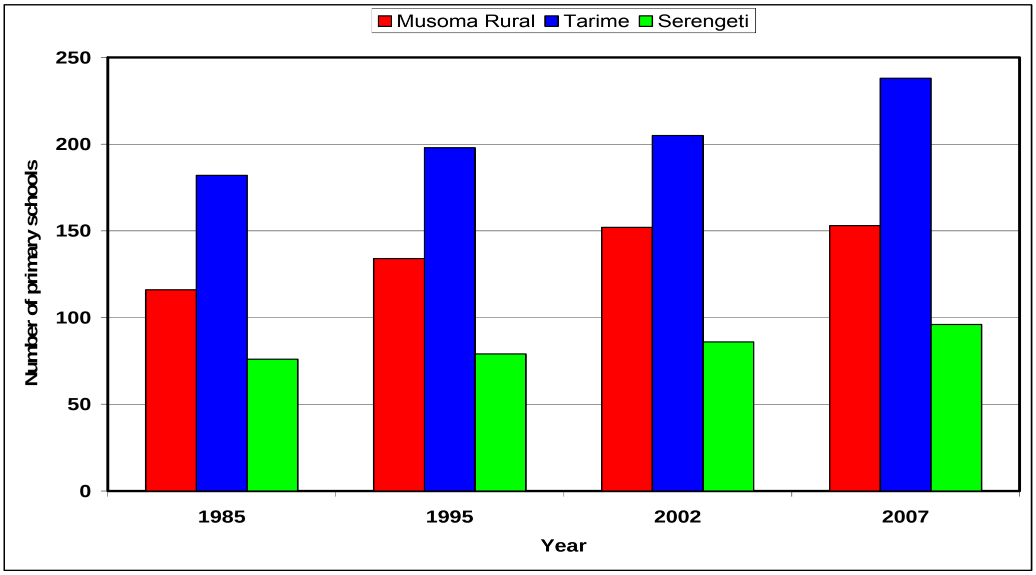
Primary education in Tanzania is based on two government initiatives. The first is the Universal Primary Education (UPE) plan introduced in 1974 to expand primary education and the level of literacy nationally. The second is the Primary Education Development Programme (PEDP) introduced in 2002 to improve the quantity and quality of primary education and eliminate literacy.

Table 9.21 shows the increase in primary schools in the three districts, and the trend is plotted in Figure 9.7. The rate of increase from 1985 to 2007 was relatively small, especially for the Serengeti district. Over 23 years (1985-2007), the number of primary schools increased from 76 to 96, which is about 1 school per year. The net increase in the number of schools for Musoma rural was 37 schools, or three schools every two years. The rate of increase of schools in Tarime was on the average five schools every two years. An analysis carried out nation wide established that the primary education pupil-classroom ratios in 2004 were Musoma Rural (100), Serengeti (74), and Tarime 80). Compared to the national average of 73, the classroom situation in Musoma Rural and Tarime is above average, while for Serengeti it is average.

Table 9.21: Number of Primary Schools by District

District	1985	1995	2002	2007
Musoma Rural	116	134	152	153
Tarime	182	198	205	238
Serengeti	76	79	86	96

Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils, 2008



Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils, 2008

Figure 9.7: Distribution of Primary Schools by District

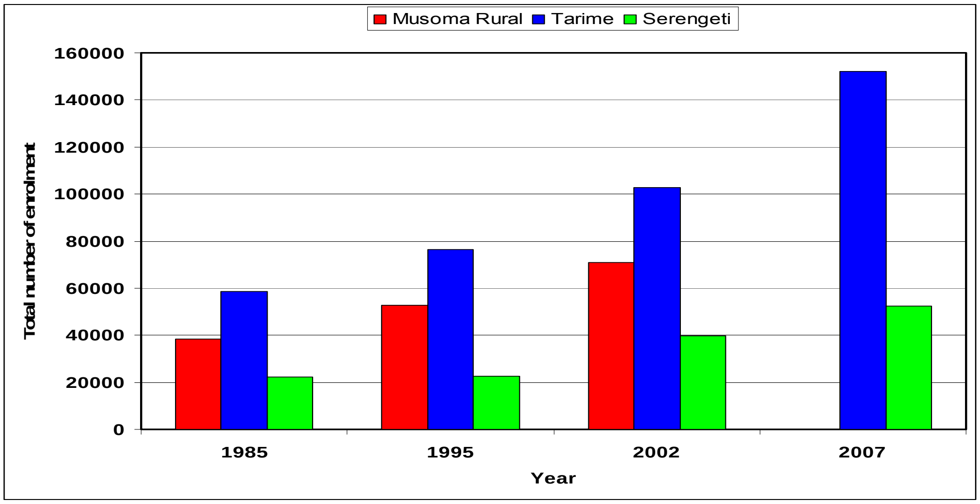
Table 9.22 presents total enrolment in primary schools by gender in the three districts. The Serengeti has been performing poorly with respect to gender ratio. The ratio has deteriorated from 1.04 in 1978, to 1.11 in 1998, and 1.14 in 2002.The ratio slightly improved to 1.08 in 2007. Performance is also consistently poor for Tarime district. The ratio deteriorated from 1.03 in 1978, to 1.10 in 1998, 1.09 in 2002, and 1.11 in 2007. The performance for Musoma Rural deteriorated from 1.02 in 2002 to 1.07 in 2007. The reason for the gender ratio imbalance most likely is the higher drop out rate of girls due to marriage at an early age.

Table 9.22: Total Primary School Enrolment by Gender and District

District	1978			1998			2002			2007		
	Males	Females	Gender ratio	Males	Females	Gender ratio	Males	Females	Gender ratio	Males	Females	Gender ratio
Musoma Rural	18,914	18,546	1.02	27,092	25,389	1.07	35,896	35,166	1.02	54,376	51,002	1.07
Tarime	29,572	28,690	1.03	38,202	34,710	1.10	53,515	49,253	1.09	80,564	72,489	1.11
Serengeti	11,208	10,782	1.04	13,086	11,797	1.11	19,574	17,143	1.14	27,267	25,305	1.08

Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils, 2008

Figure 9.8 displays total enrolments in primary schools between 1985 and 2007. The figure shows considerable progress over the reported period (of 20 years) where total enrolment has more than doubled in all three districts.



Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils, 2008

Figure 9.8: Total Enrolment in Primary Schools by District

Secondary Education, Distribution of Schools, and School Enrolment

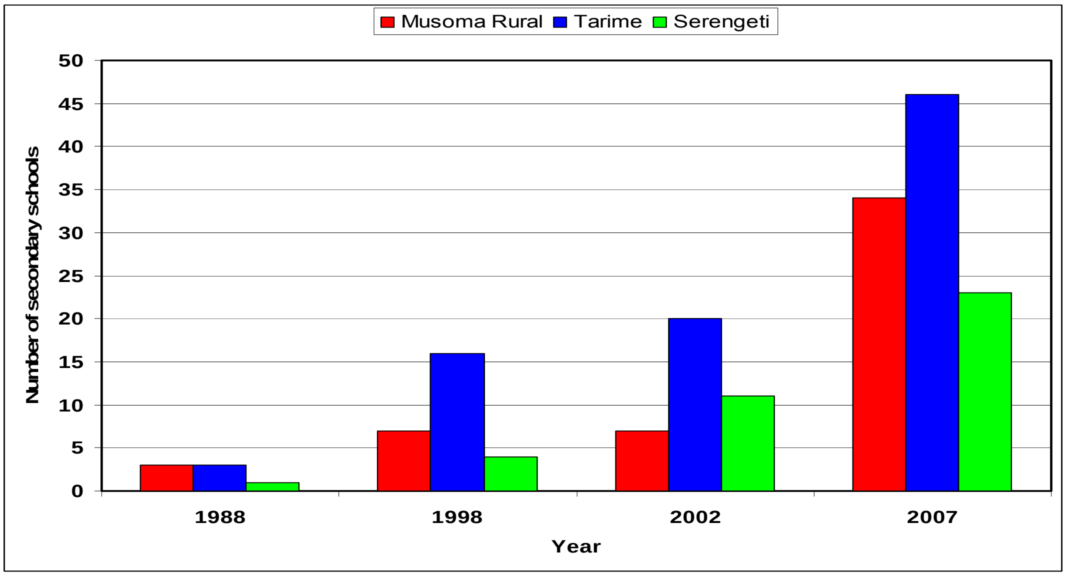
Secondary education was not easily accessible prior to 2003, due to an inadequate number of secondary schools. Following the successful implementation of the Primary Education Development Programme (PEDP), secondary education improved with the Secondary Education Development Programme (SEDP) in 2003/04 (RAWG, 2005). The SEDP programme focused on increasing the number of secondary schools available. This section presents the status of secondary education in three Mara Basin districts.

Table 9.23 shows the distribution of secondary schools from 1988 to 2007. Secondary school ownership is both public and private. Prior to 2002, the rate of increase of secondary schools was relatively small. The number of secondary schools for Musoma Rural increased from 3 in 1988 to 7 in 2002, while for Serengeti the increase was from 1 to 11 during the same period. The situation was better in Tarime where the number of secondary schools increased from 12 in 1988 to 20 in year 2002. Rapid expansion in secondary schools is noted to have taken place after 2002. A major expansion is noted for Musoma Rural, especially, where the number of secondary schools increased from 7 in 2002 to 34 in 2007, a 5-fold increase over 5 years. The number of secondary schools doubled during the same period for Serengeti from 11 to 23. In Tarime, the number of secondary schools increased from 20 in 2002 to 46 in 2007, which was an increase of 5 schools per year. Figure 9.9 shows the increasing trend in secondary schools from 1988 to 2007.

Table 9.23: Number of Secondary Schools by District

District	1988			1998			2002			2007		
	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
Musoma Rural	1	2	3	5	2	7	5	2	7	32	2	34
Tarime	1	2	3	12	4	16	17	3	20	42	4	46
Serengeti	0	1	1	2	2	2	9	2	11	21	2	23

Source: District Education Offices: Musoma Rural, Serengeti and Tarime



Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils

Figure 9.9: Distribution of Secondary Schools by District

Table 9.24 presents the total enrolment in secondary schools by gender. The number of students increased substantially from 2002 to 2007. This is consistent with the increase in the number of secondary schools and is a result of the 2003 SEDP. Between 2002 and 2007, the total enrolment in Musoma Rural secondary schools increased from 960 to 5,280. The net increase of 4,320 students is equivalent to 450%. Despite the increase, by the end of 2007, the enrolment of females compared to males was only 35%. This can be explained by the fact that the communities in the three districts have negative attitude towards educating girls. The culture encourages girls to be married at a very young age.

Unlike primary school enrolment, the gender ratio in secondary schools was unbalanced and poor in all districts. The gender ratio in Musoma Rural was 1.95 in 2002, and remained low at 1.84 in 2007. Likewise, Serengeti reported a ratio of 1.60 in 2007, and Tarime 1.5 in 2002. The reason for the imbalance is due to the fact that the enrolment of girls in primary schools is low compared to the enrolment of boys. Considerable efforts are still required to balance the gender ratio in secondary schools.

Table 9.24: Enrolment in Secondary School by Gender and District

	2002				2007			
	Males	**Females**	**Total**	**Sex ratio**	**Males**	**Females**	**Total**	**Sex ratio**
Musoma Rural	635	325	960	1.95	3,420	1,860	5,280	1.84
Tarime	2,656	1,771	4,427	1.50	N/A	N/A	N/A	N/A
Serengeti	1,966	1,372	3,338	1.43	1,423	887	2,310	1.60

Source: District Education Offices: Musoma Rural, Serengeti and Tarime District Councils, 2008

9.3 Public Health

This section gives an overview of the health trends, causes of diseases and death, HIV/AIDS infections, immunizations, food security and nutrition in the Mara River basin.

9.3.1 Health Trends and Indicators

Kenya

In the health sector, programs are being undertaken in partnership with stakeholders, government ministries, private health providers, church organizations, and nongovernmental organizations (NGOs), such as Malaria Prevention and Treatment, Reproductive Health, HIV/AIDS Prevention and Management, Integrated Management of Childhood Illness (IMCI), and the Expanded Program on Immunization and Control of Communicable Diseases.

The health trends can be gauged by indicators including life expectancy, child mortality, birth rates, death rates, and fertility rates. According to the Ministry of Health Performance Status Report 2003, a gradual fall in the crude (gross) death rate (from 17 to 11 per 1,000) and the persistently high crude (gross) birth rate (over 40 per 1,000) have driven the population growth rate (KDHS, 2003). The national total fertility rate rose from 6.7 in 1948 to 7.9 in 1979 before dropping back to 6.7 in 1989 and to 4.8 in 2003. Basic health indicators are shown in Figure 9.25. The figure shows that crude death rates and under five death rates in the Mara basin districts of Narok, Bomet, and Transmara are comparable to the national levels. However, crude birth rates in these districts are higher than the national rates implying a high level of unattended births.

Life expectancy rose to a peak of 60 in 1989 from 50 in 1969. In 1999, the life expectancy was 56.6 (52.8 years for males and 60.4 years for females). Life expectancy has since fallen and is estimated at 47, years, (2004). The effects of mortality due to the HIV/AIDS epidemic are major contributors to the lowering in life expectancy. Data from the 2003 Demographic and Health Survey shows that child mortality levels have been fairly stable over the last few years. For the five-years preceding the survey, infant mortality was 77 deaths per 1,000 live births and under-five year mortality was 115 deaths per 1,000 live births. These statistics indicate that one in every nine children born in Kenya die before attaining their fifth birthday.

Table 9.25: Health Indicators for Mara Basin, Kenya

Region/District	**Crude birth rates (per 1000)**	**Crude death rates (per 1000)**	**Infant Mortality Rate (Per 1000 live births**	**Under Five Mortality (Per 1000 live births)**	**Maternal mortality**
Kenya	41	11	77	115	414 (1993-2003)
Rift Valley	45	9	61	77	N/A
Bomet	49	7	35	94	N/A
Nakuru*	41	11	42	96	N/A
Narok*	51	7	55	85	N/A
Transmara	54	10	67	116	N/A

Source: Provincial Statistics Office, Nakuru, 2003
Source: Narok District Development Plans, 2002-2008
N/A: Not Available
* The information for Molo and Narok South districts are contained in Nakuru and Narok districts respectively.

Tanzania

Infants (under one year), young children (under five years), and expectant/lactating mothers are the three groups most at risk of death. The survival indicators Infant Mortality Rate (IMR), the Under Five Mortality Rate (U5MR), and the Maternal Mortality Rate (MMR) are presented in Table 9.26. Serengeti has the lowest IMR ranging from 5 to 11 per 1000 live births during the period from 2002 to 2006. This information (unpublished) was collected during the study field visits to the Serengeti District Council. The low values reported most likely are because of the poor reporting system of data in the district. IMR for Musoma Rural ranged from 89 to 95 per 1000 live births. The data for Musoma Rural compared to the national (2004) average value of 89 per 1000 live births is on the higher side. The U5MR statistics for Serengeti were again on the very low side, ranging from 22 to 34 per 1000 live births. As indicated above, there are reasons to suspect the validity of this data. The IMR statistics for Musoma Rural are comparable to the national (2004) average value of 112 per 1000 live births, except for 2006 when the value for IMR increased to 154, which may indicate better reporting of IMR cases. The MMR statistics for both Serengeti and Musoma Rural are below the national (2004) average value of 578 per 100,000 births. In 2006, MMR in Musoma Rural drastically dropped to 105 from 300 in 2004. This effect can be linked to increased use of maternal health services in the district. Unfortunately, the data for Tarime was not made available despite several attempts to obtain them. The 2004 national health indicators for IMR, U5MR, and MMR are also presented in Table 9.26.

Improvement of maternal health in the districts is guided by the National Reproductive Health Strategy 2005-2010 which stipulates that the general objective of maternal health is to provide comprehensive, integrated services that are of good quality, equitable, accessible, affordable, and appropriate to the needs of individuals, families, and communities (MoHSW, 2006a). The strategy addresses the following seven maternal health thematic areas:

- Focused antenatal care;
- Skilled care during delivery;
- Care of obstetric emergencies;
- Post-partum care;
- Post–abortion care;
- Family planning; and
- Prevention of harmful practices.

The National Roadmap Strategy Plan to Accelerate Reduction of Maternal and Newborn Deaths in Tanzania (2006-2015), which was developed in 2006, further strengthened the focus of the Maternal and Newborn care component of the National Reproductive Health Strategy 2005-2010 (MoHWS, 2006b). These strategies aim to help the health system at all levels to manage pregnancy related complications, unsafe abortion, and newborn care, to prevent unwanted pregnancies, and to establish a functional referral system.

Table 9.26: Infant Mortality, Under Five Year Mortality, and Maternal Mortality Rates, Mara Basin, Tanzania

District	**2002**			**2004**			**2006**		
	IMR	**U5MR**	**MMR**	**IMR**	**U5MR**	**MMR**	**IMR**	**U5MR**	**MMR**
Musoma Rural	90/1000	100/1000	315/100,000	89/1000	97/1000	300/100,000	95/1000	154/1000	105/100,000
Tarime	No Data available								
Serengeti	11/1000	34/1000	174/100,000	5/1000	30/1000	115/100,000	6/1000	22/1000	154/100,000
Indicator	**Health indicators (2004)**								
IMR	89								
U5MR	112								
MMR	578								

Source: District Health Offices: Musoma Rural and Serengeti, (RAWG, 2005)

9.3.2 Causes of Disease and Death in Kenya

The national morbidity trend in Kenya has remained relatively constant over the last four decades with malaria and respiratory infections holding number one and two positions respectively, and accounting for over 55% of the total (Ministry of Health, 2003). In the Mara River basin, the Transmara district had the highest Malaria cases with 267 cases per 1000 people in 2004. Other morbidity causes include diarrhea, skin and intestinal worm related diseases, pneumonia, and rheumatism. Table 9.27 depicts the outpatient morbidity trends for Bomet, Narok, Transmara, and Nakuru districts for 2003 and 2004.

Table 9.27: Top Ten Causes of Outpatient Morbidity, Mara Basin, Kenya, 2003 and 2004

	BOMET		NAROK		TRANSMARA		NAKURU	
DISEASE	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
1. Malaria	67,604	60,100	67,138	68,920	38,165	28,063	147,720	165,065
2. Disease of the respiratory system	4,865	50,423	34,419	53,102	27,221	91,789	175,176	286,023
3. Disease of the skin (including ulcers)	3,047	18,425	7,758	12,496	9,639	21,038	53,589	45,161
4. Diarrheal diseases	1,532	13,401	9,086	12,880	7,386	16,540	31,011	27,102
5. Intestinal worms	1,341	13,599	2,839	5,333	3,826	6,374	19,387	16,986
6. Pneumonia	560	4,998	8,764	9,962	5,210	6,368	19,413	32,231
7. Accidents (fractures, burns)	766	6,093	3,210	5,285	3,756	11,905	19,648	18,463
8. Rheumatism, joint pains, etc.	316	2,469	1,893	3,836	1,239	2,089	9,564	14,076
9. Urinary Tract Infections	554	3,851	3,905	4,673	2,125	5,863	12,310	11,172
10. Eye Infections	459	3,277	3,027	3,834	2,888	3,311	14,997	11,596

Source: Ministry of Health, Performance Status Report 2003-2004 – Kenya

The above reported cases are converted into percentages of the district population in Table 9.28 for purposes of comparison. The results indicate that morbidity levels in Transmara district are much higher than in the other districts. Consequently, there is need to enhance healthcare services in this district and upgrade them to the level of the other districts.

Table 9.28: Reported Morbidity Cases as Percent of District Population, 2003/2004

Disease	**Bomet**		**Narok**		**Transmara**		**Nakuru**	
	2003	2004	2003	2004	2003	2004	2003	2004
	% of popultn.	% of popultn.	% of popultn.	% of popultn.	% of popultn.	% of popultn.	% of popultn.	% of popultn.
Malaria	15.9	13.9	16.1	16.2	20.6	14.9	10.9	11.9
Respiratory system	1.1	11.6	8.3	12.4	14.7	48.9	12.9	20.6
Skin including ulcers	0.7	4.3	1.9	2.9	5.2	11.2	4.0	3.3
Diarrhoea	0.4	3.1	2.2	3.0	4.0	8.8	2.3	2.0
Intestinal	0.3	3.1	0.7	1.3	2.1	3.4	1.4	1.2
Pneumonia	0.1	1.2	2.1	2.3	2.8	3.4	1.4	2.3
Accidents (burns, fractures)	0.2	1.4	0.8	1.2	2.0	6.3	1.5	1.3
Rheumatism	0.1	0.6	0.5	0.9	0.7	1.1	0.7	1.0

Urinary tract	0.1	0.9	0.9	1.1	1.1	3.1	0.9	0.8
Eye infection	0.1	0.8	0.7	0.9	1.6	1.8	1.1	0.8

The above results show that water borne and water related diseases are among the top ten causes of outpatient morbidity. These diseases are mainly caused by lack of sanitation facilities and contaminated water and food. Pollution to water systems by sewage and domestic/chemical effluents has resulted in unsafe drinking water and the subsequent escalation of waterborne diseases. Solid waste dumping, which is common in the urban and rural market centers, has resulted in garbage accumulation that also becomes mosquito breeding grounds.

Respiratory diseases are exacerbated by increased use of firewood and charcoal. Diarrhea diseases (cholera and typhoid) are also common. The Ministry of Health through the Public Health Department has been promoting public education on general hygiene through public meetings (barazas) and health institutions. Further analysis of outpatient morbidity in the districts within the Mara River basin shows the following disturbing trends:

Malaria (Mara Basin, Kenya)

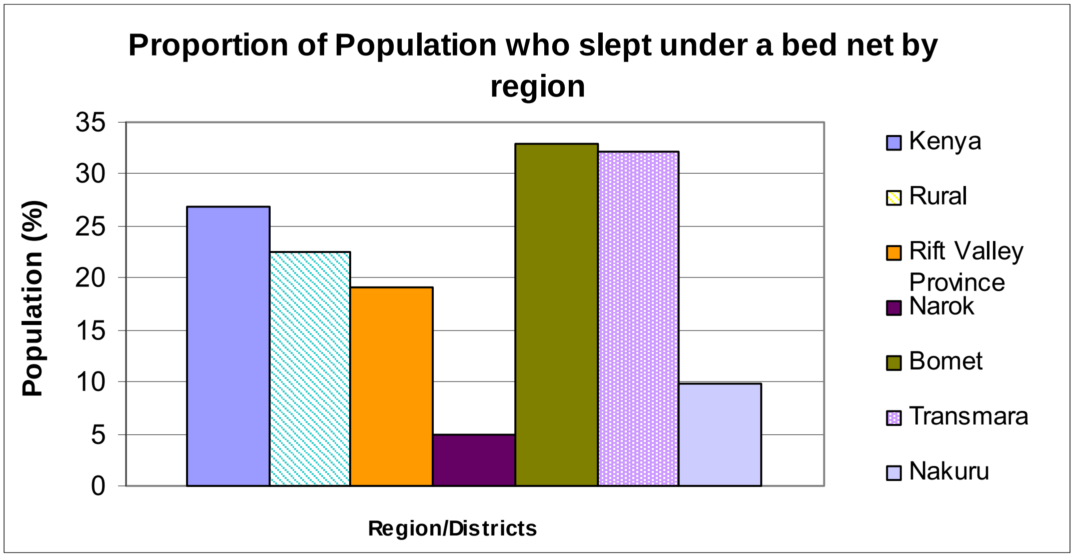
Malaria is the leading cause of outpatient morbidity in the Rift Valley Province and contributes 30% of the total new cases reported. 50% the districts in the province are in malaria prone regions. Bomet and Transmara districts are malaria epidemic. The disease is spreading to the districts that were previously malaria free, which includes Nakuru (Molo) and Narok (Narok South). Narok district has already joined the malaria epidemic districts in Kenya. Table 9.29 presents the malaria cases reported in the four districts within the Mara basin from 2001 to 2007. These reported cases have been converted into percentages of total population in the districts in order to assess the trend in morbidity. The results show very high infection rates of over 20% in all districts except Nakuru which is not yet placed in the malaria epidemic list. However, there is general increase in the reported cases even for Nakuru, indicating the need for greater awareness creation on prevention mechanisms.

Table 9.29: Reported Cases of Malaria and Percentage of Population Affected, Mara Basin, Kenya, 2001-2007

Year	Bomet		Narok		Transmara		Nakuru	
	Cases	% of population	Cases	% of population	Cases	% of population	Cases	% of population
2001	52,668	13	49,902	13	26,354	15	113,879	9
2002	61,476	15	24,975	6	39,585	22	127,765	10
2003	67,604	16	67,138	16	38,165	21	147,720	11
2004	60,100	14	168,920	40	28,063	15	165,065	12
2005	78,517	18	120,217	28	24,718	13	223,989	16
2006	68,401	15	106,332	24	34,546	18	230,200	16
2007	92,805	20	92,247	20	42,876	22	274,046	18

Source: Provincial Health Information System (PHIS)

The Kenyan Ministry of Health established the Division of Malaria Control in 2000 to reduce malaria infections and associated deaths. One of the measures was vector control with insecticide-treated mosquito nets (ITNs). When ITNs are used by all or most households, they have been seen to reduce malaria transmission. Figure 9.10 compares the percentage of the population that used nets in 2005 at the national level, provincial level, and the Mara districts in Kenya. Comparing the results from Table 9.29 (increased cases of malaria infections) and Figure 9.10 (low use of nets), there is need to carry out advocacy programs among the Kenyan population in malaria epidemic districts to increase ITNs use.



Source: Kenya Integrated Household Budget Survey (2005/06)

Figure 9.10: Proportion of the Population Using a Bed Net at National, Provincial and District levels

Tuberculosis (Mara Basin, Kenya)

Tuberculosis (TB) is a leading killer disease, is highly contagious, and contributes 0.2% of the new outpatient cases reported. Table 9.30 shows TB trends for 2001 to 2007. Tuberculosis cases in Bomet, Narok, and Transmara districts for 2003 were not available for analysis. In the case of Nakuru district (population 1,450,116 in 2006), tuberculosis cases reported for 2006 and 2007 were much higher than previous years. Part of this increase was due to public health awareness of the need to access medical care from government hospitals and the availability of free medicine for tuberculosis diseases in these hospitals.

Table 9.30: Reported TB Cases in the Mara River Basin, Kenya, 2001-2007

Year	Bomet	Narok	Transmara	Nakuru
2001	124	103	217	335
2002	459	40	119	987
2003	-	-	-	197
2004	350	212	233	633
2005	284	326	262	686
2006	205	129	128	4,206
2007	193	148	120	3,529

Source: Provincial Health Information System (PHIS)

Diarrhoea (Mara Basin, Kenya)

Diarrhoea is one of the top ten causes of morbidity in the Rift Valley Province and the districts in the Mara basin, accounting for 4% of the total new cases reported annually. Children under 5 years are the most affected group. Table 9.31 presents reported cases of diarrhoea in the Mara basin districts in Kenya for the period 2001 to 2007. Although there might be discrepancies in the reporting, there is a general trend in the increase of diarrhoea cases in all districts which points to the possibility that the quality of water being used by the population for domestic purposes is deteriorating.

Table 9.31: Reported Diarrhoea Cases in the Mara Basin, Kenya, 2001-2007

Year	Narok		Bomet		Transmara		Nakuru	
	Cases	% of population	Cases	% of population	Cases	% of population	Cases	% of population
2001	10262	2.6	8430	2.1	10481	5.8	19011	1.5
2002	4790	1.2	8750	2.1	4223	2.3	24343	1.8
2003	7570	1.8	9406	2.2	7376	4.0	24945	1.8
2004	14873	3.5	13401	3.1	7773	4.1	27102	2.0
2005	8772	2.0	15876	3.6	10113	5.3	42492	3.0
2006	12266	2.7	15461	3.5	13372	7.0	50567	3.5
2007	34222	7.5	29328	6.5	25532	13.2	63538	4.3

Source: Provincial Health Information System (PHIS)

9.3.3 Causes of Disease and Death in Tanzania

A pre-requisite to a productive society is a healthy and long living population. This section gives an overview of health status in the Tanzanian Mara basin.

Musoma Rural

The information presented in Table 9.32 shows that the major five causes of morbidity in 2005 were malaria, Acute Respiratory Infection (ARI), pneumonia, diarrhoea, and intestinal worms. Malaria alone, accounted for roughly half of the top 10 causes of morbidity. Out of the top 10 diseases for the population less than 5 years, three of the causes are water-related (malaria), water-based (skin infection), or water-borne (diarrhoea). These three diseases jointly accounted for 60%, (malaria 45%, diarrhoea 10%, and skin infection 5%) of the incidences. For the population older than 5 years, four of the top 10 causes are also related to water. These four diseases jointly accounted for 60 % (malaria 44.5%, diarrhoea 7.2 %, schistomiasis 4.2 %, and skin infection 4%).

Table 9.32 Top 10 Reported Causes of Morbidity, Musoma Rural District 2005

	Age < 5 years			Age 5+ years		
Rank	**Disease**	**Cases**	**%**	**Disease**	**Cases**	**%**
1	Malaria*	54,292	45.1	Malaria*	74,448	44.4
2	ARI	16,445	13.6	ARI	25,240	15.1
3	Diarrhea*	12,028	10.0	Pneumonia	13,563	8.1
4	Pneumonia	11,340	9.4	Diarrhea*	12,006	7.2
5	Intestinal Worms	6,324	5.2	Intestinal Worms	11,198	6.7
6	Skin Infection*	5,810	4.8	Schistomiasis*	6,987	4.2
7	Eye Infection	4,514	3.7	Skin Infection*	6,716	4.0
8	UTI	3,426	2.8	Eye Infection	6,331	3.8
9	Anemia	3,341	2.8	Minor Surgical	6,293	3.8
10	Ear Infection	2,976	2.5	UTI	4,842	2.9
Total		**120,496**	**100.0**		**167,624**	**100.0**

*Disease related to water

Source: Health Department, Musoma Rural District Council

Serengeti District

Table 9.33 shows that the top five causes of morbidity in the Serengeti district for 2007 for the population with age less than 5 years and age more 5 years were Malaria, ARI, Urinary Track Infection (UTI), Pneumonia, and intestinal worms. Malaria accounted for 49% and 48% of the top 10 causes of morbidity for the population at age less than 5 years and age more than 5 years respectively. Out of the top 10 causes of morbidity for the population with age less than 5 years, three were diseases related to water. Jointly, these three diseases accounted for 58%, with Malaria 49%, Diarrhoea 6.8%, and skin infection 2.6% of the incidences. In the case of population with age more than 5 years, also three of the top 10 morbidity causes were diseases related to water. The three diseases jointly accounted for 60 % of the incidences, with Malaria 48%, Diarrhoea 4.4%, and skin infection 2.6%.

Table 9.33: Top 10 Reported Causes of Morbidity, Serengeti District 2007

	Age < 5 years	Age 5+ years

Rank	Disease	Cases	%	Disease	Cases	%
1	Malaria*	23,047	49.1	Malaria*	19,160	47.8
2	ARI	6,080	13.0	ARI	6,807	17.0
3	UTI	3,528	7.5	Intestinal Worms	4,412	11.0
4	Pneumonia	3,520	7.5	UTI	3,823	9.5
5	Intestinal Worms	3,501	7.5	Pneumonia	1,778	4.4
6	Diarrhoea*	3,169	6.8	Diarrhoea*	1,766	4.4
7	Eye Infection	1,490	3.2	Skin Infection*	1,061	2.6
8	Skin Infection*	1,236	2.6	Eye Infection	1,056	2.6
9	Ear Infection	1,194	2.5	Ear Infection	185	0.5
10	Anaemia	135	0.3	Anaemia	65	0.2
Total		**46,900**	**100.0**		**40,113**	**100.0**

** = Disease related to water*

Source: Health Department, Serengeti District Council, 2008

Tarime District

Table 9.34 shows the top two causes of morbidity in Tarime for 2001 were the water related diseases of malaria (52.5%) and diarrhoea (12.1%). Skin infection was the third water related disease listed in the top 8 morbidity causes. Overall, these three diseases accounted for 68 % of the incidences.

Table 9.34: Top 8 Reported Causes of Morbidity, Tarime District 2001

Rank	Disease	Cases (total)	%
1	Malaria*	79499	52.5
2	Diarrhoea*	18332	12.1
3	Intestinal Worms	10483	6.9
4	Pneumonia	7104	4.7
5	Eye Infection	5637	3.7
6	Skin Infection*	5070	3.3
7	UTI	4134	2.7
8	Other	21218	14.0
Total		151477	100.0

*Disease related to water)

Source: Health Department, Tarime District Council, 2008

9.4 HIV/AIDS Infection

Acquired Immune Deficiency Syndrome (AIDS) is caused by the human immunodeficiency virus (HIV) that weakens the immune system and renders the body susceptible to other diseases causing death through secondary infections (KDHS, 2003). This is a serious public health and socio-economic problem in many countries around the world. The most affected countries are found in sub-Saharan Africa, especially those located in the eastern, central, and southern parts of the continent.

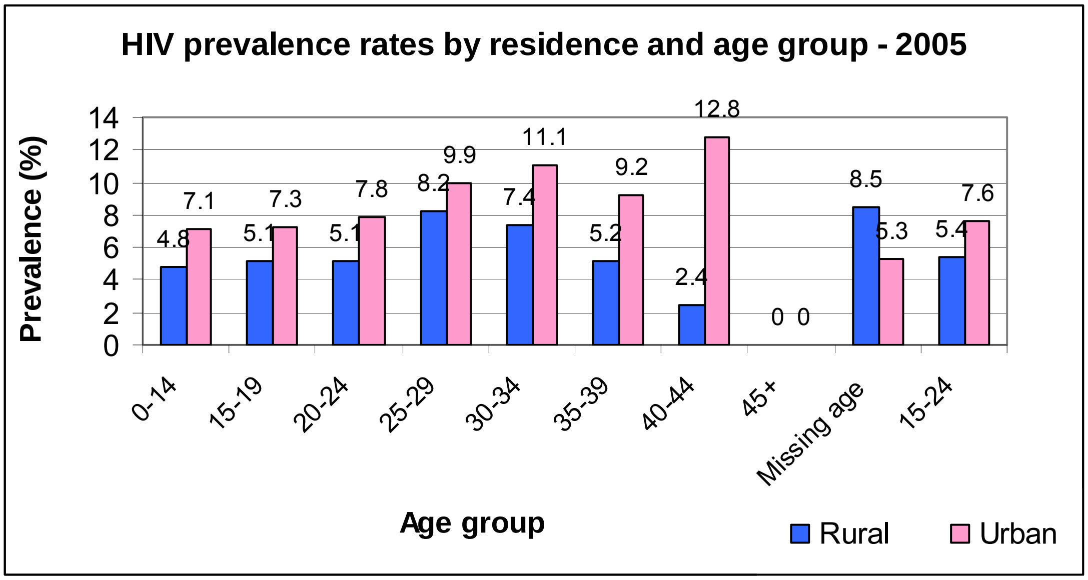
9.4.1 HIV/AIDS Infection in Kenya

In Kenya, as in most of sub-Saharan Africa, national HIV prevalence estimates have been derived primarily from sentinel surveillance in pregnant women. Kenya started an HIV/AIDS surveillance system in 1990, carried out by the National AIDS/STD Control Program every year. The system surveys women of all ages, who attend ante-natal clinics (ANC) for the first time during pregnancy, and men of all ages seeking medical treatment for sexually transmitted infections (STI). To track the HIV/AIDS trends over time and place, sero surveys are conducted at repeated intervals using a consistent methodology in the same population groups. Currently, the national sentinel surveillance system consists of 42 government and mission health facilities that represent the different groups, regions, and rural and urban populations.

For three months each year since 1990, pregnant women registering their first visit and patients with sexually transmitted diseases are anonymously tested for HIV. The results are analyzed and reported by the National AIDS/STD Control Program (NASCOP; Ministry of Health, 2001). The information derived is used to improve planning, policy development, and interventions.

HIV/AIDS remains a major concern in Kenya because of high prevalence among adults and significantly higher rates among younger ages (Ministry of Health, 2001). For the last decade, the HIV national infection rates have been rising from 6.1% in 1990 to a peak of 13.4% in 2000. Prevalence has since declined to 7.3% in the 2005 (NASCOP, 2005). HIV/AIDS prevalence rates are high among the ANC clients aged 20 to 30, those who live in urban or peri-urban areas, those in polygamous marriages, and those with only primary school education (NASCOP, 2005). The age specific prevalence results among ANC respondents indicates that the 25 to 29 age group had the highest prevalence (8.2%) for rural areas and the 40 to 44 age group for urban areas (12.8%). The HIV among adolescents 15 to 19 was 5.1% and 7.3% in rural and urban areas, respectively. Figure 9.11 shows the HIV prevalence among ANC clients by rural/urban area and age group for 2005.

The age group 15 to 24 is used as an impact assessment indicator for establishing infection rates among the young and monitoring achievements towards the United Nations General Assembly Special Session on HIV/AIDS (UNGASS) targets. HIV prevalence for this group was 5.4% (95% confidence limit (CL) 4.7-6.2%) for rural and 7.6% (95% CL 6.7-8.7%) for urban areas.

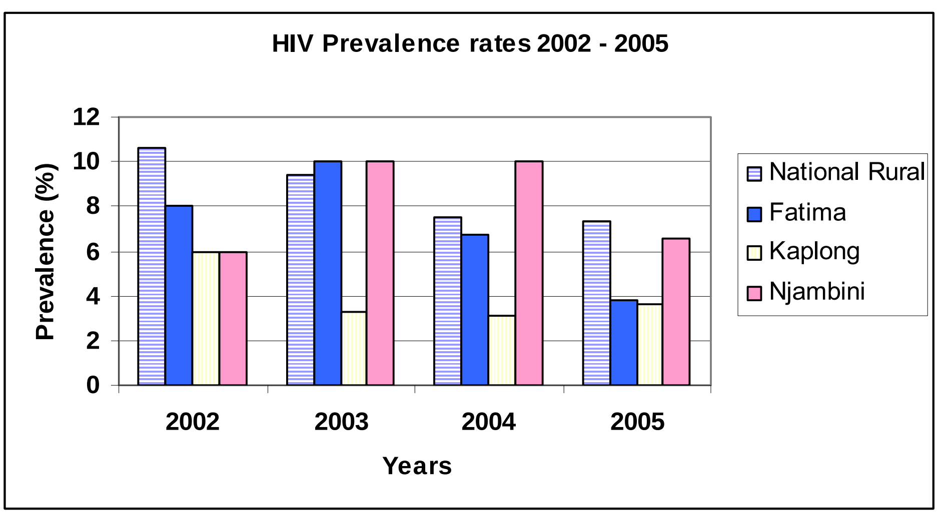


Source: Sentinel Surveillance of HIV and STD's in Kenya, 2005

Figure 9.11: National HIV/AIDS Prevalence by Area Type and Age Group

In the Mara River basin, the National AIDS/STD Control Program (NASCOP) selected Fatima, Kaplong and Njambini as sentinel surveillance rural sites in Narok/Transmara, Bomet, and Nakuru districts, respectively, where pregnant mothers and people infected with STD visiting the health centers were routinely tested. Figure 9.12 shows the prevalence in rural sentinel sites between 2002 and 2005. The figure also compares these sites with the national rural HIV prevalence. Prevalence increased between 2003 and 2004 and declined in 2005 in the rural sites, while nationally the trend has been declining but rose again 2005.

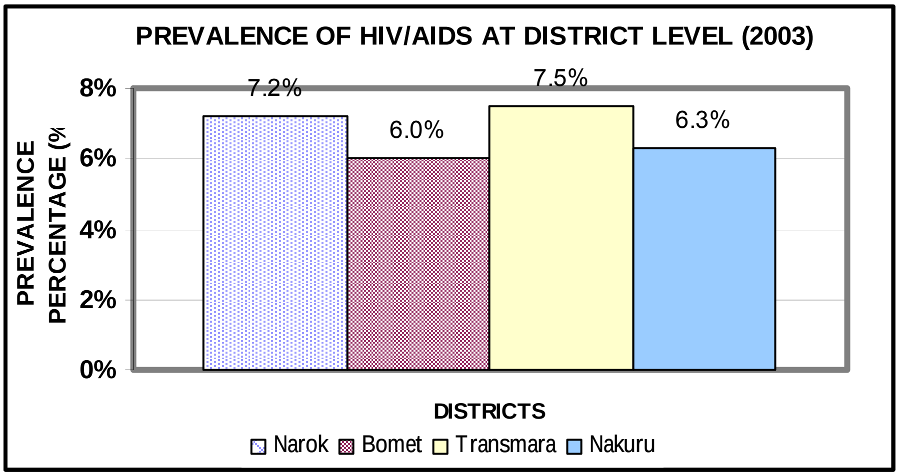
Other HIV/AIDs diagnostic centres in the Mara catchment include Kilgoris district hospital, St. Joseph Mission Hospital and Akemo Valley Nursing Home in Transmara district, and Tenwek Hospital in Bomet.



Source: Sentinel Surveillance of HIV and STD's in Kenya, 2005

Figure 9.12: Selected Sentinel Surveillance Sites in the Mara River Catchment

Figure 9.13 shows the HIV/AIDS prevalence for the districts in the rural areas for 2003. Prevalence rates were between 6% and 8% with Transmara leading at 7.5%. The prevalence rates of HIV/AIDS in the catchment are still high, although nationally infection rates have gone down.



Source: Ministry of Health, Performance Status Report 2003-200, Kenya
Figure 9.13: HIV/AIDS Prevalence Rates in the Mara River Basin

Some factors leading to high infection rates include cultural/traditional practices like circumcision of both male and females, moranism, wife sharing, and less than 15% of deliveries done in hospitals usually under unhygienic conditions. Other factors include high poverty levels promoting women have commercial sex, high mobility in search of employment (especially in the tourist hotels), lack of information, and lack of education among rural people.

The impact of HIV/AIDS has already been felt in many areas. These impacts include increased number of orphans, child prostitution, child labor, decreased agricultural and industrial productivity, increased dependency rates, increased school drop out rates, and increased healthcare costs.

Measures to help curb the spread of HIV/AIDS and eliminate the stigma include increased awareness by the Ministry of Health, churches, and NGOs; peer group education; school curriculum education; video shows; posters; booklets; and promotion of condom use (for example, condom dispensers in public offices). Other measures include introduction of home-based care and provision of anti-retroviral drugs at subsidized prices.

HIV/AIDS management at the district level is done through the District AIDS Control Committees (DACCs) and the Constituency AIDS Control Committees (CAACs) with technical assistance from the Ministry of Health. The biggest challenge in the fight against HIV/AIDS is human sexual behavior since it is the major cause of infection. Voluntary

Counseling and Testing (VCT) is now acknowledged as an effective strategy for prevention. HIV testing through VCT or in clinical settings is essential for access to AIDS care.

To meet the challenges of the HIV/AIDS epidemic, Kenya approved the Sessional Paper No. 4 on AIDS in September, 1997 (Ministry of Health, 1999). The intention was to support effective programs to control the spread of AIDS, to protect the human rights of those with HIV/AIDS, and to provide care for those infected and affected by HIV/AIDS. The goal of the Sessional Paper was to "provide a policy framework within which AIDS prevention and control efforts will be undertaken for the next 15 years and beyond." The Sessional Paper recognizes that responding effectively to the crisis will require a strong political commitment at the highest level; implementation of a multi-sectoral prevention and control strategy with priority focus on young people; mobilization of resources for financing HIV prevention, care, and support; and establishment of a National AIDS Control Council to provide leadership at the highest level possible.

9.4.2 HIV/AIDS Infections in Tanzania

The prevalence of HIV/AIDS has serious implications for the welfare of the society. HIV/AIDS are the most potentially threatening causes of morbidity and death to the communities. Noting that the disease targets the most economically active layers of the society, with women being particularly vulnerable, the impact of the disease on productivity and income generation is catastrophic. This section depicts the trends of HIV prevalence in the Mara Basin districts of Tanzania.

Musoma Rural

Table 9.35 for Musoma Rural shows that HIV prevalence increases with age between 20 and 24 but increases most dramatically above 25. The population above 20 is considered to be most at risk. The table shows that infection is higher among females than males. The high infection rate among females 20 to 24 suggests that women become sexually active earlier than men. Table 9.27 also shows that the infection rate was highest in 2002 for both males (10%) and females (19%). From 2003 to 2005 the infection rate for males remained at 5%. On the other hand, the infection rate for females decreased from 19% in 2002 to 11% in 2003, and increased to 13% in 2004 and 14% in 2005. For all age groups for the period from 2002 to 2005, females are more at risk from HIV infection.

Table 9.35: HIV Infection by Gender and Age, Musoma Rural

Age	**2002**		**2003**		**2004**		**2005**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
< 19 years	1	2	0	0	2	4	2	1
20 - 24 yrs	4	7	3	13	4	20	0	4
25+	46	27	36	22	27	23	33	41
Total	51	36	39	35	33	47	35	46
No. Screened	489	188	770	322	780	366	684	326
% of HIV Infection	10	19	5	11	4	13	5	14

Source: Health Department, Musoma District Council (provided during field visits 2008)

Serengeti District

Table 9.36 shows HIV infection among males and females in the Serengeti district. As for Musoma Rural, HIV prevalence increases with age between 20 to 24 years and again above 25. Infection is also higher among females than among males. Comparing the rate of HIV infections in the two districts, the rates of infection for Serengeti are much lower than those of Musoma Rural. For example, Musoma Rural infection rates for men and women were 10% and 19% compared to 3% and 5% in Serengeti. Overall, from 2002 and 2005 the rates of infection for males was 2 to 3 % while for women it was 5%.

Table 9.36: HIV Infection by Gender and Age, Serengeti District

Age	2002		2003		2004		2005	
	Male	Female	Male	Female	Male	Female	Male	Female
< 19 years	4	5	1	2	3	11	5	13
20 - 24 yrs	2	10	6	8	14	22	6	23
25+	34	45	23	45	80	141	73	162
Total	40	60	30	55	97	174	84	198
No. Screened	1419	1260	1432	1381	3801	3507	4542	3825
% of HIV Infection	3	5	2	4	3	5	2	5

Source: Health Department, Serengeti District Council (provided during field visits 2008)

Table 9.37 compares HIV prevalence in the three Mara Basin districts. The table shows that the infection rate was higher in females than males in all three districts confirming that females are more at risk. The HIV prevalence was the lowest in Serengeti (3.2%) and highest in Tarime (11.1%). Prevalence in Musoma Rural was also high (8%).

Table 9.37: HIV Prevalence among Blood Donors by Gender and District, 2000

District	Males			Females			Total		
	Total donors	Number positive	% Positive	Total donors	Number positive	% Positive	Total donors	Number positive	% Positive
Musoma Rural	574	38	6.6	140	19	13.6	714	57	8.0
Serengeti	651	21	3.2	551	18	3.3	1202	39	3.2
Tarime	1359	134	9.9	1046	133	12.7	2405	267	11.1

Source: Mara Region Socio-economic profile, June 2003

9.5 Immunization

Kenya

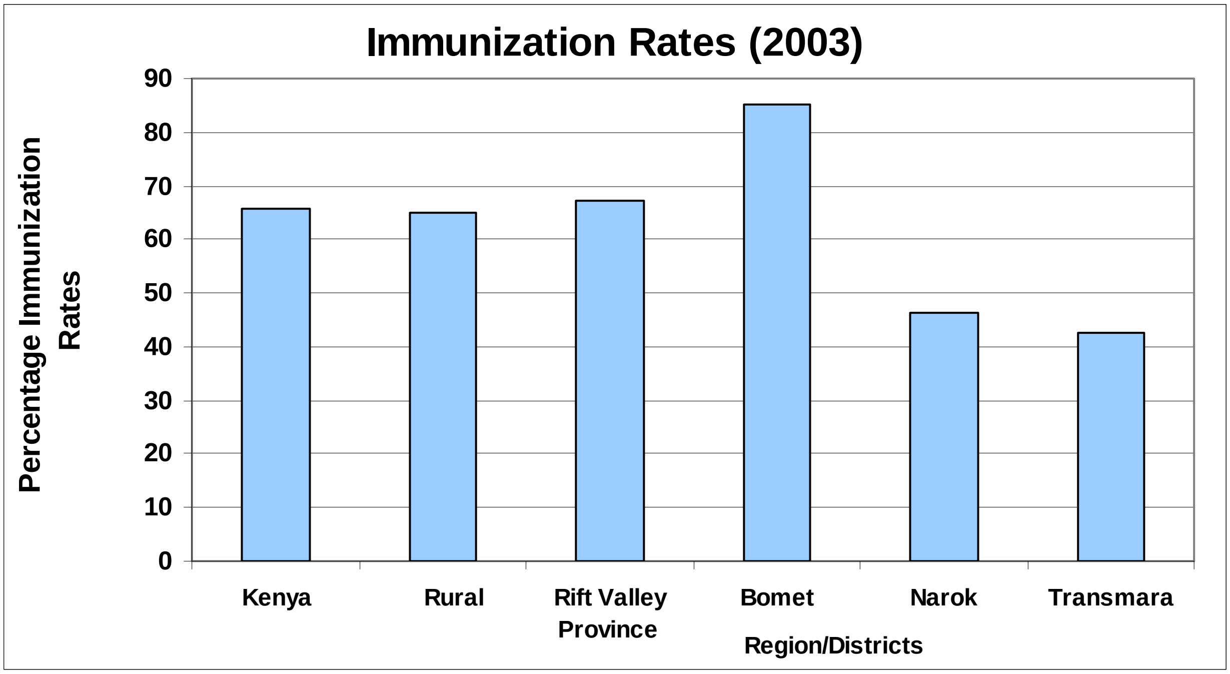
Child immunization is vital to survival and growth as it prevents some diseases. The Kenya Expanded Program on Immunization (KEPI) tries to ensure that children are immunized against tuberculosis, polio, tetanus, hepatitis B, influenza, and measles. KEPI adopted the WHO vaccination guidelines. Table 9.38 presents the distribution of children by immunization type and Figure 9.14 shows the percentage of children fully immunized in Narok, Bomet, Transmara, and Nakuru districts in 2003. The analysis focuses on children 12 to 23 months old since this is the target immunization interval.

At the national level, about 66% of children were fully immunized in the Mara River Basin. Bomet district had the highest immunization rate (85.2%) and Transmara had the lowest (42.5%). The Ministry of Health Performance Status Report (2003/2004) indicates more immunizations in 2004 than 2002 (86% versus 49%, based on the Kenya Expanded Program on Immunization, KEPI). Penta-1 coverage (the first combination of immunizations given to a child when born) was 84% down from 87% in 2003 indicating a reduction in accessibility to KEPI services. Measles coverage also declined from 69% to 65% in 2004, an indication of poor utilization.

Table 9.38: Immunization Rates of Children 12 to 23 Months

Region	Vaccination	BCG	PolioB	Polio1	Polio2	Polio3	DPT1	DPT2	DPT3	Measles	Fully Immunized	Total Count
Kenya	64.2	91.2	75.5	90.0	87.4	77.6	89.29	85.9	80.3	76.7	65.9	1,006,733
Kenya Rural	64.6	91.3	73.8	89.7	86.7	77.6	89.3	85.6	79.3	74.7	64.8	808,212
Rift Valley Province	64.7	94.0	77.7	93.5	91.5	80.2	93.3	90.5	84.3	80.2	67.1	249,115
Bomet	58.9	100	90.9	99.6	99.6	93.1	100	92.1	91.7	99.2	85.2	11,555
Narok	69.3	100	58.3	100	97.6	69.2	98.4	98.4	81.3	76.2	46.4	19,695
Transmara	79.5	90.6	43.0	100	89.6	66.8	100	86.6	71.5	53.8	42.5	6,692
Nakuru	70.7	90.6	77.9	94.1	91.2	86.4	95.3	86.1	86.6	78.9	70.5	46,289

Source: Kenya Integrated Household Budget Survey, 2005/06



Source: Ministry of Health, Performance Status Report 2003-2004 - Kenya

Figure 9.14: Fully Immunized Children (12-23 months) in Mara River Basin

Tanzania

Immunization against vaccine-preventive diseases is vital to reducing child morbidity and mortality in Tanzania. The expanded Program on Immunization (EPI) under the Ministry of Health and Social Welfare (MoHSW) is aimed at ensuring that all children are fully immunized by their first birthday. Children are supposed to receive one dose of tuburculosis vaccine (BCG); three doses of the vaccine against diphtheria, pertussis, tetanus, and hepatitis B (DPT-HB); four doses of oral polio vaccine (OPV); and one dose of measles vaccine (MoHSW, 2007). According to the 2004-05 Tanzania Demographic and Health Survey (TDHS), only 71% of the children of age 12 – 23 months were fully immunized compared with the EPI target of 90% (NBS and ORC Macro, 2005).

Table 9.39 presents the distribution of children by immunization type. The analysis is focused on children under one year old. The coverage for BCG vaccination in all three districts was very high (above 90%). The coverage for DPT3, though not as good as BCG, is fairly good. The districts coverage statistics for 2001 with respect to polio vaccination was poor. The districts of Musoma Rural and Tarime had poor coverage at 54.6% and 45.3% respectively. Most probably, the mobilization exercise to motivate the population to participate in the vaccination was not carried out effectively. Coverage of measles vaccination in the three districts was considered satisfactory, but there was still room for improvement.

Table 9.39: Immunization rates of children under one year, 2001

District	BCG	DPT3	OPV3 (Oral Polio Vaccine)	Measles Vaccine
Musoma Rural	92.1	90.0	54.6	87.4
Serengeti	95.0	91.4	71.0	87.5
Tarime	92.0	85.1	45.3	80.7

Source: The Regional Commissioner's Office, Musoma, 2002

9.6 Health Institutions

9.6.1 Health Institutions in Kenya

The Kenyan health institutions include government hospitals, private hospitals, health centers, dispensaries, and private clinics. Research has shown that many Kenyans do not have access to health facilities because private health services are too expensive for the rural poor and most patients have to walk long distances (KIHBS 2005/06). Table 9.40 shows the number of health facilities in the four districts of the Mara River Basin.

Table 9.40: Number of Health Facilities in the Mara Basin, Kenya

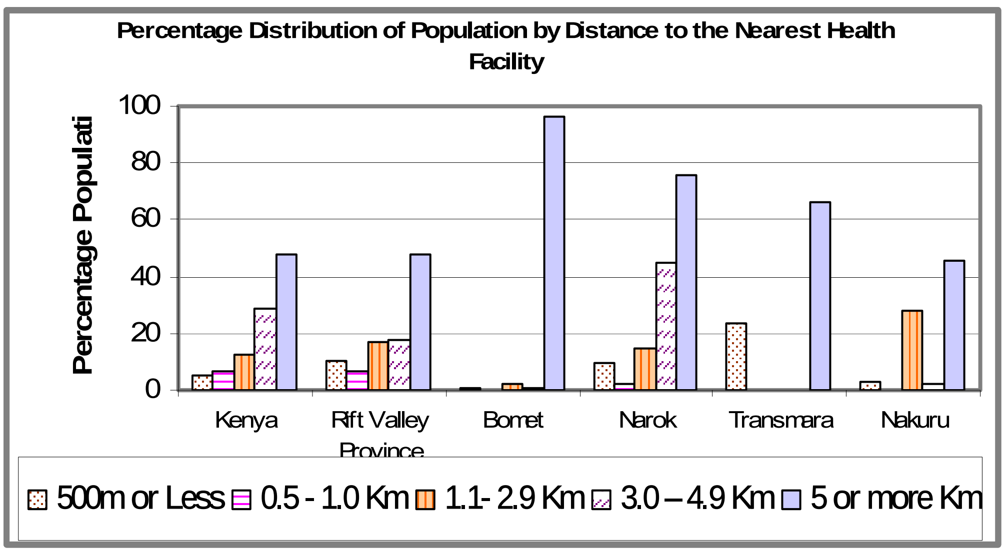
	Health Facility	**Service provider**				**Total facilities**
		Government	**Private**	**Community**	**Mission**	
Bomet						
1	Hospitals	2	1			3
2	Health Centres	9	1			10
3	Dispensaries	22				22
4	Clinics		16			16
Narok* (Narok South)						
1	Hospitals					
2	Health Centres	5	1		1	7
3	Dispensaries	7		1	15	23
4	Clinics					
Transmara						
1	Hospitals	1	1		1	3
2	Health Centres	5			1	6
3	Dispensaries	14	3	3	1	21
4	Clinics		17			17

Nakuru (Molo)*						
1	Hospitals	2				2
2	Health Centres	3				3
3	Dispensaries	16			5	21
4	Clinics			6		6

* The institutions considered are within the new districts created from the former Nakuru and Narok districts.
Source: Ministry of Health, Health Management Information Systems

According to the KIHBS (2005/06) survey, only 11% of Kenyans travel one kilometer or less to reach a health facility, while about half of the population (48%) travel for five kilometers or more. Approximately 12% of urban dwellers travel 5 km or more, while half of the rural dwellers travel similar distances to reach a health facility. Figure 9.15 shows the percent population by distance to the nearest health facility in the Mara River basin districts. The list of the health facilities in the basin are attached as Appendix 9A.

Despite health facilities in the Narok district, the Masai community rely on traditional remedies. The use of herbal medicine by the Masai is widespread and has been practiced through the generations. The Masai seek conventional medicine or hospitals only under extreme illnesses. Some areas are also remote and far from health and medical centres, hence the reliance on herbal drugs.



Source: Kenya Integrated Household Budget Survey (2005/06)
Figure 9.15: Percent Population by Distance to the Nearest Health Facility, Kenya

9.6.2 Health Institutions in Tanzania

Three levels of health facilities exist at the district level, namely district hospitals, health centers and dispensaries. Dispensaries are the lowest level of the public health system and provide the first point of contact. Dispensaries provide maternal and child health care, treat simple medical problems, conduct normal deliveries, and provide basic outpatient care. Health centers provide a wider range of services, including basic curative and preventive services for adults and children, reproductive health services, and minor surgical services (such as incisions and drainage). District hospitals offer outpatient and inpatient services at a higher level. They offer diagnosis services based on laboratory testing as well as radiology, surgical services, and obstetric care. The private sector is also allowed to invest in the health sector. Table 9.41 presents health facilities currently available in the three districts in the Mara Basin.

Table 9.41: Health Facilities in the Three Mara Basin Districts

No	Health Facility	Service Provider			Total facilities
Government Private Institutions					
		Musoma Rural			
1	Hospitals	1			1
2	Health Centres	2			2
3	Dispensaries	41		13	54
	Total				**57**
		Serengeti District			
1	Hospitals	1			1
2	Health Centres	2			2
3	Dispensaries	25	4	3	32
	Total				**35**
		Tarime district			
1	Hospitals	1		2	3
2	Health Centres	5	3	4	12
3	Dispensaries	49			49
	Total				**64**

Source: District Health Offices: Musoma Rural, Serengeti and Tarime (data provided during field visits, 2008)

Table 9.42 presents health facility coverage in the three Mara Basin districts. Tarime has the lowest coverage of 1 facility per 8,841 people, and Serengeti is best at 1 facility per 5,794 people. This situation is likely to have influenced the lower statistics of IMR, U5MR, and MMR for Serengeti as reported in Table 9.26 above.

Table 9.42: Health Facility Coverage Density by District, 2007

No	District	Estimated population, 2007	Total number of health facilities	Average population per health facility	Average number of health facilities per 10,000 people
1	**Musoma Rrl.**	380,000	57	6,667	1.5
2	**Serengeti**	202,800	35	5,794	1.7
3	**Tarime**	565,800	64	8,841	1.1

Source: District Health Offices: Musoma Rural, Serengeti and Tarime (Information provided during field visit, 2008)

9.7 Food Security and Nutrition

Reducing hunger and achieving food security and nutrition is a primary development goal for both Governments of Kenya and Tanzania. The Economic Recovery Strategy for Wealth and Employment Creation (ERSWEC) recognizes the role of human capital and emphasizes good nutritional status for human development and productivity enhancement (KIHBS 2005/06). The nutritional assessment status is based on the concept that in a well nourished population, the distribution of children's weight and height at a given age will follow a predictable statistical distribution.

9.7.1 Rural Food Poverty

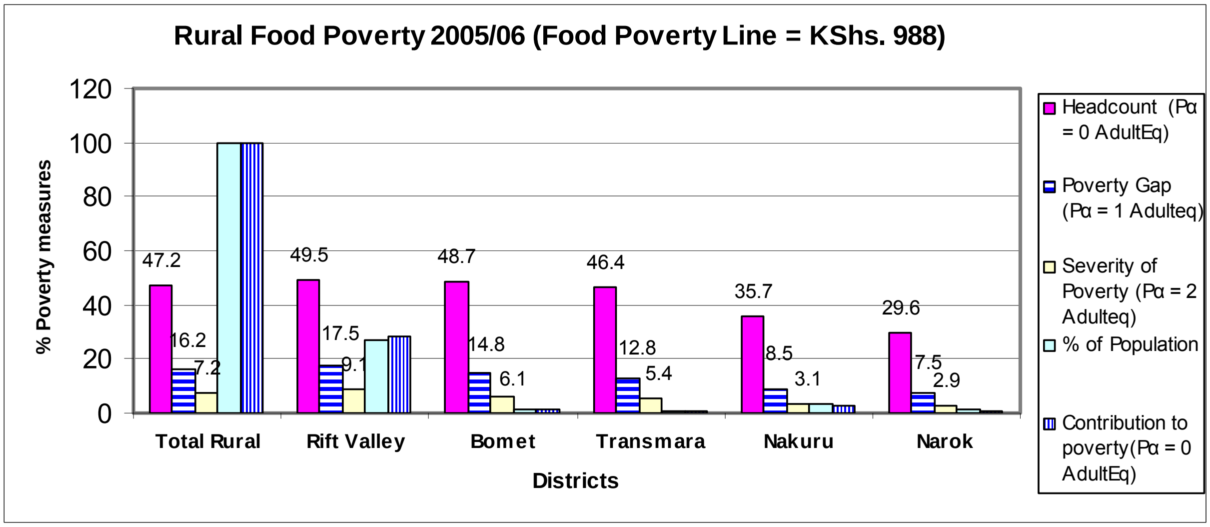
Kenya

According to the Kenya Integrated Household and Budget Survey of 2005, the rural food poverty line was estimated at 988 KShs per month per adult equivalent. The main measures of food poverty used are: the **'Headcount Index'** which measures the prevalence of poverty and is insensitive to how far below the poverty line each poor person is; the **'Income gap'**, the average of the poverty gap expressed as a fraction of the poverty line; and the **'Severity of Poverty'** or coefficient of variation of expenditure distribution of the poor.

A common poverty measure used in Kenya is the Foster, Greer, and Thobecke (FGT) poverty sensitivity indicator **P(α)** (KIHBS, 2005/2006). The FGT has three different indices:

a) **The Poverty Headcount Index (P(α)=0)**: Measures the proportion of the population that cannot afford to purchase the basic basket of goods and services as measured by the food and overall poverty lines. This is the most basic measure of poverty.
b) **The Poverty Gap Index (P(α)=1)**: Measures the depth of poverty and provides information on how much poorer individuals are relative to the poverty line.
c) The **Poverty Severity Index (P(α) =2)**: Shows how severe poverty levels are, and it can be used to assess the impact of policies aiming to reach the poorest sectors.

Figure 9.16 presents the incidence ($P(\alpha) = 0$), depth ($P(\alpha) = 1$) and severity ($P(\alpha) = 2$) of rural food poverty using food expenditures per adult equivalent in the Mara districts. The figure indicates that the overall rural food poverty incidence was 47.2%. The Rift Valley Province was highest at 49.5% followed by Bomet at 48.7%. Narok had the lowest poverty incidence at 29.6%, lowest poverty gap of 7.5% lowest food poverty severity at 2.9%. The figure also highlights the region's national share of population and its contribution to the overall poverty. The Rift Valley province was found to contribute up to a hundred percent to the nation's rural food poverty.



Source: KIHBS 2005/06, Basic Report on Well-Being in Kenya

Figure 9.16: Rural Food Poverty 2005/06

An individual is defined as hard core poor if he/she has resources that would be inadequate to meet basic food needs alone, even if he/she were able to forego all non-food purchases in order to consume food. Nationally, the overall incidence of total rural hard core poverty was estimated at 21.9%, while the Rift Valley Province had an estimate of 20.6%. The Rural Hard Core Poverty levels in the Mara basin in relation to the national and provincial hard core poverty levels are presented in Table 9.43.

Table 9.43: Rural Hard Core Poverty 2005/06 (Threshold: 988 KShs per month)

Region/ District	**Headcount (Pα = 0 Adult equivalent)**	**Poverty Gap (Pα = 1 Adult equivalent)**	**Severity of Poverty (Pα = 2 Adult equivalent)**	**% of Population**	**Contribution to poverty (Pα = 0 Adult equivalent)**
Total Rural	21.9	6.9	3.3	100.0	100.0
Rift Valley	20.6	7.8	4.5	26.7	25.1
Transmara	21.3	4.2	1.3	0.7	0.7
Bomet	17.8	4.9	2.1	1.6	1.3
Nakuru	9.1	1.5	0.4	3.3	1.4
Narok	9.0	2.5	0.8	1.6	0.6

Source: KIHBS 2005/06, Basic Report on Well-Being in Kenya

Tanzania

The analysis of income poverty requires data on household income or expenditure, and one or two pre-determined poverty lines. Poverty lines proposed for Tanzania are absolute lines defining poverty in terms of some exogenous measurement of income or expenditure required to provide a defined level of living. The two poverty lines used are the Food Poverty Line, which reflects the cost of a basic food basket, and the Basic Needs Poverty Line which provides for other, non-food expenditures. The study carried out in 1999 jointly by the National Bureau of Statistics (NBS) of Tanzania and the Oxford Policy Management Ltd of UK, developed a poverty baseline in Tanzania for the early nineties. The poverty lines developed were expressed in expenditure per adult for 28 days in December 1994 prices. The study established the food poverty line has a value of 5,113 TShs per adult for 28 days in 1994 prices (NBS and OPM, 2000). The corresponding value of the Basic Needs Poverty Line was established as 7,453 TShs. Using the data which was obtained during the Household Budget Survey (HBS) conducted in 1991/92 by the Bureau of Statistics, the Food Poverty Line represents 36% of the average expenditure and the Basic Needs Poverty Line 53%.

Two measures of level of poverty have been used to develop a poverty baseline in Tanzania. The two measures are:

- ***The headcount ratio***, defined as the proportion of people living in households where total expenditure per adult is below the poverty line.
- ***The poverty-gap measure***, which is the average percentage shortfall of total expenditure of households below the poverty line.

Using the poverty lines and indexes mentioned above, Table 9.44 shows the level and depth of poverty in Tanzania as a whole based on the data obtained from the 1991/92 Household Budget Survey. The Table shows that the HBS data identifies 27% of the people as being poor using the Food Poverty Line and 48% using the Basic Needs Poverty Line. The table also, shows that poverty is most prevalent and more severe in rural areas, where 32% fall below the Food Poverty Line and 57% below the Basic Needs Line.

Table 9.44: The incidence and Depth of Poverty in Tanzania in 1991/92

Poverty Line	Rural Area	Tanzania Mainland
Headcount ratio - Food Poverty Line	31.8%	26.6%
Headcount ratio - Basic Needs Poverty Line	57.0%	48.4%
Poverty-gap - Food Poverty Line	9.5%	7.8%
Poverty-gap - Basic Needs Poverty Line	20.9%	17.5%

Source: Developing a poverty baseline in Tanzania, 2000

The most recent House Budget Survey conducted in 2000/01 provides national and regional estimates of income poverty. The survey indicates that about 36% of Tanzanians are living below the poverty line while 19% of the Tanzanians are living below the food poverty line (RAWG, 2005). Using the poverty mapping technique, which allows for low level estimation of poverty, estimates at district level were also obtained. Table 9.45 provides the district level estimates of income poverty. Estimates of income poverty are high in Musoma Rural and Serengeti where more than half of the population lives below the basic needs poverty line. The two districts rank in the bottom 10 districts in the country. The level of poverty for Tarime is average.

Table 9.45: Percent of the Population below the Basic Needs Poverty Line, 2001/01

District	Poverty Head Count
Musoma Rural	63.7
Serengeti	60.6
Tarime	31.9

Source: Poverty and Human Development Report, 2005

9.7.2 Nutrition

Kenya

Nutritional status is a complex interaction between food consumption and the overall health status. Poor nutritional status is one of the most important health and welfare problems facing Kenya today and afflicts the most vulnerable groups, women and children. At the individual level, inadequate or inappropriate feeding patterns lead to malnutrition. Numerous socioeconomic and cultural factors influence the eating and nutritional status.

Feeding practices play a pivotal role in optimal infant development. Poor breastfeeding and infant feeding practices have adverse health consequences that also affect mental and physical development. Breastfeeding is nearly universal in Kenya at 97%. The median duration of breastfeeding is 20 months, similar to the duration documented in the 1993 and 1998 KDHSs. The 2003 KDHS data indicate that supplementary children feeding begins early.

Survey data shows that the nutritional status of children under five has improved only slightly in the past few years. At the national level, 30 percent of children under five are stunted (low height-for-age), while 6 percent of children are wasted (low weight-for-height) and 20 percent are underweight (low weight-for-age). According to the Ministry of Health Performance Status Report 2003-2004, the rate of malnutrition ranged between 7% and 17%, and the percentage of children with stunted growth was between 2.4% and 13.8% by province.

Tanzania

Malnutrition continues to be a major cause of morbidity and mortality in children under five in Tanzania. It is reported that malnutrition is the main underlying factor for about 70% of the illnesses that cause death among children under the age of five. The Tanzania Demographic and Health Survey, 2004/05 found that 38% of children under age five in Tanzania are stunted, that is, too short for their age, and 22% are underweight, that is too thin for their age. The survey also showed that prevalence of stunting is far higher among rural children (41%) than urban children (26%). In mainland Tanzania, prevalence of stunting was estimated to be 38% (NSB and ORC Macro, 2005). The national target is to reduce stunting to 20% by 2010.

9.8 Gender Inequality

Gender mainstreaming is still a major challenge to economic development and productivity in the Mara River basin. For meaningful development there is need for equal participation of both men and women. Gender imbalances still exist in decision making, resource control, and production processes. Research has shown that poverty levels are higher among women than in men (Basic Report on Well-being in Kenya). Women are usually left out of many development initiatives, and the perception exists that women's reproductive and domestic responsibilities should be their primary function.

In the Mara basin, gender inequalities persist mainly due to very strong traditional/cultural beliefs and practices. These include lack of education for girls, early marriages, exclusion of women in decision making, lack of access to income and other means of production, discriminative property ownership and inheritance, female circumcision and child labour.

In Narok district, women contribute up to 75% of agricultural labour in the rural households, but they have access to only 40% of the benefits accrued. Women also participate actively in water projects, where they help to install pipes, rock catchments, and excavate. However benefits largely go to men through increased incomes.

Women attend barazas more than men, but they do not take leadership positions due to cultural barriers. Women also lack technological know how since men generally attend seminars and workshops. However, in practice women use the technologies more since they implement most of the activities.

Both men and women do not have equal access to credit facilities. Men usually undertake projects with higher returns and access credit facilities more than women. Men can use property ownership documents that women lack.

The situation regarding gender inequality in Mara basin can be improved by pursuing the Millennium Development Goal No. 3, which aims to promote gender equality and empower women. One of the ways to achieve this goal is to eliminate gender disparity in primary and secondary education to start with and then at tertiary education. In Tanzania, good progress has been made on the enrolment of girls in primary education whereby the gender ratio is approaching 1.0. Attention is needed to improve the situation concerning enrolment of girls in secondary education, where gender disparity is still considerable.

9.9 Summary of Issues

The issues raised in the above sections concerning population, social development, and public health in the Mara River Basin are summarized in Table 9.46. The table highlights the causes, impacts and ongoing and potential intervention measures.

Table 9.46: Matrix of Issues on Population and Social Development

Issues	Causes	Impacts	Intervention Measures
1.High population growth rate	-Under-utilization of family planning services.	-Over-use of environmental resources, e.g., forests, water, etc. -Environmental degradation.	-Enhance the reproductive health service through the promotion of safe motherhood and child survival. -Promote activities that help decline population growth rates.
2.High poverty levels	-Frequent drought. -Reliance on rain fed agriculture. -Lack of other off-farm job opportunities. -Low entrepreneur capacities. -Poor seed quality. -Lack of agro-based industries. -Inadequate extension services.	-High dependency on relief food.	
3.Poor educational levels	-Inadequate learning physical facilities. -Early marriages. -High drop-out from schools. -High cost of education. -Negative community attitude towards education, especially for girls. -Lack of sufficient number of teachers.	-Overstretched educational facilities. -Overcrowding in schools. -Inefficient teacher utilization.	Development of physical facilities using funds released through: - Constituency development Fund (CDF); - Local Authority Transfer Funds (LATF); - NGOs funding; - Other fund sources. Promotion of cultural attitude change towards education. Training of local teachers.
4.Poor health status of the communities	-High cost of drugs. -Costly healthcare services. -Inaccessible health facilities (facilities too far apart). -Spread of HIV/AIDS epidemic.	-Loss of productivity. -Declining health standards and increased incidences and re-emergence of diseases.	Make medical services and drugs available, especially to the vulnerable groups. Preventive measures and counselling to control HIV/AIDS spread.

5.Poor quality housing	-High cost of building materials.	-Exposure of communities to diseases. -Mushrooming of slums in urban and peri-urban areas.	Investment in middle and low cost housing. Provide opportunities for increased family income.

10.0 Trade, Industry, and Macro-economic Development

10.1 Introduction

This chapter gives an overview of trade and industry in the Mara River basin. The sector plays a central role in economic development. The Mara River basin earns both Kenya and Tanzania foreign exchange, largely through the world famous Masai Mara National Reserve and the Serengeti National Park. The catchment also has small and large scale agricultural activities and a few small scale industries, but no manufacturing. The major service industries include transport, telecommunications, construction, and water supply.

10.2 Trade in Mara River Basin Districts

10.2.1 Economic Activities in Mara Basin

The main economic activities are farming (large and small scale), tourism, livestock rearing, forestry, fishing, and mining. The main commercial activities revolve around trading goods and services, and they are mostly concentrated in the town centers, including Bomet, Mulot, and Longisa in Kenya, and Musoma, Mugumu, and Tarime in Tanzania.

10.2.2 Agricultural Trade

The commercial activity which employs the most people is crop trading, mainly maize, rice, beans, bananas, potatoes, and cash crops including cotton and sugar cane. Most farmers with surplus harvests are suppliers (sellers). Produce trading is carried out at village production points where middlemen buy crops at relatively low prices and sell to urban market at higher prices. For example, sugarcane growers in the Keiyan division (outside the Mara River Basin) of Transmara district sell their sugar cane to SONY Sugar Company in Migori district.

10.2.3 Service Industries

Service trading in the Mara River basin is mainly small-scale. Services include the commercial, transportation, housing, health, and education sectors. Commercial services include wholesale and curio shops, hotels, restaurants, beer and soft drink distributors, livestock and crop sales, and transport activities. There are many other informal sector activities (jua kali in Kenya) including tailoring, furniture workshops, motor vehicle garages, welding, metalwork, and radio and television repairs. These informal businesses employ almost five times more people than other off-farm enterprises.

The dominant commercial services in Tanzania are the shops and kiosks (Table 10.1).

Table 10.1: Registered Business in Mara Districts

No	Business	Musoma Rural	Serengeti	Tarime
1	Shops/Kiosks	245	231	605
2	Hotels, restaurants, and bars	184	64	55
3	Guest houses	67	21	53
4	Milling machines	104	75	n.a.
5	Meat shops	93	30	75
6	Carpentry workshops	n.a.	15	n.a.
7	Garages	n.a.	3	2
8	Pharmaceticals	n.a.	16	82
9	Filling stations	n.a.	2	6
10	Small industries	n.a.	n.a.	21
11	Market	n.a.	16	26
12	Livestock traders	n.a.	18	23
13	Fish traders	214	n.a.	15

Source: Musoma Rural, Serengeti and Tarime District councils

The table shows that there are significant differences from one Tanzanian district to another which are attributed to the level of social and economic activity.

10.2.4 Mining Trade

Although agricultural crops and services trading are the largest part of the regional micro-economy, gold trading contributes substantially. There are several small-scale and two large-scale gold mining centers in Mara. One large commercial gold mine is located in Buhemba (Musoma Rural district) and the other is in Nyamongo (Tarime district). Small-scale gold mining is carried out in five centres in Musoma (Sirorisimba, Nyasirori, Katario, Suguti, and Ikungu) and four in Serengeti (Majimoto, Kemarambo, Mirenga, and Naigoti). The small-scale gold miners and middlemen in Mara are benefiting from gold mining activities. However, despite the estimated large number of small scale gold miners, annual production was estimated at 6 to 10 kilograms between 1998 and 2001.

10.2.5 Cross-Border Trade

Kenya and Tanzania are traditional partners in trade. Sirari town in Tarime district, located at the border between Tanzania and Kenya, is an important transaction point for both exports and imports. Table 10.2 shows the value of exports from Tanzania to Kenya and the value of imports into Tanzania from Kenya for 2006 and 2007. From July to December 2006, the value of exports exceeded imports by about 15%. During the same period in 2007, Tanzanian imports exceeded exports by more than 60%. The exports from Tanzania normally comprise of mainly agricultural products while imports from Kenya comprise of industrial goods.

Table 10.2: Tanzania/Kenya Cross-border Trade

Year	**Month**	**Value of Exports (TShs)**	**Value of Imports (TShs)**
2006	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul	42,900,802,954	68,832,297,088
	Aug	33,119,028,476	41,138,498,246
	Sep	33,119,028,476	19,234,787,956
	Oct	40,089,828,631	19,759,319,616
	Nov	36,876,518,440	16,681,823,984
	Dec	27,757,513,513	19,422,965,754
Total Jul-Dec 2006		**213,862,720,492**	**185,069,692,645**
2007	Jan		
	Feb		
	Mar	34,704,607	n.a
	Apr	703,742,373	n.a
	May	65,155,970	n.a
	Jun		
Total Jan-Jun 2007		**803,602,950**	
	Jul	20,660,323,620	34,518,249,065
	Aug	15,361,092,070	24,901,140,525
	Sep	10,467,813,453	24,325,201,700
	Oct	11,564,942,488	31,201,060,000
	Nov	16,869,332,303	26,987,382,438
	Dec	26,059,122,520	22,664,422,333
Total Jul-Dec 2007		**100,982,626,456**	**164,597,456,061**

Source: Tanzania Revenue Authority (TRA) Musoma Regional Office (Unpublished data)

Table 10.3 shows at the national level the major Tanzanian exports to Kenya and the major imports from Kenya. Exports include agricultural, livestock, fish, and unrefined gold. Imports include industrial and petroleum products and machinery. The Mara basin districts make significant contribution to almost all Tanzanian exports (Table 10.3).

Table 10.3: Tanzanian Exports to and Imports from Kenya

No.	Exported goods across the Tanzania/ Kenya border	No.	Import goods across the Tanzania/Kenya border
1	Cotton seed cake	1	Petroleum products
2	Fish products	2	General merchandise products
3	Cotton lint	3	Mining consumables
4	cotton waste	4	Fish packing materials
5	Agricultural products, i.e., maize	5	Mining equipment & consumables
6	Herds of cattle	6	Mining consumables
7	Cow hides		
8	Rice		
9	Chicken peas		
10	Unrefined gold		

Source: Tanzania Revenue Authority (TRA) Musoma Regional Office (UnPublished information)

Apart from the recorded formal transboundary trades, informal trades that are not recorded also take place by border communities. Commodities are usually transported by cyclists and small trucks which maneuver more easily through unofficial cross-border routes. The main informal trade commodities are agricultural products (maize, beans, and bananas) and fish from Tanzania and industrial products from Kenya. Kenya is the main market for Tanzanian agricultural products.

10.3 Industries in the Mara Basin

10.3.1 Types of Industries

In Kenya, a few small-scale industries are based on agriculture, livestock, timber/wood and tourism. Industrial activities in the catchment include gold mining (Transmara district), milk cooling (Siongiroi plant in Bomet district), flour milling, timber milling, brick making and honey processing. Gold exploration and mining has been on-going for several decades. The SEBIMU Mining Company is in-charge of gold mining and local small-scale community initiatives at approximately 3 sites. Ore refining using mercury is also practiced. Data documenting the value of the gold mining and the small-scale industries are not available.

The main industrial activities in Tanzania are crop processing and mining. The processing industries mainly deal with cash crops (cotton and coffee), which are located near the production areas. Coffee processing industries are found in Tarime district and some trial farms in the Serengeti highlands. Cotton processing ginneries are located closest to production areas in the three districts. Cotton production in the three districts in Mara basin accounts only for 10% of the total annual cotton production in Mara Region, while the remaining 90% is produced in Bunda district.

The major mining industries are centered in the two large-scale commercial mines of Buhemba and Nyamongo, located in Musoma Rural and Tarime districts, respectively.

However, mineral processing including cutting and shaping are done outside the districts in other regions such as Dar es Salaam and Arusha, as well as outside the country.

10.3.2 Contribution of Trade and Industry

Trade and industry support entrepreneurial and management skill development as well as financing for medium, small, and micro enterprises. The sector is a source of foreign exchange through exports, and it creates an enabling environment for private sector development. In Kenya, the sector employs over 4 million people nationally and contributes about 21.3% of Kenyan GDP every year.

Tourism plays a major role in the Mara River basin and in the Kenyan and Tanzanian economies as a whole. Revenue from the Masai Mara Game Reserve and the Serengeti National Park is generated from accommodation tariffs, game reserve entry fees, aircraft landing fees, balloon safari operations, game drives, camping fees, and permits for film making.

The industry generates revenue from the Masai Mara Game Reserve for the Narok and Transmara County Councils, and provides employment for hotel workers and game wardens. The industry also provides a market for various goods and services. Regionally, the Masai Mara ecosystem generates about Kshs. 520,000,000 annually. Out of the annual revenue collection by the two County Councils, 19% is directly paid to local communities to finance micro-projects (Narok, Trade and Industry, Annual report 2005). However, there is lack of transparency and equity in the distribution of the funds to the communities. There is a need to make the communities aware of the funds collected and introduce an equitable benefit sharing approach. At the national level, tourism earnings have been increasing. Earnings rose from Kshs. 48.9 billion in 2005 to Kshs. 56.2 billion in 2006 (Economic Survey, 2007).

10.3.3 Industrial Potential

Growth potential exists in agro-based and cottage level industries in the Mara River basin represented by flour milling, livestock products processing, and honey processing. The Mara River basin districts are well endowed with natural resources that could provide raw materials for industries. For example, hides and skins are produced which can be used in the tannery industry, but this potential remains largely untapped. Milk goes to waste due to poor handling and poor road networks, especially in Bomet district (Kenya). Some of the possible cottage level industries for development include brick and tile making, belts and jewelry bangle making and other traditional crafts (jua kali) activities (Narok, Bomet and Transmara DDPs, 2002-2008). There is a potential to develop a sugar factory in the Tanzanian Mara basin.

10.3.4 Constraints to Industrial Development

Some industrial development constraints include inadequate and poorly developed infrastructure, underdeveloped human resources, poorly developed local raw materials, poor and mismanaged marketing systems, and inaccessibility to credit for the small scale and rural based organizations. Industrial development opportunities in the Mara River basin include:

- Develop human resources to provide the necessary skills and knowledge (e.g., equipping youth polytechnics (artisan schools);
- Develop infrastructure (e.g., improve road networks, provide electricity and telephones);
- Improve marketing systems for agricultural products and handicrafts;
- Improve access to credit facilities; and
- Establish information centers and publicize opportunities.

10.4 Macro-economic Development

10.4.1 Kenya

The Kenyan economy is predominantly agricultural with a strong industrial base. The Real Gross Domestic Product (GDP) expanded to 6.1% in 2006 compared to 5.7% in 2005 (Economic Survey, 2007), with the agricultural, transport, and communication sectors driving the growth. The economy recorded a GDP of Kshs. 1,642.4 billion in 2006 compared to Kshs. 1,445.5 billion in 2005, a growth of 13.6%. Table 10.4 shows key economic indicators in Kenya.

Table 10.4: Key Economic Indicators in Kenya

Indicator	2001	2002	2003	2004	2005	2006
GDP Growth rates (%)	4.5	0.6	3.0	4.9	5.8	6.1
GDP at market (billion KShs)	1,020.0	1,022.2	1,136.3	1,282.2	1,445.5	1,642.4
Wage Employment (‘000)	1,677.1	1,699.7	1,727.3	1,763.7	1,807.7	1,868.5
GDP per capita (current KShs)	33,767	32,132	34,309	37,639	41,136	45,447
GDP per capita (constant KShs, 2001- base year = 100)	33,767	31,828	31,825	32,457	33,376	34,435
GNP (billion KShs)	1,010.5	1,010.9	1,129.6	1,272.5	1,406.9	
Inflation rate (% change in Consumer Price Index (CPI))	5.8	2.0	9.8	11.3	10.3	14.5

Source: Republic of Kenya, Economic Survey, 2007

Inflation

Inflation in Kenya increased from 10.3% in 2005 to 14.5% in 2006. The increase was mainly due to drought in the first quarter 2006 and high international oil prices in the third and fourth quarters. Government efforts were directed at maintaining low inflation rates; however, excess liquidity (due to unprecedented high cash holdings by the public) affected the government’s ability to control inflation.

Trade Balance

Key international trade indicators for 2006 in Kenya show a widening trade deficit. The trade balance widened from a deficit of 182,670 million KShs in 2005 to 270,489 million

KShs in 2006, which is an increase of 48.1% (Economic Survey 2007). The increased deficit indicates increased imports relative to exports. Within East Africa, Kenya and Tanzania have continued to develop healthy trading relationships, particularly as part of the East Africa Community. Table 10.5 shows the Kenyan exports to and imports from Tanzania for the period 2002 to 2006. These values represent the global situation and not cross-border trade at a particular crossing location.

Table 10.5: Kenyan Exports to and Imports from Tanzania, 2002 – 2006, (x10^3 KShs)

	2002	2003	2004	2005	2006
Exports	14,180,573	14,588, 254	17,920,984	19,953,695	18,288,422
Imports	802,666	1,387,610	2,009,133	3,099,493	4,514,229

Source: Republic of Kenya: Economic Survey, 2007

Public Finance

Kenyan government revenue, including grants, increased 19.2% from 336.8 billion KShs in 2005/06 to 401.5 billion KShs in 2006/07. Total government expenditure increased by 44.3 percent from 392.3 billion KShs in 2005/06 to 565.9 billion KShs in 2006/07 (Economic Survey 2007).

The total public debt increased from 688.0 billion KShs in June 2005 to 708.9 billion KShs in June 2006. Domestic borrowing rose from 253.5 billion KShs in June 2005 to 277.7 billion KShs in June 2006 (Economic Survey 2007). The increase in domestic borrowing is attributed to increase in borrowing through the fixed rate and floating rates of Treasury Bills whose stock increased by 31.8% from June 2005 to June 2006. However, the high fuel prices will continue to be the major contributor to growth recession in Kenya.

Human Development Index

The Kenya Human Development Index (HDI), a composite index measuring average conditions (life expectancy, education, and standard of living), has been decreasing since 1990 (UNDP- Human Development Index, 2005). The HDI ranges from one (perfect equality in access) to zero (total inequality) although these two extremes are hard to attain. The decline in the Kenyan HDI has been associated with increase in vulnerable population, reduced access to basic services, corruption, mismanagement, and failure to identify and support informal institutions. Disaggregated HDI values at provincial and district levels show significant variations in human capabilities and welfare. HDI values are higher for the districts in high potential areas as compared to districts in low potential areas. High potential areas are able to provide food and income-generating opportunities for a majority of the people. In addition, policies and allocation of resources have tended to favour the high potential areas. The 2004 HDI for Kenya showed that most of the districts in the low potential areas had HDI values ranging between 0.365 and 0.228. Narok and Transmara districts fell within this range. However, Bomet district, which is actually a high potential district, had a HDI value of 0.591, falling within the first ten districts with the highest HDI values in Kenya (4th Human Development Report, 2005). The tourism activities in the two districts of Narok and Transmara should have promoted the HDI levels in these districts.

Unfortunately, lack of transparency, accountability, equity, and fiducial management of tourism funds prevent them from reaching and benefiting the communities.

To raise the national HDI level, Kenya Vision 2030 gives priority to communities which are left behind, in an effort to upgrade their position. Table 10.6 shows the Kenyan national trend in human development indices from 1975 to 2005. The Kenya HDI for 2006 was estimated at 0.532.

Table 10.6: Kenya Human Development Indices

Indicator	1975	1980	1985	1990	1995	2000	2005
Human Development Index (HDI)	0.466	0.514	0.534	0.556	0.544	0.529	0.521

Source: UNDP-Human Development Report 2007/200)

10.4.2 Tanzania

Tanzania experienced weak economic growth in the early 1990's when the growth rate was lower than that of the population. However, from the mid 1990's, Tanzania experiences a higher growth rate, increasing from an average of 4.0% between 1995 and 1999 to 5.8% between 2004 and 2005. In 2004, the growth rate was 6.7%, which exceeded the 6% target. In 2005, the growth rate remained at 6.7%. In 2006 the growth rate decreased to 6.2%. The decline was caused by severe drought during the 2005/06 rainy season, inadequate power supply, and increased oil prices. The sectors most affected by drought were agriculture, manufacturing, electricity, and water. Table 10.7 shows key economic indicators in Tanzania.

A major challenge is how to sustain the growth rate and ensure that the benefits are truly shared among the population. The growth rate attained has been attributed to the macro-economic reforms adopted in 1990's. Some of the policy changes include free trade and exchange, parastatal sector reform, investment promotion, tax reforms, financial sector reforms, civil service reforms, and political stability. The reforms encouraged private sector participation in the economy, and direct investment increased substantially since the end of the 1990's.

Table 10.7: Key Economic Indicators in Tanzania Mainland

Indicator	2001	2002	2003	2004	2005	2006
GDP Growth rates (%) (at 1992 constant prices)	5.7	6.2	5.7	6.7	6.7	6.2
GDP at current prices (Tshs. Million)	7,624,616	8,699,887	9,816,319	11,331,638	13,063,317	14,995,247

GDP at constant 1992 prices (Tshs. Million)	1,749,358	1,857,175	1,962,432	2,094,516	2,234,752	2,374,329
GDP per capita (at current prices (Tshs))	231,751	258,925	287,027	321,010	360,865	399,873
GDP per capita (at constant 1992 prices (Tshs)	53,172	55,273	57,381	59,335	61,733	63,315
Inflation rate (2001 Base year)	5.1	4.3	5.3	4.7	5.0	7.3

Source: MPEE, 2007

Table 10.8 presents the contribution of various sectors to national GDP, with agriculture being the largest contributor. Between 2000 and 2006, agricultural contributions ranged from 45% to 48%. Trade, hotels, restaurants, financial and business services, and manufacturing also made significant contributions.

Table 10.8: Sector Contribution to Overall GDP (%)

Economic Sector	Year			
	2000	2002	2004	2006
Agriculture	48.1	47.5	46.3	44.7
Mining and quarrying	2.3	2.7	3.2	3.8
Manufacturing	8.3	8.4	8.8	9.2
Electricity and water	1.7	1.6	1.6	1.4
Construction	4.6	5	5.4	5.8
Trade, Hotels & Restaurants	16.4	16.6	16.9	17.5
Transport and Communication	5.4	5.5	5.4	5.4
Financial and Business Services	10.4	10	9.7	9.5
Public Administration and Other services	7.7	7.3	7.1	6.9

Source: Ministry of Planning, Economy and Empowerment, 2007

Inflation

Inflation in Tanzania (estimates determined using 2001 as a base year) decreased dramatically from 21% in 1996 to 6% in 2000. Inflation further dropped to 4.3% in 2002, but it increased to 4.7% in 2004 and has reached 7.3% in 2007 (MPEE, 2007). This increase has been attributed to the 2005/2006 drought and the high international oil prices.

Balance of Merchandise Trade

In 2006, the deficit in the balance of merchandise trade registered a deficit of 2,141.1 million US Dollars compared to a deficit of 1,321.8 million US Dollars in 2005, equivalent to an expansion of 13.7 percent (MPEE, 2007). Expansion of the deficit was mainly caused by the increase in the value of import goods, compared to the value of exports.

Government Finance

During the 2006/07, the government planned to collect domestic revenue amounting to 2,460,995 million TShs, equivalent to 14.5 % of GDP, compared to actual collection of 14.1 % of GDP in 2005/06 (MPEE, 2007). During the same period, the Government estimated to receive grants and foreign loans including dept relief amounting to 2,226,115 million TShs, equivalent to 46.0 % of the national budget.

In 2006/07, the Government planned to spend a total of 4,788,497 million TShs, equivalent to 26.9 % of the GDP, compared to 27.5 % in 2005/06 (MPEE, 2007). Out of total amount 3,054,030 million TShs was for recurrent expenditure, and 1,734,467 million TShs was for development expenditure.

At the end of 2006, the national debt stock stood at 7,188.2 million US Dollars, compared to 9,383.9 million US Dollars at the end of 2005, equivalent to a decrease of 23.3 percent (MPEE, 2007). At the same period, the external debt stock stood at 5,748.8 million US Dollars, equivalent to 80 % of the national dept stock, compared to 8,153.7 million US Dollars at the end of 2005, equivalent to a decrease of 29.3 %. The decrease in the external debt stock was mainly attributed to debt relief obtained under the Multilateral Debt Relief Initiative band Government efforts in servicing to service external debt.

10.5 Issues on Trade, Industry and Macro-economic Development

Issues raised concerning trade, industry. and macro-economic development in the Mara River Basin are summarized in Table 10.7, highlighting the causes, impacts, intervention measures. and investment opportunities.

Table 10.9: Issues Matrix on Trade, Industry and Micro-economic Development

Issues	**Causes**	**Impacts**	**On-going & Planned Intervention Measures**	**Potential Investment Projects**
1. Weak industrial base	Low investment to establish agro-based industries.	i) Adding value to un-processed agricultural products is limited. Some of the constraints to industrial development in the area include inadequate and poorly developed infrastructural facilities, i.e., access to electricity. ii) Creation of employment opportunities is	-Mobilization of funds to establish agro-based industries/ -Implementation of mitigation measures by Ministry of Trade and Industries and Private Institutions.	Consolidate efforts to establish agro-based industries.

		constrained.		
2. Illegal trade across the border.	Lack of harmonized cross-border trade at border points.	-Lack of accurate data on cross-border trade	-The East African countries have joined together to form a strong trade block.	
3. Inadequate and poorly developed infrastructure.	-Low investment in infrastructural development. -Lack of information on available opportunities in the region.	-Low employment levels. -Low business activity. -Lack of incentives for private sector investors.	-The regional governments have initiated programs to develop the national infrastructure though this process is currently based on individual countries. -Both Kenya and Tanzania are promoting rural electrification programs in the region.	
4. Undeveloped human resources	-Low investment in human resources development. -Lack of incentive to develop human resources.	-Low response to changes triggered by regional and global economic transformations. -Inadequate planning and management.	Kenya Vision 2030 takes a proactive stance on human resources development.	
5.Poorly developed raw materials	-Lack of developed processing facilities.	- Lack of incentives to invest in the region.		
6. Poor and mismanaged marketing systems	-Undeveloped human resources. -Lack of processed goods.	-Uncoordinated marketing. -Exploitation of regional resources.		
7. Inaccessibility to credit for small scale and rural based organizations	-Lack of awareness on the availability of credit. -Low human resources capacity to utilize the credit facilities.	-Low levels of development in the region.	-Establish information centers. -Publicize available opportunities.	

11.0 Integrated Water Resources Management

11.1 Introduction

Integrated water resources management is a process, which promotes the coordinated development and management of water, land, and other resources to maximize the economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000).

It is a participatory planning and implementation process, based on sound science that brings stakeholders together to determine how to meet society's long-term needs for water resources while maintaining essential ecological services and economic benefits (USAID, 2005).

Integrated water resources management is considered to be international best practice for managing water resources. It arises from the reality that water resources is a cross-cutting discipline whose management needs to be undertaken within the context of other natural resources including forests, wildlife, and land. However, few countries have been able to implement it in practice by adopting legal and institutional frameworks upon which this concept can be founded. Typically, countries, including Kenya and Tanzania, manage their water and other natural resources within sector specific legal and institutional frameworks.

Establishing IWRM is a serious challenge for governments and institutions as it requires bringing to bear and institutionalizing several interlinked administrative, financial, and technical changes. These include restructuring of the legal and institutional frameworks, investing in infrastructure, enabling stakeholder participation in decision making, building capacity, developing information (through monitoring systems), converting this information to knowledge and experience, and using this wisdom to guide the planning and management processes.

11.2 Policy, Legal, and Institutional Framework

The general policy, legal, and institutional framework for water resources management in Kenya and Tanzania is discussed in detail in a separate report (Mara Cooperative Framework Draft Report, WREM International, 2008). That discussion covers all aspects of policy, legal, and institutional frameworks governing the management of water resources including: Constitutional provisions, national policies relevant to the management of the water resources sub-sector, and sector specific laws and institutions.

This section is not intended to repeat that discussion but rather to focus on the operationalization of IWRM principles by the two countries in the Mara River Basin.

In Kenya the closest approximation of a framework built on the concept of integrated water resources management is found in the framework establishing the regional development authorities. With regard to the Mara Basin, the relevant regional development authority is the Lake Basin Development Authority (LBDA), established by the *Lake Basin Development Authority Act*. The functions of the LBDA are primarily to plan for and coordinate the development of the area and to initiate project activities identified through such planning. The LBDA has the main advantage that it is uniquely structured around a catchment as the basic planning unit.

However, in reality these regional development authorities have not managed to establish themselves as important players in the water resources management sub-sector. Planning for water resources management and coordination of water resources management activities have continued to be carried out on a sectoral basis, by Water Ministries within the framework of administrative districts, completely outside the catchment-based legal and institutional framework provided for in the regional development authority framework. This reality illustrates the difficulties that countries have experienced in implementing the concept of integrated water resources management in their water resources legal and institutional frameworks.

In mainland Tanzania, it is the river basins under the Ministry of Water and Irrigation that are responsible for integrated water resource management. Mainland Tanzania is divided into nine hydrological zones or river basins for water resources management purposes. The Tanzanian part of the Mara River Basin falls under the Lake Victoria Basin and is managed as part of that hydrological zone.

11.2.1 Local Water Resources Management Structures

Upper Mara in Kenya:

The Water Resources Management Authority (WRMA) has already established its formal institutions, namely the Board, national and regional offices and Catchment Area Advisory Committees (CAACs) and is presently in the process of operationalizing them in the Mara Basin. The Mara Basin in Kenya is managed by a WRMA sub-regional office in Kericho. A coordination office at Bomet District specifically handles all Mara water resources management issues. A Mara River Water Resources Users Association (MRWRUA) in the Kenyan part of the basin has also been formed.

In the case of water supply and sewerage, the Act gives responsibility for service delivery to Water Services Boards, who in turn, contract Water Service Providers (WSP) such as water companies, NGOs, institutions, and community owned schemes, to provide day-to-day water supply services within their areas of jurisdiction. For instance in Bomet District, LVWSB has contracted Chemosit Water Company to supply the town from a Mara tributary. Lake Victoria South Water Service Board (LVWSB) is responsible for delivery of water services in the Mara Basin. LVWSB is regulated by the Water Services Regulatory Board (WSRB). WSPs are supposed to submit specific data about their facilities and operations, e.g., consumer and water use data, among other statistics, to LVWSB annually.

Lower Mara in Tanzania:

The institutional framework for water resources management in Tanzania provides for four levels of management at the Basin level, namely, Basin Water Offices & Board, Catchment Water Committees, Districts, and Water User Associations or Groups. It is intended that, eventually, they will all be self-financing.

Basin Water Offices & Boards - Basin Water Offices (BWOs) are the executive offices of the Board and are headed by the Basin Water Officers who are also the secretaries of the respective Basin Water Boards. The management of the Mara and other rivers within the Lake Victoria Basin is the mandate of the Lake Victoria Basin Water Office (LVBWO) in Mwanza. A Basin Water Board, consisting of 10 members representing different stakeholders, guides the office in its work. In addition, there exists a regional office for LVBWO in Musoma. The main activities of the Basin Water Office are (1) regulating, monitoring, and policing of water use; (2) controlling water pollution in the Basin; (3) issuing water rights; (4) facilitating and assisting in the formation of water users associations; (5) billing and collecting water user fees; and (6) creating awareness among water users regarding water resources management. Presently, LVBWO is not fully operational and not all staff have been appointed. Formation of Catchment and sub-catchment management committees and the National Water Boards is still pending until the enactment of the Water Resources Management Bill.

Catchment Committees - Below the BWO, Catchment Water Committees and sub-catchment Water Committees will also be established, comprising representatives from the public and private sectors and from the Water User Entities (WUE) within the Basin. The role of these Committees will include the preparation and implementation of catchment plans, and the resolution of conflicts within catchments. An interim Catchment Committee for the Mara has been proposed but is not yet operational.

WUGs and WUAs - At the lowest level, WUG's are responsible for local-level management of allocated water resources; mediation of disputes; monitoring of water use; participation in the preparation of water utilisation plans; conservation of water sources and catchment areas; ensuring return flows; enforcing bye-laws; and ensuring compliance with water rights conditions.

Districts Councils - The framework for WRM in Tanzania, allows District Councils to fully participate in Basin Water Boards and Catchment Water Committees. The districts have been assigned the role of planning and development of water resources in accordance with basin plans; protection and conservation of natural resources; enactment of water management bye-laws; and conflict resolution.

Water Supply and Sanitation Services - The majority of institutions responsible for provision of Water Supply and Sewerage Services (WSSS) within the Mara Basin are Community Owned Water Supply Organisations (COWSOs). COWSOs are regulated by their respective District Councils and many still rely on the District Water Offices for technical support. COWSOs are usually legally constituted by a community to own, manage, operate, and maintain the water supply systems on behalf of the community. These bodies may take various legal forms, such as Water Consumer Associations or Water Consumer Trusts. COWSOs can also contract part or all of their operation and maintenance responsibilities to private companies or individuals, or to NGOs. The big towns (e.g., Musoma) are served by Water Supply and Sewerage Authorities (WSSAs). WSSAs are financially autonomous statutory organisations. WSSAs normally procure Service Providers to provide water supply and sewerage services under varying contractual arrangements, such as service, management or lease contracts. A Service Provider is usually a private sector company or may be a Non-government or Community Based Organisation. WSSAs are regulated by the Energy and Water Utilities Regulatory Authority.

11.3 On-going and Planned Transboundary Water Resources Projects

There are a number of ongoing water related projects and programs at regional, national and local levels aimed at addressing water related issues in the Mara River Basin. Most notable of the national and local projects include water supply and sanitation projects, afforestation projects, soil and water conservation projects, agricultural projects, water resources management projects, biodiversity conservation projects, and irrigation development projects.

There are also a number of regional projects within the Lake Victoria Basin which have relevance to the Mara basin that are being implemented by different regional organizations. Among others, these include:

1. *Lake Victoria Environment Management Project (LVEMP)*

LVEMP-I undertook studies in water quality, limnology, fishery biodiversity, and aquaculture potential. The project also collected baseline data which has resulted in improved ability of the riparian countries (Kenya, Uganda, and Tanzania) to embark on a long-term program on sustainable resource management and environmental improvement. This phase was funded by the World Bank. The preparation of LVEMP-II, which includes Rwanda and Burundi, is nearing completion. LVEMP-II will focus on applied research, socio-economic development, and development of a comprehensive Lake Victoria water resources management framework.

Within the Mara River Basin, the LVEMP has been monitoring the water quality of the Mara River and its main perennial rivers, the Nyangores and Amala. Unfortunately, monitoring has not been systematic. However, based on the available data, the water quality characteristics of the Mara River system is shown in Table 2.10. The water quality monitoring stations coincide with those for water quantity monitoring. The LVEMP office in Kisumu has established a water quality database for the Lake Victoria and rivers discharging into the Lake.

2. *Lake Victoria Fisheries Management Plan (LVFMP)*

The LVFMP is being implemented by the Lake Victoria Fisheries Organization (LVFO) with focus on: Supporting fisheries monitoring, control and surveillance; promoting community participation in the management of fisheries resources; monitoring the Lake Victoria fisheries resources, addressing the environment and socio-economic factors affecting the Lake Victoria fisheries sector; providing information and databases to guide fisheries management decisions; providing appropriate policies, laws and regulations for the management of fisheries resources and the fish habitat; building capacity to implement fisheries activities nationally and regionally.

3. *Lake Victoria Region Water and Sanitation Initiative (UN Habitat-LVWATSAN)*

The UN Habitat-LVWATSAN initiative covers six towns around Lake Victoria, namely, Kisii and Homa Bay Towns in Kenya, Mutukula and Kyotera towns in Uganda, and Muleba and Bukoba in Tanzania. Its main objective is to support secondary urban centres around the lake area to achieve the Millennium Development Goals target for water and sanitation (to halve the number of people without access to water and sanitation by 2015). The project is funded by the Government of Netherlands.

4. *Lake Victoria Region City Development Strategy Program*

In 2002, with the support of SIDA, the UN HABITAT through its Urban Management Programme (UMP) initiated the Lake Victoria Region City Development Strategies Program to strengthen the capacities of urban centres located along the shores of Lake Victoria. This program aims at:

- Mobilizing local authorities and stakeholders to develop programmes for laying out City Development Strategies (CDS) for Improved Urban Environment and Poverty Reduction; and
- Addressing the absence of effective planning in the urban centres.

The pioneer cities in the CDS Phase I were Kisumu, Kampala, and Musoma. The next group of towns will include Homa Bay, Entebbe, and Bukoba.

5. *FAO Nile Basin Water Resources Project*

This regional project implemented by the 10 Nile basin countries, with funding from the Government of Italy and technical support from FAO. Major areas included; Development of the Nile Basin Decision Support System (Nile DST), upgrading of the hydrometric monitoring system in the basin, strengthening of water resources databases, capacity building in legal, institutional and GIS skills, and improving agricultural water use efficiency in the basin.

6. *The Nile Basin Discourse (NBD)*

The NBD was created to mobilize civil society and enhance their effective participation in the development of the Nile basin. The NBD has facilitated the establishment of National civil society forums and initiated capacity building activities in all Nile basin countries.

7. *Nile Basin Initiative Shared Vision Program*

This is a regional initiative implemented by 9 Nile basin countries and is comprised of 7 projects in the following areas: Environment, applied training, agriculture, hydropower, water resources management, socio-economics, and confidence building.

8. *Nile Equatorial Lakes Subsidiary Action Program*

This is a regional program implemented by 6 countries (Democratic Republic of Congo, Burundi, Rwanda, Kenya, Tanzania and Uganda, with Egypt and Sudan as observers) and comprises several projects in the following areas: River basin management, fisheries management, hydropower development, and agriculture development.

9. *Mara River Basin Management Initiative*

The Mara River Basin Management Initiative (MRBMI) is a transboundary project implemented by WWF Eastern African Regional Program Office (WWF- EARPO) in Kenya and Tanzania in partnership with national agencies, local governments, and other stakeholders. The project is funded by NORAD and WWF-Norway. Phase I of the project was implemented during 2003 - 2005. Phase II has been on-going since 2006 and is expected to end by the end of 2008.

According to the MRBMI annual reports and consultations with the project executants in Kenya and Tanzania, the Project has registered the following achievements:

(i) Gathered and documented information about demography, fisheries, socioeconomic characteristics, stakeholder relationships, wildlife, forestry and hydrology of the Mara river basin. Additional information and knowledge gaps were identified.
(ii) Organized a number of consultative stakeholder workshops in Tanzania and Kenya intended to identify threats to the Mara ecosystem, raise awareness, facilitate dialogue, and propose strategic interventions.
(iii) Facilitated formation of WUAs, and preparation of community action plans. Facilitated the formation of MRWUA in Kenya and an interim Mara catchment committee in Tanzania. Suggested the need to have a transboundary catchment forum.
(iv) Facilitated LVBWO to establish some baseline water quality monitoring stations.
(v) Supported the Bomet Municipal council in the preparation of proposals and plans for a sewerage treatment facility.
(vi) Initiated strategic partnerships with the Global Waters for Sustainability (GLOWS) program and USAID. Under the GLOWS program, data was collected for future Environmental Flows Assessments (EFA). Detailed proposals for the development of a Biodiversity action plan and environmental services surveys were made.

(vii) MRBMI has identified a number of schools to participate in their environmental education program. The program will be implemented in collaboration with the Ministry of Education in both Narok and Bomet.
(viii) The project has identified a venue for a resource centre and has supported three central tree nurseries which supply certified tree seeds of indigenous species and other agro-forestry species.

10. *Transboundary Water for Biodiversity and Human Health in the Mara River Basin*

A Project on the Transboundary Water for Biodiversity and Human Health for the Mara River Basin in Tanzania is to be implemented by Care International. This project aims to implement a coordinated and highly participatory project to improve water resource management in ways that reduce and mitigate threats to biodiversity in the Mara River Basin and the Mara-Serengeti Eco-region, and enhance the health and livelihoods of communities living in the basin. The Project will provide safe water and adequate sanitation in selected communities. It is expected that about 7,000 community members will benefit from this project through improved health and hygiene.

11.4 Water Resources Data Management and Information Sharing

The water resource data that currently exists in the database of the basin is inadequate. It does not reflect the significant changes in flows, climatic changes, and sediment loads that have occurred over the recent years as a result of catchment degradation, urbanization, pollution, and other human activities.

The water resources database and information flow is characterized by data gaps due to inoperative gauging stations and disruptions in water resource assessment programs. The funds allocated for these purposes by the Central, District, and Provincial Governments are seriously deficient.

In both Kenya and Tanzania, various institutions and programs dealing with water resources related data and information have developed their individual databases. There are databases developed by Ministries responsible for water, meteorological departments, the Lake Victoria Environmental Management Project, the FAO-Nile Basin Water Resources Project, and others. However, these data bases are not linked.

At the regional level, there is also need to develop data and information sharing/exchange protocols. This issue is being addressed as part of the current Mara River Basin project. There is need to develop database structures that are harmonized for ease of data and information exchange. Currently, Kenya and Tanzania use different formats and standards in data collection and the development of geo-referenced information. These differences make it difficult to merge even simple GIS layers of the Mara River basin.

The status of water related data collection, processing, storage, and dissemination in the basin is discussed in detail in the previous chapters of this Monograph.

12.0 Investment Strategy

12.1 Overview

The Mara River Basin Investment Strategy is intended to provide a mechanism through which stakeholders in Kenya and Tanzania can jointly identify and prioritize specific development projects targeted at addressing water resources related issues and challenges in the basin to stimulate economic development and improve the livelihoods of the basin riparians.

This being a transboundary initiative, the investment strategy places emphasizes on *transboundary* projects that will enhance collaboration between local communities across the border and strengthen inter-state cooperation in the joint management and development of the shared Mara water resources. It is envisioned that the national and local governments in the basin will continue to plan and implement their national development programs in line with their national development plans and objectives. Therefore some of the intervention measures and projects that were identified by the stakeholders as being critical will inevitably be implemented through the ongoing and planned national and local government programs in the two countries.

Proposed Intervention Measures

The proposed Investment Strategy consists of nine strategic intervention measures designed to address the most critical water resources related socio-economic issues and challenges in the Mara basin to ensure sustainable management and development of the catchment's water resources. These nine measures are based on a comprehensive analysis of the critical water resources related issues in the basin and were arrived at through a participatory stakeholder consultative process. The total cost of the proposed intervention measures is estimated at US$ 252.0 million out of which US$ 72.0 million will be required for implementation of the regional transboundary projects. The proposed intervention measures are divided into two broad categories, i.e., Regional Transboundary Programs and National Programs. The full details of the Mara Investment Strategy are presented in a separate report (WREM International, 2008). Following is a summary of the proposed investment programs.

12.2 Regional Transboundary Programs

For purposes of this Investment Strategy, regional transboundary programs refer to intervention measures that meet the following criteria:

(i) Programs that are transboundary in nature and whose implementation requires to be done concurrently in both countries in order to address a critical transboundary issue, e.g., pollution, soil erosion, etc.; and/or

(ii) Programs that may not be transboundary in nature but which are (or whose impacts are) considered to be critical for the entire or significant part of the catchment and whose implementation at regional level would be considered efficient and effective due to economies of scale.

The proposed transboundary intervention measures include:

(1) **Mara River Basin Tourism Development and Diversification Program:** The objective of this program is to enhance the tourism sector in the Mara basin as a major revenue source through diversification of tourism activities, improving on tourism related infrastructure, and strengthening of tourism management and revenue sharing mechanisms. The program will focus on improvements in the existing tourism infrastructure, development of untapped tourism resources such as ecotourism, historical sites, cultural shrines, caves, etc. This will be complemented with the development of a comprehensive joint marketing strategy for the tourism opportunities in the basin as a whole. The program will also address the inconsistencies in the existing tourism management policies, laws, and institutional frameworks in the Masai-Mara Game Reserve and the Serengeti National Park to ensure coordinated planning and management of tourism activities. Improvements in the tourism management mechanisms will also address the existing inequitable sharing of tourism benefits among the major stakeholders.

The estimated cost of the program is US$ 20 million.

(2) **Mara River Basin Wildlife Management and Conservation Program:** The objective of this program is to promote sustainable management and conservation of the basin wildlife resources, a unique asset of the Mara Basin.

The program will focus on enhancing active local community participation in wildlife management through Community Based Wildlife Management. For example, the adjacent group ranches and local communities will be encouraged and supported in developing wildlife conservancies and ecotourism sites to complement the existing tourism and wildlife conservation measures. The program will also address the increasing human-wildlife conflicts in the basin through sensitization and investment on other local community income generating activities to reduce encroachment on wildlife habitat for farming activities. The program will support a basin-wide wildlife disease prevention and control initiative to foster timely information sharing on wildlife disease outbreaks between the two countries and facilitate joint research and wildlife disease surveillance and control programs in the basin. In addition, a study will be commissioned to understand better the relationship between temporal and spatial wildlife dynamics and the hydrology of the Mara ecosystem.

The estimated cost of the program is US$ 8 million.

(3) **Mara River Basin Forest Management and Conservation Program:** The objective of this program is to ensure sustainable management and conservation of the Mara forest resources to sustain their unique biodiversity and the significant benefits accruing to the basin riparians**.**

The program will focus on reversing the current trend in catchment degradation through implementation of a basin-wide tree planting, agro-forestry, soil and water conservation, and river bank protection initiative. It will also advocate for a review of the current forest policies and management practices in the basin with a view of promoting community based forestry management practices. The program will also support a basin-wide forest survey, classification, and mapping program to establish the extent and severity of forest encroachment and degradation. In addition, the program will undertake sensitisation and training of all major stakeholder groups and local communities on sustainable management and exploitation of forest resources.

The estimated cost of the program is US$ 10 million.

(4) **Mara River Basin Water Resources Monitoring and Assessment Program:** The objective of this program is to strengthen the water resources monitoring and assessment capabilities and thus enhance the planning and management processes in the basin.

The program will support the rehabilitation and expansion of the water resources monitoring network (hydrometeorological, hydrogeological, and water quality) in the basin. It will also facilitate the development of compatible water resources Databases and Decision Support Tools and support the establishment of a Mara basin Hydro-informatics Center to coordinate water resources data collection, processing, and analysis activities. The program will facilitate a basin-wide water resources (groundwater & surface water) assessment and mapping exercise including assessments pertaining to climate and demand change. In addition, the program will also undertake a basin-wide wetlands mapping and conservation initiative that will also include sensitization of local communities on sustainable utilization and management of the basin's wetlands resources.

The estimated cost of the program is US$ 5.0 million.

(5) **Mara River Basin Fisheries Management Program:** The objective of this program is to increase fish production and consumption in the Mara basin and contribute to the basin's food security and diversified revenue base.

The program will promote sustainable fisheries management in the basin through sensitization and training of BMUs and local communities in sustainable fisheries management practices. The program will also support aquaculture development as an alternative fisheries source. Among the initiatives that will be supported and promoted through the program are the establishment of ice production facilities to supply ice to fishermen to preserve their fish catches and minimize losses, and the establishment of a fish gear and mesh manufacturing plant in the basin to curb the rampant use of illegal mesh sizes and gear types.

The estimated cost of the program is US$ 10 million.

(6) **Mara River Basin Capacity Building Program:** The objective of this program is to strengthen the capacity for planning, management, and implementation of water resources related activities in the Mara basin.

The program will focus on implementing the activities proposed in the Mara basin Capacity Building, Stakeholder Participation, and Gender Mainstreaming Plans.

The estimated cost of the program is US$ 12.0 million.

(7) **Create an Enabling Environment** – The objective of this program is to create the necessary enabling environment for the sustainable management and utilization of the shared Mara water resources.

The program will focus on implementation of the proposed Mara Policy, Legal, and Institutional framework. This will help build trust and confidence among stakeholders in the two countries and facilitate joint planning, management, and implementation of development activities. This measure will require fast tracking the establishment of the proposed Mara River Basin institutional structure, and commencement of the process of harmonization of relevant policies and laws.

The estimated cost of the program is US$ 3.0 million.

12.3 National Programs

To avoid duplication, projects that have already been identified as part of the national and local government development programs shall be implemented at that level and are not necessarily part of the regional project portfolio. The projects will be planned, funded, and implemented through existing national and bilateral funding mechanisms in the two countries.

Intervention measures that are part of the investment strategy but will be implemented under the existing national and local government development programs in the two countries include:

(1) **Water Supply and Sanitation Program:** The objective of this program is to ensure access to safe and reliable water supply and sanitation services for all Mara basin riparians through implementation of water supply and sanitation projects in different parts of the basin. The program will address both rural and urban water supply and sanitation needs through construction of appropriate water supply and sanitation facilities and supporting the establishment of effective operation and maintenance mechanisms for the installed facilities.

The estimated cost of the program is US$ 150.0 million.

(2) **Agricultural Development Program:** The objective of this program is to increase agricultural production and ensure food security in the Mara basin.

The program will focus on promoting the use of improved agricultural practices such as the use of high yielding, disease resistant, and drought resistant crop varieties; adoption of simple on-farm water harvesting techniques for supplementary irrigation; and proper use of fertilizers and other farm inputs to increase crop yield. The program will also include promotion of irrigated agriculture through provision of technical and financial support for irrigation infrastructure development, acquisition of equipment, and training in efficient irrigation water use practices. It will also include strengthening of extension services to farmers, and provision of water for livestock production.

Other areas that will be supported under the program include:

i) Promotion of value addition to agricultural produce through supporting the establishment of rural based agro-processing industries;
ii) Reduction of post-harvest losses through supporting the establishment of appropriate post-harvest storage facilities;
iii) Increasing access to markets by farmers through supporting rural infrastructure development that targets rural feeder roads and markets;
iv) Increasing access to loan facilities for viable commercial agricultural activities through supporting the strengthening of rural based micro-finance and credit facilities and facilitating the formation of cooperative and savings societies.

The estimated cost of the program is US$ 30.0 million.

The main reason that the above projects have been included in the Mara Investment Strategy is to highlight their importance for the sustainable management of the basin and to build a case for their urgent prioritization by the two countries and potential development partners under the existing bilateral funding mechanisms.

12.4 Program Ranking

All above-proposed programs are crucial for the sustainable development of the basin and were arrived at following comprehensive stakeholder consultations and detailed analysis of the critical water resources related socio-economic issues and challenges in the Mara basin. However, for practical reasons, it is recognized that implementation of all the programs cannot commence at the same time due to financial, logistical, and technical constraints. It is, therefore, necessary that some ranking of the programs be done mostly for purposes of implementation sequencing and not as a matter of relative importance. This ranking exercise will take place during the planned round of national and regional stakeholder workshops scheduled to take place in September 2008 to review the Mara draft final reports.

The criteria to be used in ranking the programs will be developed through stakeholder consultations and will consider, among others, the following factors:

(i) Whether or not a program (either scope or its impacts) is transboundary in nature: Preference will be given to programs that are transboundary in nature or with basin-wide impacts.

(ii) Nature and extent of socio-economic and environmental impacts: Preference will be given to programs with positive and wide-spread socio-economic and environmental impacts.
(iii) Sustainability of program outputs: Preference will be given to programs the outcomes of which can easily be sustained by the beneficiary communities in the short and long term.
(iv) Incentives for attracting private sector investment: Preference will be given to program options will the highest incentives for private sector investment.
(v) Availability of technical and managerial capacity in the basin to plan, manage, supervise, monitor and evaluate implementation of the program: Preference will be given to programs which can be easily planned and implemented using the existing technical and managerial institutional capacity in the basin.
(vi) Per capita investment costs: Preference will be given to program options with the lowest per capita investment costs.

12.5 Funding and Implementation Mechanisms

Relevant Mara basin stakeholder agencies will be responsible for implementation of the proposed activities as an integral part of their existing development programs. The role of the Mara PMU/Secretariat will be to coordinate and facilitate the different stakeholder agencies in implementation of the activities.

Funds for implementation of the regional transboundary projects will be jointly mobilized by the participating countries and will include contributions from the beneficiary countries, to meet the recurrent expenditures of the Mara Secretariat, and a significant contribution from external support agencies in the form of grants or loans to finance development projects.

If the countries decide to anchor the Mara cooperative framework under the LVBC/EAC, then resources for implementation of the regional projects will be mobilized as part of the overall Lake Victoria recurrent and development funds. These funds will be managed through the two proposed Lake Victoria funds, i.e., the Lake Victoria Trust Fund for management of the recurrent funds and the Lake Victoria Development Fund for management of the development funds.

On the contrary, if the countries choose to anchor the Mara cooperative framework under the NBI, then most of the funding for the regional projects will be mobilized as part of the overall Nile Basin development funds which will be administered through the existing Nile Basin Trust Fund.

Mechanisms for implementation, coordination, monitoring, and evaluation of the proposed intervention measures are discussed in details in the Investment Strategy Report.

12.6 Implementation Plan

Phase 1 of implementation of the Investment Strategy will mainly focus on establishing the necessary institutional framework and capacity building for implementation of the investment projects. It is envisioned that all relevant organs of the permanent Mara Institutional Framework will have been established by the end of Phase 1.

Feasibility studies for the investment projects will also be undertaken during Phase 1. Results of the feasibility studies will be useful in mobilizing the necessary financial resources for implementation of the investment projects during Phase 2.
In preparation for the feasibility studies, comprehensive pre-feasibility studies of the proposed investment projects will be undertaken at the beginning of Phase 1 to determine whether the programs are technically sound and likely to be economically, socially, and environmentally sustainable. Terms of Reference (ToR) for the pre-feasibility studies are included in the Investment Strategy Report.

It is recommended that the Mara Water Resources Monitoring and Assessment Project commences during Phase 1 to ensure availability of adequate and reliable data for effective planning, design, and implementation of the investment projects of subsequent phases.
Phases 2 and 3 of the Strategy will focus on implementation of the investment projects. It is assumed that the funds for implementation of Phase 2 activities will be secured during Phase 1.

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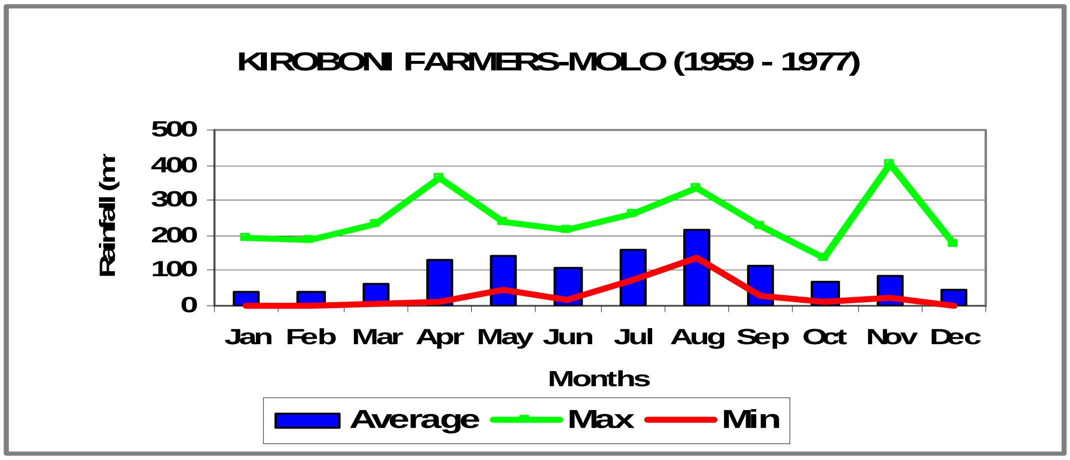
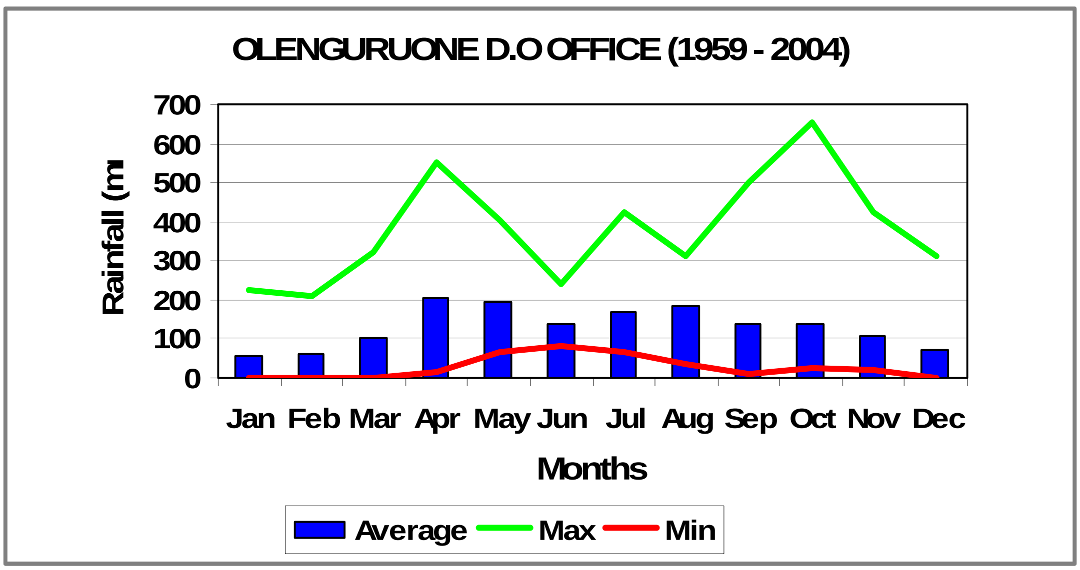
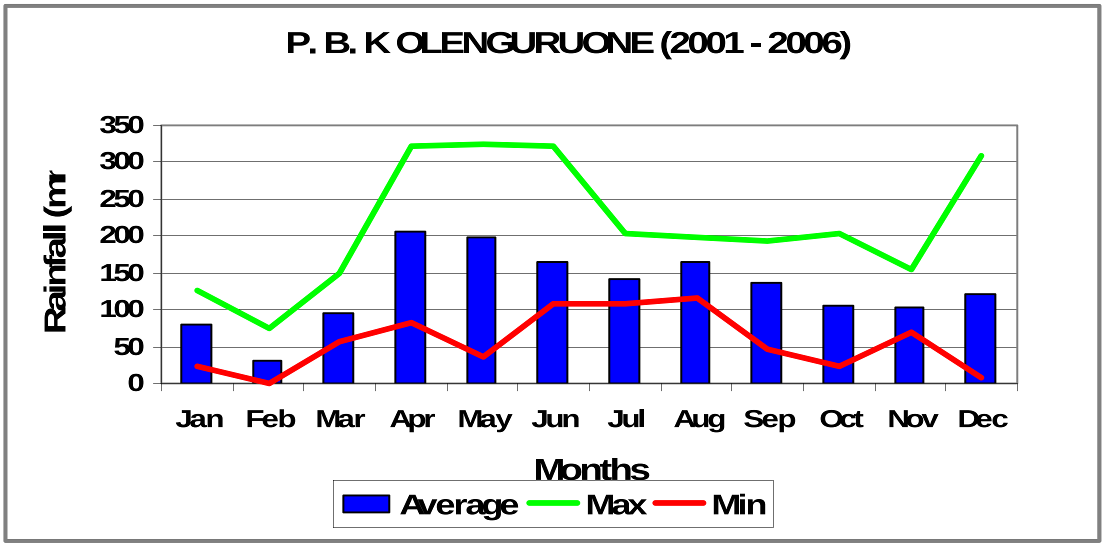
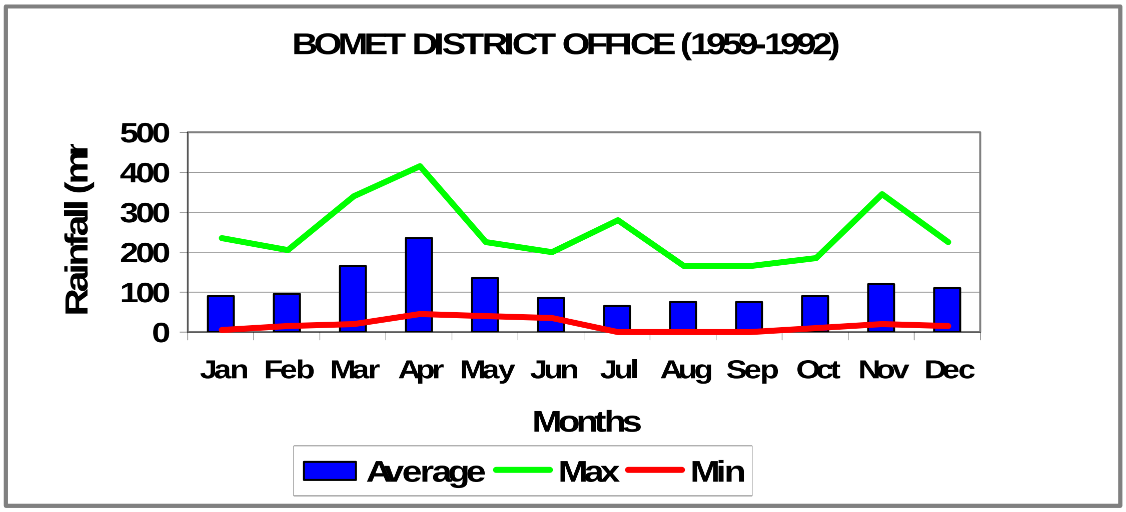
Appendix 2A

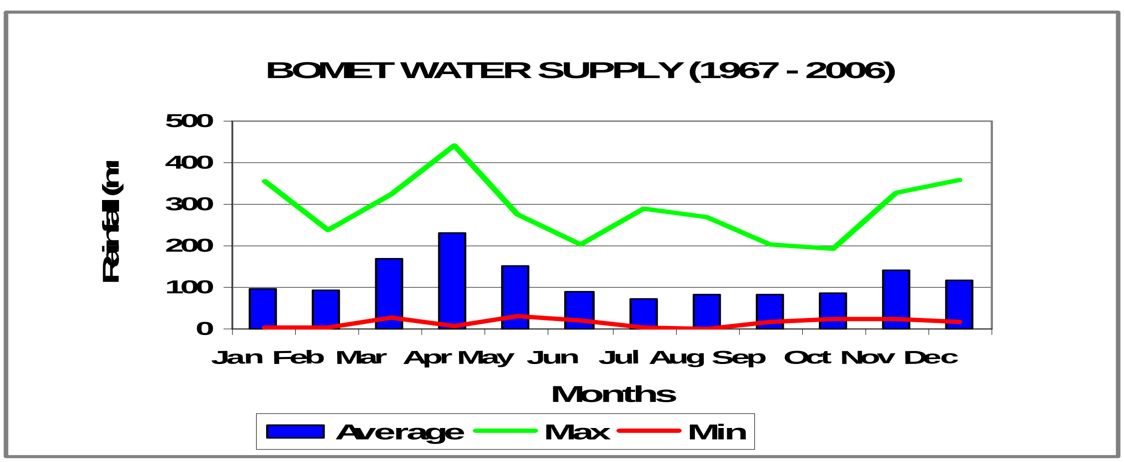
Monthly Mean, Maximum, and Minimum Rainfall

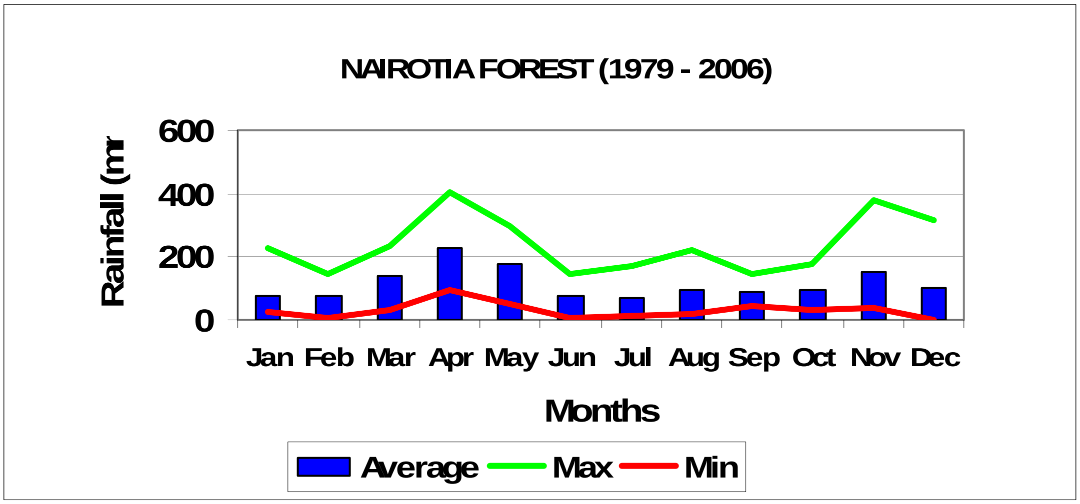


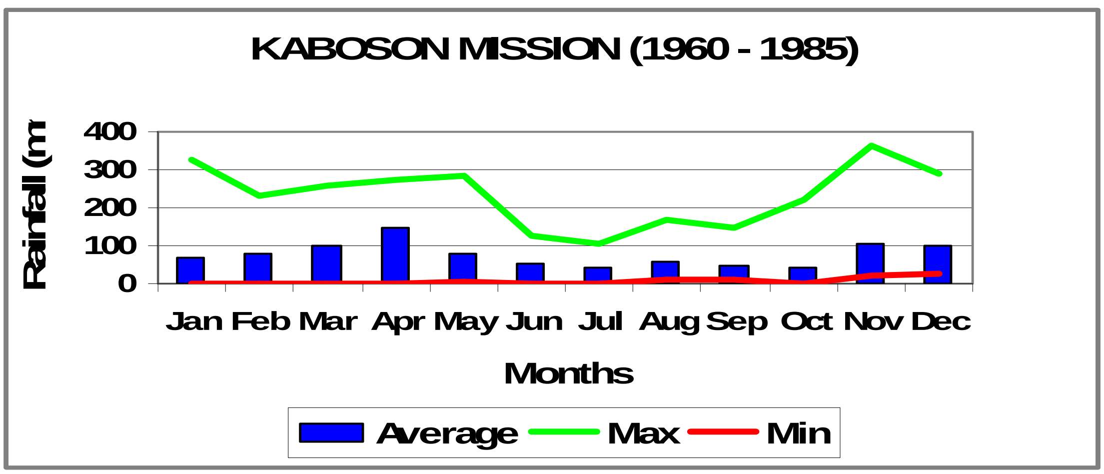


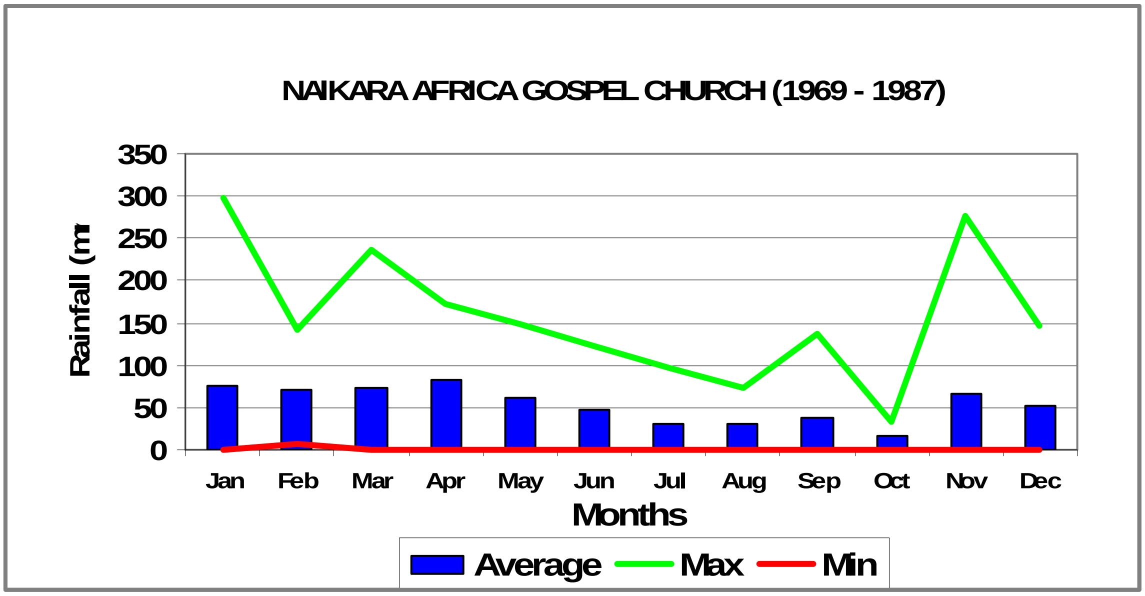

P. B. K OLENGURUONE (2001 - 2006)
Rainfall (m
350
300
250
200
150
100
50
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average
Max
Min

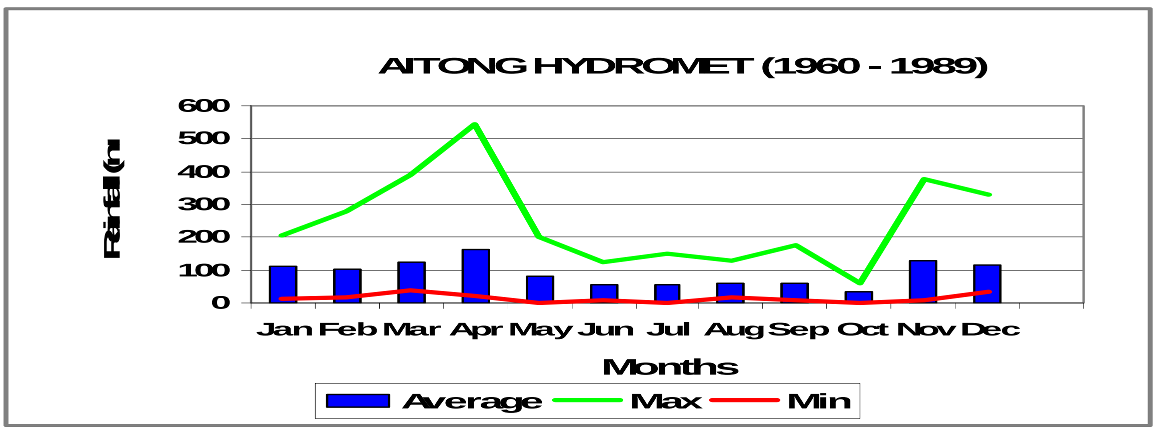

BOMET DISTRICT OFFICE (1959-1992)
Rainfall (m
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average
Max
Min

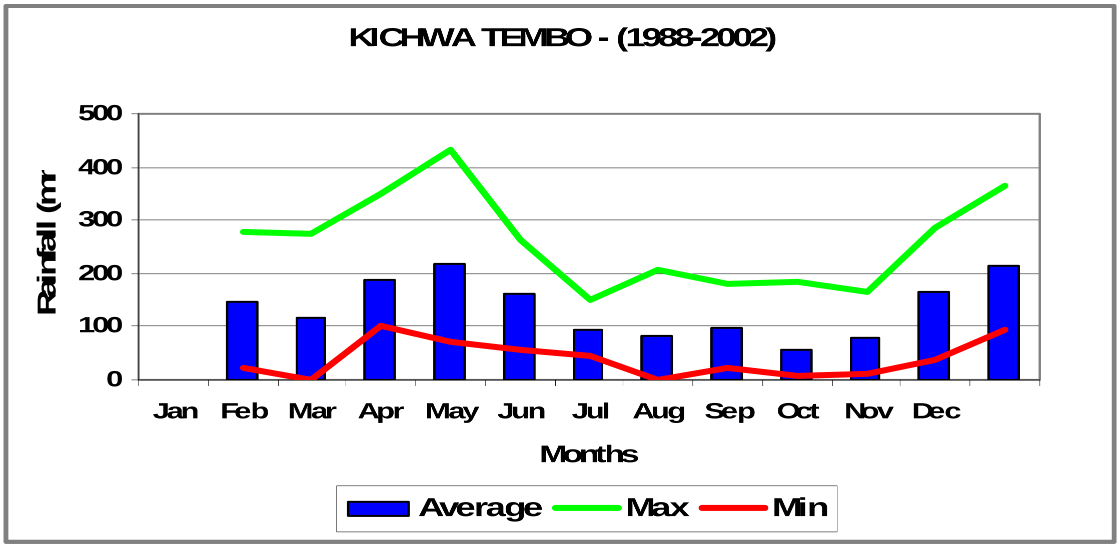

BOMET WATER SUPPLY (1967 - 2006)
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average
Max
Min

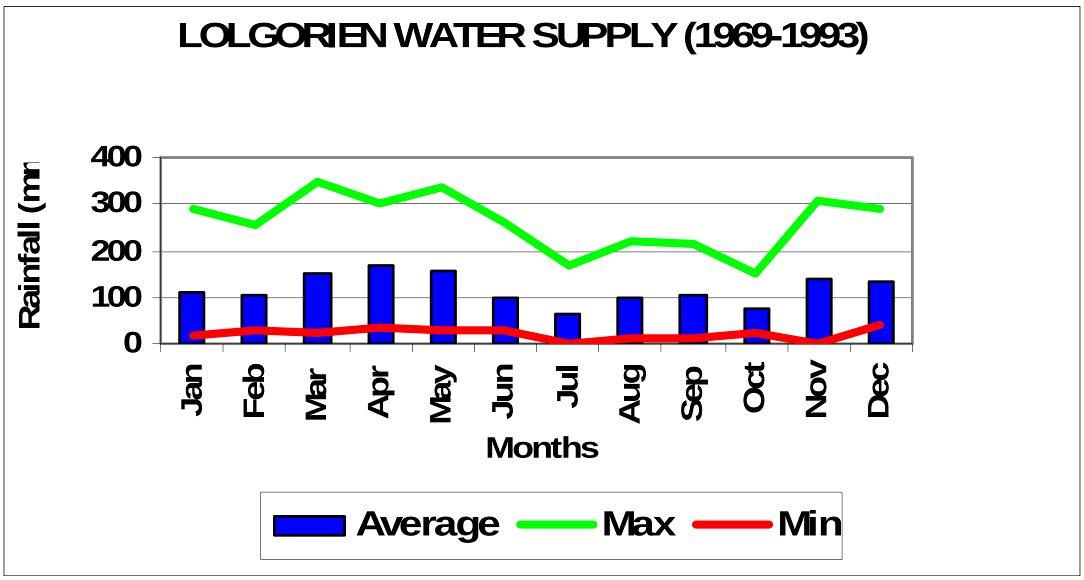

NAIROTIA FOREST (1979 - 2006)
Rainfall (mr
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average
Max
Min


KABOSON MISSION (1960 - 1985)
Rainfall (mr
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average
Max
Min


NAIKARA AFRICA GOSPEL CHURCH (1969 - 1987)
Rainfall (m
350
300
250
200
150
100
50
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average Max Min

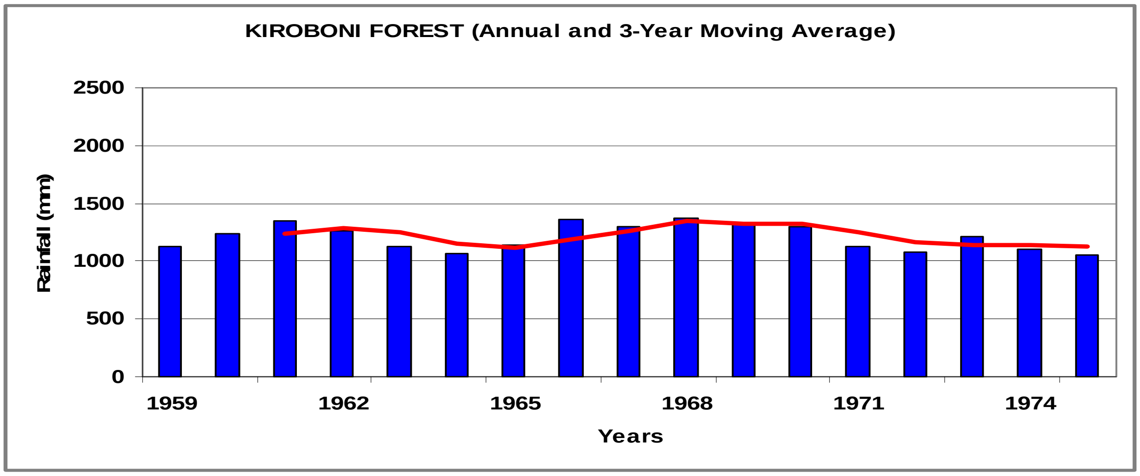

AITONG HYDROMET (1960 - 1989)
Rainfall (m
600
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average Max Min

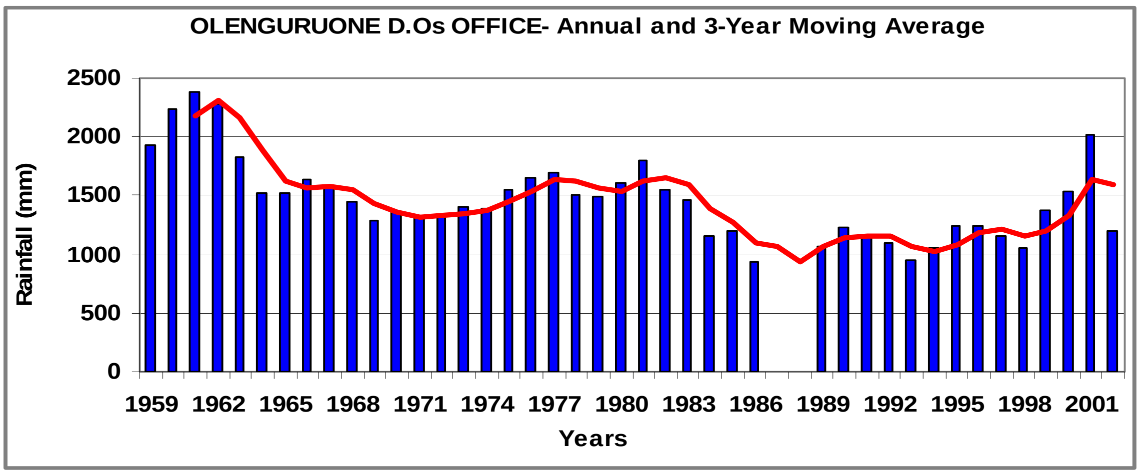

KICHWA TEMBO - (1988-2002)
500
400
300
200
100
0
Rainfall (mm
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average Max Min

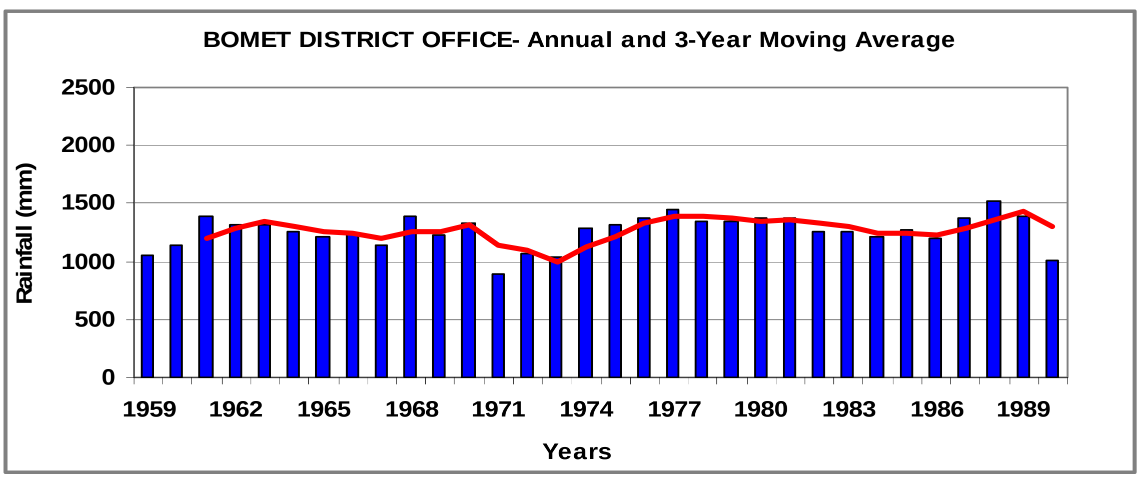

LOLGORIEN WATER SUPPLY (1969-1993)
400
300
200
100
0
Rainfall (mm
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Months
Average Max Min

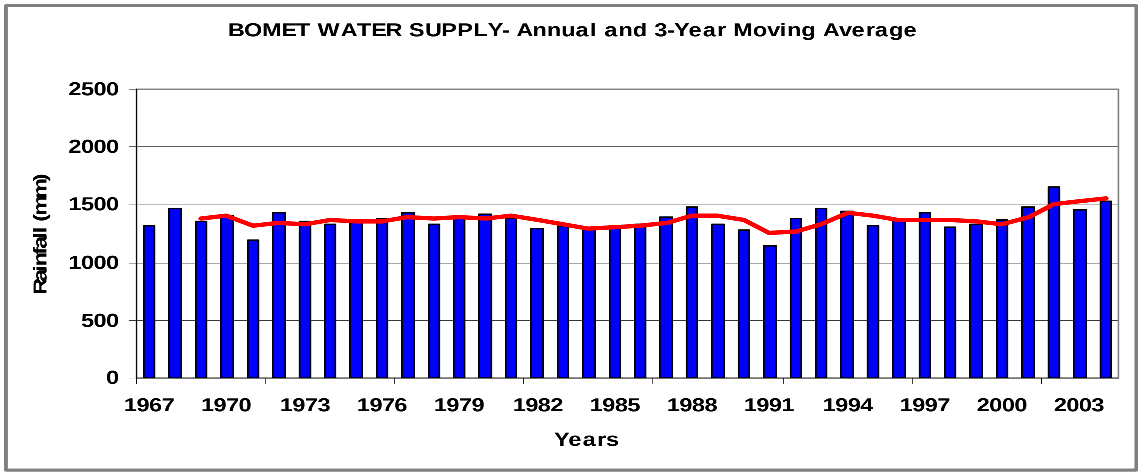
Appendix 2B

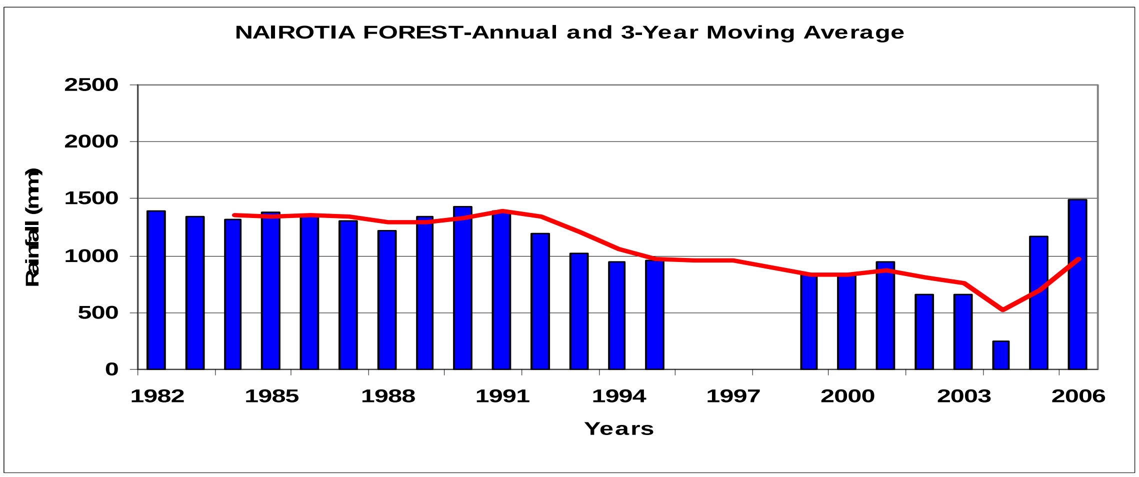
Annual Rainfall and 3-Year Moving Average Sequences

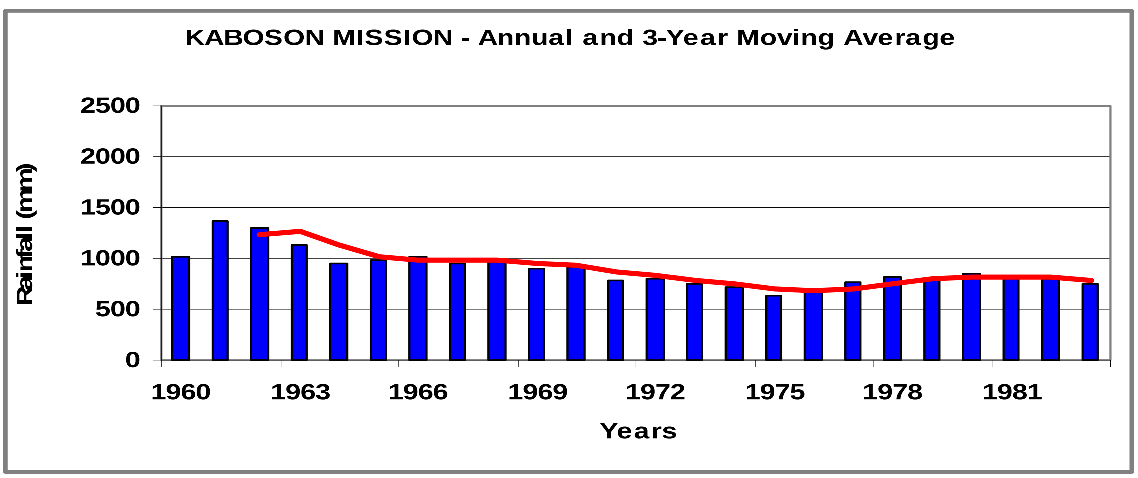


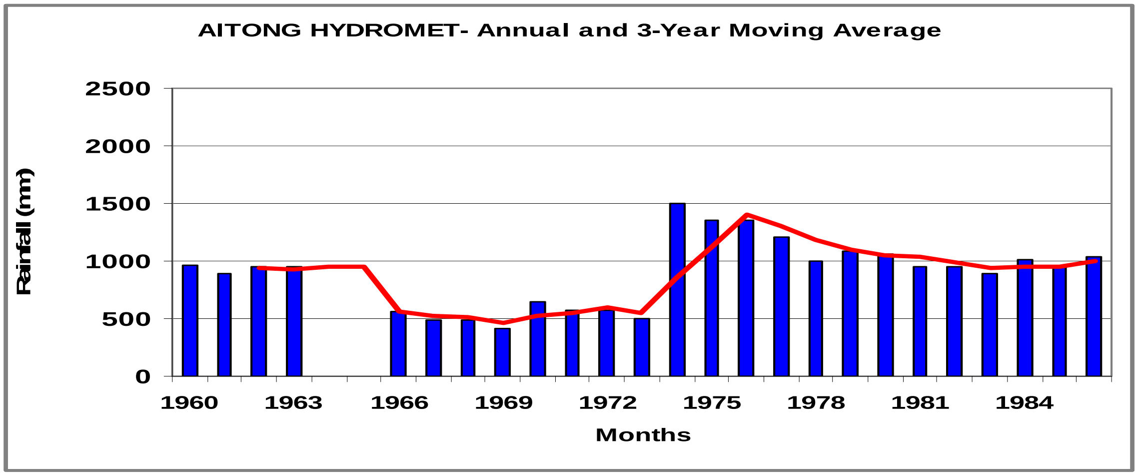


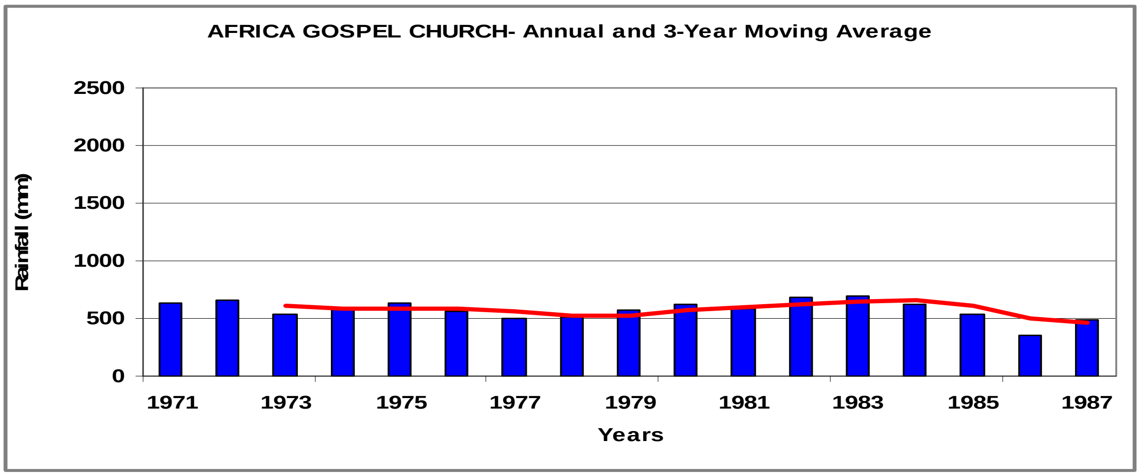


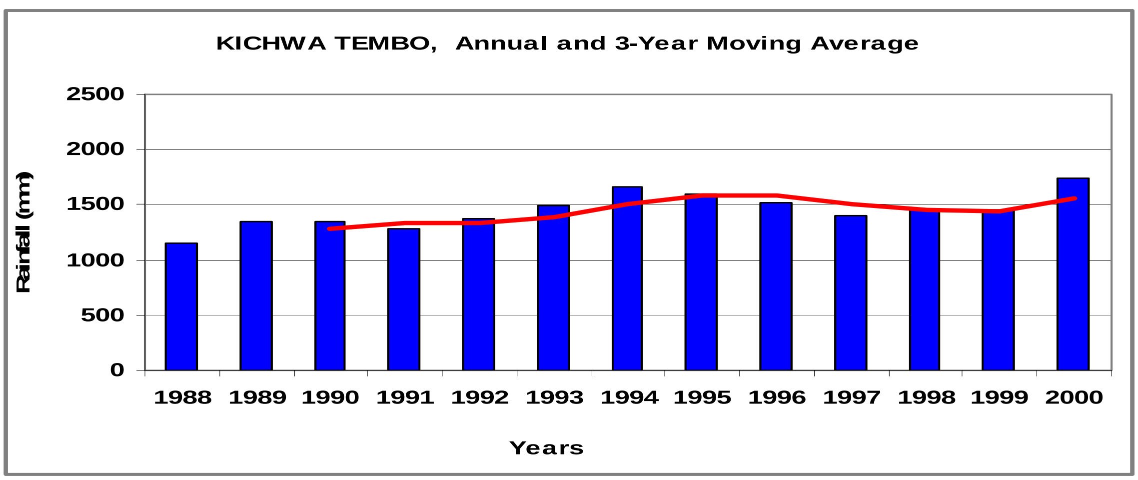

BOMET WATER SUPPLY- Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
Years

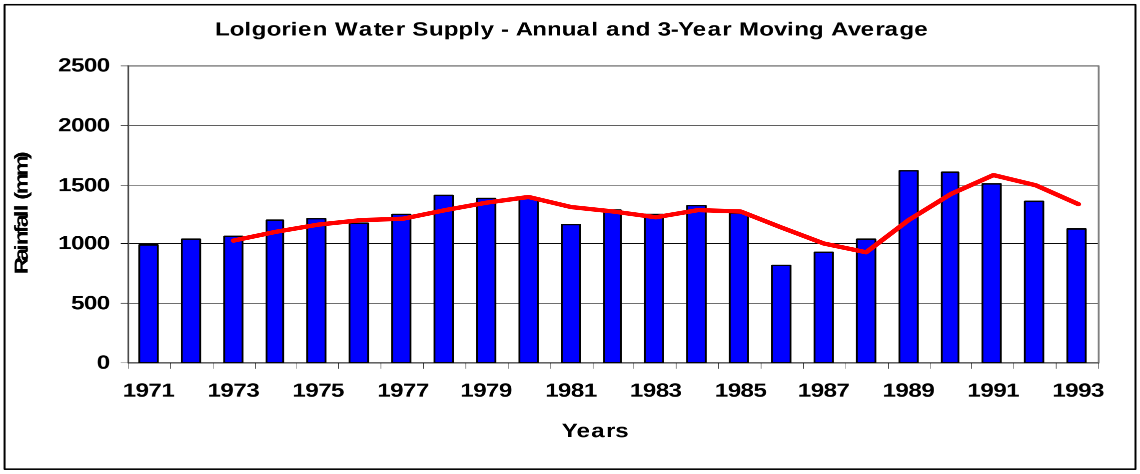

NAIROTIA FOREST-Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1982
1985
1988
1991
1994
1997
2000
2003
2006
Years


KABOSON MISSION - Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1960
1963
1966
1969
1972
1975
1978
1981
Years


AITONG HYDROMET- Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1960
1963
1966
1969
1972
1975
1978
1981
1984
Months


AFRICA GOSPEL CHURCH- Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
Years


KICHWA TEMBO, Annual and 3-Year Moving Average
Rainfall (mm)
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Years


Lolgorien Water Supply - Annual and 3-Year Moving Average
2500
2000
1500
1000
500
0
Rainfall (mm)
1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993
Years

Appendix 3A

Table 3A.1: Water Supply Facilities in the Mara River Basin, Kenya

BOMET DISTRICT					
Name/ Scheme	Operating Agency	Urban/Rural	Production (m^3/day)	Population Served	Present Status/Remarks
Bomet Water Supply Source of Water: Nyangores River	Chemosit Water & Sanitation Co.	Urban	382	512	-Operating but not meeting the demand -NBI funding construction of Bomet Sewage Works
Chepalungu Water Supply Source of Water: Nyangores River	Chemosit Water & Sanitation Co.	Rural	318	345	-Operating but not meeting the demand
Sigor Water Supply Source of Water: Nyangores River	Chemosit Water & Sanitation Co.	Rural	308	286	-Operating but not meeting the demand
Longisa Hospital Water Supply Source of Water: Spring	Chemosit Water & Sanitation Co.	Rural	120	Longisa Hospital	-Operating but not meeting the demand
Sergutiet Community Water Project Source of Water: River		Rural			-Operating but not meeting the demand
Sogoet W/S Source of Water: River	Community	Rural			-Operational
Longisa Community Water Project Source of Water: River		Rural			-Operational

Kaporuso W/S Source of Water: River	Community	Rural			-Operational
Mugombet W/S Source of Water: Nyangores River	Community	Rural/Urban			-Operating but needs funds for expansion
Itembe Water Supply (Proposed)	Unknown	Rural			Unknown
Kapcheluch W/S Source of Water: River	Unknown	Rural			-Operational
Marinyin W/S Source of Water: River	Community	Rural			-Operational
Ndaraweta W/S Source of Water: River	Institutional	Rural			-Operational
Tenwek Hospital W/S Source of Water: Nyangores River	Institutional	Rural			-Operational
Kiplokyi Sec School W/S Source of Water: Borehole	Institutional	Rural			-Operational
Kipkoi Academy Source of Water: Spring	Institutional	Rural			-Operational
NAROK DISTRICT					
Name/ Scheme	Operating Agency	Urban/Rural	Production (m^3/day)	Population Served	Present Status/Remarks
Morijo Loita Water Supply	Min of Water Res Man. and Development	Rural Gazetted water supply	Borehole yield 7.2m^3/hr	1,200 people 4,000 Livestock	-Operational, though borehole is caved in, needs to be drilled and

Source of Water: Borehole and shallow well					equipped.
Lemek Water Supply Source of Water: Borehole and Spring	Min of Water Res Man. and Development	Rural Gazetted water supply	Borehole yield $10.6m^3/hr$	2000 people 2,000 Livestock units	-Operational
Mulot Water Supply Source of Water: Amala River	Min of Water Res Man. and Development	Rural Gazetted water supply	-	3,000 people	-Stalled
Olkinyei Water Project Source of Water: Borehole	Beneficial Community	Rural	Borehole yield $8.52\ m^3/hr$	5,000 people 50,000 Livestock Units	-Operational
Naroosura Water Supply Source of Water: Natural Springs	Water User's Association	Rural	-	4,000 people 50,000 Livestock Units	-Operational
Ololulunga Water Supply Source of Water: Ewaso Nyiro River	Community	Rural	-	5,000 people 5,000 Livestock Units	-Operational but requires major rehabilitation/extensio n
Olomirani Water Project Source of Water: Chepinyinyi Springs	Community	Rural	-	2000 persons (students and teachers)	-Operational, Serves only Olomorani Secondary School
TRANSMARA DISTRICT					
Name/ Scheme	Operating Agency	Urban/Rural	Production (m^3/day)	Population Served	Present Status/Remarks
Emurua Dikkir Water Supply			$18{,}000m^3$/day	1,500	-Dam reservoir completed

Murkan			15,000m^3/day	2,000	-Operational
Ilkerin Water Project			15,000m^3/day	2,500	-Operational
Tumbelyan			15,000m^3/day	1,800	-Operational
Ilokwaya			25,000m^3/d	2,600	-Operational
Araret			-	-	Construction on-going , 10% done
Lolgorian Water Supply					_Operational
Kawai			20,000	1,200	-Operational
Siria High school			10m^3/Hr	Expected 1,800	-90% Operational
Oldonyorok			6m^3/Hr	Expected 1,500	-60% completed, Equipping required

Table 3A.2: List of Successful Boreholes in Narok South District

ITEM	B/H NO.	NAME OF OWNER	LOCATION	DIVISION	TOTAL DEPTH	YIELD (m^3/hr)
1	C3882	M.O.L.D (Ole Keiwa)	Ngore Ngore	Ololunga	143.5	8.2
2	C4319	Morijo Loita SHWP	Morijo	Ololunga	150	7.2
3	C4649	J. Haryanto	Mara River	Mara	28.1	2.55
4	C4694	M.O.T& W.	Sekanani	Maasai Mara	200	1.2
5	C4695	MOW (County Council)	Talek Gate	Maasai Mara	100	17.3
6	C4696	MOWD	Talek Gate	Sand River	60	-
7	C4715	M.O.T& W.	Sekanani	Maasai Mara	87	3.6
8	C4831	Isaih K. Chelugat	Sekanani	Mara	220	5.5
9	C4844	Mara Rwer Camp	Maasai Mara	Mara	52.7	-
10	C4905	Isaih K. Chelugat	Ilmotiok	Mulot	154.3	6.1
11	C5794	MOW Ngorengore II	Ngore Ngore	Ololunga	98	Untested
12	C5804	Musiara Ltd	Maasai Mara	Mara	131	2
13	C6017	Ngorengore II (MOWD-Ole Ntutu)	Ngore Ngore	Ololunga	-	-
14	C6018	MOWD	Ngosuani	Mara	90	10.8
15	C6054	MOWD	Olkinyei	Mara	102	1.98
16	C6068	Musiara Ltd(Main Governor's Camp)	Maasai MaraMara		111	8.52
17	C6080	MOWD Ngorengore IV	Ngore Ngore	Ololunga	114	3
18	C6316	Lemek Catholic Mission	Lemek	Ololunga	62	3
19	C8298	Keekorok Lodge	Keekorok	Mara	62	6
20	C8515	Kichwa Tembo	Oloololo	Mara	48	5
21	C12063	Vittoria Ltd	Ngosuani	Mara		10.56

		(LengijebiRidge-Olarro Camp)				
22	C12832	Mara Intrepids Club	Maasai Mara	Mara	65.5	2.8
23	C10732	Keekorok Lodge	Masai Mara	Mara	65	3.6
24	C10963	Fig Tree Camp	Talek Gate	Mara	63.2	2.7
25	C11128	L. Ole Ntutu	Ngore NgoreOlolunga		-	-
26	-	Ngore Ngore Community I	Ngore Ngore	Ololunga	90	2.5
27	-	Ngore Ngore Community II	Ngore Ngore	Ololunga	92	4.5
28	-	Samuel Koriata	Ololunga	Ololunga	102.6	10
28	-	Wasafiri Ltd	Aitong	Mara	35	18
29	-	Empora/Olomonira Community	Emporo	Mara	120	4
30	-	Kijirjir Community	Kijirjir	Mara	150	4
31	-	Sogoo Water project	Sogoo	Mulot	216	3
32	-	Morijo Loita (c/o RVWSB)	Morijo Loita	Loita	103	7
33	-	Iltirban Water Project	Iltirban	Ololunga	94	6
34	-	Enererai Water project	Enererai	Mulot	106	5

Appendix 4A

Livestock Data Sheets for the Kenyan Mara Districts

Table 4A.1: Pasture and Fodder Development

District	Type of Fodder/Pasture	2006 (Ha)	2005 (Ha)	2004 (Ha)
Bomet	Ley Natural pastures	499.8 44,800	NR NR	1,552.3 18,400
Narok	Ley Natural pastures	NR 1,040,784	NR 1,040,278	NR 1,042,198
Nakuru	Ley Natural pastures		41,482 206,491	38,155 220,481
Trans Mara	Ley Natural Pastures	NR NR	381.1 189,000	388 189,000

NR – Not reported
Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.2: Fodder Conservation

District	Method of Conservation	Tonnage	Remarks
Nakuru	Silage Hay	121,591 50,530 bales	2,1740 acres left as standing Hay
Bomet	Silage Hay	150 1,050 bales	Tube silage
Narok	Silage Hay	280 tons 150,500 bales	Mainly by institutions around town 120 tons of Wheat/Barley straws baled
Trans Mara	Hay Silage	Nil Nil	Drought affected availability of material

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.3: Water Sources

District	No. of Rivers	No. of Dams	No. of B/Holes	Springs/ Wells	Remarks
Bomet	5	NR	NR	NR	Only rivers indicated
Narok	7	4	84	47	1 Pipeline
Nakuru	10	76	35	-	
Trans Mara		9	6	1102	

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.4: Tick-borne Disease and Control

District	Number of dips	No of spray races	Hand Sprays	Operational dips & spray races	Not operational dips & spray race	Remarks
Bomet	113	-	Several	94	19	-
Narok	127	NR	NR	32	95	There is need to repair some of the dips
Nakuru	154	17	Several	89	75	-
Trans Mara	40	-	Several	6	34	Same as last year

NR – Not reported
Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.5: Dairy Cattle Population

District	Grade Cattle	Crosses (Dairy)	Total 2006	Total 2005	Total 2004	Total 2003
Bomet	-	-	188692	185,208	190,150	182,750
Nakuru	149,000	98,180	251,700	246,180	2,433,600	234,906
Narok	27,176	27,140	47,306	45,485	43,565	40,956
Trans Mara	-	-	61,000	57,825	54,554	53,340

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.6: Estimated Milk Production

District	Total (Kg)
Bomet	30,925,804
Nakuru	230,305,500
Narok	20,539,050
Trans-Mara	6,428,402
Total	905,209,996

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.7: Sheep and Goats Population Trends

	2004				2005				2006			
District	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats
Bomet	50,950	25,980	43,710	1,146	50,950	25,980	43,710	25,980	51,171	27,730	62,808	2,059

Nakuru	156,948	61,838	115,737	5,978	130,731	58,762	109,253	7,052	194,650	70,530	111,600	16,134
Narok	661,928	211,552	589,700	705	577,140	288,920	691,310	710	484,798	241,635	596,320	821
Trans Mara	73,399	-	51,848	93	76,550	0	57,625	102	78,400	0	59,000	150
Total	5,128,711	661,134	6,511,809	22,916	4,715,402	448,261	5,590,729	43,015	4,688,444	695,030	6,679,677	48,762

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.8: Hive Population and Production, 2006

District	KTBH	Loghives	Langstroth Hives	Honey Production (kgs)	Price/kg kShs	Wax (kg)
Bomet	1,955	9,649	1631	129,637		-
Nakuru	8,590	9520	120	120,000		9,600
Narok	2,315	29,664	282	318,896		-
Transmara	899	6,150	387	77,780		7,798
TOTAL	64,246	316,079	7768	2,010,661	200.00	8,182

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.9: Livestock Population Estimates

District	Dairy Cattle	Beef Cattle	Hair Sheep	Wool Sheep	Meat Goats	Dairy Goats	Camels	Rabbits	Donkey	Ostriches
Bomet	188,692	137,900	51,171	27,730	62,808	2,059	7,818	3,250	7,200	0
Nakuru	251,700	110,180	194,650	70,530	111,600	16,134	26,310	29,930		61
Narok	47,306	322,350	484,798	241,635	596,320	821	95	4,200	101,934	0
Trans Mara	61,000	455,600	78,400	0	59,000	150	0	490	12,700	0
Total	2,027,023	2,970,735	4,687,724	695,030	6,679,677	48,762	246,902	89,739	291,622	2,326

Source: Rift Valley Provincial Director of Livestock Development Reports for 2006

Table 4A.10: Livestock Population Estimates cont'd

District	Local Chicken	Layers	Broilers	Pigs	KTBH	Log hives	Langstroth	Turkey	Ducks	Geese
Bomet	352,400	2,664	4,200	0	1,955	9,649	1,631	39	1386	40

Nakuru	739,960	166,930	109,131	5,795	8,590	9,520	120	32,591	9,497	4,181
Narok	301,193	5,200	320	95	2,315	29,664	282	498	3531	1184
Trans Mara	190,500	430	0	70	899	8,000	387	160	550	0
TOTAL	5,622,509	437,143	257,794	27,194	64,409	322,905	7,768	55,962	36,683	14,335

Source: Rift Valley Provincial Director of Livestock Development Reports, 2006

Appendix 6A

Common and Scientific Names of the Larger Mammal Species of the Serengeti-Mara Ecosystem

Order Proboscidea
Loxodonta africana African elephant

Order Artiodactyla
Potamochoerus porcus Bushpig
Phacochoerus aethiopicus Warthog
Hippopotamus amphibious Hippopotamus
Giraffa camelopardalis Giraffe
Sylvicarpa grimmia Common duiker
Raphicerus campestris Steinbok
Ourebia ourebi Oribi
Oreotragus Oreotragus Klipspringer
Rynchotragus kirkii Kirk's dikdik *{Madoqua}*
Redunca redunca Bohor reedbuck
Redunca fulvorufula Mountain reedbuck
Kobus ellipsiprymnus Defassa waterbuck
Aepyceros melampus Impala
Gazella thomsoni Thomson's gazelle
Gazella granti Grant's gazelle
Hippotragus equinus Roan antelope
Damaliscus koligum Topi
Alcelaphus buselaphus Kongoni or Coke's hartebeest
Connochaetes taurinus Wildebeest
Tragelaphus scriptus Bushbuck
Tragelaphus strepsiceros Greater kudu
Tragelaphus imberbis Lesser kudu
Taurotragus oryx Eland
Oryx gazella Oryx
Syncerus caffer African buffalo

Order Perissodactyla
Equus burchelli Burchell's zebra
Diceros bicornis Black rhinoceros

Order Carnivora
Panthera leo Lion
Panthera pardus Leopard
Acinonyx jubatus Cheetah
Felis serval Serval
Felis caracal Caracal

Felis sylvestris African wildcat
Canis aureus Golden jackal
Canis mesomelas Black-backed jackal
Canis adustus Side-striped jackal
Lycaon pictus African wild dog
Otocyon megalotis Bat-eared fox
Ictonyx striatus Zorilla
Poecilogale albinucha African striped weasel
Melivora capensis African honey badger, ratel
Viverra civetta African civet
Nandinia binotata Palm civet
Genetta genetta Common genet
Herpestes ichneumon Great grey mongoose
Herpestes sanguineus Slender or black- tipped mongoose
Helogale parvula Dwarf mongoose
Atilax paludinosus Marsh mongoose
Mungos mungo Banded mongoose
lchneumia albicauda White-tailed mongoose
Proteles cristatus Aardwolf
Crocuta crocuta Spotted hyena
Hyaena hyaena Striped hyena

Order Primates
Erythrocebus patas Ikoma patas monkey
Cercopithecus aethiops Vervet monkey
Cercopithecus mitis Blue monkey
Colobus abyssinicus Black and white colobus
Papio cynocephalus Olive baboon

Order Hyracoidea
Dendrohyrax arboreu Tree hyrax
Heterohyrax brucei Bush hyrax
Procavia johnstoni Rock hyrax

Order Pholidota
Manis temmincki Ground pangolin

Order Lagomorpha
Lepus capensis Cape hare
Lepus crawshayi Crawshay's hare

Order Rodentia
Hystrix crisata African porcupine
Hystrix africaeaustralis Cape porcupine
Pedetes capensis Spring hare

Order Tubulidentata
Orycterpus afer Aardvark

Appendix 9A

Health Facilities in the Districts within the Mara River Basin - Kenya

BOMET DISTRICT					
Health Facility Name	**Type**	**Ownership**	**Division**	**Location**	**Village**
Longisa D.hospital	Hospital	GOK	Longisa	Cheboin	Samituk
Tegat	Health centre	GOK	Longisa	Tegat	Tegat
Olokyin	Health centre	GOK	Longisa	Kiplobotwa	Olokyin
Menet	Dispensary	GOK	Longisa	Kembu	Kongotik
Kapkimolwo	Dispensary	GOK	Longisa	Kapkimolwa	Kapkimolwa
Chemaner	Dispensary	GOK	Longisa	Chemaner	Chemaner
Sigor	S.D.Hosp	GOK	Sigor	Sigor	Sigor
Kapkesosio	H/C	GOK	Sigor	Kapgesosio	Kapgesosio
Lugumek	Dispensary	GOK	Sigor	Lelaitich	Lugumek
Kamongil	Dispensary	GOK	Sigor	Kaboson	Kaboson
Kapkoros	H/C	GOK	Bomet Central	Sabayian	Kapkors
Bomet	H/C	GOK	Bomet Central	Township	Township
Irwaga	H/C	GOK	Bomet Central	Kiromwok	Ment
Segutiet	Dispensary	GOK	Bomet Central	Chesoen	Kamogoso
Chesoen	Dispensary	GOK	Bomet Central	Chesoen	Chesoen
Ndaraweta	Dispensary	GOK	Bomet Central	Ndaraweta	Kabusare
Silibwet	Dispensary	GOK	Bomet Central	Township	Kitoben
Merigi	Dispensary	GOK	Bomet Central	Merigi	Merigi
Kiplelji	Dispensary	GOK	Bomet Central	Chesoen	Kplelji
Kitoben	Dispensary	GOK	Bomet Central	Mugango	Kitoben
Singorwet	Dispensary	GOK	Bomet Central	Sigorwet	Singorwet
Siongiroi	H/C	GOK	Siongiroi	Siongiroi	Siongroi
Olbutyo	H/C	GOK	Siongiroi	Kongasis	Segemik
Kipsuter	Dispensary	GOK	Siongiroi	Siongiroi	Kipsuter
Chebunyo	Dispensary	GOK	Siongiroi	Chebunyo	Chebunyo
Kataret	Dispensary	GOK	Siongiroi	Mogor	Kataret
Cheboyo	Dispensary	GOK	Siongiroi	Mogor	Cheboyo
Chebango	Dispensary	GOK	Siongiroi	Makimeny	Makimeny
Kapoleseroi	Dispensary	GOK	Siongiroi	Bingwa	Kapoleseroi
chepwastuiyet	Dispensary	GOK	Siongiroi	Bingwa	Chepwastuiyet
Makimeny	Dispensary	GOK	Siongiroi	Makimeny	Mabema
Chelelach	Dispensary	GOK	Siongiroi	Bingwa	Chelelach
Tenwek	Hospital	Mission	Bomet Central	Township	Silibwet
Kaboson	H/C	Mission	Sigor	Kaboson	Kaboson
Sot	Nursing Home	Private	Bomet Central	Township	Kabisoge
Bomet	Clinic	Private	Bomet Central	Township	Township
Kataret	Clinic	Private	Siongiroi	Mogor	Kataret
Chebunyo	Clinic	Private	Siongiroi	Chebunyo	Chebunyo
Kigana	Clinic	Private	Ndanai	Ndanai	Ndanai
Ndanai	Clinic	Private	Ndanai	Ndanai	Ndanai

Morit	Clinic	Private	Bomet Central	Chekoen	Chekoen
Zerch	Clinic	Private	Bomet Central	Silibwet	Silibwet
Serch	Clinic	Private	Longisa	Cheboin	Longisa
Siongiroi	Clinic	Private	Siongiroi	Siongiroi	Siongiroi
Soin	Clinic	Private	Bomet Central	Township	Bomet
Bomet Med. Centre	Clinic	Private	Bomet Central	Township	Bomet
Merigi	Clinic	Private	Bomet Central	Merigi	Merigi
Mercy Kaboson	Clinic	Private	Sigor	Kaboson	Kaboson
Kaboson	Clinic	Private	Sigor	Kaboson	Kaboson
Kapkoros	Clinic	Private	Bomet Central	Kapkoros	Kapkoros
NAROK DISTRICT					
Ilkerin Loita	Dispensary	NGO	Loita	Ilkerin	Ilmarae
Entasekera	Dispensary	GoK	Loita	Loita	Entasekera
Entasekerra -Catholic	Dispensary	Mission	Loita	Loita	Entasekera
Morijo Loita	Dispensary	GoK	Loita	Morijo loita	Morijo loita
Elmesutie	Dispensary	GoK	Loita	Olmesutie	Olmesutie
Olorte-CMF	Dispensary	Mission	Loita	Olorte	Olorte
Aitong-CMF	Dispensary	Mission	Mara	Aitong	Aitong-CMF
Mara Rianda - CMF	Dispensary	Mission	Mara	Aitong	Mara Rianda
Keekorok Lodge	H/Centre	Private	Mara	Koyaki	Koyaki
Sekenani gate	Dispensary	GoK	Mara	Koyaki	Sekenani gate
Eldonyo Rinka	Dispensary	Mission	Mara	Mengi	Eldonyo rinka
Naikarra	Dispensary	Mission	Mara	Naikara	Naikarra
Olkoroi-CMF	Dispensary	Mission	Mara	Olkoroi	Olkoroi
Megwara	Dispensary	GoK	Mara	Siana	Megwara
Talek-CFM	Dispensary	Mission	Mara	Talek	Talek
Mulot - catholic	Dispensary	Mission	Mulot	Mulot	Mulot
Nkiito - AIC	Dispensary	Mission	Mulot	Mulot	Nkiito
Sogoo	H/Centre	GoK	Mulot	Sogoo	Sogoo
Enabel bel	H/Centre	GoK	Olokurto	Enabelbel	Kisiriri
Olokirikirai	Dispensary	Mission	Olokurto	Enabelbel	Kisiriri
Olokurto	H/Centre	GoK	Olokurto	Olokurto	Okurto
Oloropil	Dispensary	Mission	Olokurto	Oloropil	Oloropil
St.Antony-lemek	Dispensary	Mission	Ololunga	Lemek	lemek
Olmegenyu	H/Centre	Mission	Ololunga	Olmegenyu	Megenyu
Ololunga	H/Centre	GoK	Ololunga	Ololunga	Ololunga
Nkori nkori	Dispensary	GoK	Ololunga	Ololunga	Nkori Nkori
Olpusimoru	Dispensary	GoK	Olukorto	Olpusimoru	Olpusimoru
Elangata Enderit- CMF	Dispensary	Mission	Osupuko	Elangat Enterit	Elangat E.
Maji Moto	Dispensary	Mission	Osupuko	Maji moto	Maji moto
Naroosura	H/Centre	GoK	Osupuko	Naroosura	Naroosura
Ewaso Ngiro	H/Centre	Mission	Osupuko		Ewaso ngiro
TRANSMARA DISTRICT					
Enoosaen	H/Center	GOK	Keiyan	Enosaen	Enoosaen
Enoosaen medical	Clinic	Private	Keiyan	Enosaen	Enosaen
Nkararo	H/Center	GOK	Keiyan	Nkararo	Nkararo
Ogwedhi Sakawa	Dispensary	Private	Keiyan	Sikawa	Sikawa
Trans mara	Hospital	Private	Kilgoris	Olamismis	Olamismis
Transmara	Hospital	GOK	Kilgoris	Ololchani	Ololchani

St. Joseph's	Hospital	Mission	Kilgoris	Ololchani	Ololchani
Kilgoris COG	Dispensary	Mission	Kilgoris	Ololchani	Ololchani
Leo	Clinic	Private	Kilgoris	Ololchani	Ololchani
Kilgoris Medical	Clinic	Private	Kilgoris	Ololchani	Ololchani
Angata Medical	Clinic	Private	Kilgoris	Ololchani	Ololchani
Aban	Clinic	Private	Kilgoris	Ololchani	Ololchani
Nganayio	Dispensary	GOK	Kilgoris	Olomismis	olomisims
Osupuko	Dispensary	GOK	Kilgoris	Osupuko	Osupuko
Akemo	Nursing Home	Private	Kilgoris	Poroko	Poroko
Poroko Friends	Clinic	Private	Kilgoris	Poroko	Poroko
Shankoe	Dispensary	GOK	Kilgoris	Shankoe	Shankoe
Olereko	Dispensary	GOK	Kilgoris	Shankoe	Shankoe
Emarti	H/Center	GOK	Kirindon	Emarti	EMARTI
Kabolecho	Dispensary	GOK	Kirindon	Emarti	Kapsasian
Chemamit	Dispensary	Community	Kirindon	Emarti	Chemamit
Mogor	Dispensary	Community	Kirindon	Esoit Naibor	Esoit Naibor
St.Teresia of Jesus	Clinic	Private	Kirindon	Esoit Naibor	Esoit Naibor
Kapsasian	Dispensary	GOK	Kirindon	Kapsasian	Kapsasian
Kimintet	Dispensary	GOK	Kirindon	Kimintet	Kirindon
Mpata Club	Clinic	Private	Kirindon	Kimintet	Pushangi
Kichwa Temba	Clinic	Private	Kirindon	Kimintet	Pushangi
Kamaget	Dispensary	GOK	Kirindon	Murkan	Iikerin
Kurangorik	Dispensary	GOK	Kirindon	Murkan	Mogondo
Iikerin	Dispensary	GOK	Kirindon	Murkan	Iikerin
Savimbi	Clinic	Private	Kirindon	Murkan	Murkan
Angata Barrikoi	H/Center	GOK	Lolgorian	Angata	Angata
Mara Serena	Clinic	Private	Lolgorian	Angata	Angata
Lolgorian	H/Center	GOK	Lolgorian	Moyoi	Lolgorian
Valley Gate I	Clinic	Private	Lolgorian	Moyoi	Lolgorian
St. Ann's	Clinic	Private	Lolgorian	Moyoi	Lolgorian
Lolgorian COG	Clinic	Private	Lolgorian	Moyoi	Lolgorian
Oldonyo-Orok COG	Dispensary	Mission	Lolgorian	Oldonyo orok	Oldonyo-Orok
Keringani	Dispensary	GOK	Lolgorian	Uoirien	Keringani
Romosha	Dispensary	GOK	Pirrar	Megwara	Romosha
Sigilai Medical	Clinic	Private	Pirrar	Njipiship	Njipiship
Kapweria	Dispensary	GOK	Pirrar	Oloimasani	Abossi
Takitech	Dispensary	Community	Pirrar	Oloimasani	Abossi
ST.ANTONT'S ABOSSI	H/Center	Mission	Pirrar	Oloimasani	Abossi
Olchobosei	Clinic	Private	Pirrar	Ololmasani	Njipiship
Shartuka	Dispensary	GOK	Pirrar	Shartuka	Shartuka
NAKURU DISTRICT					
Elburgon Maternity. Home	Nursing Home	Private	Elburgon	Elburgan	Elburgon
Elburgon Hosp	Hospital	GoK	Elburgon	Elburgon	Elburgon
St. Claire Disp	Dispensary	Mission	Elburgon	Elburgon	Elburgon
Mariashoni Disp	Dispensary	GoK	Elburgon	Marishoni	Marishoni

Nyakiambi Disp	Dispensary	GoK	Elburgon	Marishoni	Kitiro
Chebara Disp	Dispensary	GoK	Keringet	Chebara	Chebara
Chemaner Disp	Dispensary	GoK	Keringet	Chemaner	Chemaner
Kapsimbeiywo Disp	Dispensary	GoK	Keringet	Kapsimbeiywo	Kapsimbeiywo
Keringet H/C	Health Centre	GoK	Keringet	Keringet	Keringet
Kerol H/Services.	Dispensary	Private	Keringet	Keringet	Keringet
Tinet Disp	Dispensary	GoK	Keringet	Tinet	Tinet
Kamwaura Disp	Dispensary	GoK	Keringet		Kamwaura
Molo South	Dispensary	GoK	Keringet		Molo
Molo Hosp	Dispensary	GoK	Molo	Molo	Molo
Molo Med. Clinic	Clinic	Private	Molo	Molo	Molo
Molo Med & Dental	Clinic	Private	Molo	Molo	Molo
Molo Gsu Disp	Dispensary	GoK	Molo	Sachangwan	Sachangwan
Sachangwany Disp	Dispensary	GoK	molo	Sachangwan	Sachangwan
St. Martin De Porris	Dispensary	Mission	Molo	Sachangwan	Sachangwan
Nessuit Disp	Dispensary	GoK	Njoro	Naswet	Naswet
Ngondu Clinic	Clinic	Private	Njoro	Nessuit	Naswet
Mutarakwa Disp	Dispensary	GoK	Njoro	Ngata	Mutarakwa
PCEA Umoja	Dispensary	Mission	Njoro	Ngata	Ngata
Egerton University	Health Centre	GoK	Njoro	Njoro	Njoro
Metta Disp	Dispensary	GoK	Njoro	Njoro	Njoro
Njoro H/C	Health Centre	GoK	Njoro	Njoro	Njoro
ACK Mutukanio	Dispensary	Mission	Njoro	Njoro	Njoro
Huruma Disp	Dispensary	Mission	Njoro	Njoro	Njoro
Njoro PCEA Disp	Dispensary	Mission	Njoro	Njoro	Njoro
Integrated Med. Care	Clinic	Private	Njoro	Njoro	Njoro
Kihingo Med Clinic	Clinic	Private	Njoro	Njoro	Njoro
Emetik Disp	Dispensary	GoK	Olenguruone	Emitik	Emitik
Kiptagich Disp	Dispensary	GoK	Olenguruone	Kiptagich	Kiptagich
Olenguruone	Hospital	GoK	Olenguruone	Olenguruone	Olenguruone