

# **Assessing policy influences on people's relationship to water ecosystem services: The Kenyan experience**

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*Report contributing to the scoping exercise managed by IIED to help develop a DFID research programme on water ecosystems and poverty reduction under climate change*



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## Executive Summary

This analysis is part of an initiative led by the International Institute for Environment and Development (IIED) aimed at developing a research programme for the Department for International Development (DFID)- UK on water ecosystem services and poverty reduction under climate change.

This paper provides an overview of Kenya's water resources, its distribution, ecosystem services and roles in community livelihoods and national economy. Kenya's water resource sector currently faces myriad problems occasioned by the overuse and inefficient extraction and utilization of the resource. Population growth, water scarcity and uneven distribution, climate variability, pollution and degradation affect the sector. These have exacerbated water shortages, threatening future prospects for the country's development. Factors that constrain water resource management include the un uniform distribution of water resources over space and time, insufficient financial, technological and human resources, insufficient data on water resources, poverty and resource degradation.

A number of policies and laws that affect water resources and ecosystem services were reviewed and re-enacted fairly recently. The water, forest and environmental conservation policies and legislation have provided for the establishment of various institutions such as the National Environment Management Authority and the Water Resources Management Authority that have specific mandates geared towards safeguarding water resources and enhancing their ecosystem services. In addition, these laws have promoted decentralization of natural resource management. They have also instituted licensing and privatization of service provision, fiscal incentives and disincentives, as well as water quality standards that need to be maintained.

Climate change impacts on water resources and their ecosystem services are highlighted. Impacts of the now, frequent and recurrent droughts and floods on economic activities such as agriculture, tourism, industrial and hydro-electric power production among others are highlighted. Other impacts on human health such as the recurrence of climate sensitive diseases such as Malaria, Rift Valley Fever and Meningitis are noted. These are then linked to poverty. The need for research that investigates the links between climate change impacts and poverty is underscored. The strengthening of stakeholder engagement and partnerships in research, development and natural resource management is recommended.

The ranges of ecosystem services offered by freshwater resources are briefly described in the second section. It is noted that whereas these services are crucial for economic growth, the provisioning and cultural services directly affect the lives of local communities whereas the regulating and supporting services have benefits that many local people can not easily identify with and directly relate to.

The government is the custodian of the country's water resources and has provided an improved policy and legal framework for resource management. Although the state's capacity to handle water ecosystem issues is constrained by factors such as insufficient data, human resource, technological and financial capabilities, the level of political awareness about water issues is high. Water assessment needs strengthening.

With increased participation in water management by other actors including civil society, donors, research institutions and private sector, some positive impacts are being realized. The need for long term investment in water projects, economic diversification through promotion of the service sector, environmental auditing and monitoring are emphasized.

Impacts of migration, population growth and industrialization on water resources and variations in poverty and demographic patterns in the country's watersheds are also examined. It is noted that about one quarter of all Kenyans live in the eight selected areas—very close to the total number of

people in all of the arid and semi-arid lowlands. The average level of well-being in Kenya's sheds however, is significantly higher than in the communities further downstream.

The paper concludes by recommending areas for further research in the development of markets in tradable water rights and its impacts on ecosystem services, as well as community livelihoods. Other areas include studies on water ecosystem services, climate change and economic development; investigation of effective tools and methods for the integration of water ecosystem services and climate change into national policy processes and up scaling best practices in watershed management.

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## **Acronyms**

ASAL	Arid and Semi Arid Lands
CBS	Central Bureau of Statistics
DRSRS	Department of Resource Surveys and Remote Sensing
EIA	Environmental Impacts Assessment
EMCA	Environmental Management and Coordination Act
GDP	Gross Domestic Product
GHGs	Greenhouse gases
HEP	Hydro Electric Power
ILRI	International Livestock Research Institute
UNFCCC	United Framework Convention on Climate Change
KP	Kyoto Protocol.
MCM/Yr	Million Cubic Metres per year
NGOs	Non Governmental Organizations
NWRAD	National Water Resources Assessment Database
UK	United Kingdom
WRI	World Resources Institute

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## Introduction

Kenya is located in East Africa. The country has an area of 582,646km<sup>2</sup> out of which 11,230 Km<sup>2</sup> is occupied by water. About 80% of the country is classified as Arid and Semi-Arid Land (ASAL). The country has a population of approximately 33 million persons out of which 24 million live in rural; and 9 million in urban areas respectively. Her water resources are characterized by high spatial and temporal variability. This is influenced by rainfall availability which ranges from an average of 200mm in the ASAL areas of northern Kenya to 2000mm in the central and south western parts of the country. Various topographical features influence water availability. Mount Kenya, Aberdare ranges, the Rift Valley, the Mau complex and Mount Elgon comprise the country's water towers and together with the Rift Valley, they influence drainage patterns. Drainage basins include the Lake Victoria, Rift Valley, Tana River, Athi and Ewaso Ng'iro basins. (UNESCO 2006). The table below summarizes water resource distribution and major uses:

**Table 1: Water Resource Distribution and Use in Kenya**

<b>Drainage Basin</b>	<b>Size in Km<sup>2</sup></b>	<b>Estimated Groundwater potential (Million Cubic Meters)</b>	<b>Estimated surface water potential (mean annual surface runoff) in Billion Cubic Meters</b>	<b>Percentage of total national water potential</b>	<b>Main water uses</b>
Lake Victoria	46,000	115.7	11.672	54.1	Domestic, industrial, small scale irrigation, HEP development (in progress)
Rift Valley	130,000	125.7	2.784	3.4	Domestic, industrial, livestock, large and small scale irrigation, HEP
Athi	67,000	86.7	1.152	4.3	Domestic, livestock, industrial, large and small scale irrigation
Tana	127,000	147.3	3.744	32.3	Domestic, livestock, industrial, large and small scale irrigation, major HEP
Ewaso Ng'iro	210,000	142.4	0.339	5.8	Livestock, domestic, major and minor irrigation

Source: National Water Master Plan 1992 (in UNESCO 2006)

The country's annual available water is estimated at 20.2 billion cubic meters. Kenya is currently classified as a chronically water scarce country, with an endowment of 612 cubic meters per person per year, with access in urban areas estimated at 89% and 49% in rural areas (UNESCO 2006). She has the lowest access to safe water in East Africa (Konig et al 2006).

Kenya shares several water bodies with neighbouring countries. Lake Victoria is shared with Uganda and Tanzania (with Kenya contributing about 45% of surface water inflows into the lake). In addition, Lakes Natron, Chala, Jipe and rivers Uмба and Mara are shared with Tanzania. Other water bodies shared with Uganda include rivers Sio, Konyao, Suam, Malaba, and Alupe. Lakes Turkana and river Omo are shared with Ethiopia, while river Daua is shared with Somalia and Ethiopia. The interdependence between Kenya and its neighbours, as well as the upstream and downstream Nile basin countries including Rwanda and Burundi among others, has considerable implications for the management of the country's water resources. For instance, Lake Victoria is one of Kenya's water surplus areas, but the area suffers from regular flooding and extreme poverty- partly attributable to inefficient water resources management (UNESCO 2006).

Countries located along the Nile basin have varied interests and stakes in the water resources of the region. Uganda, Burundi and Rwanda are interested in developing and expanding hydropower generation, whereas Kenya has mainly been concerned about irrigation potential, water pollution control and the water hyacinth problem. Further north, Sudan and Egypt depend on river Nile mainly for irrigation and electricity generation. With projected increase in population and increased urbanisation, the demand for water is set to increase in the region. Coupled with political opportunism, this is likely to increase social discontent and may spark social conflicts in the region in future (Ewald et al 2004).

The Lake Victoria Environmental Management Program (LVEMP) aims to rehabilitate the Lake's ecosystem and its catchments; on the other hand, the Nile Basin Initiative aims to build trust and confidence on large scale use of water resources among riparian countries for poverty reduction and economic development. The East African Community's Lake Victoria Development Project also provides a basis for cooperation in the management of the region's shared water resources. Emphasis is placed on the need for equitable sharing of the water resources and benefits that accrue from resource development and sustainability (UNESCO 2006).

**Figure 1: Map of Kenya's Major Water Resources Distribution**



Source: [www.unesco.org/.../img/kenya\\_big.gif](http://www.unesco.org/.../img/kenya_big.gif)

The demand for water across various sectors in Kenya is varied and is expected to increase by more than double in future due to increased urbanization, industrialization, and population growth among others. Given the finite nature of water resources, coupled with inefficient water abstraction and utilization, and climatic variability, water shortages are likely to worsen in future. The table below summarizes water demand in 1995 and provides projected demand in 2010.

**Table 2. Estimated Water Demand in Kenya**

Category	Demand (1,000 M <sup>3</sup> /Day)	
	(Year)1995	(Year) 2010
Residential (urban)	747.8	1642.8
Residential (rural)	468.2	932.6
<b>Sub Total</b>	<b>1216.0</b>	<b>2575.4</b>
Non residential, health facilities, schools,	593.9	986.3



industries and commerce		
<b>Total</b>	<b>1809.9</b>	<b>3561.7</b>
Livestock water	376.6	621.4
Irrigation	3.9M	8.1M
<b>Grand Total</b>	<b>2186.6</b>	<b>4183.2</b>

Source: Ministry of Water and Irrigation (in UNESCO 2006)

Kenya's ASAL areas mainly depend on groundwater resources. Many parts of the country have been experiencing increased water scarcity due to changes in climate, unsustainable use of water, catchment degradation and general weakness in water resource management.

The over use and abuse of water resources has intensified over the past decade, reaching a point where water shortages, water quality and ecosystems services degradation is threatening future prospects for human development and social stability. Challenges facing the water sector include: population growth (resulting in increased demand for water for domestic, agricultural, and industrial use); water scarcity; climate variability; invasive species; pollution; ground water depletion; water resources and catchment degradation among others.

According to the National Water Master Plan of 1992, water demand currently stands at 3900 MCM per annum and will increase to approximately 5817 MCM/year in 2010 (UNESCO 2006).

### **Purpose of the paper**

This paper analyses and highlights various aspects of selected Kenyan laws that influence and affect the quantity and quality of water available, the resource's ecosystem services and livelihoods. The impacts of climate change on water availability and poverty are also analyzed, and potential research areas in water ecosystem services, poverty and climate change identified.

The first section focuses on Kenyan laws that expressly deal with, and others that affect water resources and their ecosystem services. These include the Environmental Management and Coordination Act (1999), the Water Act (2002), the Forest Act (2002) among others. Institutions, structures and mandates provided for within legislation, for the management of water resources and their catchments are reviewed. Aspects of policy and legislation geared towards improvement of water resources management including decentralization of policy implementation, privatization of service provision and licensing, environmental quality standards and fiscal incentives/disincentives are highlighted.

The second section looks at various aspects of water availability and its impacts on ecosystems and livelihoods; water quality and its impacts on biodiversity, the effects of climate change on water quality; and water in relation to human health and economic development in Kenya.

State roles and interest in water ecosystem services as the custodian of the country's water resources are mentioned. Politicians' interests in water ecosystem issues as well as the state's capabilities in handling water issues are analyzed in section three.

Section four tackles other parties' (including donors, community based organizations, non-governmental organizations, donors and the private sector's) involvement in water issues and some of the impacts of their activities on water resources and communities' livelihoods.

The fifth section highlights various drivers of socio-economic change that affect water ecosystem services such as urbanization, industrialization, population growth among others.

The paper concludes with suggestions of areas where research can contribute to the enhancement of water ecosystem services, communities' livelihoods and climate change resilience in the country. North-south collaboration is encouraged and potential areas of collaboration identified.

This analysis is part of an initiative led by the International Institute for Environment and Development (IIED) aimed at developing a research programme for the Department for International Development (DFID) - UK on water ecosystem services and poverty reduction under climate change.

## 1. Policies that affect the relationship between Water Ecosystems Services and the Poor

There are several policies and laws that impact on water resources and their ecosystem services in Kenya. In this section, a review of the Kenya constitution, the Environmental Management and Coordination Act (1999), the Water Act (2002), the Kenya Forest Development Policy Sessional Paper number 9 and the Forest Act (2005), the Agriculture Act (1980) and the Energy Act (2006) are given. These laws were selected because of their relevance and influence on water availability, quality and the ecosystem services. The sectors that these laws touch on are inter-related and have a significant influence on the country's economic development and communities' livelihoods.

The failure by various policies to address problems in the past, coupled with changes in the international policy arena, together with changes within the Kenyan society motivated a review and re-enactment of a number of policies highlighted below.

### 1A. The Kenya Constitution

The Kenya constitution is the overarching force of law in the country. Section 47 of the constitution states that if any other law is inconsistent with the constitution, it (constitution) shall prevail and the other law shall to the extent of the inconsistency, be void. (GOK 1998).

The Kenyan constitution is currently under review. There are two main versions of the draft reviewed constitution and various issues are still under debate. For the purposes of this study, reference has been made to the current Kenyan constitution (revised in 1998). The current constitution does not make a direct reference to water resources and their ecosystem services. However, Clause 75 of Chapter V of the constitution strives to protect individuals from deprivation of property and touches on natural resources (which include water). It states that 'No property of any description shall be compulsorily taken possession of, and no interest in or right over property of any description shall be compulsorily acquired, except where the following conditions are satisfied:

(vii) 'for so long only as may be necessary for the purposes of an examination, investigation, trial or inquiry or, **in the case of land, for the purposes of the carrying out thereon of work of soil conservation or the conservation of other natural resources** or work relating to agricultural development or improvement (being work relating to the development or improvement that the owner or occupier of the land has been required, and has without reasonable excuse refused or failed, to carry out).'

This provision is consistent with the laws reviewed below and given that the constitution gives the government power to compulsorily acquire land for the purpose of conservation of natural resources, it provides for the enhancement of water ecosystem services including provisioning, regulating, cultural and supporting services through natural resource conservation.

### 1B The Environmental Management and Coordination Act No 8 of 1999

This Act provides the overall legal and institutional framework for the management of the environment (including water resources) in Kenya. Section 42 of part V of the Act provides for the protection of rivers lakes and wetlands. Among other things, it prohibits the alteration, disturbance and/or drainage of the above. It also empowers the Minister to declare 'protected area status' to a water resource and impose restrictions that would protect the said water resource, and issue regulations, guidelines and/or standards; including pollution prevention and control as well as sustainable use of water resources and their sources. Section 47 of part V of the Act mandates the National Environment Management Authority, in consultation with relevant lead agencies to issue guidelines and prescribe measures that will protect water catchment areas. Under section 50 part V, the Authority is mandated

to measure the value of unexploited natural resources in terms of watershed protection, influences on climate, cultural and aesthetic value among others. Section 54 (1) states, ' The Minister may in consultation with the relevant lead agencies, by notice in the Gazette, declare any area of the land, sea, lake or river to be a protected natural environment for the purpose of promoting and preserving specific ecological processes, natural environment systems, natural beauty or species of indigenous wildlife or the preservation of biological diversity in general.' Furthermore, section 2 mandates the Authority, in consultation with the relevant lead agencies, to issue guidelines and prescribe measures for the protection and management of protected natural environments. Section 58 (b) provides for fiscal incentives in form of tax rebates on machinery and equipment to industries and other establishments that invest in pollution control, re-cycling of waste, water harvesting and conservation, and prevention of floods among others.

In Section 71 of part VIII, the Standards and Enforcement Review Committee is obligated to recommend minimum water quality standards for all waters of Kenya for different uses; including drinking, industrial, agricultural, recreational, fisheries and wildlife, and any other prescribed water use to the Authority. The Committee is also meant to prepare and recommend guidelines or regulations for the preservation of fishing and aquatic areas, water sources and reservoirs, and other areas where water may need special protection. The Act prohibits water pollution and has prescribed a penalty for such offences. It has also put in place a licensing system for effluent discharges.

The sections highlighted above provide regulations geared towards protection, quality maintenance and management of the environment, including water resources and their catchments. Its effective enforcement should enhance freshwater ecosystems services and contribute towards poverty reduction by ensuring that good water quality and sufficient quantity is sustained. This will maintain natural resources that local communities' livelihoods and health depend on and enable them to continue engaging in their economic activities.

### **1C. The Water Act No. 8 of 2002 Cap 372 Laws of Kenya**

The Water Act, no. 8 of 2002 is the main law governing the management, conservation, use and control of water resources, the acquisition and regulation of rights to use water, as well as the regulation and management of water supply and sewerage services. It was enacted in March 2003 and provides for a reformed legal institutional framework for the management and development of Kenya 's water resources and the provision of water services. Section 2 of part I of the Act defines a "water resource" as any lake, pond, swamp, marsh, stream, watercourse, estuary, aquifer, artesian basin or other body of flowing or standing water, whether above or below ground (GOK 2003).

The Ministry of Water and Irrigation is the policy making body in charge of providing an enabling framework for effective service provision.

Under the Water Act 2002, various state corporations that affect water ecosystem services have been established. Part III of the ACT establishes The Water Resources Management Authority that is responsible for regulation of water resources management issues including the allocation of water, catchment protection and conservation, water quality management and pollution control, and international waters. It also facilitates cooperative management of water resources in catchments areas and conflict resolution among Water Resource Users Associations. Catchment Area Advisory Committees at the regional level advise the authority on issues of water resources conservation, use and apportionment, and cancellation or variation of permits. Other state corporations include the Water Services Regulatory Boards, Water Services Trust Fund, Water Appeals Board, Water Services Boards, the National Water Conservation and Pipeline Corporation and the National Irrigation Board.

Section 11 of part III of the Act deals with the national water resources management strategy and states:

**11.(1)** 'Following public consultation, the Minister shall formulate, and publish in the Gazette, a national water resources management strategy in accordance with which the water resources of Kenya shall be managed, protected, used, developed, conserved and controlled.'

**(3)** 'The national water resources management strategy shall prescribe the principles, objectives, procedures and institutional arrangements for the management, protection, use, development, conservation and control of water resources and, in particular, for—

**(a)** determining, in accordance with this Part, the requirements of the reserve for each water resource;

**(b)** classifying water resources in accordance with this Part; and

**(c)** identifying areas which, in accordance with this Act, should be designated protected areas and ground water conservation areas.'

Section 15, part III deals with the catchment management strategy. It states that:

15. (1) 'Following public consultation, the Authority shall formulate a catchment management strategy for the management, use, development conservation, protection and control of water resource within each catchment area.'

The Act also provides for a water abstraction permits system in an effort to regulate water abstraction. This is a positive step. However, the issuance of licenses without full understanding of ecosystem needs can place a heavy burden on the resource, thereby impacting on its ecosystem services. For example, extraction of large volumes of water from Lake Naivasha, mainly for horticulture, has caused a steady reduction in the lake's water volume by about 800million cubic meters over a period of about 14 years; over and above climate induced fluctuations. The horticultural farms are not paying for the scarce resource, ecosystem damages and livelihoods of other people dependent on the lake. This is symptomatic of the water-use situation in many parts of the country. The Water Act does not address the fragmentation of water resource management responsibilities arising from other sectoral legislation. (World Bank 2004).

Effective policy implementation and enforcement of legislation on water has also been impeded by inadequate funding, lack of consensus and support from other sectors, and poor communications. Policies on other water using sub-sectors such as agriculture, livestock, industry, and hydropower generation need to be re-aligned and harmonized with the water policy (ibid).

Coordination of national legislation is important as it would facilitate local level decisions by the Catchment Area Advisory Committees and Water Users Associations. It would also be useful for the Meteorology Department and the Water Resources Management Authority to sign an agreement to share climatic and hydrological data for national benefit. The restructuring, streamlining and elimination of overlapping functions of various agencies across relevant ministries and departments and consolidation of responsibilities in new emerging institutions such as the Water Resource Management Authority and Catchment Area Advisory Committees would be a viable alternative.

Adequate funding for water resources management is important to enable consistent hydrological data collection and analysis, enforcement of water use permits and pollution control, ground water monitoring, water infrastructure rehabilitation and catchment restoration. In addition, there is need for

awareness creation on water user charges and their implications. Funds raised from water user charges should be used strictly for water resource management, including water infrastructure operation, maintenance and development (World Bank 2004).

Water pricing structures should be developed to provide funding for water management, encourage water efficiency in irrigation, reduce leakage and increase water re-use and recycling.

From the foregoing, provisions within the Water Act have the potential to improve water resources management and safeguard communities' livelihoods. Water Users Associations and Catchment Areas Committees will empower communities to hold their stake and play a more active role in decision making, thereby enhance their lot.

#### **1D. Kenya Forest Development Policy Sessional Paper number 9 of 2005 and The Forest Act No. 7 of 2005 Cap 385 Laws of Kenya**

The policy aims to promote sustainable forest management, enhancement of ecosystem services, poverty reduction and stakeholder participation. Its specific objectives include:

- Contribute to poverty reduction, employment creation and improvement of livelihoods through sustainable use, conservation and management of forests and trees.
- Contribute to sustainable land use through soil, biodiversity and water conservation and tree planting through the sustainable management of forests and trees.
- Promote the participation of the private sector, communities and other stakeholders in forest management to conserve water catchment areas, create employment, reduce poverty and ensure sustainability of the forest sector.
- Promote farm forestry to produce timber, wood fuel and other forest products
- Promote dryland forestry to produce wood fuel and to supply wood and non-wood products.
- Promote forest extension to enable farmers and other stakeholders to benefit from forest management technologies and approaches.
- Promote forest research training and education to ensure a vibrant forest sector.

The Forest Act provides for the establishment, development and sustainable management of forests and woodlands on state, local authority and private land in Kenya for socio-economic development. In the preamble, the Act recognizes that forests play a vital role in the stabilization of forests and ground water, thereby supporting the conduct of reliable agricultural activity, and that forests play a crucial role in the rainfall regimes in Kenya and moderate climate by absorbing greenhouse gases.

Clause 24 of part III of the Act gives the Minister the power to declare any land under the jurisdiction of a local authority to be a local authority forest where among other things, ' the land is an important catchment area, source of water springs, or is a fragile environment'. This is upon the recommendation of the forest conservation committee, the Forest Board and the relevant local authority.

Clause 46 of the Act provides for community participation in forest conservation and management through established community forest associations. Clause no. 52 prescribes prohibited activities and penalties for contravention of the terms and conditions spelt out in the Act.

Kenya's gazetted forest area covers about 1.7 million hectares representing, about 2.5% of the country's total land area (UNEP 2001). Forest conservation is important for sustained water conservation as well as the sustenance of ecosystem services; including biodiversity conservation; soil and water conservation, micro-climate regulation; carbon dioxide sequestration; aesthetic, existence and cultural values; and wildlife habitats among others.

In spite of the need for forest conservation, Kenya's forests continue to be degraded. The 2002 excisions in the eastern Mau forest complex, the Molo forest and Nakuru scrublands led to an estimated decline of woodland and bush land by about 55,000 ha/year. In addition, illegal tree felling continues in spite of the ban on timber harvesting from public forests. This could partly be attributed to weak enforcement of legislation, inadequate human and infrastructural capacity to enforce law and corruption. Tree loss through forest conversion and harvesting, coupled with poor land management and inappropriate agricultural practices has increased soil erosion and sedimentation of water bodies. This has resulted in reduced economic life of reservoirs, reduced hydraulic capacity of water conveyance facilities, disruption of water supply operations and negative impacts on various ecological functions of various ecosystems. For example, the reduction in the depth of Lake Baringo from over 15 meters in 1921 to an average of 1.8 meters in 2004, is partly due to increased sediment load from surrounding catchment areas. (World Bank 2004). Among other things, reduced water quality and quantity negatively affects agriculture, livestock production as well as other sectors.

### **1E The Agriculture Act of 1980 Cap 318 Laws of Kenya**

This Act aims to promote and maintain stable agriculture and provide for the conservation of soil and its fertility among other things in the country. The agricultural sector contributes about 30% of the country's GDP and provides the main source of livelihood for about 80% of the population (UNESCO 2006). It is therefore important that provisions within the Agricultural policy and law promote sustained agricultural production, natural resource management, optimize benefits to farming communities and contribute positively to the economy.

Section E of Clause 48 of the Act empowers the Agriculture Minister to make rules that would ensure maintenance of water in a water body within the meaning of the Water Act. These include:

i) the afforestation or re-afforestation of land;

(ii) the protection of slopes, catchment areas or areas where rules made under paragraph (e) are in force;

It is augmented by other laws such as the Irrigation Act Cap 347 that provides for large scale irrigation development and management under the National Irrigation Board, this Act does not recognize the other types of irrigation projects that have been developed and managed by the Ministry of Water and Irrigation. However, the national irrigation policy is currently under review by the Ministry of Water and Irrigation and it is hoped that it will recognize the role of local communities and the private sector in accelerating and sustaining sound development of the sector (UNESCO 2006). The Land use policy is under preparation and a draft has not yet been published.

Given the important role that agriculture plays in providing for the livelihoods many Kenyans, as well as the sector being the major user of fresh water, its role in water degradation through pollution for example, it is important for the policy to address issues of water resource management and the amelioration of ecosystem services (in line with the environmental policy) and improvement of the sector's economic performance in order to reduce poverty and sustain sector activities.

### **1F. The Energy Act Cap 12 of 2006**

Kenya's total energy demand is 3 million tones of oil equivalent. Energy demand is increasing at a rate of 5% per annum. Hydro-electric power provides for 57% of Kenya's domestically generated electricity (World Bank 2004). Water availability therefore has a strong influence on energy availability, which in turn affects the level of industrial, commercial and household activities (especially in urban areas). It is

therefore important to intensify catchment and riparian management to mitigate siltation in hydro-electric power plants, in order to improve electricity generation per capita.

Although it doesn't directly refer to water resources or water ecosystem services, it mentions the need for environmental considerations in regard to energy provision. Under part III, clause 30 (b) of the Act, the Energy Regulatory Commission must consider the need to protect the environment and to conserve the natural resources in accordance with the Environmental Management and Coordination Act of 1999; among other things in granting or rejecting an application for a license of permit to generate, import, export, transmit, distribute or supply electrical energy to consumers.

A draft energy policy states that 'power will continue to be produced under a least cost plan, which will involve development of additional hydro and geothermal power stations.' The policy is focused on maximum benefits for the energy sector and does not attempt to provide for water management as a multi-sectoral resource (World Bank 2004).

From the foregoing, it is clear that various roles and functions provided for in the laws highlighted are closely inter-related and interlinked. This is attributed to the multiple functions of water and its ecosystem services across various sectors for example forestry, agriculture, energy among others.

In terms of Institutions that affect water ecosystem services, there are numerous institutions established within government such as ministry of water, environment and natural resources, agriculture and energy. Under these ministries, various state corporations and departments with varied roles have been established.

Other Institutions that affect water ecosystem services include: regional development authorities such as the Lake Basin Development Authority and the Tana and Athi Rivers Development Authority; Community Based Organizations that are engaged in activities that contribute to, and affect water resources and the ecosystem services provided-both positively and negatively, environmental and development NGOs that implement projects that impact on water resources for example The World Agroforestry Centre, Kenya Forests Working Group, Nature Kenya, Oxfam among others.

Programmes and initiatives that affect water ecosystem services include the permanent presidential commission on soil and water conservation and afforestation; afforestation, re-forestation, agroforestry projects; integrated natural resources management programmes such as the Lake Victoria Environmental Management Project and the Nile Basin Initiative; private water companies such as the Nairobi, Eldoret, Mombasa, Kisumu and Nyeri Water companies.

In practice, there are myriad factors that contribute to the sub-optimal and inequitable delivery of water ecosystem services. Whereas policies in place endeavor to promote sustainable development, the inadequate enforcement of various laws, including the relatively slow judicial process and corruption, propagate continued misuse, overuse and abuse of water and other natural resources, resulting in degradation of various ecosystem services.

In addition, there is a general lack of awareness of stakeholders' environmental rights and responsibilities among a large proportion of the country's population. As a result, people do not usually seek legal redress for environmental injustices that affect their lives (including degradation of ecosystem services).

Widespread poverty among majority of the population, coupled with high population densities in resource-rich regions exacerbates pressure on water, among other natural resources on which people depend and that are closely inter-related with, and inter-dependent on water and its ecosystem services. This contributes to degradation of ecosystem services through high rates of deforestation for example.



Other factors that constrain water resources management in Kenya thereby affecting the delivery of ecosystem services include:

- Un uniform distribution of water resources across space and time.
- Insufficient financial resources, coupled with low levels of investment in water infrastructure and water resources assessment.
- Insufficient data on water resources to provide a sound basis for appropriate decision making on water resource management. This is partly due to absence of a formal method of ensuring that climate and water resources data are shared in a timely manner and free of cost to maximise national benefit. In addition, information on ground water is limited. Main information sources are Ministry of Water and Irrigation's National Water Resources Assessment Database (NWRAD) and reports on regional assessment studies. NAWRD has no new data entries since 1998 and other reports are difficult to access as there is no central location where they are housed and those who have the information may not readily share them. There are no monitoring records or data about the present status of boreholes. The surface water database is also not up to date.
- Lack of a well established and coordinated information system and public participation.
- Lack of modern and innovative management technologies.
- Inadequate human resource capacity to deal with water's complex ecosystem linkages.
- Water catchments degradation and improper land use practices.
- Transboundary nature of water resources-requiring trans boundary water resource management frameworks and strategies, which are a challenge to date.

(World Bank 2004).

### **1G. The Economic Recovery Strategy for Employment and Wealth Creation (ERS) (2003-2007) and the Millennium Development Goals (MDGs)**

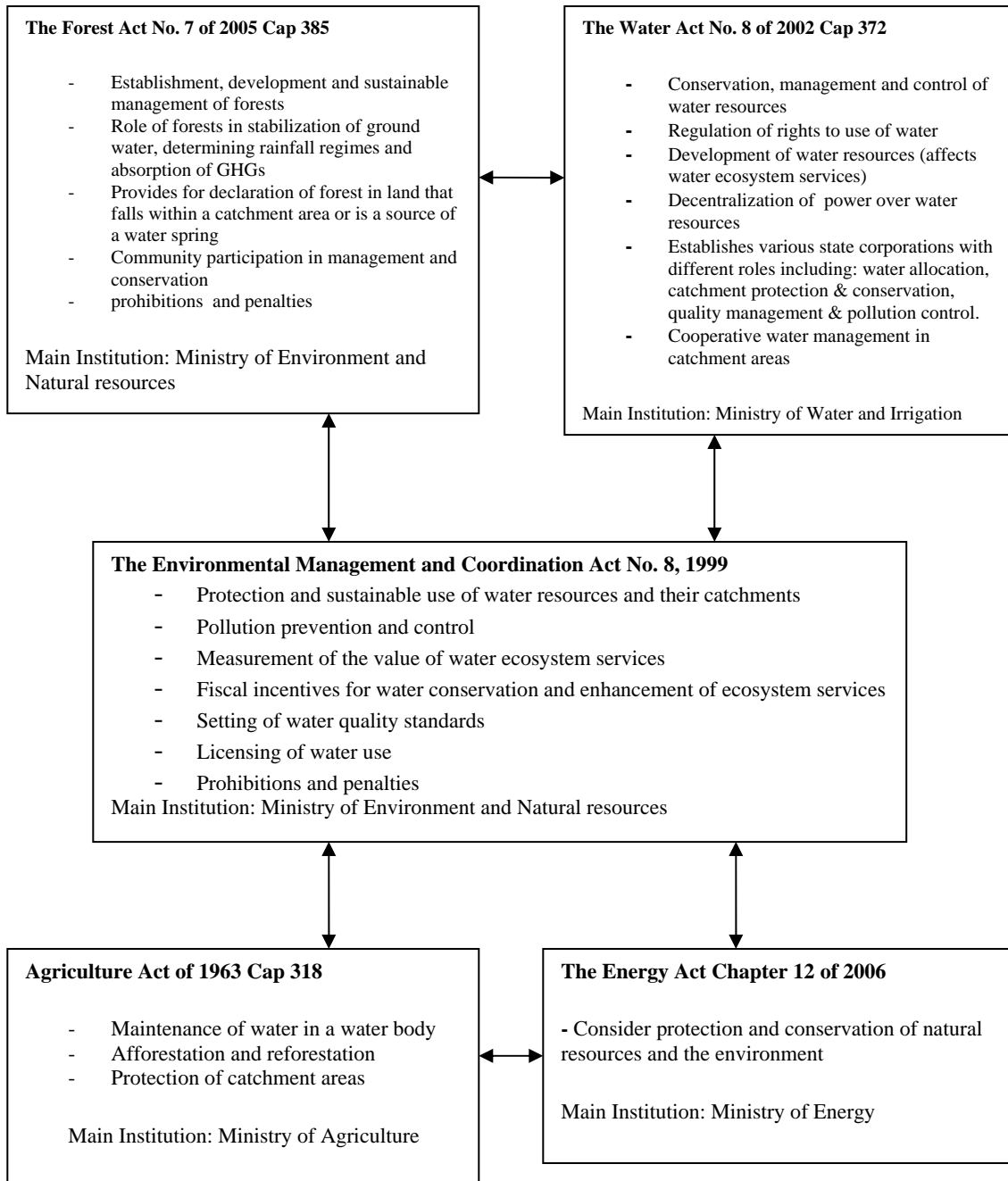
The ERS proposes a programmed approach to the water sector by putting strong emphasis on providing services to the poor while ensuring adequate water for competing demands. Kenya's Poverty Reduction Strategy Paper (PRSP) recognizes that water is a basic need and an important catalyst for the country's economic and social development.

It notes that the reasons behind the deterioration of water supply in rural and urban areas are poor management of water supply schemes and catchment destruction. In two out of ten districts, water was specified as an integral part of the definition of poverty, while in six out of ten districts, water was seen as a cause of poverty. Nine out of ten districts proposed solutions for tackling poverty that included various improvements in water resources (World Bank 2004).

The PRSP commits to providing water and sanitation to most people at a distance of 2 Km. The Strategy aims to involve local authorities and communities more actively in the management of water. The government aims to increase urban water supply to serve 84% of the urban population and 74% of the rural population by 2015, in line with the MDGs (UNESCO 2006).

The Rural development strategy envisages rehabilitation of existing irrigation schemes and development of new ones. However, it does not address issues of water storage on farm and off farm to buffer against climate variability. Similarly, the draft land policy has the potential to control the location of land uses that affect water use and quality, and to restrict settlement in floodplains, water catchments and recharge areas (World Bank 2004). However, it is important that viable and productive alternative land is designated elsewhere for settlement. Proper education and land ownership should also be addressed to encourage appropriate land use and natural resource management.

**Figure 2: Water Ecosystem Services- Policy Links**



## 1.1 Policy Impact Ranking

Kenya's water resources issues are complex and challenging. While many people understand water needs in various sectors, few people understand the linkages and differences between the sectors and water resource management, ecosystem services. Important elements in water resource management include planning, assessment, allocation, monitoring and enforcement, pollution control, source protection, drought and flood management and conservation. (World Bank 2004).

### 1.1A Water Policy

Most of the laws that affect water ecosystem services in Kenya were reviewed and enacted fairly recently. There isn't much information available on enforcement and impacts of legislation. It is therefore challenging to objectively rank the intensity of their effects on water ecosystems services and poverty. However, their effective enforcement presents several opportunities for positive influence and effects on water ecosystems services and poverty reduction.

Prior to the current water sector reforms, a number of institutions and organizations had been involved in the water services provision including the Ministry of Water and Irrigation, the National Water Conservation and Pipeline Corporation, local and municipal councils, and about 3000 community based organizations (Konig et al 2006).

The Water Act was reviewed and enacted in 2003. It provides for the decentralization of power from national to the regional and local level; the separation of water resources management from the water services sector and institutional separation of policy, asset holding, regulatory and operational functions.

Water resources management should be promoted by:

- Broadening involvement in reforms to include all key sectors of government and the Kenyan community.
- Integrating the water sector reform process with other sectoral reforms and realigning policies, legal frameworks and legal institutions.
- Developing an environment that promotes investment in water resources infrastructure (both small and large scale) and management to provide a basis for economic growth and poverty reduction.
- Promoting regional cooperation and finding mutually beneficial development opportunities with the country's neighbors for transboundary water resources management.

There is need to develop consensus within the Ministry of Water and Irrigation and with other relevant ministries about the process and strategy for implementing water sector reforms. In addition, there is need to broaden the staffing and oversight of the water reform secretariat by including other ministries and developing a technical advisory committee to guide the secretariat. The inter-ministerial steering committee that includes senior members of other ministries should be strengthened. In addition, cabinet support should be obtained to elevate reforms to a national level and funding be obtained through the Economic Recovery Strategy. Some of these funds should be channeled towards water resources assessments. It is also important to develop a communications strategy to build community support for the necessary behavioral and cultural changes, and enhance broad understanding and ownership of the Water Act 2002. The Ministry of Water and Irrigation needs to broaden and strengthen donor coordination to organize focused support from international development partners in water resources management (World Bank 2004).

## **1.1B. Decentralization of Policy Implementation**

The laws reviewed above have devolved and decentralized rights and responsibilities over resource management from national to provincial to district levels. In addition, they have put structures in place for the coordination of a bottom-up approach in policy implementation and monitoring, as well as integrated natural resource management. Various committees have been established to achieve this; including District Environment Committees under EMCA. Coupled with the above, there have been deliberate and increased efforts to actively involve local communities and other stakeholders in the management of natural resources that affect water ecosystem services.

Emerging decentralized responses such as water user associations and community driven development in rural areas present a good opportunity for the improvement of water resources management and benefits to the poor. The country also needs to effectively tap on its academic and technical base to support water sector reforms (World Bank 2004).

These are all positive steps towards enhancement of water resource management, which will contribute positively towards sustenance of ecosystem services and local economies and livelihoods. The National Water Resource Management Strategy is still being developed. It is anticipated that the document will come up with a comprehensive, cross-sectoral strategy for managing water resources in recognition of its ecosystem services and that management strategies will recognize variability in water availability and address issues of access across various regions. It is also hoped that inter-basin water transfers will be facilitated through the strategy.

## **1.1C. Licensing and Privatization**

Under the highlighted laws, various systems are in place to grant permits and licenses for water resource extraction and utilization. Clear guidelines and criteria have been set under the laws (including requirements for preparation of forest management plans, environmental impacts assessments, and licenses for effluents and emissions discharge). Relevant organs or bodies have been mandated to administer the licensing processes.

A good understanding of the multiple roles of water across sectors is necessary for appropriate resource use and management. Licensing and privatization systems will work as long as procedures are adhered to and requirements met. However, they have the potential to exclude community groups that have inadequate human resource and financial capacity to meet some of the requirements, for example, to commission EIA's and develop proper environmental management plans. Under the Forest Act, there is provision for the Forest Service to assist communities to develop environmental management plans. This enhances their involvement in natural resource management.

In urban areas, there has been a move to privatize water services provision through establishment of autonomous water companies such as the Nyeri, Eldoret, Kisumu and Nairobi water companies. While this has positive effects on service provision, water quality, infrastructure maintenance and revenue collection, their impacts on water ecosystem services are mixed. Such companies are well placed to deliver good quality water for drinking and domestic use. However, some of them are not involved in catchment area management hence they are unlikely to positively affect other ecosystem services. It is only the Eldoret water Company that is engaged in forest conservation. It has established the Moiben River Catchment and Conservation Association which provides tree seedlings to area farmers (Wambua 2004). Information on whether the farmers actually plant the tree seedlings on their farms and whether the association monitors the quality of the environment is not available.

In addition, such companies currently don't serve rural areas where a majority of the population resides. Many of them don't serve poor neighborhoods in urban areas, thereby exacerbating inequity

in water quality and access. The Nyeri and Eldoret Water Companies are exceptions. They supply water to slum areas at different (lower) tariffs from those charged to richer neighbors through water kiosks (Wambua 2004), others such as Nairobi Water Company don't. The urban poor end up relying on water vendors to supply water. This is expensive and exacerbates financial hardship. For instance, less than 40% of households in Kibera slum in Nairobi have access to legal water connections, usually a standpipe. About a third of these receive water only once in two days. Approximately 80% of these households purchase some or all of their water from water vendors, whose prices average \$ 3.50 per cubic metre but rise to almost double in the dry season. The price is seven times higher than that paid by people in high income settlements served by Nairobi Water Company and takes up about 20% of income for a family with two adults earning minimum wage (UNDP 2006).

With support from government agencies, NGOs among other stakeholders, active local community participation in water resource management and infrastructure maintenance and development is improving in various areas. Partnerships between government and private sector should be fostered to enhance quality, and access in urban water supply. In turn, this will improve water quality and availability and support economic activities that will enhance benefits to communities.

### **1.1D. Environmental Quality Standards and Resource Valuation**

Provisions have been made for the setting of various environmental standards, especially on water and air quality, under the Agriculture and EMCA Acts respectively. These are in line with international water and air quality standards. However, these standards have not been effectively enforced so far and degradation of water ecosystem services continues unabated. Polluted water has found its way to rural households, with deleterious impacts on human and livestock health in several instances.

EMCA also provides for quantification of non-economic values of resources, including determination of existence values. Information is unavailable on the extent and impact of this. However, resource valuation in monetary terms has the potential to motivate stakeholder interest and participation in sustainable resource management and facilitate equitable delivery of water ecosystem services.

### **1.1E. Fiscal Incentives and Disincentives**

In addition to prohibitions and penalties, innovative economic incentives and disincentives have been incorporated into the revised water, forest and environmental management legislation. Tax breaks on industrial equipment that clean effluent, credit facilities and technical training to local communities engaged in forest based industries for sustainable forest resource use have been offered. So far, the desired effect has not been achieved. This is mainly attributed to lack of broad awareness of these instruments, weak enforcement of laws and corruption. There is need for awareness creation and modification of some of these economic instruments to enable them to benefit local communities, thereby elicit active participation.

Water resources management needs to be cross-sectoral. Investments in agriculture, transport, tourism, manufacturing, energy and communication among others, must be simultaneously supported by purposeful management of underlying water resource base. The Ministry of Water and Irrigation needs to develop a coordinated approach to water resources management partly because decisions taken in the highlighted sectors impact on water resources, and partly because of the extent of financial, human and other resources that will be needed to appropriately manage water resources. Through a coordinated approach, the country could develop and implement effective multi-purpose infrastructure investment plans, catchment and riverine management plans, capacity building for institutional staff and other involved groups and pilot projects. Such an approach could lead to effective, efficient and fair management of water resources. (World Bank 2004).

A high level technical advisory committee, consisting of representatives from government agencies, academia, NGOs and private sector should, be used to guide water resources management, and build cross-sectoral support (ibid ).

In development of water infrastructure in future, it will be crucial to address social, environmental, economic and transboundary issues in a timely, systematic, responsible and transparent manner than in the past. Stakeholder engagement is also important in the decision-making process.

## **2. Overlay of the Policy Map with Climate Change**

This section highlights the impacts of climate change on water resources and ecosystem services in Kenya. Climate change impacts present significant opportunities as well as challenges on water ecosystem services, poor people and the relevant national policies. The country has been negatively affected by climate change to a large extent. This is partly due to lack of adequate human resource, technological and financial capacity to exploit opportunities, such as storage of surplus water during flooding, which could be used for agricultural and industrial production during drought.

Service provision from water often leads to conflicting benefits and costs, depending on the perspective of the different users. This is because a service for one group may be a disservice” for another. For example, damming rivers for hydroelectric power generation may benefit urban electricity users but harm local fishers. Floods can have both positive and negative impacts depending on the context. While floods can destroy homes, crops, and kill people and animals, they often serve as an important supplier of nutrients to floodplains and are an important factor in maintaining biodiversity and freshwater systems.

With increasing evidence of climate change being experienced globally, various impacts are already being experienced in parts of Kenya. Increased incidences of droughts and floods, as well as shifts in rainfall seasons, are the most notable climate change impacts. These have a significant influence and impacts on water ecosystem services and poor people’s livelihoods respectively. The 1997-98 drought and the 1999-2000 floods illustrate the impacts of climate change and neglect of water resources management on the economy. The El nino rains in 1997, for example, caused flooding that affected Nairobi, lower parts of the Tana River, and Western Kenya, mostly Busia and Nyando Districts (SoK 2003 in Adam et al 2007). These floods cost the country at least Ksh 70 billion (11% of GDP), mainly in form of damage to infrastructure (excluding irrigation infrastructure), and the drought cost the country at least Ksh 120 billion (16% of GDP) in each year that they occurred. The drought affected most sectors. The greatest costs were incurred in manufacturing and electricity production. Given the recurrence intervals of droughts and floods, and natural resource degradation, the losses translate into annual average losses of about Ksh 4.4 billion in infrastructure and an average loss of production of about KSh 10 billion (1.6% of GDP). Social, environmental and developmental costs were not included in the figures above, meaning that actual costs are much higher than what is documented. (World Bank 2004). Due to climate change, it is projected that rainfall will increase on average but it will decline in Arid and Semi-Arid areas, leading to decline in basic food crops, coffee and tea, which could fall by a third according to some IPCC scenario projections (UNDP 2006).

In May 2005, devastating floods displaced ten thousand people, especially along the shores of Lake Victoria, as well as in Tana River and Garissa Districts further east. Residents of affected areas reported the flooding to be the heaviest since 1963. Heavy rains also caused flooding in Isiolo District and in the Dadaab refugee camp in Northeastern Kenya, leaving more than 25,000 Somali refugees homeless. Impassable, waterlogged roads seriously hampered efforts to help the victims (Relief Web 2005).

On the other hand, flooding can sometimes be helpful to both ecosystems and people. About one million people (IUCN 2003) depend on the Tana River’s flooding regime for their livelihoods, including

nomadic and semi-nomadic pastoralists, who rely on floodplain grasslands for dry season pasture. Some seasonal fisher folk and fish traders also depend on the Tana's flooding pattern, as do some farmers, who count on seasonal floods to irrigate their riverbank farms. In addition, birds and wildlife are dependent on the annual flood cycle of the Tana for habitat and forage. Wetlands are often replenished by the flooding as well (Adam et al 2007).

Studying the hydrological response to different types of land cover and land uses in flood-prone areas, implementing better land use planning, and establishing early flood warning systems are possible interventions that could mitigate some of the worst flood impacts.

### **2.1A. Climate Change and the Provisioning Services**

Provisioning services of freshwater systems include the storage and retention of water (in lakes, rivers, and as groundwater) for domestic, agricultural, and industrial use. Water is a vital input for the production of food (e.g., fish, irrigated crops, and livestock), timber, fiber, and fuel. Of course, freshwater itself is a product for consumption (Adam et al 2007).

The World Commission on Water has estimated that global demand for water will increase by 50% in the next 30 years, and that approximately half of the world's population will experience severe water stress by 2025. Three quarters of African countries are expected to experience unstable water supplies, whereby small decreases in rainfall induce much large reductions in stream flow. Vital water catchments have been lost, or are being degraded, causing concerns about the loss of hydrological functions and increasing competition for water resources between agriculture, industry, wildlife and urban centers. (Ong et al 2006). These sectors influence economic growth and given that as of 2005, approximately 42% of Kenya's population lived below the poverty line (UNDP 2005), the government proposed the ERS that recognizes water as a vital element in poverty reduction and emphasizes the importance of providing services to the poor, while ensuring adequate water for competing demands.

Highly variable and unpredictable rainfall occurrence coupled with a general increase in temperatures, could have varied impacts on water ecosystem services and poor communities' livelihoods in Kenya. Unreliable water availability coupled with lack of resources for investment on water reservoirs among the poor, has exacerbated inequity in water access. Reduced water quantity and availability has also increased competition for water and has fuelled several social conflicts especially among some ASAL communities in Turkana, Tana River and Laikipia districts in Kenya in the recent past. Between January 1998 and May 2003, a total of 80 incidents of conflicts over water resources and water shortages were reported in the national newspapers. In 2001, clashes between Somali and Samburu pastoralists over access to water and grazing areas in the Kipsing/ Longobito area led to 11 deaths, whereas in Tana River district, similar conflicts led to over 100 deaths. The loss of productive man hours (spent in fighting), injury and death, has high social costs, and it is the poor who bear a disproportionately large burden in such instances. For example, during the 1999-2000 drought, the cost of a 20 liter container of water rose from Ksh 5 to 10. (World Bank 2004).

Reduced water availability negatively affects agricultural production, and nature-based economies among the poor. The country's annual agricultural growth rate has decreased from 4.8% in 1970s through 3.3% between 1980 and 1990, to -1.9% between 1990 and 2000. There are various exogenous factors that contribute to this including urban growth, lack of access to stable markets for agricultural produce, environmental degradation among others. (World Bank 2001). The percentage of people with access to safe water in urban areas is 68% and 49% in rural areas. Almost 40% of the water in urban area is unaccounted for due to leakages and illegal connections. Water borne and sanitation related diseases are a major cause of morbidity in Kenya, making up over 60% of premature deaths (UNESCO 2006).

## **2.1B. Climate Change and Regulating Services**

Regulating services of freshwater systems and important freshwater habitats such as wetlands, include modifying water flows (hydrological flows), recharging and discharging groundwater resources, and diluting or removing pollutants. The ability of freshwater systems to provide these services is strongly linked to the type of vegetation cover and to land cover changes, such as conversion of wetlands or expansion of urban areas. Kenya's Wetlands cover only 2-3 percent (640,000 ha) of Kenya's surface area (SoK 2003: Adam et al 2007) but play a critical role in Kenya's ecosystems.

Shifts in climatic regimes are known to lead to changes in water flows and water quality. During flooding, overflowing water erodes soil and causes damage to agricultural crops, livestock and other property, including buildings, and affects the Western part of the country, mainly such as Yala swamp and Kano plains (Adam et al 2007). As noted earlier, people are forced to migrate to higher ground till the waters subside. In addition, polluted water flows into residential areas and farms causing the spread of diseases among humans and livestock.

## **2.1C. Climate Change and Supporting plus Cultural Services**

Supporting services of the hydrological cycle are important for soil formation and soil loss (erosion) and nutrient cycling. Freshwater ecosystems also provide habitat for a great number of species, promoting biodiversity, which underlies the resilience and productivity of ecosystems. Cultural services on the other hand, include the important recreational benefits provided by lakes and rivers, as well as their spiritual and inspirational roles in different cultures (Adam et al 2007).

As noted earlier, increased floods and droughts negatively affect various ecosystem services, impacting negatively on water reservoirs and altering habitats such as wetlands. This in turn leads to changes in species composition and abundance, with increased likelihood of species extinction and invasive species altering such ecosystems.

Studies on climate change and biodiversity in Kenya have mainly focused on Marine biodiversity, specifically coral reefs, marine fish and tourism. It is reported that certain fish species are disappearing and coral reefs, which are like the rainforest of the sea, have been seriously affected by changes in sea temperatures and coral bleaching caused by flooding and the attendant siltation. Most local community members residing at the coast don't have the resources to escape their changed circumstances. Kenya's marine fisheries are dominated by small scale fishermen with limited capacity to fish. They have no means to go beyond the mangroves and corals, and cannot venture into the open seas where there are more fish. (Mulama 2007). Impacts of climate change on soil formation and soil loss impact negatively on agriculture and the economy. Some of these impacts have already been highlighted earlier. The loss of recreational and spiritual benefits through degradation of water masses, and loss of biodiversity of cultural significance, would also affect local communities. This would particularly affect hunter-gatherer communities such as the Dorobo in Kenya, whose religious and socio-cultural practices are closely tied with nature.

## **2.1D. Climate change and Health**

Many vector and water-borne disease are influenced by climate (Nganga et al., 2002: Orindi 2005). Climate change may increase the prevalence of some vector-borne diseases (e.g. malaria) and vulnerability to water, food or person- to- person borne diseases (e.g. cholera and dysentery) (AfDB et al.,2003: Orindi 2005). Climatic anomalies associated with El Nino-Southern Oscillation phenomenon have been linked to outbreaks of malaria in Africa (Githeko et al., 2000: Orindi 2005).



Increased frequency and intensity of droughts and floods associated with such climatic anomalies, impacts directly on human well-being and health, and more so in poor urban and rural areas where health services, water supply and sanitation facilities are inadequate. Climate change will also affect ecological and social systems, thereby creating additional challenges (IPCC, 2001; Orindi 2005).

Climate variability and change have been identified as some of the key drivers in the increased incidence and spread of climate sensitive diseases (e.g. resurgence of Malaria) (Zhou et al.,2004; Githeko and Ndegwa, 2001;Githeko et al.,2000), even though some authors (Hay et al.,2004;2002; Thomas, 2004) feel that other factors including drug resistance, demographic and land use changes, could be more important in explaining the recent resurgence in malaria than climate change (Orindi 2005).

The morbidity disease pattern for Kenya indicates that over 60% of the diseases are waterborne, water related or sanitation related. Malaria is leading with 32.6%, followed by the respiratory system 24.6%, skin diseases, diarrhea and intestinal worms, which are more prominent as far as water and sanitation are concerned, can be classified as number three with a morbidity of 17% (UNESCO 2006). Despite this relationship, almost nothing is known of the economic burden of malaria epidemics in sub-Saharan Africa (IRI, 2005).

The occurrence of Meningitis is associated with increase in temperature and decrease in humidity, and related to dust. With climate change, arid and dusty conditions will spread spatially, leading to increased risks of meningitis outbreak (DFID, 2004: Orindi 2005). Despite the moderately strong relationship between climate and outbreaks of meningitis, understanding of this relationship is still poor (IRI, 2005).

The Rift Valley Fever- a mosquito borne virus, is closely associated with heavy rainfall and affects people and livestock (DFID, 2004: IRI, 2005). Outbreak of Rift Valley Fever epidemic in 1997/98 as a result of the El-Nino rains killed up to 80% of livestock in Somalia and Northern Kenya (DFID, 2004: Orindi 2005). Another Rift Valley Fever outbreak recurred in Kenya early between November 2007 and March 2007, causing death of 155 persons (WHO 2007). It also led to a ban on livestock imports from the region (IRI, 2005). This resulted in loss of income to pastoralists.

Reducing the incidence of climate induced diseases for example, will require taking into consideration information on the seasonality of climate and its variability when coming with up with control strategies (i.e. routine health campaigns, epidemic preparedness, dealing with outbreaks).

Since both temperature and rainfall are thought to have synergistic effects on malaria transmission, simultaneous analysis of climatic and vector data is needed to show the effects of climate on malaria cases. Other equally important factors that may need to be looked at include; change in land use and the role of topography. Land use changes for example, may create more mosquito breeding sites, change water chemistry and temperature of mosquito habitats, thereby fostering their development and survival. The fact that vector species are adapted to existing ecosystems means that change in the ecosystems will definitely affect their distribution.

The most important, cost-effective and urgently needed measure is to rebuild public health infrastructure. Many diseases and public health problems that may otherwise be exacerbated by climate change could be substantially prevented with adequate financial and human public health resources. These resources would encompass public health training programs, research to develop and implement more effective surveillance and emergency response systems, and sustainable prevention and control programs (DFID 2000: Reid et al 2005).

## 2.1 E. Climate Change and Economic Development

General degradation of water resources and ecosystem services, be it due to natural or anthropogenic factors, contributes additional and little noticed costs to the economy. Siltation reduces operating life of water infrastructure, increased costs of groundwater pumping due to over abstraction of surface water, costs of desalination of coastal ground water because of sea water intrusion, the loss of potential fish production because of eutrophication, the costs of additional time and transport equipment modifications because of the presence of the water hyacinth in lake Victoria, and the additional water treatment costs arising from discharge of pollutants increase the nation's financial burden (World Bank 2004).

The tables below summarize costs that arose from El-nino induced floods and the La nina drought on various economic sectors.

**Table 3. Costs Arising from 1997-98 El-nino induced Floods**

				Estimated Cost (000,000)
Attribute	Effects	Associated Costs	Ksh	US\$
Floods	Damage to infrastructure	Water systems	3,600	45
		Road network, communication and buildings	62,000	777
	Public health hazard	Treatment costs	4,500	56
	Loss of crops	Crop loss/reduced production	33	
<b>Total</b>			<b>70,000</b>	<b>870</b>

Source: World Bank 2004

**Table 4. Costs Arising from 1998-2000 La nina drought**

				Estimated Cost (000,000)
Attribute	Effects	Associated Costs	Ksh	US\$
Drought	Loss of crops	Crop loss	19,000	241
	Loss of livestock	Livestock deaths	58,000	73
		Veterinary costs	93,000	1
		Reduced livestock production	5,100	64
		Conflict management	6	
	Forest fires	Forest destruction and	29	

		damage		
	Damage to fisheries	Reduced aquaculture production	19	
	Reduced hydro-power generation	Increased cost of generation	51,000	632
		Increased import subsidies	806	10
	Reduced industrial production	Loss of production	110,000	1,400
	Water supply		5,100	64
		Increased water collection times-ASALs	4,400	55
		Increased water collection time-Nairobi		
		Time spent on conflict management	3	
		Cost of water vendor in Nairobi	22,000	270
<b>Total</b>			<b>220,000</b>	<b>2,800</b>

Source: World Bank 2004

It should be noted that it is difficult to accurately estimate the above costs since they were incurred over a long period of time and across large spatial areas. The poor quality of monitoring data and lack of specific understanding of the processes that link sites of degradation and the sites of impact, were also a challenge. Due to data limitations, costs were estimated for specific locations in Kenya. If extrapolated across the whole country, the full cost will be much higher. (World Bank 2004).

It is worth noting that while climate change will exacerbate economic and other costs to the country, it does present several opportunities for economic development. For example, about one million people in the lower Tana River depend on the river's flooding regime for their livelihoods. In addition, birds and wildlife depend on the annual flood cycle of the Tana for habitat and forage (Adam et al 2007). This could be facilitated through adaptation of local livelihoods to new forms of economic activities such as aquaculture in areas of water abundance, and cultivation of improved varieties of drought-escaping crops to cope with increased drought in arid areas. Investments should be made in the construction of water reservoirs from regional to local levels to promote perennial water availability. Technologies for construction of flood and storm-proof housing; as well as harnessing other forms of energy for development should be explored and promoted. Peer learning should be encouraged at community level.

## 2.2. National Policies and Climate Change

So far, most Kenyan policies and laws do not recognize climate change. It is only the Forest Act of 2005 that recognizes the role of forests in greenhouse gas sequestration. The policies and laws in

place have made provisions geared towards promotion of sustainable natural resource management and economic development. EMCA, the Water, Forest and Agriculture Acts, have provisions for water catchment management, and the Energy Act strives to promote the use of renewable energy. Proper implementation could potentially improve the country's resilience to climatic changes, whilst providing water ecosystem services.

Awareness and understanding of climate change issues has been relatively low-even within the national policy arena, as climate change is considered a new phenomenon and most relevant policies were reviewed and laws enacted without incorporation of climate change considerations.

However, since Kenya hosted the UNFCCC's COP 12/COP MOP 2 meeting in Nairobi in November 2006, awareness level and adaptation activity on the ground has increased. While this is a notable improvement, it is not yet sufficient and a lot more needs to be done to elicit increased interest and involvement of key policy makers (in economic and national planning, health, agriculture, energy etc.), industrial sector and local communities, among other groups.

More research on the linkages between climate change and its impacts on other aspects such as health and economic development is required, and findings communicated to various audiences in a suitable way. There is need to inform and adapt national policies to incorporate climate change and ecosystem services offered by water among other natural resources.

Currently, government policies are focusing on poverty reduction, economic and improvement of health and social welfare. However, proper understanding of the linkages between climate change and these sectors, and the magnitude of impacts, would promote policies geared towards redressing challenges posed by climate change as part of the strategies for combating problems.

NGOs are well placed to facilitate information sharing among researchers, policy makers, local communities and private sector. They are also well placed to inform and influence policies, and promote climate change adaptation and mitigation from national to local levels. There is need to strengthen information sharing and partnerships among stakeholders to facilitate informed decision making.

### **3. Interest and Effectiveness of the State in Water Ecosystem Services**

The ranges of ecosystem services offered by freshwater resources have been briefly described in section two. It is noteworthy that whereas these services are crucial for economic growth, the provisioning and cultural services directly affect the lives of local communities. Regulating and supporting services have benefits that many local people can not easily identify and directly relate to.

#### **3.1. State Roles and Interest in Water Ecosystem Services**

The Kenyan government is the custodian of the country's water resources. Section 3 of part II of the Water Act 2002 states 'Every water resource is hereby vested in the State, subject to any rights of user granted by or under this Act or any other written law'. Section 21(1) of the 2005 Forest Act states 'All forests in Kenya other than private forests, are vested in the state ...'. The Laws prescribe for the establishment of various state corporations and other organs, with defined roles and mandates that have a significant role in providing water ecosystem services (GOK 2002).

EMCA provides for the establishment of the National Environment Management Authority to supervise and coordinate environmental matters, and is the government's principal instrument for the

implementation of environmental policies. In addition, various committees, including the National Environmental Action Plan Committee, have been formed. Efforts have been made to draw membership on such organs from various sectors, including academic and research institutions, related government ministries and departments, civil society and private sector (GOK 1999). This promotes the incorporation of inputs from various stakeholders in the decision-making process and has the potential to effectively cater for myriad interests.

The Forest Act establishes the Kenya Forest Service to formulate policies on management, conservation and utilization of forests; manage forests on water catchment areas for water and soil conservation, as well as greenhouse gases sequestration, and collaborate with local communities and other organizations in the management and conservation of forests, as well as sustainable utilization of the resources therein (GOK 2004).

Under the Water Act 2002, various state corporations that affect various water ecosystem services have been established. Part III of the ACT establishes The Water Resources Management Authority (WRMA) that is responsible for regulation of water resources management issues including the allocation of water, catchment protection and conservation, water quality management and pollution control, and international waters. It also facilitates cooperative management of water resources in catchment areas and conflict resolution among Water Resource Users Associations. Catchment Area Advisory Committees at the regional level advise the authority on issues of water resources conservation, use and apportionment, and cancellation or variation of permits. Other state corporations created include the Water Services Regulatory Boards, Water Services Trust Fund, Water Appeals Board, Water Services Boards, the National Water Conservation and Pipeline Corporation and the National Irrigation Board. Water resource and forest management has been decentralized and devolved from national, regional to local level, with greater opportunities for local community participation and increased role of local authorities in active resource management (GOK 2002).

Since 2004, the provision of water and sanitation services in urban areas has been transferred to private companies. This has had both positive and negative impacts in various respects. In cities such as Nairobi, privatization of water services has improved water quality and supply to the upper and middle class residents, while excluding the poorer people who cannot afford to pay for water at set prices. This exacerbates inequality between the rich and the poor, and between men and women (Grossman et al 2003).

Regulation and monitoring of water ecosystem services is done by the Ministry of Water and Irrigation, and the Ministry of Environment and Natural Resources respectively.

There are indications of an awareness of pro-poor issues in the regulatory process. However, the definition of targets has remained vague and implementation of various measures is at the initial stages. It is therefore difficult to determine their efficacy and impact at this stage. There are indications that water service provision in large informal settlements remains outside the regulatory regime. Presently, the sector institution with a pro-poor focus and mandate is the Water Service Trust Fund (UNESCO 2006).

### **3.2. Politicians Interests in Water Ecosystem Issues**

Given that Kenya relies heavily on nature-based industries including agriculture, and poverty levels are still high especially in rural areas, the value of water and the ecosystem services it provides cannot be underrated. Water resources play a significant role in the country's quest for economic development.

The present institutional arrangements for the management of Kenya's water sector can be traced to the launch of the National Water Master Plan in 1974. Its main aim was to ensure availability of potable water at a reasonable distance to all households by the year 2000. This required the government to directly provide water to consumers in addition to its roles in policy making, regulation and financing activities in the water sector. (Ngigi and Macharia 2006)

The government upgraded the then Department of Water Development (DWD), within the Ministry of Agriculture, into the Ministry of Water, which embarked on a water supply development programme, and established the National Water Conservation and Pipeline Corporation (NWCP) in 1988, to manage government operated water supply systems on commercial basis. (Ngigi and Macharia 2006)

Due to budgetary constraints, the government began handing over the management of water supply systems to communities and this was followed by the development of the National Water Policy in 1999. Among other things, it tackled water resources management (Ngigi and Macharia 2006). This was followed by the review and enactment of the Water Act of 2002.

The government provides some of the funding used in water resources management. Additional funding is provided by bilateral and multi-lateral donors, including developed countries' governments and the Breton Woods institutions (World Bank 2004).

At present, politicians in the country are aware of water ecosystem issues, simply because these are closely intertwined with economic issues. Several politicians are also leaders of various development initiatives within their jurisdictions, and some of these initiatives deal with management of water ecosystem services. Some of them even pledge to work towards improvement of water quality, as well as education and health during their political their campaigns. However, equitable benefits sharing has not been widely realized in many cases due to other factors, such as inadequate resource distribution, ill-informed decision making, the priority given to political interests over all else, relatively rapid changes in socio-economic and environmental dynamics, corruption among others.

### **3.3. State Capabilities to Handle Water ecosystem Issues**

The government currently does not have adequate human, technical and financial resources to safeguard and enhance water ecosystem services. This is in light of the challenges posed by unequal spatial distribution of national water resources (UNESCO 2007). In addition, laxity and ineffective policy implementation and law enforcement among relevant staff, contribute to continued resource degradation. Several initiatives have been established in an attempt to address this. The current policy framework provides for devolution of power and responsibility from national to local level, and collaboration with other stakeholders, including local community groups, private sector and NGOs in watershed management programmes. The establishment of performance monitoring and evaluation systems in the civil service has the potential to improve government performance in service delivery. This could be beneficial for the water sector and has the potential to strengthen water resource management and enhance ecosystem services.

Water resources assessment in Kenya is weak. This is partly due to inadequate budgetary allocation (UNDP 2006), leading to neglect of flow monitoring stations. Even where stations are operational, operating funds are often insufficient to obtain readings. By 2001, 78% of the registered stations were not operational (World Bank 2004).

The policy framework provides for data gathering and analysis to facilitate evidence-based policy making (GOK 2002). However, the country's institutions do not possess adequate human resource and financial capacity to conduct long term research, generate continuous data, and analyze it over a long duration (UNESCO 2006). Other organizations such as the African Centre for Technology

Studies are taking a lead in efforts to build capacity in science and technology literacy to enhance effective use of science-based information in policy making and review.

Efforts should be made to involve and support institutions of research and higher education to facilitate relevant long term research projects and use findings to inform policy and decision-making. Additionally, the setting up of various institutional structures is a step in the right direction. Better harmonization and coordination among various institutions is necessary to avoid overlapping and duplication of efforts and major conflicts of interests, as has been common in the past.

Changes in the political roles highlighted above have the potential to influence national governance. This could positively affect water ecosystem services. With the reforms made in the water, environment and forest polices, the delineation of roles and responsibilities, capacity building and creation of opportunities for stakeholder participation, it is likely that management of natural resources will improve.

#### **4. Role and Effectiveness of Other Parties in Influencing Relevant Policies and Forecast of Other Changes**

Lately, civil society and private sector have been partnering with the national government in development. Sessional Paper number 9 of 1999 provides for more active participation by other stakeholders in conservation and management of water catchment areas (UNESCO 2006). Many NGOs take part in water resources management and endeavor to influence policies that affect ecosystem services through project implementation, advocacy and lobbying. Local community groups, especially those residing in water catchment areas, have formed Water Users Associations that are engaged in various projects geared towards enhancement of water ecosystem services. Such groups involve both the rich and the poor, although it is generally thought that the elite within such groups usually dominate discussions and processes. Therefore, poor people's needs and priorities do not get articulated in the corridors of power many times (Grossman et al 2003)

##### **4.1 External Actors**

Various external actors such as donors, have contributed to shaping issues that affect water ecosystem services in various ways. In the recent past, external actors, especially International Non Governmental Organizations, have contributed positively towards shaping policies that affect water ecosystems services, by facilitating capacity building from local to national levels, funding projects, awareness creation in the international policy arena, advocating for good governance and accountability, and informing national policies.

There are a number of donor-funded projects being managed by the Ministry of Water and Irrigation and other ministries that relate to, or affect water resources development. These include the IFAD/GEF funded Mt Kenya pilot project for natural resources management, the UN Centre for regional development Ewaso Ng'iro Development Authority among others. These projects provide good avenues for natural resource management and can provide best practices for water resource management for the enhancement of ecosystem services in the country. The development of geographic information systems at district level by the Arid Lands Resource Management Project provides a basis for water resources management in such areas. This needs to be scaled up to other districts to enable informed decision-making, proper planning and implementation (World Bank 2004).

There is need to increase long term investment in water projects to allow them time to provide lessons, best practices that could be adopted widely, and enable long term sustainability and development. Current efforts aimed at promoting integrated water resources management, and environmental conservation are commendable and should be effectively implemented and monitored.

Efforts towards economic diversification, for example, through expansion of the services sector is also welcome, though care should be taken in selecting alternatives. Efforts to develop formerly marginalized areas will be beneficial in de-congesting resource-rich areas, thereby reducing human pressure on such environments. It is recognized that this may be financially costly, but it is worth exploring.

It is important that environmental valuation and auditing be conducted and this information availed to the public in simple language. Other innovative economic instruments should be developed to elicit greater local community participation in resource management.

#### **4.2. Drivers of Socio-Economic Change Affecting Water Ecosystem Services**

Various factors affect water ecosystem services in Kenya. Key amongst these are population growth and the concentration of large populations in resource-rich areas, urbanization, migration and poverty. It is acknowledged that population growth, coupled with concentration and unsustainable resource uses, usually lead to increased pressure on water resources and subsequent degradation of ecosystem services.

Studies show that increased human migration from rural to urban areas multiplies water demand (Thompson et al. 2002; Katui-Katua 2004), and creates a challenge for cities to provide residents and businesses with adequate amounts of clean, piped water for household, commercial, and industrial use. Urban dwellers tend to use about twice more water than rural residents, and households with piped connections (mostly in urban areas) use, on average, three times more water than those without connections (Katui-Katua 2004).

The table below summarises information on poverty in Kenya's major watersheds and rivers.



**Table 5. People, poverty and Kenya's major Watersheds and Rivers**

<b>Name of Upper Watersheds and Major rivers</b>	<b>Mountain Ranges</b>	<b>Area</b>	<b>People</b>	<b>Poverty</b>
Upper Tana River  - Tana River and its tributaries draining mount Kenya and the Aberdare range	Mount Kenya, Aberdares	12,474 KM <sup>2</sup>  2.1% of Kenya	3.1 Million  11.4% of Kenya  250 persons/KM <sup>2</sup>	1.3 million  9.2% of Kenya's poor  43% average poverty rate  107 poor individuals/ KM <sup>2</sup>
Upper Ewaso Ngiro (North)  Ewaso Ngiro (North) and its tributaries draining the Aberdare Range and Mt Kenya	Mount Kenya, Aberdares	10,541 KM <sup>2</sup>  1.8% of Kenya	0.5 million  1.7% of Kenya  44 persons/ KM <sup>2</sup>	0.2 million  1.2% of Kenya's poor  36% average poverty rate  16 poor individuals/ KM <sup>2</sup>
Lakes Nakuru, Elementaita and Naivasha (tributaries)	Mau escarpment  Aberdares	5,508 KM <sup>2</sup>  0.9 % of Kenya	0.8 million  3.1% of Kenya  152 persons/ KM <sup>2</sup>	0.3 million  2.2% of Kenya's poor  38% average poverty rate  58 poor individuals/ KM <sup>2</sup>
Upper Ewaso Ngiro south Ewaso Ngiro south and its tributaries draining the Mau forest complex into the rift valley	Mau Escarpment	5,881 KM <sup>2</sup>  1.0% of Kenya	0.1 million  0.4% of Kenya  19 persons/ KM <sup>2</sup>	0.1 million  0.4 % of Kenya's poor  49% average poverty rate  10 poor individuals/ KM <sup>2</sup>
Upper western watersheds of the Mau escarpment  Mara, Sondu Miriu, Nyando, and other rivers draining the Mau Forest complex	Mau escarpment	9,826 KM <sup>2</sup>	1.6 million  5.7% ok Kenya  160 persons/ KM <sup>2</sup>	0.8 million  5.5% of Kenya's poor  51% average poverty rate  81 poor individuals/ KM <sup>2</sup>

Upper Eastern watersheds of Mount Elgon  Malakis river and tributaries feeding the Sio and Nzoia rivers from Mt Elgon	Mount Elgon	2, 846 KM <sup>2</sup>  0.5% of Kenya	0.9 million  3.2% of Kenya  308 persons/ KM <sup>2</sup>	0.5 million  3.3% of Kenya's poor  55% average poverty rate  168 poor individuals/ KM <sup>2</sup>
Upper south western watersheds of the Cherangani hills  Upper tributaries of the Nzoia river	Cherengani hills	2,811 KM <sup>2</sup>  0.5% of Kenya	0.4 million  1.3% of Kenya  126 persons/ KM <sup>2</sup>	0.2 million  1.1% of Kenya's poor  46% average poverty rate  57 poor individuals/ KM <sup>2</sup>
Upper northern watersheds of the Cherengani hills  Tributaries of Mt Turkwel, Marun and Kerio rivers	Cherengani hills	8,692 KM <sup>2</sup>  1.5% of Kenya	0.2 million  0.8% of Kenya  24 persons/ KM <sup>2</sup>	0.1 million  0.7% of Kenya's poor  50% average poverty rate  12 poor individuals/ KM <sup>2</sup>
<b>Total for eight upper watersheds</b>		<b>58, 579 KM<sup>2</sup></b>  <b>10.1% of Kenya</b>	<b>7.5 million</b>  <b>27.6% of Kenya</b>  <b>129 persons/ KM<sup>2</sup></b>	<b>3.4 million</b>  <b>23.7% of Kenya's poor</b>  <b>45% average poverty rate</b>  <b>58 poor individuals/ KM<sup>2S</sup></b>

(Adopted from Adam et al 2007)

Of the eight outlined areas, the greatest numbers of people live in the upper Tana (3.1 million). Poverty rates for the 222 Locations within this area range from very low to very high, covering all four classes in the table. The upper Tana includes a large cluster of the least poor communities, but also some very poor administrative areas, most of them in the drier plains below the hills, downstream of the Aberdare Range and Mount Kenya.

This brief comparison shows that poverty and demographic patterns in Kenya's major water sheds and rivers differ. About one quarter of all Kenyans live in the eight selected areas—very close to the total number of people in all of the arid and semi-arid lowlands. The average level of well-being in Kenya's 'water towers,' however, is significantly higher than in the communities further downstream

(Adam et al 2007). Efforts should be made to educate, train and empower local people, especially females on natural resource management.

In lieu of the crucial functions of water and its close linkage with livelihood activities including agriculture, industry, electricity production, health, domestic, cultural and tourism, sustainable water management and equitable distribution is important for economic and livelihood development in the country.

The country has been relatively peaceful for many decades. It is therefore important to uphold peaceful co-existence among the diverse ethnic groups in the country as well as -its neighbors, taking cognizance of the transboundary nature of some water resources and transboundary nature of the impacts of resource degradation.

The links between poverty and environmental degradation are widely acknowledged. It is crucial to pragmatically and inclusively tackle poverty in the country. In addition, environmental sensitization needs to be done across various sectors and political processes should uphold good governance and public accountability.

Concerted efforts should be made to improve the country's economy and better still, facilitate equitable economic benefits sharing and poverty reduction across regions. It is important for all stakeholders to strive to reduce the national gap between the rich and the poor. In addition, financial incentives should be enhanced to promote adoption of 'green' technologies and renewable energy. The health sector should also promote disease prevention alongside cure and control. There is also need to create greater awareness of public health and environmental issues, and involve stakeholders in crafting solutions to health problems.

## **5. Suggested Research Areas**

This paper has so far identified key water ecosystem services and their links with community livelihoods in Kenya. Policies that influence water resources management and their ecosystem services have also been reviewed, and the strengths of revised policies highlighted. Although policy impacts haven't been effectively ranked, constraints to effective water resource management; including un uniform distribution of water resources, weak enforcement of laws, insufficient financial, human and technological capacity, insufficient data collection and assessment leading to weak water resource monitoring, and poverty and water degradation have been identified.

Whereas the current policy framework has established various institutions and agencies within various ministries, and created avenues for inter-ministerial and inter-agency collaboration in water resource management, there is need for overall coordination and harmonization of water-related activities across the sectors. The National Water Resource Management Strategy has the potential to ensure this.

This paper recommends areas for further research below:

1. Examination of the feasibility of development of markets in tradable water rights and its potential impacts on ecosystem services and community livelihoods. It would be useful to see whether this could work, how it could work, including potential stakeholder roles and impacts.
2. An assessment of the impacts of existing methodologies and technologies for water and ecosystem service provision in rural areas. This should be done to identify strengths and weaknesses of methodologies and technologies, with a view to consolidate information that would optimize benefits to the environment and communities.

3. Studies on climate change, water ecosystem services and economic development. These could make up proper baselines against which future changes and impacts of interventions would be measured and assessed in future.

4. An examination of appropriate tools and methods for the integration of water ecosystems services and climate change into national policy processes. These need to be identified and their suitability assessed in order to effectively integrate climate change into national policies.

5. Appropriate tools and methods for effective up scaling of successful watershed management initiatives to national level. These would contribute towards the promotion of appropriate conservation and development actions of national benefit.

6. Investigation of institutional and legal framework that would enable proper implementation of payment for water ecosystem services. This is an area that needs to be developed to improve efficiency in natural resource management and promote equity in resource distribution and benefits sharing.

Stakeholder engagement in research is important and action research conducted where feasible. Inter-disciplinary research networks need to be strengthened in Kenya, and partnerships formed and strengthened (where they already exist) between developing and developed countries research institutions.

Research findings have been used to inform and conceptualize many projects implemented by NGOs. In light of existing partnerships between government and other stakeholders, and capacity building in science and technology for policy, various government programmes have begun to utilize information generated through scientific research. A good example is the drought management project implemented by the Arid Lands Resource Management Project in Kenya. This should be encouraged. In addition, the potential for successful long term research within institutions of higher learning needs to be recognized. Investment in capacity building and funding for research should be increased, both by the national government and other actors (including private sector and donors). Capacity building in effective packaging, communication and delivery of research findings among varied audiences, should be enhanced to enhance acceptance and impact.

## References

- Adam et al (2007), Nature's Benefits in Kenya: An Atlas of Ecosystems and Human Wellbeing. WRI, DRSRS, CBS, ILRI (Washington DC and Nairobi).
- Ong C. K., Black C. R., and Muthuri C. W., (2006) 'Modifying Forestry and Agroforestry to increase Water Productivity in the Tropics. CABI Publishing, Nairobi, Kenya.
- Ekobom A., (2002), Kenya-Environmental Policy Brief. GBG University.
- Ewald J. et al (2004), Strategic Conflict Analysis: Lake Victoria Region. SIDA, Sweden.
- Government of Kenya (2005) 'The Energy Act Chapter 12 of 2006' Government Printer, Nairobi, Kenya.
- Government of Kenya (2004) 'The Forest Act No. 7 of 2005 Cap 385 Laws of Kenya. Government Printer, Nairobi, Kenya.
- Government of Kenya (2002) 'The Water Act No. 8 of 2002 Cap 372 Laws of Kenya. Government Printer, Nairobi, Kenya.
- Government of Kenya (1999) 'The Environmental Management and Coordination Act No. 8 of 1999'. Government Printer, Nairobi, Kenya.
- Government Printer, Revised Edition (1998)  
The Kenya Constitution. Government Printer  
Nairobi, Kenya.
- Government of Kenya (1980) 'The Agriculture Act of 1963 (revised 1980) Cap 318 Laws of Kenya' Government Printer, Nairobi, Kenya.
- Grossman A., Johnson N., Sidhu G., (2003). Diverting the Flow: A Resource Guide to Gender Rights and Water Privatization. WEDO, New York, U.S.A.
- IRI (The International Research Institute for Climate Prediction) (2005). Sustainable development in Africa. Is the climate right? The Earth Institute at Columbia University, U.S.A.
- Katui- Katua M.( 2004). Drawers of Water II: Thirty Years of Change in Domestic Water Use and Environmental Health in East Africa-Kenya Country Study. London: International Institute for Environment and Development. (IIED). Online at <http://www.iied.org/pubs/pdf/full/9050IIED.pdf>
- Mulama, J. (2007 May). Environment-Kenya: Biodiversity Fades as Coral Bleaches. IPS, Nairobi, Kenya in <http://ipsnews.net/news.asp?idnews=37830>
- Reid, H., Murray L., Kovats S. (2005): Climate Change and Development: Consultation on Key Researchable Issues. IIED, London, England.
- World Conservation Union (IUCN). (2003). Tana River, Kenya: Integrating Downstream Values into Hydropower Planning. Case Studies in Wetland Valuation Number 6, May 2003. IUCN. Online at <http://www.iucn.org/themes/wani/econ/CaseStudy06Tana.pdf>
- Korig A., Werchota R., Barmeer N., (2006). Regulation and Supervision in Water Supply and Sanitation- Kenya. GTZ.
- Ngigi A., Macharia D., (2006) 'Kenya Water Sector Overview Paper' A paper Commissioned by the European Commission.
- Orindi et al (2005). Climate Change and Development: Consultation on Key Researchable Issues. Kenya Scoping Study. IIED, London, England.
- Relief Web (2005). International Federation of Red Cross and Red Crescent Societies (IFRC) Report Flooding in Kenya, 31 May 2005. Online at <http://www.reliefweb.int/rw/RWB.NSF/db900SID/EGUA-6CWKSN?OpenDocument>
- The World Bank (2004). 'The Republic of Kenya: Towards a Water Secure Kenya'. Water Resources Sector Memorandum. Nairobi, Kenya.
- The World Bank (2001). 'World Development Indicators. Washington DC, USA.
- Wambua, S. (2004). Water Privatisation in Kenya. Global Issues Paper number 8. Henrich Boll Foundation. Berlin, Germany.

- World Health Organization (2007). Rift Valley Fever in Kenya, Somalia and the United Republic of Tanzania. [http://www.who.int/csr/don/2007\\_05\\_09/en/index.html](http://www.who.int/csr/don/2007_05_09/en/index.html)
- <http://www.water.go.ke/wsrmdrafts.html>
- [http://www.unesco.org/water/wwap/wwdr2/case\\_studies/pdf/kenya.pdf](http://www.unesco.org/water/wwap/wwdr2/case_studies/pdf/kenya.pdf)