

Preliminary Environmental Audit of Sasumua Watershed

**A consultancy Report to the *World Agroforestry Centre*
(*ICRAF*),**

**United Nations Avenue, Gigiri,
P.O. Box 30677 - 00100**

Nairobi

Dr Caleb Mireri

Dept of Environmental Planning & Management

Kenyatta University

P. O. Box 43844 – 00100

Nairobi

Final Report

April 23, 2009

Table of Content

1.	Introduction-----	3
2.	Methodology-----	4
3.	Policy and legislative framework-----	4
4.1	Environmental Management & Co-ordination Act (EMCA)-----	5
4.2	Vision 2030-----	7
4.3.	Forest policy and legislative framework-----	8
	Forest Policy-----	8
	Forest Act 2005-----	10
4.4.	Water Policy and Act-----	14
4.5.	Agriculture policy and legislation-----	16
5.	Location of Sasumua watershed-----	17
6.	Demographic Characteristics-----	18
7.	Main land uses in Sasumua catchments-----	19
	Crops and livestock farming-----	19
	Urban settlements-----	20
	Rural settlements-----	22
8.	Key potential water contamination sources-----	23
9.	Other major challenges facing the sustainability of the Dam-----	23
10.	Synthesis of the status of Sasumua watershed-----	25
11.	Opportunities for intervention-----	26
12.	Potential challenges to interventions-----	26
13.	Conclusions and recommendations-----	27
14.	References-----	27

List of Figures

Figure 1: Sasumua and adjacent watersheds (Land use and land cover).....	17
--	----

1. Introduction

Preliminary audit of Sasumua watershed is a self audit aimed at informing the design and implementation of interventions that would reduce sedimentation and water contamination in the Sasumua reservoir. Sasumua and Chania are important sources of water for Nairobi City. Sasumua Dam alone supplies the City of Nairobi on a daily basis with 40,800 m³ of water, which accounts for 20% of the City's daily water supply. This audit is done within the framework of ICRAF's Global Research Project (GRP) 6 on "Developing policies and incentives for multi-functional landscapes with trees that provide environmental services". The World Agroforestry Centre (ICRAF) and its partners is currently initiating processes to improve the management of the Sasumua watershed. Sasumua watershed is strategically important not only to the local communities, but also to the beneficiaries of environmental services further afield. These includes the residents of Nairobi City, downstream farming communities especially irrigators and hydropower schemes like the Seven Folks that provide 80 percent of Kenya's electricity. The local communities living within the watershed access various ecosystem services (e.g. water, farming, livestock keeping, timber and other wood products) and in the process influence the quantity and quality of water flowing into the Sasumua reservoir. Due to land use and land cover changes in upstream areas, Sasumua reservoir is threatened with sedimentation and water contamination. These have increased treatment costs incurred by Nairobi City Water and Sewerage Company (NCWSC). Conservation of the Sasumua watershed is therefore a priority.

The conservation of the catchments has been prioritized against the backdrop of increasing anthropogenic pressures on the catchments on the one hand and rising demand for water resources on the other. The anthropogenic pressures have seen the water volume in the dam significantly decline within the last four decades. In order to reverse the ongoing decline in water resources, there is need to identify key anthropogenic processes and explore possible mitigative measures. The preliminary environmental audit is aimed at achieving this end by identifying environmental processes and their drivers. Further, the audit captures key environmental issues that should be considered in the preparation of land use plan and integrated natural resources management plan for the Sasumua watershed.

State of Environment Report (2006) prepared by the National Environment Management Authority (NEMA) states that Njambini area (which is upstream of Sasumua Reservoir) in South Kinangop receives the highest amount of rainfall at 1,620mm within Nyandarua District, which receives a mean annual rainfall of 979mm per year. This high rainfall supports different livelihood activities as well as sustains the recharge of water resources with maintenance of reasonable vegetative cover. The forest cover is declining in both area and quality. The decline is caused mainly by human activities and population growth. This increase has continued to raise pressure on the forest resources through a growing demand for forest products and land for agriculture.

2. Methodology

Preliminary audit of Sasumua Watershed was based on secondary and primary data. The main sources of secondary data were: policies and legislations, and other government reports. Primary data was obtained from farmer groups, business persons, opinion leaders and resource persons from relevant government departments. Two focus group discussions were undertaken within the watershed. One focus group discussion involved farmers while the other focused on traders within Njambini Township. Each focus group discussion attracted 20 participants with equal proportion of men and women. In addition, field visits of the hot spots were made, especially water intake, riparian reserve, water reservoir, market, petrol stations and garages.

3. Policy and legislative framework

There are several legislations of relevance to watershed management in Kenya. Kenya has during the last decade made efforts to improve institutional frameworks in diverse fields. Serious efforts have been directed towards environment, water, and forest sectors. In 1999, Environmental Management and Co-ordination Act was passed into law to provide a basis for environmental governance in the country. Other notable efforts was seen in the preparation of Water Policy in 1999 and passage of Water Act in 2002. In addition, the government prepared Forest Act in 2005 and Forest Policy in 2007 to improve management of the forest sector. The preparation of Vision 2030 in 2007 was a major effort

geared towards consolidating government development agenda. It is worth noting that the implementations of these policy initiatives are still at infancy. The implementation of these policies and legislations face several challenges including weak capacity and overlapping/conflicting mandates.

4.1 Environmental Management & Co-ordination Act (EMCA)

Section 3(1) of EMCA entitles every person in Kenya to a clean and healthy environment and every person has a duty to safeguard and enhance the environment. Part VIII of EMCA on Environmental quality standards makes elaborate provisions to safeguard environmental quality. The actors within Sasumua watershed including local authority, farmers, traders and industrialists are bound by these legislative provisions. For example section of 72(1) prohibits discharge of any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permits any person to dump or discharge such matter into the aquatic environment. Section 87(1) of the Act states that no person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such manner as to cause pollution to the environment or ill health to any person. Section 87(5) states that every person whose activities generate wastes shall employ measures essential to minimize wastes through treatment, reclamation and recycling. Environmental audit is provided for in part VII of EMCA. Section 68 (3) states that the owner of premises or the operator of a project shall take all reasonable measures to mitigate any undesirable effects not contemplated in the environmental impact assessment study report.

Environmental Audit Regulations No 31 (1) states that environmental audit shall be undertaken on (a) ongoing projects commenced prior to the coming into force of the regulations; or (b) new projects undertaken after completion of an environmental impact assessment study. Regulation No 34 specifically deals with self audit. Regulation No 34 states that in executing a project, the proponent shall take all practical measures to ensure the implementation of the environmental management plan by (a) carrying out self-auditing study on a regular basis; (b) preparing an environmental audit report after each audit; and (c) ensuring that the criteria used for the audit is based on an environmental management plan.

Preliminary audit of Sasumua watershed differs from those prescribed in EMCA and Environmental Audit Regulations. While EMCA and Environmental Audit regulations

envisages an audit on a project with an approved EIA report or an initial audit report for projects, which existed before EMCA took effect, preliminary audit of Sasumua watershed is focusing on a whole catchment. Also, it is meant to inform a planned development – improved watershed management. This is a preemptive audit as it will ensure that environmental consideration will be mainstreamed in the planned project to assure sustainability.

Waste management in Kenya is further elaborated in Waste Regulation of 2003. Section 5(1) of waste regulation states that any person whose activities generate waste, shall segregate such waste by separating hazardous waste from non-hazardous waste and shall dispose of such wastes in such facility as is provided for by the relevant Local Authority. Section 6(1) of the Regulation further states that any person who owns or controls a facility or premises which generates waste shall minimize the waste generated by adopting cleaner production principles. Section 17(1) of the regulation states that every trade or industrial undertaking shall install at its premises anti-pollution technology for the treatment of waste emanating from such trade or industrial undertaking. During field survey there was no evidence of deliberate efforts by Nyandarua County Council and Horticultural factory in Njambini township to comply with these legislative provisions.

State of Environment Report (2006) states that Kenyan main urban centres are characterized with high presence of oxides of sulphur, nitrogen, carbon monoxide particulates, hydrogen sulphide and other organic gaseous pollutants. Most local authorities are unable to cope with demands for collection, treatment and disposal of wastes due to inadequate capacity and financial constraints. In addition, agricultural activities, industrial processes, and service providers have become major polluters of the environment. All these environmental problems have serious implications on public health. As such Njambini township which is a rapidly growing urban centre upstream Sasumua watershed could be generating similar wastes.

There have been noticeable cases of land degradation. For example, improper use of agro-chemicals has polluted water sources, poisoned and compacted soils. At the same time, inappropriate tillage methods and cropping practices have accelerated environmental degradation. Unsustainable land-use practices have severely reduced the potential of some areas. There is therefore need for efficient and appropriate use of fertilizer, pesticides, tillage methods, and cropping practices in order to reduce or control degradation. However,

agricultural intensification is likely to put additional pressure on water, soil, forestry and wildlife resources (NEMA, 2006).

Despite good legislative provisions in EMCA and related subsidiary legislations, enforcement remains weak. Therefore, environmental degradation persists mainly because of weak enforcement of the legislations. Weak enforcement of the legislations is blamed in part on inadequate capacity of the existing institutions.

4.2 Vision 2030

Kenya has developed a long term development policy, known as Vision 2030, as a blueprint to guide development in the country during the 2008/30 period. Vision 2030 aims at making Kenya a newly industrialising, “middle income country providing high quality life for all its citizens by the year 2030”. The vision is based on three pillars: economic, social and political pillars. The economic pillar aims at providing prosperity of all Kenyans through an economic development programme aimed at achieving an average Gross Domestic Product (GDP) growth of 10% per annum during the next 25 years. The social pillar seeks to build “a just and cohesive society with social equity in a clean and secure environment”. The political pillar aims at realising a democratic political system founded on issue based politics that respects the rule of law, protects the rights and freedom of every individual in the Kenyan society.

Water and environmental management is also captured in the Vision 2030. The vision concurs that the country is water scarce. The country therefore aims to conserve water resources and start new ways of harvesting and using rain- and ground-water. It will also ensure that improved water and sanitation in both rural and urban areas are available and accessible to all. The goal for 2012 is to increase both access to safe water and sanitation in both rural and urban areas beyond present levels. To promote agricultural productivity, the area under irrigation and drainage will increase from 140,000 to 300,000ha.

Kenya’s main forests constitute five water towers (Mt. Kenya, Aberdares Range, Mau Escarpment, Cherangany Hills and Mt. Elgon), which cover more than 1 million hectares and form the upper catchments of all main rivers in the country. In the past two decades, Kenya’s forests have experienced severe destruction as a result several factors, the main one being increased demand for agricultural land. This has, in turn, affected the hydrological cycles in the water towers and resulted in water shortages across the country. Current forest

cover is less than 3 per cent compared to the internationally recommended 10 per cent. Degradation of Mt Elgon and Cherangany catchment areas has resulted in flooding in the regions around River Nzoia (Budalangi). Further, continued degradation of the Mau escarpment, which supports the Mara reserve, will have adverse effects on the tourism sector in the future.

The vision for the environmental sector is “a people living in a clean, secure and sustainable environment”. The vision is inspired by the principle of sustainable development and by the need for equity in access to the benefits of a clean environment. The country will intensify conservation of strategic natural resources (forests, water towers, wildlife sanctuaries and marine ecosystems) in a sustainable manner without compromising economic growth. Kenya intends to have achieved 10 per cent forest cover by 2030. In addition, specific measures will be adopted to promote bio-prospecting activities e.g. research and development of commercial products such as drugs, cosmetics and detergents. The overall goal in forest conservation is to increase current forest cover by 50 per cent. This will include significantly improving the contribution of forest services to the economy and providing a base for the growth of the forestry sector. Regarding wildlife conservation, the goal is to fully protect all wildlife ecosystems. This will sustain the anticipated high growth rate of the tourism sector.

4.3. Forest policy and legislative framework

Forest Policy

The general goal of the forest policy is to enhance the contribution of the forest sector in the provision of economic, social and environmental goods and services. The forest policy statements are:

1. Promote the sustainable management of forests for climate amelioration, soil, water and biodiversity conservation.
2. Carry out inventories and valuation of forest resources and their utilization to generate accurate information for decision making.
3. Empower local communities to manage forests through community forest associations.
4. Ensure that forest plantations are sustainably managed to realize their maximum potential.

5. Support forest management, which will embrace preservation of religious and cultural sites, traditional medicinal sources, water catchments, and habitats for endemic and threatened species of flora and fauna.
6. Support the formulation of criteria and indicators for sustainable forest management.
7. Promote good governance in the forest sector.

The specific objectives of the forest policy are to:

- 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, water and biodiversity 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 the sustainability of the forest sector;
- Promote farm forestry to produce timber, woodfuel and other forest products;
- Promote dryland forestry to produce woodfuel and to supply wood and non-wood forest products;
- Promote forest extension to enable farmers and other forest stakeholders to benefit from forest management approaches and technologies; and
- Promote forest research, training and education to ensure a vibrant forest sector.

The above policy statements are unique on a number of fronts. First, the policy provides for the multi-dimensional function of forest management especially water catchment, biodiversity, soil conservation and socio-economic resources. Second, the policy provides for community participation in the management of both state and individual forests. Third, the policy recognizes the local communities' right to access resources from the forests, such as medicines which they have traditionally been denied access to in gazetted forests. In the past forest management has always been seen as a state responsibility, thus local communities adjacent to forests have always been officially excluded from forest management even though these same forests have all along been part of their heritage. Before the designation of these forests, local communities have always accessed resources from them, especially medicine, honey, building materials and firewood. Therefore, the

policy creates a framework for fundamental reforms in forest management in the country. However, the implementation will require reforms in the value systems and capacity building of the beneficiary communities as well as the lead agencies to embrace and effectuate these changes to sustainably manage forests and forestry resources in the country. Otherwise forests may suffer accelerated degradation due to weak capacity to enforce the reforms.

Forest Act 2005

The Forest Act (2005) creates Kenya Forest Service (KFS) to oversee forest management in the country. The functions of KFS include the following:

1. Manage all state forests;
2. Manage all provisional forests in consultation with the forest owners;
3. Promote capacity building in forest management;
4. Collaborate with other organizations and communities in the management and conservation of forests and for utilization of biodiversity therein;
5. Promote the empowerment of associations and communities in the control and management of forests;
6. Manage forests on water catchment areas primarily for purposes of water and soil conservation, carbon sequestration and other environmental services.

Section 7 of the Act exhibits a strong top – down power structure, for example the Act gives the board the following powers:

- Consider all management agreements including granting of management licenses for state plantation;
- Negotiate financial and other incentives for the advancement of the forestry – related activities of private persons, companies, communities, NGOs and local authorities;
- Consider applications for the undertaking of activities within forest areas;
- Establish forest conservancy areas for purposes of conservation and management of forests in Kenya; and
- Approve the provision of credit facilities and technical training for community based

forest industries and the provision of incentives to persons who exploit wood and non-forest products sustainably

Section 13 (4) establishes conservancy and the conservancy's functions include: to inform the board on the ideas, desires and opinions of the people within the forest conservancy areas in all matters relating to the conservation and utilisation. Review and recommend to the Board applications for licenses and renewals, and regulate the management of forests in the relevant conservancy areas, including the setting up charges and retention of income.

Section 20 of the Act states that all forests in Kenya, other than private and local authority forests, are vested in the state, subject to any rights of user in respect thereof, which by or under this Act or other written law, have been or are granted to any other person. Section 21 states that nothing in this Act shall be deemed to prevent any member of a forest community from taking, subject to such conditions as may be prescribed, such forest produce as it has been the custom of that community to take from such forest otherwise than for the purpose of sale.

Upon recommendation of the forest conservation committee for the area within which a forest is situated, the local authority and the Board, the Minister shall declare any land under the jurisdiction of a local authority to be a local authority forest where the –

- a) land is an important catchments area, a source of water springs, or is a fragile environment;
- b) land is rich in biodiversity or contains rare, threatened or endangered species;
- c) forest is of cultural or scientific significance; or
- d) forest supports an important industry and is a major source of livelihood for the local community.

Section 24 (1) of the Act states that a person who owns a private forest, including a forest in the course of establishment, on land owned by the person may apply to the Service for registration under this section.

Part IV of the Act creates structures for community participation in forest management. Section 45 (1) of the Act states that a member of a forest community may, together with other members or persons resident in the same area, register a community

forest association under the Societies Act. Subsection (2) states that an association registered under subsection (1) may apply to the Director for Permission to participate in the conservation and management of a state forest or local authority forest in accordance with the provisions of this Act. Section 46 (1) states that an association approved by the Director under section 46 to participate in the management or conservation of a forest or part of a forest shall include—

- a) protect, conserve and manage such forest or part thereof pursuant to an approved management agreement entered into under this Act and the provisions of the management plan for the forest;
- b) formulate and implement forest programmes consistent with the traditional forest user rights of the community concerned in accordance with sustainable use criteria;
- c) protect sacred mangroves and protected trees;
- d) assist the Service in enforcing the provisions of this Act and any rules and regulations made pursuant thereto, in particular in relation to illegal harvesting of forest produce.

The management agreement between the Director of KFS and the association may confer on the association all or any of the following forest user rights – (a) collection of medicinal herbs; (b) harvesting of honey; (c) harvesting of timber or fuel wood; (d) grass harvesting and grazing; (e) collection of forest produce for community based industries; (f) ecotourism and recreational activities; (g) scientific and education activities; (h) plantation establishment through non-resident cultivation; (i) contracts to assist in carrying out specified silvicultural operations; (j) development of community wood and non-wood forest based industries; and (k) other benefits which may from time to time be agreed upon between an association and the Service: provided that none of the activities specified in this subsection shall be carried out so as to conflict with the conservation of biodiversity.

52 (1) Except under a licence or permit or a management agreement issued or entered into under this Act, no person shall, in a state, local authority or provisional forest –

- a) fell, cut, take, burn, injure or remove any forest produce;
- b) be or remain therein between the hours of 7 p.m. and 6 a.m. unless he is using a recognized road or footpath, or is in occupation of a building authorized by the Director, or is taking part in cultural, scientific or recreational activities;

- c) erect any building or livestock enclosure, except where the same is allowed for a prescribed fee;
- d) smoke, where smoking is by notice prohibited, or kindle, carry or throw down any fire, match or other lighted material;
- e) de-pasture livestock, or allow livestock to be therein;
- f) clear, cultivate or break up land for cultivation or for any other purpose;
- g) enter any part thereof which may be closed to any person;
- h) collect any honey or beeswax, or hang on any tree or elsewhere any honey barrel or other receptacle for the purpose of collecting any honey or beeswax, or enter therein for the purpose of collecting honey and beeswax, or be therein with any equipment designed for the purpose of collecting honey or beeswax;
- i) construct any road or path;
- j) set fire to, or assist any person to set fire to, any grass or undergrowth or any forest produce;
- k) possess, bring or introduce any chain saw or logging tools or equipment; and
- l) damage, alter, shift, remove or interfere in any way whatsoever with any beacon, boundary mark, fence notice or notice board.

Section 54 (8) states that any person who, in any forest area –

- a) introduces any exotic genetic material or invasive plants without authority from the Service;
- b) dumps any solid, liquid, toxic or other wastes;
- c) grows any plant from which narcotic drugs can be extracted; or
- d) extracts, removes or causes to be removed, any tree, shrub or part thereof for export, commits an offence and is liable on conviction to a fine not exceeding five million shillings or to imprisonment for a term not less than ten years, or to both such fine and imprisonment.

The key issues in the forest sector include:

- The new forest policies and legislation are currently being implemented. Effective implementation of the Act can potentially reverse the ongoing loss of forest cover and create a basis for sustainable management of forestry resources.

- The Act bestows too much power on the Board and Minister, e.g. issuance of a license, permit, and levy charges on the beneficiaries.
- The new forest policies and legislation have instruments for better community participation in forest management, for example it requires of KFS to collaborate with other stakeholders as well as supporting local communities and associations in forest management.
- Weak capacity of the established institutions to carry out the devolved functions (KFS, conservancy and community forest associations) may trigger serious risks of forest resources degradation
- Overlapping mandate of management of forest areas which double as watersheds
- Multiple licensing authorities (for forest produce extraction) including local authorities, provincial administration and other departments
- Depletion of forest cover through over-exploitation and excision
- Land-use conflicts between forests, agriculture and urban development

4.4. Water Policy and Act

National Policy on Water Resources Management and development (1999) outlines the following specific policy objectives:

- Preserve, conserve and protect available water resources and allocate it in a sustainable, rational and economical way;
- Supply water of good quality and in sufficient quantities to meet the various water needs while ensuring safe disposal of wastewater and environmental protection;
- Establish an efficient and effective institutional framework to achieve a systematic development and management of the water sector;
- Develop a sound and sustainable financing system for effective water resources management, water supply and sanitation development.

Water Act of 2002 section 3 of the Act states that every water resource is vested in the State, subject to any rights of user granted by or under this Act on any other written law. The

Act establishes Water Resources Management Authority (WRMA) (part III, section7). The Authority shall have the following powers and functions (Section 8): -

- to develop principles, guidelines and procedures for the allocation of water resources;
- to monitor, and from time to time reassess, the national water resources management strategy;
- to receive and determine applications for permits for water use;
- to monitor and enforce conditions attached to permits for water use;
- to regulate and protect water resources quality from adverse impacts;
- to manage and protect water catchments;
- in accordance with guidelines in the national water resources management strategy, determine the charges to be imposed for the use of water from water resource;
- to gather and maintain information on water resources and from time to time publish forecasts, projections and information on water resources;
- to liaise with other bodies for the better regulation and management of water resources; and
- to advise the Minister concerning any matter in connection with water resources.

The instruments provided for in the Act for water resources management include: a water resources management strategy, classification of water resources and resources quality objectives and determination of reserves. The water resources management strategy defines the manner in which water resources in Kenya shall be managed, protected, used, developed, conserved and controlled. The Minister shall determine the reserve for the whole or part of each water resource which has been classified. A determination of the reserve shall ensure that adequate allowance is made for each aspect of the reserve. Water reserve is the amount of water resource that must be retained in the environment to guarantee sustainability of water supply as well as proper ecological and bio-physical functions of the said resources. Below the water reserve, it is possible to expect depletion of water resources with serious ramification on the environment.

4.5. Agriculture policy and legislation

Sessional Paper No 3 of 1993 on national food policy states that the country seeks food self-sufficiency, food security, employment creation, income generation, generation of foreign exchange earnings, rural-urban balance, and overall growth. Other important objectives of the agricultural sector are generation of raw materials for domestic industry and agricultural exports. An economy based on agriculture, as is the case in Kenya, must allocate sufficient resources to its agricultural sector to ensure that national food security is achieved, through self-sufficiency in the production of basic food commodities and the generation of foreign exchange, which can be used for the importation of other foods, and the occasional importation of basic food when the need arises.

Agriculture Act CAP 318 is the main legislation governing agriculture sector, although there are numerous legislations specific to sub-sectors. Section 48 (1) states that the government can, for the purposes of the conservation of the soil or prevention of the adverse effects of soil erosion on any land, make rules for any or all of the following matters: prohibiting, regulating or controlling the breaking or clearing of land for the purposes of cultivation; grazing or watering of livestock; the firing and clearing and destruction of vegetation including stubble. Pursuant to section 48(1)(b) of the Act, the government may require, regulate and control afforestation or reafforestation of land; the protection of slopes, catchments areas, the drainage of land including the construction or maintenance or repair of artificial or natural drains, gullies, contour banks, terraces and diversion ditches. Section 48 (1)(c) states that the government may require uprooting or destruction, without payment of any compensation therefore, or any vegetation which has been planted in contravention of a land preservation order. The Act empowers the government to supervise unoccupied land and to prohibit, restrict or control the use of land for any agricultural purpose.

Despite the existence of the instruments provided for in Agriculture Act to support soil conservation, land degradation has heightened over the years. The full effects of these noble intentions have not been achieved partly because of weak institutional framework. Also, the Act is characterized by top – down approach to soil conservation. In addition, the sectoral nature of the Act makes it difficult for the sector to harness the full potential of integrated natural resource management. Kenya has not been able to effectively implement a comprehensive soil and water conservation strategy even though agriculture Act takes cognizance of soil conservation as means of enhancing productivity and soil conservation.

5. Location of Sasumua watershed

As shown in figure 1 below, Sasumua watershed covers a relatively small area measuring 107km². It forms part of Aberdares Water Tower. Aberdares Water Tower is one of the most important water towers in Kenya, as Nairobi city receives most of its water supply from there. Sasumua watershed is located towards the southern side of the water tower. Sasumua watershed borders Chania watershed and both of them drain into Tana river, which feeds Kenya's most important hydro – electric power stations – Seven Folks.

It is worth noting that most of the watershed is dominated by small – holder agriculture, which is practiced upstream of the water reservoir. Other important land uses are forest, human settlements (rural and urban), and water reservoir downstream of the watershed. Given the relatively small area feeding the dam, any major changes in the flow regime of the river including disruption of the vegetation cover and changes in rainfall can greatly disrupt the amount of water flowing in the dam.

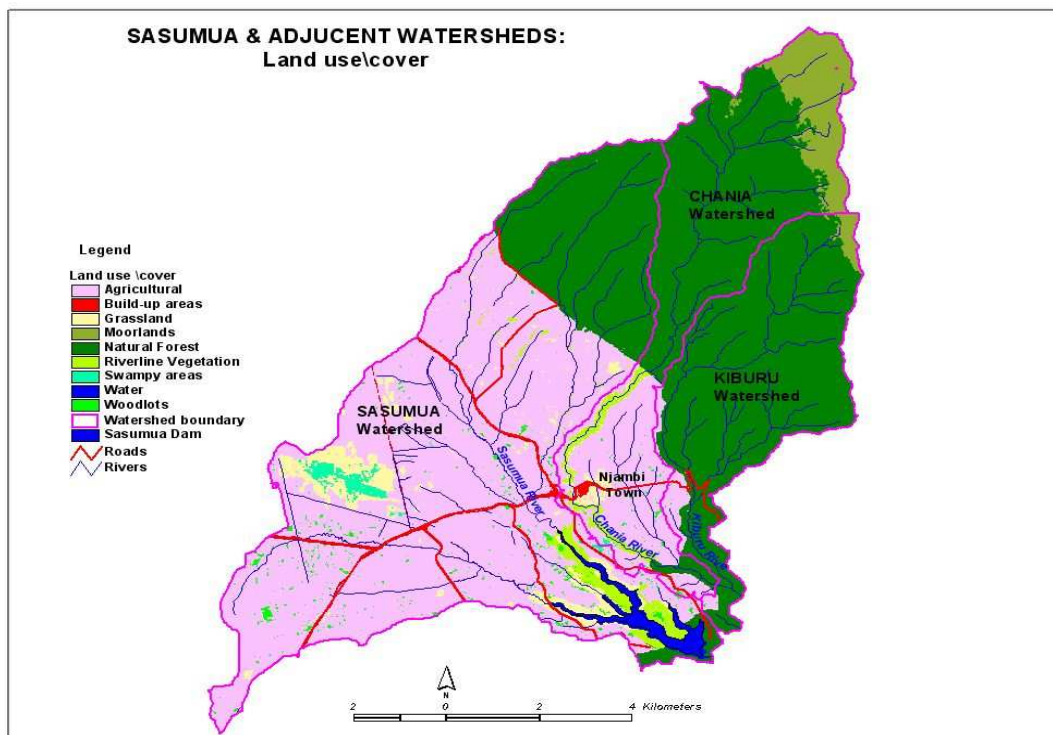


Figure 1: Sasumua and adjacent watersheds (Land use and land cover)
Source: ICRAF, 2009

6. Demographic Characteristics

The analysis of demographic data of the catchment is based on demographic data of Njambini location. Sasumua watershed is located in Njambini location in Nyandarua District. The total population of Njambini location shows an increasing trend (National Population Census and Household Survey, 2001). Based on the 1999 population census and projections indicates that the 2008 population of the location stands at 41,029 people having risen from 30,486 in 1999. This translates to a population growth rate of 3.8 per cent per year, which is above the national average growth rate of 2.9 per cent. The sex ratios remain relatively stable with women slightly more than men. In 1999 and 2008, men were 15088 and 20306 respectively compared with 15,398 and 20,723 women during the same period. The difference in sex ratio is insignificant indicating gender balance in the population.

The rapid population growth has seen the number of households increase within the location. During the 1999 – 2008 period the number of households rose from 6625 to 8919 in an area of 154.2 km² giving rise to an increase in population density of 198 and 266 per km² in 1999 and 2008 respectively. As the population density increases, we expect rising demand for key natural resources, especially land, water and energy, which will heighten risks of environmental degradation. Intensification of farming, application of chemicals as well as irrigation, soil erosion, firewood and charcoal are bound to rise with increase in population density.

The rapid population growth and the associated increase in the number of households and increase in population density have serious implications on the management of Sasumua watershed. These changes increase pressure on natural resource base especially land, water and forestry. Increase in population raises demand for land for settlements, agriculture, livestock husbandry, fuel wood, charcoal, timber and water for irrigation, livestock and domestic uses. Continued land subdivision driven by rapid population growth and cultural practices on land inheritance whereby parents successively bequeath pieces of land to their children. These anthropogenic processes can cause catchment degradation, for example crop farming involves application of chemicals while human settlements lacking basic infrastructure are potential sources of pollution.

7. Main land uses in Sasumua catchments

Crops and livestock farming

There is a strong relationship between land uses within the Sasumua watershed and the sustainability of the Sasumua dam. This is mainly because as land users draw on resources from the watershed they cause degradation. Watershed degradation is in the form of land clearance to give way for farming, soil erosion and the ensuing siltation and reduction in underground water recharge as well as pollution emanating from the application of farm chemicals. While land uses are integral part of the livelihoods of the local communities, the manner in which they are carried out significantly undermine the sustainability of the Sasumua dam thus the water supply to the rapidly growing Nairobi city.

Field survey results show that Sasumua watershed has attracted intensive crop farming since independence. This has been closely linked to increased densification of settlements as a result of subdivision of the hitherto white settler farms into small holding farms. Apart from dairy and sheep farming, crop farming is one of the most important socio-economic activities within the catchments. The main cash crops grown are Irish potatoes, cabbages and carrots. Other crops grown are garden piece, snow piece, beat roots, cowry flower, and broccoli. The area under crop is about 2.5 acres per household and most crops are grown throughout the year. Current mean household land holding is 5 acres. Farmers growing cabbage earn (gross) about Ksh 80,000 with a range of Ksh 40,000 to 150,000 per acre per harvest and those growing Irish potatoes earn a similar amount.

It was reported that almost all farmers use chemicals of varying types in their farms, especially fertilizers and insecticides. Given the size of the catchments and proximity of the farms to the dam, inappropriate application of chemicals can see chemical residues washed into the rivers and the dam itself. During focus group discussions, farmer groups reported that are they trained on appropriate application of chemicals. The training is restricted to members of farmer groups. This is rather restrictive as not all farmers belong to the existing farmer groups. Also, it was reported that despite the previous trainings not all farmers have fully internalized good farming practices. Therefore, there is need for continuous training to increase coverage of participating farmers as well as ensure high uptake of good farming practices. Since it is expected that intensification of farming will increase in future, there is

need to intensify efforts on good farming practices to reduce the risks of pollution of water resources by the farm chemical residues.

Preliminary field survey shows that local communities have embraced dairy farming and sheep farming as important sources of income. Each household owns dairy cows in the range of 1 – 5 and 10 – 50 sheep. Livestock keeping is basically based on free range grazing supplemented in some cases with fodder. Each dairy cow produces about 10 litres per day and each litre of milk fetches Ksh 20. On average each household produces about 30 litres of milk, thus earning about 600 per day. A mature sheep earns between Ksh 3000 and 5000. A sheep matures after one year. With rising population it is expected that the number of livestock will similarly increase. The environmental safety concerns from livestock are mainly intensive grazing along the riparian reserves within the catchments. This is driven mainly by inadequate supply of fodder for livestock, lack of grazing grounds in the private land because of dwindling land sizes, rising livestock numbers and failure to secure riparian reserve. Zero grazing of dairy livestock could be a viable option, but major challenges stand on the way especially access to affordable feeds.

The City Council of Nairobi made an initial but important step of acquiring the riparian reserve within the catchments, but the Council did not fence off the riparian reserve. As a result local communities see the riparian reserve as an open access grazing area. Thus, as a result of intensive grazing along the riparian reserve, the area is often bare of grass cover and vegetation, which often serves as breathing ground for the river and retaining silts and other residues from being drained into the river by the storm water. Further, the intensification of grazing creates potential risks of pollution by the livestock waste. Livestock waste in the homestead is often used to support crop farming, but those disposed off by grazing livestock in the riparian reserve can cause pollution of water resources, especially with increasing livestock numbers grazing along the riverbanks.

Urban settlements

Sasumua watershed has attracted urban settlements, especially within Njambini Township and proliferation of commercial/residential buildings along the major roads. The urban growth has been closely linked to independence of the country and commercialization of socio-economic activities. Since independence, areas which were typically rural centres such as Njambini have rapidly grown as farmers took up market economic opportunities.

The independence also guaranteed free movement of people from the countryside to the urban centres. Also, the subdivision of the former white highlands into small land holdings attracted populations and urban socio-economic activities.

While urban growth of Njambini Township and other rural centres could be good for the flow of goods and services, the relationship between the town and Sasumua dam represents one of the greatest challenges to the sustainability of the dam. This is mainly because the town is located immediately upstream of the dam. The town is located 3km upstream of the dam. This situation is further compounded by lack of basic infrastructure and services in the township (sewage and solid waste management), which predisposes the dam to risks of pollution. The waste disposal in the township relies heavily on pit latrines and a few septic tanks. Pit latrines are potential sources of water pollution through overflow and cross contamination of underground water resources, particularly during the rainy season. Similarly there is no functioning solid waste management system, so wastes are either burnt or disposed off in any open space. Urbanisation problems are further compounded by lack of planning of the Township. At the moment, Nyandarua county council has not prepared physical development of the township. As a result, the township exhibits organic form of urban growth with urban structures put up either along or in proximity of existing roads. There is no deliberate defined form, direction and function of urban growth. Organic form of urban growth is associated incongruent land use patterns, and lack of basic infrastructure and services. It is expected that with continued urbanization within Njambini Township and along the major roads, risks of pollution of water resources will heighten.

The other potential sources of pollution are: the open air market and petrol stations. There are 3 petrol stations within the township lacking basic waste management systems which are often prerequisites for the establishment of such services such oil traps. Other important potential sources of pollutions are motor vehicle garages and battery wastes from different sources. Motor vehicle repairs litter within the urban landscape. It is important to note that a horticultural processing industry is set to open within Njambini Township. There are three slaughter houses within the township with rudimentary waste disposal mechanism. The slaughter houses are potential sources of pollution mainly because they lack standardized waste disposal mechanisms. The horticultural processing industry is located upstream of the dam and in proximity to Sasumua River. The industry is set to start processing horticultural products, especially potatoes and carrots. Major environmental

concerns of the industry are the expected solid and liquid wastes and increased human population which will occur because of the industry. Therefore, it will be critical to monitor the performance of the industry to contain the potential risks of pollution from the plant.

Rural settlements

Following conversion of white highlands into smallholder farming units, the catchments has seen increased land subdivision into small units in the range of 2.5 acres per household. Against cultural practices of bequeathing land to the children, this trend is likely to continue. Continued land subdivision will not only create additional homesteads, but will also adversely affect farm productivity, increase risks of soil erosion and increase application of chemicals in the farms. Another area of major environmental concern is not only the proximity of settlements to the dam, but also the dispersal nature of settlements making it difficult to conceive a suitable waste management system. Most rural households rely on pit latrines as the most important means of disposal of human waste with no mechanism of emptying whenever they are filled up. This situation is made worse during the rainy season as the filled up pit latrines overflows increasing the risk of contamination of water resources. Also, the pit latrines can cause cross contamination of ground water resources within the the catchments and possibly the dam. Thus, pit latrines raise serious health and environmental risks. As population increases, wastes emanating from smallholder rural settlements will continue to raise sustainability concerns of the dam. It is important to consider preparing land use plan for the catchments and develop innovative waste management technologies.

It was evident that planting of eucalyptus trees in the catchments including proximity to water resources is on the increase. Planting of eucalyptus trees is very popular with the households because of rapid rate of maturity and high yield. So farmers grow eucalyptus trees to meet their energy, timber and other household needs. It has been reported that eucalyptus trees are high water consumers. Therefore, it would be important to regulate not only where they are grown but also the amount. This would be important to safeguard water resources from threats of depletion as planting of eucalyptus trees increases. At the same time, it would be important to consider alternative types of trees, which are not heavy water consumers-how about timber?.

8. Key potential water contamination sources

- a) Urban settlements especially Njambini township – residential, industrial and commercial facilities. The catchments has registered rapid rate of urbanization especially Njambini Township. Population growth rate within the watershed stands at 3.8 per cent per annum. These settlements lack basic infrastructure and services, thus predisposing the watershed to high risk of pollution. Continued densification of settlements in the catchments represents a real threat to the sustainability of the dam.
- b) Farmlands as they use different types of chemicals ranging from fertilizers to insecticides. Agriculture and livestock farming are the main socio-economic activities within the catchments. Farmers engage in intensive crop farming especially Irish Potatoes, cabbages, and carrots involving application of chemicals. Also dairy farming is also an important source of income. Inappropriate application of chemicals can cause pollution of land and water resources. Increased intensification of farming and livestock keeping will increase pressure on the water and biodiversity resources.
- c) Siltation from the farmlands, forest and settlements. There was evidence of siltation from forest, farms and settlements, which can affect water quality and quantity in the dam.
- d) Reintroduction/illegal farming in the forest. There was evidence of reintroduction of farming in the forest under the *shamba* system. Farmers clear forest and farm in areas above 45⁰ gradient, which is against Agriculture Act. It was reported that some of the farming activities in the forest are illegal. Farming in the forest disrupts groundwater recharge, causes rapid rate of storm water flow, affects river flow regime, soil erosion and siltation. Therefore, farming in the forest affect not only the conservation of the watershed, but also the water quality and quantity.

9. Other major challenges facing the sustainability of the Dam

- a) Persistent grazing along the riparian reserve, which affects groundcover and protection of the rivers. Due to lack of alternative sources of pasture for livestock and the open access that seem to characterize riparian reserve of Sasumua watershed, the riparian reserve is highly degraded lacking the much needed grass and vegetative

- cover. As a result the riparian reserve cannot effectively filter silts and other residues as well as act as a breathing room for the river.
- b) Planting of eucalyptus trees in proximity to the riverbanks. During field survey, it was evident that eucalyptus trees are very popular among households in the watershed because they are high yielding and fast maturing. So, households grow eucalyptus trees to meet various needs, especially energy and timber. Some of the households have planted eucalyptus trees in proximity to the riverbank. It has been reported that eucalyptus trees are high water consumers. So, with increasing numbers of eucalyptus trees along riparian reserves and wetlands, they can adversely affect water balance thus supply.
 - c) Inadequate physical infrastructure, especially heavy reliance on pit latrines and weak solid waste management mechanisms. Lack of functioning solid and liquid waste management system in the rapidly growing urban centre represents an important source of pollutants, which may find its way into water resources.
 - d) Organic urban growth exacerbated by lack of land use planning. Njambini Township existed before independence. Since independence in 1963, the Township has attracted increasing numbers of immigrants. Nyandarua County Council has not made any effort to plan the township. As a result, the rapid rate of urbanization has occurred in the absence of land use planning. Given the location of the Township upstream of the Sasumua Dam, haphazard urban growth represents a major threat to the water quality in the dam.
 - e) Weak community participation in natural resource management, local community's access to treated water. During field survey, it was reported that local communities do not access the treated water in Sasumua Water Works. This makes it difficult to harness local communities' contribution to conserve the catchments for the purposes of conserving water resources and the dam. It was similarly reported that in the past Nairobi City attempted to connect local communities with water from the river, but two major problems arose. The first problem related to vandalism and theft of water pipes supplied by the City Council. The other problem arose from the resistance by the local communities to pay for water. In order to improve local communities; participation in the conservation of the watershed, it is important for them to access the water for domestic purposes or explore alternative water sources. However, this

must be done in a well structured manner and the local communities must somewhat meet the cost of supplying as Nairobi Water and Sewerage Company is expected to supply water on a cost recovery basis. Further, it was reported that irrigation is on the increase, it is important to rationalize water resources extraction for different uses.

- f) Dwindling water resources against rising demand. A visit to Sasumua dam revealed that the water in the dam has significantly declined during the last three decades. Currently, Nairobi Water and Sewerage Company processes about 1500 m³/hr, which it then supplies to the City of Nairobi through Gravity. The decline in the volume of water is blamed mainly on anthropogenic pressures associated with poor management of the watershed. Apart from Sasumua Water Works, there are five permits for water abstraction. Water Resource Users Association has not yet prepared a water budget to guide water allocation within the catchments. Clearance of the watershed for timber, firewood, charcoal, settlements, farming and planting of eucalyptus trees have significantly contributed to decline in water resources. It was reported that Nairobi Water and Sewerage Company does not pay for water abstraction, which somewhat depresses the value of water resources extracted.

10. Synthesis of the status of Sasumua watershed

The results of this study show that the area of Sasumua watershed is relatively small measuring 107km². The watershed is an integral part of Aberdares Water Tower, which supplies most of Nairobi City's water requirement. The conservation of the watershed faces a number of challenges, including increasing demand for natural resources driven by rapid population growth. The potential sources of water contamination within the watershed are: densification of smallholder settlements and farms, emerging urban settlements, and heavy reliance on pit latrines as the most important means of waste disposal. The watershed has witnessed increased densification of settlements, intensification of farming associated with application of chemicals and soil erosion. The location of the water reservoir downstream of urban settlements and smallholder farms represents a great challenge, especially in relation to water contamination. Smallholder

households engage in crop and livestock farming. Njambini township lacks a land use plan and basic infrastructure and service delivery mechanisms.

The recent policy and legislative reforms initiated by the government creates a window of opportunity for better watershed management. The government has in the recent past prepared environmental, water and forest legislations whose effective implementation can significantly contribute to effective management of the environment. The implementations of these legislations are still at their infancy and facing a lot of challenges.

11. Opportunities for intervention

1. There exists policies and legislation, which provide framework for watershed management, such as Water, Environment and Forest Acts.
2. There is increasing pressures on natural resources, which threaten the sustainability of the local and downstream communities. Therefore, interventions provide the only viable means of guaranteeing sustainability within and downstream of the watershed
3. Global and regional interests including international conventions and agreements on sustainable development make it possible to benefit from experiences and support from development partners. Kenya is a signatory to most of the international conventions and agreements.

12. Potential challenges to interventions

1. Conflicting and overlapping legislative mandates on watershed management, for example Water and Forest Acts bestows authority to manage watersheds to the respective institutions.
2. Increasing incidence of poverty will affect both the government's and local community's commitment to watershed management.
3. Low levels of awareness about the risks associated with poor watershed management including benefits of effective watershed management.
4. Low rate of implementation of older policies and legislations may bedevil these new ones.

13. Conclusions and recommendations

The results of the preliminary audit of the Sasumua catchments show that human induced changes occurring within the catchments in the absence of planning and weak infrastructure represent a real threat to the sustainability of the dam. There is evidence of rapid rate of urbanization in Njambini Township and mushrooming of settlements along the major roads. The location of Njambini Township 3km upstream of the Sasumua dam, in the absence of functioning liquid and solid waste management system in the township is an important potential source of pollutants. The settlements within the township and rural parts use mainly pit latrines. In addition, the catchments have witnessed increased intensification of crop and dairy farming as well as small holder settlements. There is widespread application of chemicals in the farms, while riparian reserve suffers from intensive all year round grazing. These land uses are potential sources of degradation of the catchments, which increase the risks of pollution of water resources. With intensification of these land uses, it is possible to expect that the water quality and quantity will be affected with serious ramification on the livelihoods of both local communities and the City of Nairobi.

The management of the catchments is hampered by weak enforcement of existing policies and legislations and inadequate baseline information to benchmark monitoring and evaluation for informed decision making. In order to improve management of Sasumua dam, there is need for a comprehensive and standardized data base to monitor environmental changes, especially pollution levels from different sources, changing land uses, socio-economic and biophysical factors. In addition, there is need to prepare a land use plan (Physical Regional Development Plan) for the catchments area to provide a basis for development. In order to reduce the pollution risks emanating from Njambini Township, there is need to invest in basic infrastructure and services, especially wastewater and solid waste management system. At the same time, there is need for integrated natural resource management plan for the catchments to provide a basis for rationalizing natural resource utilization.

14. References

- Republic of Kenya (2007a) Vision 2030: Globally competitive and Prosperous Kenya.
Nairobi: Government Printer.
- Republic of Kenya (2007b). Sessional Paper No 1 on Forest Policy. Nairobi:
Government Printer.

Republic of Kenya (2006a). Waste Management Regulations. Nairobi: Government Printer.

NEMA (2006). State of Environment Report, Nyandarua District. Nairobi: NEMA.

Republic of Kenya (2005). Forest Act. Nairobi: Government Printer.

Republic of Kenya (2003). Environmental (Impact Assessment & Audit) Regulations. Legal Notice No. 101. Nairobi: Government Printer.

Republic of Kenya (2002). Water Act. Nairobi: Government Printer.

Republic of Kenya (2001). National Population Census and Household Survey. Nairobi: Government Printer.

Republic of Kenya (1999a) Environmental Management & Co-ordination Act. Nairobi: Government Printer.

Republic of Kenya (1999b). Sessional Paper No. 1 of 1999 on National Policy on Water Resources Management & Development. Nairobi: Government Printer.

Republic of Kenya (1993). Sessional Paper No 3 on National Food Policy. Nairobi: Government Printer.

Republic of Kenya (1986). Agriculture Act Chap 318. Nairobi: Government Printer.