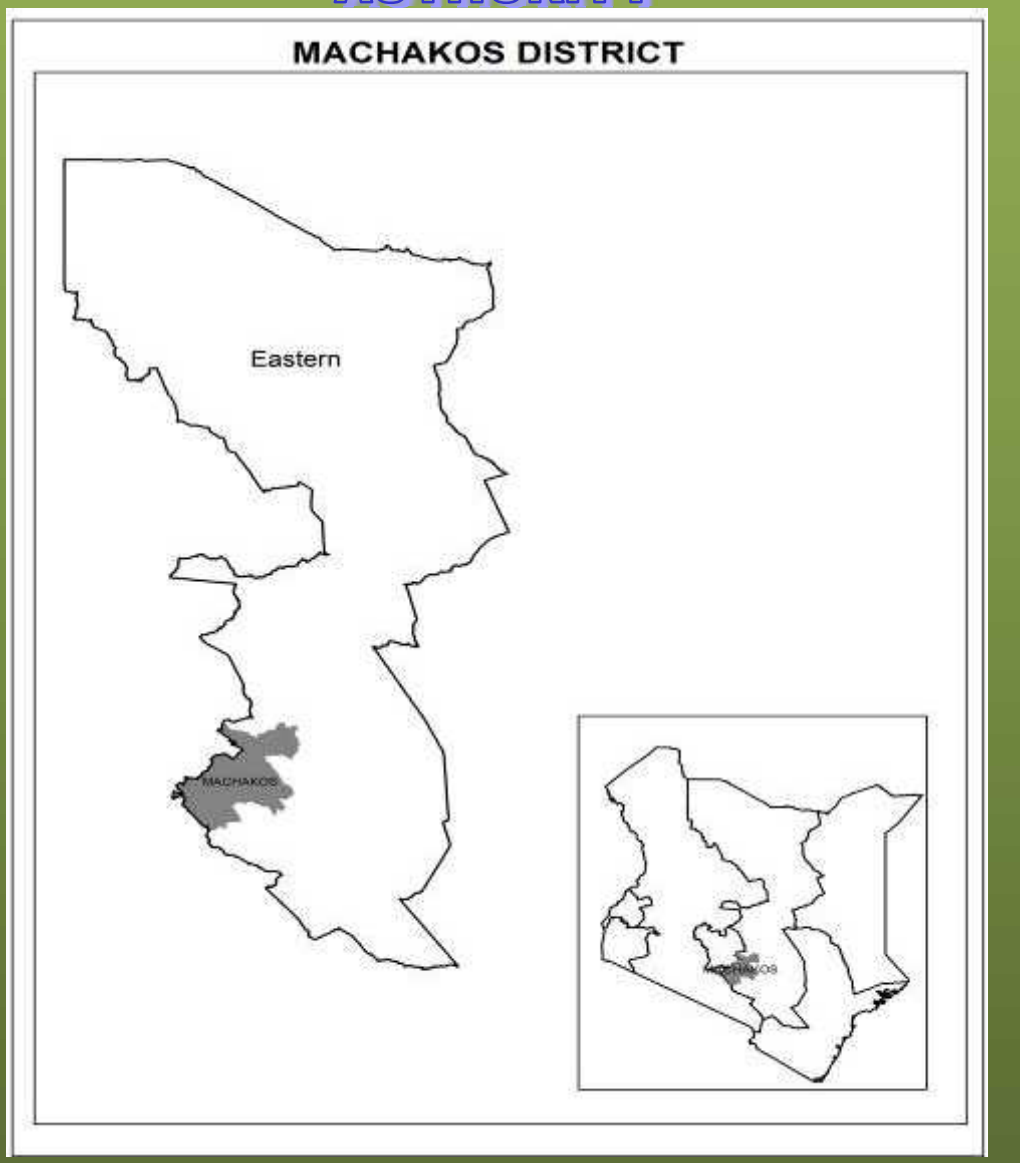
REPUBLIC OF KENYA

MINISTRY OF ENVIRONMENT AND MINERAL RESOURCES

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY



MACHAKOS DISTRICT ENVIRONMENT ACTION PLAN 2009-2013

EXECUTIVE SUMMARY

The Environmental Management and Coordination Act 1999 provides for the formulation of the District Environment Action Plans every five years. This is the first District Environment Action Plan (DEAP) for Machakos District. The preparation of the DEAP was undertaken through a participatory process both in the public, private and civil sectors.

The DEAP highlights priority environmental issues requiring action to mitigate increasing environmental degradation for the District to achieve sustainable development. The report is divided into eight chapters. Chapter one gives the challenges of sustainable development and also describes the rationale for and preparatory process of the DEAP. It presents the district's main profile covering the physical features, demographic and agro-ecological zones.

Chapter two describes the District's Environment and Natural Resources of Land, Water, Biodiversity, rare, threatened and invader species, wetlands and agriculture, livestock and fisheries. For each resource, major environmental issues, challenges and proposed interventions have been identified.

Chapter three entails the human settlements and infrastructure in Machakos District covering situation analysis, challenges and proposed interventions. Environmental challenges addressed include; waste management, sanitation, pollution, diseases, land use, demand for water, energy, materials for construction, land and wetlands degradation, policy and legislation..

Chapter four addresses environmental aspects in trade, industry, tourism and services sectors. The key issues under this chapter are high pollution levels from production and consumption sectors including weak enforcement of relevant legislations.

Chapter five discusses environmental hazards and disasters. The major hazards covered include those related to climate/weather and drought, flood, fire, galleys, disease outbreaks like malaria, and invasive species. Mitigations measures have been proposed for implementation.

Environmental information, networking and technology are discussed in chapter six. It emerges that environmental information and networking technology have continued to receive scanty attention. In order to achieve sustainable environmental management, it is necessary to focus on raising awareness and enhancing public participation at all levels.

Governance, Policy and Legal Framework as well as Institutional arrangements are covered in chapter Seven. The key issues addressed include, non compliance with environmental regulations, Conflicting laws and regulations, delays in approving EIA/EA, high cost of environment impact assessment and audit experts for small projects, weak enforcement of environment laws, lack of environment standards and regulations, inactive District Environment Committee. Chapter eight is the implementation Matrix.

FOREWORD

The 1992 Earth Summit held in Rio de Janeiro came up with various recommendations, among them Agenda 21, a Global Environmental Action Plan. The theme of the Summit focused on how nations could attain sustainable development. The Government of Kenya embraced this idea by developing the first National Environment Action Plan (NEAP) in 1994.

Since independence, Kenya has continued to demonstrate her commitment to environmental management through various initiatives, among them the National Development Plans of 1974 and the National Environment Action Plan of 1994. Further, there have been a number of sectoral policies on environment in fields such as Agriculture, Livestock, Water, Energy, Food, Land, Wildlife, Forest, Industry, Trade, Arid Lands, Disaster Management and the Draft Sessional Paper No. 6 of 1999 on Environment and Development.

The Environmental Management and Coordination Act (EMCA, 1999) provides for the integration of environmental concerns in national policies, plans, programmes and projects. In this regard, EMCA 1999 provides for the formulation of National, Provincial and District Environment Action Plans every five years.

Environmental Action Planning is a tool that aims at integrating environmental concerns into development planning. The process followed in preparing this DEAP was participatory, involving various stakeholders from institutions and sectors, including the public, private, Non Governmental Organizations (NGOs) and local communities at District and Divisional levels. These consultative meetings provided the basis also for formulation of the District Environmental Action Plans (DEAPs) and finally the Provincial Environment Action Plan (PEAPs).

The DEAP addresses environmental issues from various sectors in an integrated manner and discusses their significance in development planning. It proposes a strategy for achieving sustainable development in line with Kenya's quest to meet the Millennium Development Goals (MDGs) Vision 2030 and Medium Term Plan (MTP). The Plan has brought out a number of proposed interventions, legal and institutional framework to be incorporated into sectoral development plans and programmes. Its implementation will be monitored by the District Environment Committee (DEC) and will be monitor though State of the Environment (SoE) Reporting

The preparation of the DEAPs for Machakos District owes much to the technical and financial assistance provided by the NEMA This support, which included innovative community and civil

society consultations, facilitation of DEC meetings, as well as final publication costs, is gratefully acknowledged

I wish to underscore that the 2009-2013 DEAP report is a broad-based strategy that will enable the District attain sustainable development as envisaged in Vision 2030.

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ACKNOWLEDGEMENT

On behalf of the National Environment Management Authority (NEMA) ,I would like to thank the Machakos District Commissioner , who is also the chairman District Environment Committee (DEC) for spearheading the preparation process for this District Environment Action Plan,(2009-2013). I also wish to thank most sincerely the District Environment Committee members and the District Environmental Action Plan Technical Committee members for their invaluable inputs and approval of this environmental action plan.

I also acknowledge the contribution of the members of the local communities from the district who actively participated in the identification and prioritization of the environmental issues which formed part of this document.

NEMA also acknowledges the Provincial Director of Environment (Eastern) and the District Environment Officer, for their insights and dedication to this process. Last but not least I extend my gratitude to all those who contributed towards the finalization of this District Environmental Action Plan.

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DIRECTOR, ENVIRONMENTAL PLANNING
& RESEARCH CO-ORDINATION

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LIST OF ACRONYMS

AIDS	Acquired Immune Deficient Syndrome
ASAL	Arid and Semi-arid Lands
BAT	British American Tobacco
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CITES	Convention on International Trade in Endangered Species
DAO	District Agricultural Officer
DDO	District Development Officer
DDT	Dicrodiethyltrichroloethane
DEAPs	District Development Plans
DEC	District Environment Committee
DEO	District Environment Officer
DLPO	District Livestock Production Officer
DRR	Disaster Risk Reduction
DWO	District Water Officer
EA	Environmental Audit
EAI	Environmental Impact Assessment
EDP	Environmental Development Plan
EMCA	Environmental Management and Coordination Act (1999)
FDA	Focal Development Area
Ha	Hectares
IK	Indigenous Knowledge
KENGEN	Kenya Power Generating Company
KWS	Kenya Wildlife Service
LIS	Land Information System
LM	Lower Midlands
MDGS	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
NEAP	National Environnent Action Plan

NEMA	National Environment Management Authority
NDP	National Development Plan
NGO	Non Governmental Organization
OPPP	Oil seed production and processing project
POPS	Persistent Organic Pollutants
PRSP	Poverty Reduction Strategy Paper
SEA	Strategic Environmental Assessment
SoE	State of Environment
SSIDP	Small scale irrigation development programme
TARDA	Tana and Athi River Development Authority
UM	Upper Midlands
UNCED	United Nations Conference on Environment and Development
WSSD	World Summit on Sustainable Development

CHAPTER ONE

1.0 Introduction

1.1 Preamble

The United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro in 1992. The mandate of the meeting was to find ways of protecting the global environment while ensuring that economic and social concerns are integrated into the process of development planning. The conference underscored the need to develop modalities for integrating environmental concerns into development policies, plans, programmes and projects. It agreed on the guiding principles and a global plan of action for sustainable development referred to as Agenda 21.

Agenda 21 is itself a declaration and programme of action for the international community. It is quite comprehensive with chapters dealing with all aspects of sustainable development including its social and economic dimensions (e.g. combating poverty and promoting human health), conservation and resource management (e.g. deforestation, sustainable agriculture, waste and water), major groups (e.g. women, indigenous people, business and unions) and means of implementation (e.g. aid, public awareness and education).

Sustainable development is commonly defined as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". Development is also sustainable if it meets ecological, economic and social needs. This calls for integration of environmental considerations at all levels of decision making in development planning and implementation of programmes and projects.

The World Summit on Sustainable Development (WSSD) held 10 years after the UNCED conference of 1992 reaffirmed the commitments of the International Community to the principles of sustainable development contained in Agenda 21 and the Millennium Development Goals (MDGs) of 2000. The WSSD was held in Johannesburg in 2002. The Government of Kenya is committed to the achievement of sustainable development stated in Agenda 21, the MDGs and the Johannesburg Plan of Implementation.

This commitment to environmental protection and sustainable use of natural resources is well articulated in various Government Policy documents including the Sessional Paper No. 6 of 1999 on Environment and Development, the Economic Recovery Strategy for Wealth and Employment Creation (20003 – 2008) and the District Development Plan (2002 – 2008). These policies and plans recognize integration of environmental concerns into national planning and management processes and provide guidelines for achieving sustainable development.

The 9th National Development Plan (2002 – 2008) states that "the full integration of environmental concerns in development planning process at all levels of decision making remains a challenge to the country, the need to integrate environmental concerns in development activities should be given top priority". The Environment Management and Coordination Act (EMCA) of 1999 provides for the integration of environmental concerns into national development process. The National Environment Management Authority (NEMA) is mandated to implement the Act and in particular coordinate the preparation of Environment Action Plans (EAPs) at the District, Province and National Levels.

Poverty is a major challenge to the goals of sustainable development. Sound Environmental and Natural resources management should contribute to poverty reduction, food security and sustainable livelihoods, enhanced environmental quality and health, promotion of sustainable energy production, minimization of pollution and waste, improvement of shelter and habitats, promotion of ecotourism and improved standards of living.

Challenges of Sustainable Development

The Districts' economy primarily depends on natural resource base and most people derive their livelihoods from these resources. The economic activities derived from the natural resources include agriculture, industry, livestock production, mining, trade. The natural resource in the district include land and soils, water, forestry and wildlife as well as commercial minerals that include building sand, limestone and granite and gypsum deposits in Athi River.

The environment and natural resources have in the recent years been under threat due to increased dependence on natural resources to meet basic needs. The situation is aggravated by the rising poverty levels. Poverty within the district is defined as the inability to clothe and feed a family adequately, inability to educate children and landlessness and it manifests itself in many ways. The district is generally dry making rain fed agriculture difficult in many areas.

The situation is further aggravated by frequent droughts that deplete any surplus food in the district while affecting pastures. These factors among others have adversely contributed to poverty in the district. Thus poverty leads to overuse and destruction of the environment where short term development goals and practices are pursued at the expense of long term environmental sustainability. A case in point is the uncontrolled harvesting of sand from various seasonal rivers leading to widespread environmental destruction in those areas. Once the resource base is degraded, poverty is aggravated because the capacity of the resource base to support the same population will have diminished. There exists a close link between poverty and environment.

The following are some of the challenges facing the district towards the goal of sustainable development:

- Inadequate water for domestic, livestock, crop and industrial use. Destruction of water catchment areas, persistent droughts, destruction of existing earth dams and pans, collapse of community water committees etc.
- High population growth has also put pressure on the available land resources.
- The climatic and human factors are causing serious threats of desertification. Poor farming methods and increased population pressure on the land have led to clearing of land which was originally reserved for forests. The district has less than 2% of its area under forest. Of these the forest department manages less than 0.5%. The district also consumes 2.5 times what it produces in terms of wood products.
- The district has a number of industries that produces different effluents. Most of the industries are situated in Athi River town. The effluent which cause pollution include: smoke, waste water, dust, solid wastes. Most of the effluents find their way to the surrounding rivers. The district is also a recipient of effluents emitted by industries in Nairobi which flows through rivers that drain into the district.The

challenge of managing environmental resources sustainably calls for the development of integrated management plans and their implementation. Integrated planning enables harmonization of sectoral priorities, stakeholder involvement and participation, proper programming and budgeting system.

1.2 Provisions of EMCA on environmental planning

Part IV of EMCA establishes the institutions that will be involved in environmental planning. A committee is established at the National level chaired by the Permanent Secretary in the Ministry responsible for national economic planning and is known as the National Environment Action Plan Committee. Membership is drawn for various sectors including the business community, various institutions, NGOs, Research institutions (Section 37).

Section 39 and 41 deals with the Provincial Environment Action Plans while section 40 – 41 deals with the District Environment Action Plans (DEAP). This DEAP manual will enable environmental managers to understand the main elements of environmental planning, put in place procedures for integrating environmental concerns into development planning process and lay the foundation for a systematic approach to improving environmental governance.

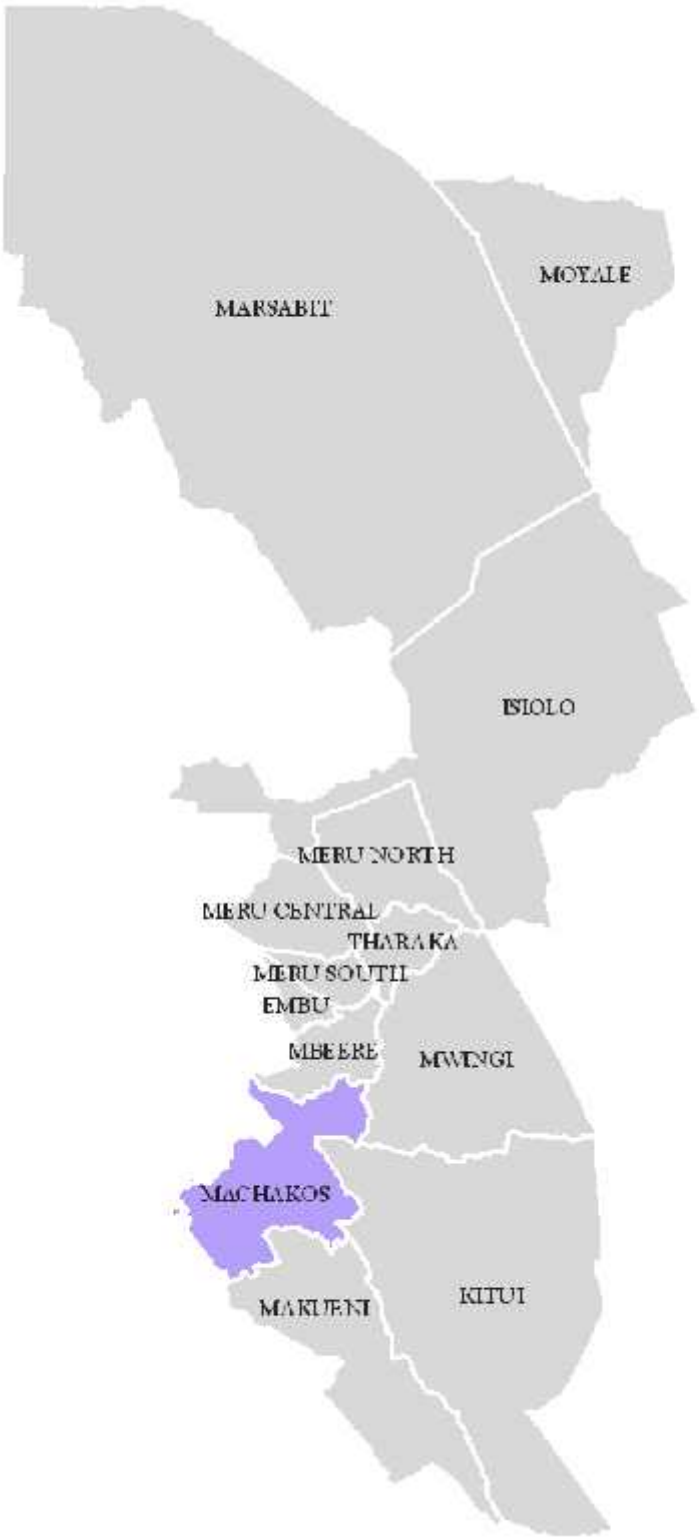
Objectives of the District Environment Action Plan

- To determine the major environmental issues and challenges facing the district
- To identify environmental management opportunities
- To create synergy and harmony in environmental planning
- To integrate environmental concerns into social, economic planning and development
- To formulate appropriate environment management strategies

1.3 District profile

Machakos District is one of the thirteen districts that form Eastern Province. The district borders Nairobi City and Thika District to the northwest, Kitui and Mwingi District s to the east, Kajiado District to the west, Makueni District to the south, Maragwa District to the north and Mbeere District to the northwest. It stretches from latitudes 0^0 45' south to 1^0 31'

south and longitudes 36^0 45' east to 37^0 45 east. The location of the district is shown on Map No. 1.



The district covers an area of 6,281.4 km^2 most of which is semi-arid. High and medium potential areas where rain fed agriculture is carried out consists of 1,574 km^2 or 26 per cent of the total area.

Administratively, the district is divided into twelve divisions, sixty two locations and two hundred and twenty five sub-locations as shown in Table 1. The district has six constituencies and five local authorities with a total of eighty electoral wards. (see table 2)

Table 1 : Administrative Units of the District

Division	Area (km^2)	Locations	Sub-locations
Central	491.5	9	31
Kalama	330.2	4	8
Kangundo	178.2	5	21
Kathiani	205.8	4	21
Masinga	1,094.1	6	20
Matungulu	634.3	7	27
AthiRiver	957.0	3	8
Mwala	481.5	7	31
Ndithini	316.8	3	8
Yathui	533.0	6	27
Yatta	491.0	4	13
Katangi	568.0	4	10
Total	**6,281.4**	**62**	**225**

Source: *District Commissioner's Office, Machakos, 2001*

Machakos Municipal Council covers Central Division while Mavoko Municipal Council covers Athi River Division. Kangundo Town Council covers Matungulu and Kangundo Divisions while Matuu Town Council covers Matuu and Kithimani locations in Yatta Division. The Masaku County Council covers all the other areas of the district.

Table 2 Local Authorities

Name of local authority	No. of wards	Area (km^2)
Machakos Municipal Council	16	491.5
Masaku County Council	36	3,745.0

Mavoko Municipal Council	10	957.0
Kangundo Town Council	12	812.5
Matuu Town Council	6	275.4
Total	**80**	**6,281.4**

Source: *District Development Office, Machakos*

The six constituencies are as shown in Table 3. Each constituency covers two administrative divisions.

Table 3 Number of Constituencies

Constituency	Divisions Covered	Area (km2)	Population (1999)
Machakos Town	Central and Kalama	821.7	184,274
Kathiani	Athi River and Kathiani	1,162.8	144,032
Yatta	Yatta and Katangi	1,059	125,755
Mwala	Mwala and Yathui	1,014.5	154,778
Masinga	Ndithini and Masinga	1,410.9	106,836
Kangundo	Matungulu and Kangundo	812.5	190,969

Source: *District Planning Unit, Machakos, 2006*

1.3.2 Climate and Physical Features

The district has a variety of topographical features. The landscape is largely a plateau that rises from 700m to 1700 m above sea level and is interrupted by an escarpment and a series of hill masses, the highest of which is Kilimambogo or Ol Donyo Sabuk, which rises to 2,144m above sea level.

The district is bound in the western part by the Kapiti and Athi Plains, in the north by the Athi River which curves round the solitary hill of Ol Donyo Sabuk to flow to the south east. Rising steeply to the north east of Athi River is the Yatta Plateau, which is broken by occasional hills. This plateau extends into the basin of River Tana. In the central part of the district is a striking series of hill masses that stretch in a roughly north-south axis. This series includes the Ol Donyo Sabuk, Kanzalu ranges, Kangundo, Mua, Mitaboni, Iveti and Kiima Kimwe.

The district is generally hot and dry. It has two rainy seasons, the long and the short rain seasons. The long rains seasons starts at the end of March and continues up to May, while the short rains season starts at the end of October and lasts till December. The annual average rainfall ranges between 500mm to 1300mm. There are significant regional and seasonal variations within the district and rainfall reliability is quite low. The high altitude areas of Matungulu, Kangundo, Kathiani, Central and Mwala divisions receive slightly higher rainfall than the low land areas.

Mean monthly temperatures vary between 18^0C and 25^0C. The coldest month is July while October and March are the hottest. The highland areas which receive higher rainfall are more suitable for rain-fed agriculture than the lowland areas, while the plains support ranching.

1.3.3 Population Size and Distribution

Tables 4 and 5 show the demographic features of the district.

Table 4 Population size and distribution (density)

Division	Area in Sq Km	1999 Population	Density	2005 Population	Density
Central	491.5	143274	292	169481	345
Kalama	330.2	41000	124	48500	147
Kangundo	178.2	91238	512	107927	606
Kathiani	205.8	95096	462	112491	547
Masinga	1094.1	74478	68	88101	81
Matungulu	634.3	99731	157	117973	186
Athi River	957	48936	51	57887	60
Mwala	481.5	89211	185	105529	219
Ndithini	316.8	32358	102	38277	121
Yathui	533	65567	123	77560	146
Katangi	568	49007	86	57971	102
Yatta	491	76748	156	90786	185
TOTAL	**6281.4**	**906644**	**144**	**1072484**	**171**

Source District statistics office, 2007

Table 5 Population Distributions by Gender

Year	1999			2005		
Division	Male	Female	Total	Male	Female	Total
Central	70999	72275	143274	83986	85495	169481

Kalama	19268	21732	41000	22792	25707	48500
Kangundo	44420	46818	91238	52545	55382	107927
Kathiani	45156	49940	95096	53416	59075	112491
Masinga	35644	38834	74478	42164	45937	88101
Matungulu	49339	50392	99731	58364	59610	117973
A/River	27409	21527	48936	32423	25465	57887
Mwala	42992	46219	89211	50856	54673	105529
Ndithini	15856	16502	32358	18756	19520	38277
Yathui	31014	34553	65567	36687	40873	77560
Katangi	22903	26104	49007	27092	30879	57971
Yatta	37891	38857	76748	44822	45965	90786
TOTAL	**442891**	**463753**	**906644**	**523903**	**548581**	**1072484**

Source: District Statistics Office 2007

1.3.4 Social, Cultural and Economic Characteristics

Poverty Levels: According to the welfare monitoring survey (WMS II) of 1994 and WMS III of 1997, the district had 68.7% and 63.3% respectively of its population below the poverty line. During the poverty assessment exercise carried out in the year 2000, the district was estimated to have 66.2% of the population as poor. The surveys were carried out under different circumstances which influenced the results. The 1994 survey was carried out when the district was experiencing very severe drought and as such most of the households could not afford basic essential needs. The 1997 survey was carried out in the March – May period when the district had just harvested crops and as such most of the households were food secure, while the 2000 poverty assessment was carried out against a background of severe drought when most of the households were dependent on relief food. From the three results, it can be deduced that over 63% of the people in the district are poor. The results also indicate that the district contributes about 4.4% to the national poverty.

People in the district define poverty as the inability of families to meet their basic needs such as food, clothing, housing, health and education for children. The great majority of the poor households are found in the drier regions of the district where frequent droughts have affected their livelihoods. Divisions like Masinga and Yatta have experienced perennial droughts that have made the people dependent on relief food. Traditional coping

mechanisms like sheep, goats and poultry rearing are no longer viable, leaving most of the families destitute.

Lack of water is perceived to be the great cause of poverty in the district. There is a perennial shortage of water throughout the district due to frequent droughts. The average walking distance to a source of potable water is 5km. This makes most families spend much of the time searching for water leaving very little time for other productive activities. Agricultural production is also greatly affected leading to low yields and perpetual food shortages. Livestock production is affected since the drought depletes pasture leading to body weight loss as the animals travel for long distances to watering points.

The poor in the district are unevenly distributed. The ranked geographical distribution of the poor is given in table 6 below.

Table 6: Distribution of poverty per division.

Division	Population (1999 Census)	Estimated Poor	% of Poor
Masinga	74478	70100	94.1
Matungulu	99731	64990	65.2
Mwala	89211	63270	70.9
Kathiani	95096	62240	64.5
Yathui	65567	60860	92.8
Yatta	76748	51785	67.5
Kangundo	91238	50985	55.9
Central	143274	43640	30.5
Katangi	49007	42140	86.0
Kalama	41000	36840	90.0
Athi River	48936	32160	65.7
Ndithini	32358	21130	65.3
Total	906644	600140	66.2

Source*: District Planning Unit, Machakos 2006*

Masinga, Yathui, Kalama and Katangi divisions lead with a deviation of over 24% from the perceived district poverty levels of 66.2%. These also happen to be the divisions that are mostly affected by drought almost on a regular basis. These divisions are in the semi arid areas of the district and received rainfall that that is too low to sustain any meaningful agriculture. Water shortage is very acute and people have to travel upto 10km in search of domestic and livestock water in the dry season. The rest of the district shows poverty levels that are close to the district level.

CHAPTER TWO

2.0 Environment and natural resources

2.1 soils and land use

LAND:

Land is the basic natural resource. It forms the basis of our country's social economic development because it supports agriculture, livestock, forestry and wildlife. Due to population pressure, poverty levels and consequent demand for the land resource, there have been instances of land and soil overexploitation thus resulting into degradation of the resources.

The majority of the people in the district depend on agriculture for their livelihood. Farm holdings range from small to large company and cooperative farms with a variety of food and cash crops, livestock and wildlife. The highly productive areas in the district are along hilly terrain and land holdings range from 0.5 – 2 acres. Over cultivation has left it bare exposing it to erosion. This has in turn greatly reduced the agricultural production in the district.

The land tenure system in district is both freehold and trust land. However, not many of the freehold land have been issued with title deeds due to wrangles and numerous court cases. Efforts to register trust land as freehold on the other hand failed due to the problem of squatters and landless people some of whom have already occupied the land and are reluctant to move. This has further aggravated the poverty in the district.

2.2 Soil Types, Distribution and Land Use

There are five major soil types in the district are alfisols, acrisols, ferrasols, vertisols and andasols.

Alfisols and Acrisols

They are classified as sandy loams to loamy sands. They are brown to reddish brown, well drained and friable. They are the predominant soils in the district are characterized by low inherent fertility, low water holding capacity, low organic matters content, high erodability and form hard pans.

These soils found on the upland lying areas are deep and where rainfall permits, they are used for coffee production. They are also used for growing drought tolerant cereals and legumes in low potential areas in the district. However, they are low in Nitrogen (N) and phosphorus (P).

Ferrasols

These are light textured, strongly leached and permeable soils which are relatively less prone to erosion. They are found on undulating uplands and on plateaus. These soils are used for production of drought tolerant cereals and legumes in low potential areas of the district. The soils are deficient of Nitrogen and phosphorus.

Vertisols

These are referred to as black cotton soils. They are characterized by cracking clays with low water permeability and high water holding capacity. The soils although moderately fertile, have poor drainage and become water logged when wet. The soils are found on plateaus and low lying flat lands in the district. They are used in production of cotton, chickpea and maize.

Andasols

They have good physical characteristics and are found on steep slopes. They are moderately fertile and are used for coffee growing and production of drought tolerant cereals and legumes.

Impact of soil types and land use practices on land degradation

Soil erosion

Soil erosion by water is the most conspicuous form of land degradation in Machakos district; wind erosion damage is insignificant.

The main forms of water erosion are inter-rill, rill or gully erosion. In inter-rill erosion, the soil is detached by raindrop splash and transported very slowly to overland flow. In rill erosion, soil is detached mainly by scouring and is transported very fast by run-off concreted

rills. Sheet erosion is the combined effect of inter-rill and rill erosion. Gully erosion is an advanced from of rill erosion, in which intermittent water draining small catchments, results in "water fall" erosion at the fully head, and deepening and widening of the gully below. Gully formation is an extension of the natural drainage network.

Less common erosion processes occur locally such as tunnel erosion, mass movement and water course erosion. Mass movement, involving land slipping and slumping has been reported in on steep land in the more humid areas of Kangundo and Kathiani.

Type of soil determines the level and amount of soil erosion.

Erosion in cropland is commonly associated with lack of cover. Where annual crops are grown, there is normally little ground cover for the first month after planting and this generally the time at which the heaviest rains are expected. Erosion on cropland is therefore associated mainly with annual crops, with perennial crops during the early years of establishment, with sloping land that lack effective conservation measures, and with terraces that are incorrectly laid out, poorly constructed or not stabilized with grass.

Erosion of grazing land in Machakos District has been noted since the early years of the century. The natural vegetation of the District is characterized by tufted and patchy perennial grasses, which when grazed down, expose intermittent bare soil to erosion and compaction by rain drops. Erosion removes the humus in the topsoil, and compaction impedes the infiltration of rain water and the germination or growth of grasses and herbs.

Depletion of soil nutrients

Continuous cultivation of the land for crop production without proper application of manure and fertilizers causes depletion of soil nutrients thus causing land degradation.

Bush clearing

Bush clearing for cultivation causes loss of biodiversity and encourages desertification. Bush clearing by fire was noted in Yatta, Mwala, Masinga, Katangi and Athi River. This causes complete loss of biodiversity.

Key Environmental Issues

- Bush clearing
- Soil erosion
- Poor soil fertility

Proposed Interventions

- Proper farming methods
- Control soil erosion

2.2.1 Agriculture

Most of the land in high potential areas of the district (around the hill masses in Kangundo, Matungulu, Central and Kathiani Divisions) is under agricultural production. In most of these areas, soil conservation measures have been put in place. However there are some areas especially around the hill masses in Kathiani and Kangundo which are too steep for cultivation but cultivation is going on. The areas are too steep and no effective soil conservation measures can be put in place when the land is under cultivation. The effect of this soil erosion in hill masses in Kathiani is demonstrated by siltation of Muoni Dam which supplies water to Kathiani town. There is also agricultural production in the low potential areas (Mwala, Katangi, Yathui, Kalama, Athi River, Masinga, Yatta and Ndithini divisions). There are soil erosion problems but farmers have put soil conservation structures in most of the farms. Use of fire for bush clearing to plant in Yatta, Katangi, Mwala, Yathui and Masinga is a major environmental concern because of loss of biodiversity.

Land Cover Patterns

- Cultivated land
- Seasonal fallows and bare field
- Field dividers
- Estate cash crops
- Small holder cash crops
- Small holder staple crops
- Horticulture
- Natural forest
- Bush land
- Woodland
- Grassland
- Plantation forest
- Woodlots

Types of Agricultural Systems

There are two types of agricultural systems in the district namely: Rain fed Agricultural and Irrigation Agricultural System The crops grown under the above systems are shown in tables 7 and 8 below. The area coverage in hectares of the crops is also shown in the table.

Table 7 Types and Status of Farming Systems in Machakos District

Rain fed Agriculture System

Extent (HA)	**Distribution (% of Total)**	**Location**	**Agricultural Products**	**Status (Current Production Level Kg/ha**
152000	43.0	Mks District	Maize	182.7
6700	2.0	Mks District	Sorghum	299.6
1750	0.50	Mks District	Millet	170.9
66800	19.0	Mks District	Beans	99.2
21800	6.0	Mks District	Cowpeas	113.9
74100	21.1	Mks District	P/Peas	184.6
6200	1.8	Mks District	G/grams	139.4
935	0.3	Mks District	Chick Pea	161.5
310	0.09	Mks District	Dolichos	145.2
165	0.05	Mks District	G/peas	133.3
4195	1.20	Mks District	Cassava	2330.2
5895	1.70	Mks District	S/Potato	1473.3
592	0.17	Mks District	A/Roots	5648.6
28	0.008	Mks District	I/Potato	2000

***Source**: District Planning Unit, Machakos 2006*

Irrigation Fed Agriculture

Extent (HA)	Distribution (% of Total)	Location	Agricultural Products	Status (Current Production Level Kg/ha
1814	0.52	Mks District	Bananas	9686.9
1865	0.53	Mks District	Citrus	10899.7

2152	0.61	Mks District	Paw Paws	9615.2
1458	0.41	Mks District	Mangoes	12449.9
465	0.13	Mks District	Avocadoes	12819.4
309	0.09	Mks District	Passion fruit	8398.1
84.0	0.02	Mks District	Guavas	8297.6
63	0.02	Mks District	Loquats	7793.7
88	0.3	Mks District	Peaches	7693.2
26	0.007	Mks District	Apples	8423.1
450	0.13	Mks District	Tomatoes	18000.0
112	0.03	Mks District	Cabbage	10000.0
283	0.08	Mks District	Kales	11000.0
225	0.06	Mks District	Onion	12000.0
126	0.04	Mks District	Thin Chillies	4500.0
410	0.12	Mks District	F/Beans	4000.0
265	0.007	Mks District	Tindoori	5113.2
44	0.013	Mks District	Duohi	9500.0
34	0.01	Mks District	Turia	3500.0
68	0.02	Mks District	Valore	3000.0
137	0.04	Mks District	B/Chillies	15000.0
157	0.045	Mks District	Karella	6000.0
63	0.018	Mks District	Okra	6000.0

***Source**: District Planning Unit, Machakos 2006*

Status and Trends of Agricultural Development

Currently the agriculture production in the district is mainly through rain fed agricultural system. This system of agriculture production has not been doing well because of poor and unreliable rainfall. There has been an increase in irrigated agriculture in the last two years. Some of the areas put under irrigation include Kayatta Irrigation scheme covering 300 acres. There are other proposed irrigation schemes like Kabaa Irrigation Scheme.

Regulatory and Management Arrangements

There are a number of regulatory bodies in the district which are overseeing agricultural production and they include: District Agricultural Committee, District Coffee Advisory Committee, and District Cotton Development Committee.

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Types of Pollutants and Wastes by Source

The environmental pollutants in agricultural production include

- Fertilizer residues which are washed into rivers during the rains and irrigation
- Chemical residues which are also washed into rivers and other water bodies during the rains
- Agricultural wastes production if not properly decomposed end up polluting the environment

Key Environmental Issues

- Excessive use of fertilizers in agricultural production is an environmental issue because the fertilizer residues are washed into water bodies where they affect aquatic life
- Use of chemicals in spraying crops or as herbicides affects chemical levels in the soils thus affecting biodiversity. These chemicals are also washed into the rivers and they affect aquatic life.
- Chemical residues in agriculture products.

Proposed Interventions

- Proper use of fertilizers
- Encourage use of organic manures
- Training of farmers on proper farming methods**.**

2.2.2 Livestock

Livestock production is practiced in both high and low potential areas of the district. Dairy farming (mostly zero grazing) is more predominant in the high potential areas of the district i.e. Kathiani, Kangundo, Matungulu, Central Division and parts of Mwala division (Masii and Wamunyu locations). Dairy farming has no serious effect on the environment. Other modes of animal production practiced in the district are ranching.

All ranches are in the low potential areas and most of them keep beef animals. The environmental issues noted are overstocking in some ranches and use of fire to clear bushes and grass for tick control. Overstocking causes soil erosion and clearing bushes by fire causes loss of biodiversity.

Types of Livestock Production Systems

- Beef production
- Dairy production
- Goat production
- Sheep production
- Poultry production
- Pig production
- Rabbit production
- Donkey production
- Bee Keeping

Area Coverage is district wide

Status and Trends

- Dairy – population has been fluctuating year after year. Farmers are seen to mind quality – high producing herd through breed improvement
- Beef – Population has shown an upward trend
- Goats – Production has been on an upward trend over the last 5 years with dairy breeds being introduced in some divisions where land parcels are becoming smaller
- Sheep – Population assuming upward trend, superior breeds to upgrade the indigenous increasing in demand.
- Poultry – Population of local birds increasing while that of layers and broilers is on a downward trend
- Pigs – Population on an upward trend for the last 5 years
- Rabbits – Population fluctuates from year to year depending on the areas
- Donkeys – Population assumed a slightly sharp increase over the last 3 years in the less hilly areas
- Bee Keeping – Population of log hives highly decreasing while that of modern hives increases.

Regulatory and Institutional Arrangements

- Kenya Dairy Board regulates milk and milk products quality

- Kenya Bureau of Standards regulates honey quality

Key Environmental Issues

- Depletion of vegetation cover
- Overstocking leading to overgrazing

Proposed Interventions

- Proper stocking rates
- Rehabilitation of denuded areas

Table 8 below documents the type and status of livestock production systems in the district.

Table 9 Type and status of Livestock Production Systems

Type	**Extend**	**Location**	**Livestock Products**	**Status**		**Challenges**	**Proposed Interventions**
				Current Production level	Potential Production Level		
Beef Production	270165	District Wide	Meat Hides Milk	Slaughter figures = 12,858	N/A	Poor feed resources Poor water resources Poor breeding structures Unorganized marketing channels	Provision of livestock water Reseeding Breed selection/proper breeding Training on good mgmt practices Organized marketing channels
Dairy Production	34069	District Wide	Milk Meat Hides	5900898 kgs milk	N/A	As above	As above
Goat Production	272988	District Wide	Meat Skins	Slaughter figures = 12445	N/A	As above	Asabove
Sheep Production	104902						

***Source**: District Planning Unit, Machakos 2006*

2.3 Water resources

Machakos District is largely in a semi-arid zone and the amount and frequency of precipitation is quite erratic. The district lies within the drainage basins of River Athi and Tana, which, together with River Thika, a tributary of the Tana are the only perennial rivers. The general drainage pattern is from West to East. Athi River and its tributaries, most of which dry up during the dry spell, drain the region to the west of the Yatta Plateau while River Tana, which forms the north western boundary of the district drains the north - most part of the district.

The Yatta Furrow, whose take off is on river Thika, runs for a distance of 60 km serving the northern part of Yatta division and is also the source of most of the streams in both Yatta and Masinga divisions.

The hills in the central part of the district namely Kanzalu Range, Mango, Kangundo, Iveti, Mua and Kiima Kimwe are a source of a few permanent springs and streams, whose flow is intermittent at low attitude.

Ground water potential in the district ranges from moderate to low. This is because of the massive nature of the parent basement rock. Because the rock bearing formation carries a high quantity of soluble minerals, most of the ground water is saline. However, the degree of salinity varies and in most cases the water is potable.

River Tana has been harnessed at Masinga, Kamburu, Gitaru and Kindaruma to provide large reservoirs of water that are primarily used for generation of hydroelectric power. These reservoirs present a great potential for irrigation and provision of water for domestic, livestock and industrial use to the surrounding areas. The water resources in the district have not been fully exploited to support domestic, livestock farming and industrial use. In most cases, it is not possible to use gravity to get water from the perennial sources to the users. This usually calls for high investment. Such as investment has been made for the supply of water to Machakos and Athi River Towns from the Nol Turesh springs on the slopes of Mt. Kilimanjaro.

Due to increase in population and economic activities, the water resource is continuously becoming scarce. Consequently, conservation measures such as afforestation, construction of sub-surface dams along the river valleys and construction of dams and pans to capture surface water run-off can improve both surface and ground water availability. However most of these conservation measures are not being taken seriously. The community in some areas however are trying to remedy this situation. An example is the community of Muusini village which has constructed a total of 16 sub-surface dams/weirs across rivers Makilu and Syuuni in Kalama division to act as water retention points. The problem facing the water resources is also of sand harvesting. This is an economic activity undertaken in various parts of the district but at the expense of the environment. A balance has to be found between the two to serve the people of Machakos district well. The sustainability of the sand resource needs to be looked at critically so that it can benefit more the people of the district and be harvested sustainably.

Within the hill of Machakos district like Iveti, Mua Hills, most of the farmers carry out soil and water conservation measures. However, lack of maintenance of these structures is a big challenge.

Unplanned development of small scale enterprises (Jua Kali) without proper infrastructural services has led to an increase in pollution of the water courses especially in the major towns. Examples are the garages within Machakos town that are located within Kariobangi and Grogan areas. These cause pollution of the Iiyini River through oil spills, inappropriate handling of the oil residues, exhaust fumes, etc. The problem is especially aggravated during the rainy season when the pollutants find their way into the river courses.

Rivers Miwongoni, Manza, Mitheu and Iiyini within Machakos municipality are predisposed to pollution emanating from coffee factories in the upstream, human settlements near them, as well as Mjini estate and the sewage retention pond in case of overflow.

Key Environmental Issues

- Over exploitation of the water resources
- Pollution
- Siltation

Proposed Interventions

- Controlled utilisation of water resources
- Pollution control mechanisms
- De-siltation of water resources

2.4. Forestry and wildlife resources

2.4.1 Vegetation Types

Altitude, rainfall, soils and rivers influence vegetation in Machakos District. This description is based on physiographic characteristics i.e. growth form and vegetation cover. The types include:-

Forest Types (Hilltop)

Vegetation is more than 10m tall and has interlocking cover of between 80 – 100%. The forests occur on hilltops above 1500m above sea level in Iveti, Kangundo, Muumandu and Mua. The National Park of Ol Donyo Sabuk in the northern part of the district is one of the hills which reach a height of 2145m above sea level. The park had indigenous tree like *Croton macrostachyus, Albizia gumnifera, Ficus thornigii* etc. On the other hills most of the indigenous trees have been replaced with forest plantations of Cypress, Pines, Eucalyptus. The relics of riverine forests of up to 100m in width are found in some parts along Athi River and Tana River.

Woodlands

The trees are usually 10 – 20 m tall with a canopy of between 50 – 79% and a well developed herbaceous cover of dwarf shrub understory. Combretun species are common in wetter areas on ridges while Commiphora species are found in drier areas. Other species include Enchea spp, Croton macrostachus, Raveta teifana, Vanguewa spp, Terminalia spp. These are common in Kangundo, Mwala, Kathiani and some parts of Katangi in areas between 150 and 1500m above sea level.

Bushland and Shrubland

The trees are 6 – 10 m tall with crowns that form a canopy of 20 – 49% and scattered but conspicuous. The herbaceous under storey is absent and the vegetation is thorny. This is common in Yatta, Masinga, Yathui and Ndithini.

Dwarf Shrub grasslands

The vegetation consists of woody plants of less than 1.0m tall and a canopy cover of 3 – 19%. The vegetation type is common in Athi River, Central and some parts of Masinga.

Forest ownership in the district is categorised into government, trust (county council and forest department) and privately owned forests as indicated in table 10 below.

Table 10 Types and Status of Forests

					Gazetted	Under Trust Land	Private Land	% Degradation	
Gazetted	606.97	1.2%	Central Mwala Kalama Yathui	Timber, Grazing, Poles, Posts, Water Catchment, Firewood, Biodiversity	Gazetted	-	-	5%	Rehabilitation of degraded sites, catchment protection through tree planting
Trust managed by the Councils	6,664	13.4%	Athi River Kangundo Katangi Masinga Mwala Ndithini Yatta	Timber, Grazing, Poles, Posts, Water Catchment, Firewood, Biodiversity	-	Under Trust	-	75%	Rehabilitation of degraded sites, catchment protection through tree planting Gazettement Declaration of provisional forests
Trust managed by the Forest Dept	1,774	3.6%	Yathui Mwala	Timber, Grazing, Poles, Posts, Water Catchment, Firewood, Biodiversity	-	Under Trust	-	40%	Gazettement Rehabilitation of degraded sites by tree planting
Free Hold (Private)	38,716.73	78%	All 12 divisions in the district	Poles Posts Fodder Firewood Biodiversity					
National Parks	1850	3.7%	Matungulu						
Total	49611	100%							

***Source**: District Planning Unit, Machakos 2006*

Regulatory and Management Arrangements

The gazetted forests are managed by forest officers who comprise of the forester and forest guards. The forester is the implementing officer for management and technical issues while the forest guards do patrolling and policing. However with the current trends in community

empowerment, it is envisaged that each forest will have a management plan that will include the forest community i.e. joint forest management approach.

The divisions have forest extension officers who guide farmers on woodlot establishment as well as Agro forestry farming. The extension foresters take charge of regulating tree harvesting through inspection visits to ensure there is no discriminate exploitation of trees and tree products. However this has many challenges given that foresters are not in every division and there are inadequate resources to enable thorough follow ups.

The trust land forests managed by the councils comprise of 6,664 Hectares out of which 780 hectares are under plantations of cypress, pines, and eucalyptus in Kangundo. Some of the forests have no management plans, others have no guards hence poaching and encroachment is rampant. The majority of the county council forests have squatters who have even settled within the forests. It is anticipated and recommended that the councils should encourage the neighbouring community to come up with community action plans especially watershed management.

Free hold (Private Forests): This is the highest percentage of forest land in the district where 78% is owned by farmers. The farm forests consists mainly of woodlots established by individual farmers, agro forestry trees on the farms, boundary planting, contour planting and planting around the homesteads. The wetter areas especially on the hills where high rainfall amounts are received have high concentrations of trees compared to the semi arid parts of the district. Tree establishment in the latter areas would require proper establishment techniques such as micro catchments to hold water, proper hole size, termite and protection from livestock. There is really great potential for farm forestry in the district.

Exploitation of Forest Resources for Timber & Non Timber Products

Forest Resources exploited in the district are mainly:-timber, resin, poles, posts, grass, firewood, medicinal plants, wood carvings, honey and soil. The consumption of firewood and charcoal according to the surveys and stakeholders sessions in *barazas* of 1998 by DFDP were as shown in the table 11.

Table 11 Charcoal and Firewood Consumption

Division	Population (Est) 1999	Charcoal Consumption		Firewood Consumption		Total (m^3)
		(tons)	(m^3)	(tons)	(m^3)	
Athi River	29,093	422	4,923	5,339	7,474	12,397
Central	155,477	2,155	25,145	28,530	39,942	65,087
Kalama	44,550	200	2,339	8,175	11,445	13,784
Kangundo	109,227	732	8,540	20,043	28,060	36,600
Katangi	56,278	253	2,955	10,327	14,458	17,412
KAthiani	111,742	503	5,866	20,505	28,707	34,573
Masinga	84,927	382	4,459	15,584	21,818	26,276
Matungulu	117,849	530	6,187	21,625	30,275	36,462
Mwala	106,196	478	5,575	19,487	27,282	32,857
Ndithini	36,093	162	1,895	6,623	9,272	11,167
Yathui	80,409	362	4,221	14,755	20,657	24,879
Yatta	89,023	467	5,445	16,446	23,024	28,469
Total	1,021,464	6,647	77,550	187,439	262,414	339,964

Lignified crop residues and thorny shrubs are not included in the firewood consumption volume. However, according to the Machakos Foresters' survey on charcoal, 30,000 bags leave the district every month mostly to Nairobi and Thika. This means at 35kg per bag, 1050 tonnes per month. Table 12 and 13 below describe total consumption of major wood products in the district.

Table 13 Total Consumption of Major Wood products (1999)

Division	Fuel wood	Poles	Timber	Total
Athi River	12,397	1,106	1,512	15,015
Central	65,087	5,508	15,456	86,457
Kalama	13,784	1,693	NA	15,477
Kangundo	36,600	4,151	3,780	44,531
Katangi	17,412	2,139	NA	19,551
Kathiani	34,573	4,246	NA	38,819
Masinga	26,276	3,227	8,904	38,408
Matungulu	36,462	4,478	NA	40,941
Mwala	32,857	4,035	NA	36,892
Ndithini	11,167	1,372	NA	
Yathui	24,879	3,056	7,539	35,473
Yatta	28,469	3,406	6,594	38,469

Charcoal	147,000	-	-	147,000
Total	486,964	38,810	43,785	569,565

NA – Not available separately, included in the other divisions

It should be noted that consumption of wood is more than the sustainable production which implies that Machakos District is gradually losing its tree cover despite actual efforts in afforestation. Table 14 below describes wood produce harvested from farms in the district.

Table 15: Wood Produce harvested from farms in the first half of 2006

Produce	Species	Units	Quantity	Jan	Feb	March	April	May	June	Unit Cost (Kshs)	Total (Kshs)
Timber	Eucalyptus	Feet	147,165	26,045	18,700	31,580	32,820	20,820	17,200	15	2,207,475
	Cypress	Feet	900	-	700	-	-	-	200	17	15,700
	Grevillea	Feet	14,600	-	3,300	700	400	3000	7,200	12	175,200
	Pine	Feet	10,000	-	1,000	4,000	5,000	-	-	17	85,000
Poles	Eucalyptus	No.	77,789	15,830	12,672	14,007	14,390	11,150	97,150	30	2,333,670
	Acacia M.	No.	19,030	2,870	5,200	2,450	3,950	2,150	2,410	30	570,900
Posts	Eucalyptus	No.	19,712	2,312	3,370	3,090	6,140	2,300	2,500	50	985,600
Withies	Eucalyptus	No.	3,140	-	-	580	2,560	-	-	5	15,700
	Acacia M.	No.	3,000	-	-	500	-	2000	500	5	15,000
Offcuts	Eucalyptus	No.	2,945	230	495	960	540	510	210	30	88,350
Firewood	Stacks	No.	31	3	3	6	9	7	3	1200	37,200
Total											6,529,395

The above table 13 indicates that if the farms intensify tree farming, they are able to produce sufficient amount of wood resources that can meet local demands as well as supply the external markets such as Nairobi, Kitengela, Thika and still conserve the environment adequately in a sustainable manner.

Wood Carving Industry

This is one of the major exploiters of forest based resources in the district and is relatively well developed. It is well organised comprising of major wood carving cooperative societies based at Wamunyu and minor wood carving societies like Musumaa carvers in Masinga, Katangi wood carvers, Maamburu wood carvers, Weta wood carvers, Ikombe wood carvers and Kyera wood carvers

The most preferred species are *Dalbergia melanoxylon, Brachylaena huillensis, Melia volkensii, Terminalia brownie, Jacaranda mimosifolia* among others. The wood carving industry in the district employs about 17,510 people on part time and full time basis (Nyandiga, 1998). While some wood is got locally, the rest is sourced far afield.

Non-Timber Industries

This includes honey production and processing where over 350 hives have been distributed by Forest department in conjunction with INRMU. Others comprise of:-

- Wild and exotic fruit processing
- Gums and resin extraction from *Pinus elliotti* on Iveti by Rosin Kenya Ltd
- Processing of medicinal products

Key Environmental Issues

- Population increase of human beings as well as livestock in Machakos district. This leads to increase in agricultural land for there is opening up of bush, woodlands and rangelands and forests. Such areas with fragile ecosystems with poor unstable and infertile soils hence with intensive agriculture will result in deforestation and environmental degradation when opening up of land to agriculture continues, it will also lead to opening up of pastureland to agriculture hence pastureland will decrease thus risking the forest areas. In essence therefore, expansion of agricultural activities will mean that most of the woody biomass will get depleted and more land under forests and wood lands will be converted to agricultural production. Forests and woodlands used to cover about 8% of the total land area in 1989, but reduced to 7.5% in the

year 2000, but it is feared that it will be far less than 7% by the year 2012. The ultimate result will be environmental degradation.

- Consumption of wood biomass in Machakos is more than sustainable production which implies that the district is losing its tree cover. This is the situation especially with charcoal export from this district to other neighbouring areas. Firewood needs for the rural population is ever increasing as the major source of domestic fuel wood. There is general loss of biodiversity resulting from conversion of bush land to agricultural land, farm forests as well as county council forest exploitation

- Destruction and encroachment of riverine vegetation coupled with general water catchment exploitation.

- Indiscriminate settlements on trust lands such as Kwa Ndolo, Mavoloni, Thatha (ndithini)

Proposed Interventions

- Human Family Planning methods district be intensified to regulate population increase while the livestock stocking densities be regulated to adhere to the carrying capacity of the farms. The woodlands should be managed sustain ably with complete involvement of the communities in their conservation.

- The community members are involved in farm forestry establishment and protection of existing tree species. Tree planting must be undertaken on a massive scale. This coupled with improved agricultural yields and fodder for livestock will stop reliance on charcoal production as source of income.
- In order to address firewood requirements of the increasing population, there is need to increase planting of fast growing and high yielding tree species

- In order to address loss of biodiversity, the current farms under agriculture be intensively used with current technologies of drip irrigation, improve soil erosion control, soil fertility enhancement and take up bee keeping as well as non timer products.

- The community to be sensitised on management of common resources such as dams, riversides and hills. This will ensure that riverine vegetation as well as general catchments would be conserved.

- The county council has to take more keen interest in the management of trust lands with proper management plans that involve community and other stakeholders. The trust lands are encroached for settlements, grazing and cutting of vegetation which leads to soil erosion and degradation. One of the best management strategies for trust lands is to allow natural regeneration and tree planting by involving neighbouring communities. In addition, these areas be done with a view of regulating non destructive use of the resources and in some parts be fenced off by use of either bushes, live hedge or wire. Finally tree planting must be commercialised as a source of income especially when the climatic conditions are unreliable for agricultural production. This is due to the fact that tree planting will increase the tree cover of the district and minimise or eliminate wood biomass deficit. The sale of the tree products will provide a source of income and employment as there is ready market. The vegetation cover will protect the soils from erosion, improve infiltration, provide fodder for livestock, enhance land productivity hence improve agricultural production thus counter environmental degradation.

2.5 Wildlife

Types of Wildlife

Zebra, Wildebeest, Cokes'heartbeest, Elands, Giraffes, Thomson's Gazelle, Grant Gazelle, Buffalo, Waterbuck, Oribi, Lion, Cheetah, Leopards, Warthogs, Ostriches, Impalas, DikDik, Hyena, Reedbucks

Area under Wildlife

Wildlife is mostly found in the private ranches within Machakos District but they also occur in other areas.

Status and trends of Wildlife Resources

Wildlife numbers are currently high and show an upward trend. The wildlife migrates between Kajiado and Machakos/Makueni Districts and the numbers depend on the seasons over the year. There is high concentration in Kajiado District and low concentration in Machakos/Makueni district during the wet season. The reverse is true during the dry season.

Regulatory and Management Arrangement

- Continuous monitoring of the wildlife
- Problematic animal control
- Wildlife security issues
- Wildlife and Environmental Conservation Awareness

Exploitation of the Wildlife Resources both consumptive and non-consumptive

- Tourism on a small scale
- Natural Beauty

Key Environmental Issues

- Land Fragmentation
- Urban Development
- Wildlife Poaching
- Human-Wildlife conflicts

Proposed Interventions

- Intensified security patrols
- Continuous monitoring of the wildlife population dynamics
- Review of the existing policies related to wildlife and land
- Creation of sanctuaries within the ranches for the benefit of the ranchers
- Provision of the necessary resources for the wildlife such as water during the dry seasons

2.6 Biodiversity conservation

There are quite a number of areas within the District that are environmentally significant and hence of communal interest. These include:-

Area Significance/Heritage

- Iveti hill 347.6 Ha – water catchment with substantial commercial trees
- Muumandu hill139.2 Ha - potential water catchment but with community grazing interests
- Kalimanzalu hill 110 Ha - water catchment with community grazing and tree harvesting interests.
- Mango hill 45 Ha - catchment area community interests centred in Grazing and encroaches for farming.
- Kibauni 1619 Ha - Community settlement interests as well as grazing. Has to be gazetted to have defined ownership for proper Management.
- Ngiluni 32Ha – Encroachment by community but with good Catchment potentials.
- KanzaluM - good catchment potential but widely encroached.
- Kima Kimwe- - degraded and need urgent conservation measures as is a water catchment area.
- Kapiti Plains Wildlife and mineral area community has interests of Exploitation.
- Ol Donyo Sabuk National Park 20.7 km^2 - park for wildlife but predisposed to farming encroachment especially burning and bush meat.
- Yatta Canal Water resources - for irrigation purposes.

Table 16Types and Status of Biological Resources

Ecosystems		**Location and Size**	**Key Species**	**Threats**	**Status**			**Proposed Interventions**
					Rare	Threatened	Vulnerable	
Gazeted Forests	Indigenous	District wide	Acacia Croton	Human Fires	EA Sandal wood	EA Sandal wood	EA Sandal wood Olea	Joint Forest Management
	Plantation	Within hilltops	Eucalyptus Pines Cypress	Human Fires			Eucalyptus	Joint Forest Management
County Forests		6,664 (Ha)	Acacias	Human Fires		Terminalia	EA Sandal wood Olea	Formation of management plans Involve community in mgt Committees formed
Community Forests					Dalbergia	Dalbergia EA Sandal wood	EA Sandal wood Olea	Formation of management plans Involve community in mgt Committees formed Sensitisation on conservation

Types and Status of Biological Resources

Private Forests	38,716.73 (Ha)	Acacias Combretum Grevillea Eucalyptus	Over harvest	Dalbergia	Terminalia	*Terminalia*	Sensitisation on conservation
Wildlife Areas	1850 (Ha)	Croton Albizia Combretum	Human Fires	EA Sandal wood	EA Sandal wood	*Terminalia*	Sensitisation campaigns

Dry lands		Acacia	Termites Human Fires		EA Sandal wood	*Comiphora*	Sensitisation on conservation

Table 17 Type, Status and Impact of Invasive Species

Name of Invasive Species	Ecosystem Affected	Size of Area Affected	Environmental Impact	Proposed Interventions
Water Hyacinth	River Athi	--	High rate of evapotranspiration leading to water loss Leads to other economic activities not being undertaken.	Introduce the Beetles that feed on the hyacinth
Acacia mearnsii (Black wattle)	Iveti Forest	3 Ha	Suppressing planted species	Eradicate using all possible means

Environmental Issues

- Inadequate water supply and Low quality of the available water resource
- Persistent droughts
- Poor Waste Management
- Human/Wildlife Conflicts
- Deforestation
- Quarrying Activities

Proposed Intervention

- Conservation of water catchment areas by involving the local communities
- Involve of local communities in income generating activities.
- Preparations of master plans for towns are in the pipeline, like for Mavoko Municipal Council are in the process of making a Master plan for Athi River Town
- Continuous public awareness creation and education and the creation of buffer zones

2.7 ENERGY SECTOR

These are commodities both renewable and non-renewable which are used in domestic and urban industry to produce and process raw materials to desired final products. It is also the energy used in running of motors. Availability of energy in its various forms sustains and fosters economic development

Inventory of Major Energy Sources and Distribution

The main sources of energy in the district are wood fuel, petroleum fuels and hydro-electric power. Other minor sources of energy are wind, solar and biogas.

Wood fuel is the largest source of the district's energy requirements. Almost the entire rural population as well as a significantly large proportion of the urban population depends on wood energy for cooking. This has gradually led to the depletion of forests and woodlands in the district. Charcoal burning is quite widespread.

Petroleum fuels are an important source of energy for transport, industry and agriculture as well as for domestic use in lighting and cooking.

There is large scale hydro-electric power generation in the district at Masinga, Kamburu, Gitaru and Kindaruma dams. The power generated is distributed as part of the extensive national grid network that covers the whole country. The power is supplied to most of the town centers within the district. This has led to the sprouting of small scale industries in most of these centers. The activities include but are not limited to posho mills, metal fabrications etc. The frequent power failures and fluctuations in voltage is a major problem to the large-scale industrial enterprises situated in the major towns.

Impacts of Exploitation of Energy Resources

- At the seven falls dams at Tana river there is physiochemical effects into the water
- Rapid degradation of the trees and loose of bio-diversity habitants
- There is conflict in the exploitation of the fuel wood between the community and the K.W.S.
- Air and noise pollution from the generators some of which may be poorly maintained.

Impacts of Management and Conservation

- It is relatively an expensive undertaking
- Creation of enmity between the local people and the lead agencies
- Require training of managers and conservationists
- With conservation, it promotes wise use of the resolve
- Management provides administration which articulates issues in an orderly manner.

Issues Affecting Availability, Access, Use and Conservation of Energy Resources

- Lack of funds to afford some of the resources and equipments.
- Lack of adequate technology and technical experts.
- Failure to understand the essence of sustainable use of resources
- Competition for example for fuel wood for many purposes e.g. timber, conservations, and micro-climate stabilization.

Alternative/Renewable Energy Resources

- Solar energy
- Wind energy
- Hydro electric

The fuel wood as a source of energy is adversely threatened to extend of depletion and therefore there is need to adopt other energy sources and integrate them together to ensure that this multipurpose resource is not depleted.

CHAPTER THREE

3.0 Human settlement and infrastructure

Population pressure is also exerting tremendous pressure on the fragile ecosystems of the dry land areas due to immigration from other areas. This has contributed immensely to unsustainable land use practices often resulting to resource use conflicts. Due to landlessness within the district, the problem of squatters is of major concern and affects the general development of the district

3.1 Land Tenure System and their Impact on Land Use

The local community (Akamba) rights in cultivated land were akin to private ownership. They distinguished between unsettled land ("weu"), which was available for communal grazing or for the establishment of new farms, and land which had been cleared and cultivated, which became a family farm (ng'undu). The first person to clear a farm could sell it, give it away, or leave it to his sons, without reference to others. The cultivation did not need to be continuous to maintain his rights. The land-owner could allow others to graze on fallowed land thus establishing a temporary grazing ground but such a tenant had to leave when the owner required the land back.

3.1.1 Impact of Land Tenure on Land Use

Land ownership in the district has positive effects on land use. People feel that they own the land and have the responsibility to take care of the land. As you move round the district, you find that most of the people who are using the land for agricultural production are conserving the soil to prevent soil erosion and therefore minimizing land degradation. Others who are using land for livestock production are also conserving soil and maintaining vegetation with indigenous trees.

On the other where lands is held under trust by local authorities or belong to the community in general or to the Government, there are a lot of human destruction on vegetation, dumping of waste materials or if cultivated, no soil conservation is carried out. (This is happening in Katoloni, Central Division, where people are cultivating and grazing on Government Land).

Impact of land use and tenure systems on land and environment

From the data analyzed, it can be deduced that the more the people the less the soil erosion. However, there are a number of challenges related to environmental safety namely:.

- Increased human activities on other land resources such as trees (vegetation), water and minerals.
- Depletion of soil nutrients through continuous land cultivation.
- Loss of biodiversity due to bush clearing for agricultural farming and settlement.

On land tenure system, the main environmental challenge is on the public utility and trust land. Environmental protection on public utility and trust land in the district is still a problem and need to be addressed. This type of land is prone to human activities such as:

- Cutting of trees for charcoal burning
- Dumping waste, soil or other unwanted materials
- Overgrazing
- Quarrying
- Sand scooping
- Continuous cultivation etc.

3.1.2 Current status of land use/land covers patterns

- Around Athi River the land use is for excavation of the cement raw materials for the Portland and Bamburi cement in Athi River and the cover vegetation is shrub and acacia trees.
- Elsewhere in the district the land is used for agricultural practices and settlement. A few areas of the district are used for conservation purposes.

Changing land use/land cover types

Changing land uses includes massive agricultural practices. Industrialization at Athi river and forestation at Kangundo of the exotic species of plants.

Land tenure systems and their impacts on land use

- Individual owned
- Communally owned.
- Impact on land use is that there is competition in exploiting the resources for everybody to maximize output.
- Open access owned: The people from everywhere have the authority to utilize the resource there and therefore there might be misuse and mismanagement of the resources.
- Trust land: The G.O.K. owned land and there are regulations on the uses of such lands and ensures sustainability.

Table 18 Land Adjudication Progress Chart – Machakos District

Adjudication Section	Appr Area (Ha)	No. of Parcels	Date Declared	Location	Division	Adjudication Register Published	Adjudication Register Final	District Total Area (Ha)	District Total Parcels
Kipandini	1416	1013	11/11/1971	Muputi	Central	18/6/1976	18/6/1976	170714	55540
Kiima Kimwe	1619	2101	11/11/1971	Muputi	Central	26/3/1974	19/4/1977	171335150	56470
Mutituni	1335	2478	3/5/1973	Mitaboni	Central	30/5/1974	18/5/1984	-	-
Mungala	698	1670	3/5/1973	Iveti	Central	27/9/1977	27/8/1990	-	-
Kiandani	1740	2474	2/11/1973	Iveti	Central	6/6/1978	26/7/1989	-	-
Misakwani	1052	1662	15/2/1974	Iveti	Central	18/12/1977	7/2/1996	-	-
Kimutwa	4047	1763	1/6/1974	Muputi	Central	22/2/1979	9/4/1987	-	-
Kaani	2030	1544	21/1/1975	Muputi	Central	16/7/1980	22/7/1993	-	-
Kaiani	850	1544	-	Mitaboni	Kathiani	14/11/1985	2/2/1995	-	-
Kathiani	600	1133	28/2/1982	Kathiani	Kathiani	-	6/4/1988	-	-
Ikombe	15200	900	27/1/1982	Kinyatta	Yatta	21/3/1983	23/3/1988	-	-
Matuu	12800	4613	28/2/1982	Kinyatta	Yatta	12/1/1983	12/1/1993	-	-
Katangi	12253	12253	25/9/1984	Kinyatta	Yatta	23/7/1975	21/12/1992	-	-
Embui	2831	659	1/11/1968	Masii	Mwala	9/3/1970	29/1/1971	-	
Mbaani	1416	270	1/11/1968	Masii	Mwala	9/5/1070	29/1/1971	-	-
Utithini	2023	558	1/11/1968	Masii	Mwala	9/3/1970	29/1/1971	-	-
Mitnini	2427	573	1/11/1968	Masii	Mwala	9/3/1970	29/1/1971	-	-
Kithagaini	2237	743	11/11/1968	Masii	Mwala	9/3/1970	29/1/1970	-	-
Vyulya	3035	1619	11/11/1969	Wamunyu	Mwala	9/3/1970	24/2/1971	25357535	56617.47
Kilembwa	2550	348	1/7/1969	Wamunyu	Mwala	15/9/1971	23/2/1971	859167.00	785.7883
Kaitha	1902	378	1/7/1969	Wamunyu	Mwala	19/01/1971	26/11/1973	6106902	91591261
Kambiti	2023	409	1/7/1969	Wamunyu	Mwala	29/11/1971	15/3/1973	66127.5	9129901
Kyangulumi	3035	361	1/7/1969	Wamunyu	Mwala	15/9/1971	12/9/1972	-	-
Kyango(Mwala)	3237	448	1/7/1969	Mwala	Mwala	29/11/1871	4/4/1973	-	-
Kyamatula	3035	757	1/7/1969	Mwala	Mwala	29/11/1971	8/8/1973	-	-
Kwakala	3074	205	19/8/1969	Mwala	Mwala	29/11/1971	9/3/1973	-	-
Mathuthuni	2427	658	19/8/1969	Mwala	Mwala	16/4/1971	11/9/1974	-	-
Maweli	3227	439	19/8/1969	Mwala	Mwala	10/1/1972	27/3/1974	-	-
Kiwanyani	3642	403	19/8/1969	Mwala	Mwala	-	26/11/1974	-	-
Mango	3561	1065	19/8/1969	Mwala	Mwala	19/10/1972	8/4/1975	9157187	48571
Kibau	2427	889	19/8/1969	Mwala	Mwala	29/11/1971	9/3/1973	93998199	15485
Ulaani	2630	231	20/3/1970	Mwala	Mwala	23/9/1971	29/7/1976	-	-
Kititu(Mbiuni	1416	1155	20/3/1970	Mbiuni	Mwala	2/12/1973	26/5/1971	-	-
Mbiuni	1821	1023	20/3/1970	Mbiuni	Mwala	29/4/1973	27/8/1875	-	-
Makiliva	2023	662	20/3/1970	Mbiuni	Mwala	6/7/1973	21/11/1975	-	-
Mumbuni(Mbiuni)	3035	867	20/3/1970	Mbiuni	Mwala	11/6/1974	30/5/1980	-	-
Kabaa	3966	872	20/7/1970	Mbiuni	Mwala	2/4/1974	6/5/1977	-	-
Utithini(Muthetheni	2954	971	20/8/1970	Muthetheni	Mwala	9/3/1970	13/6/1978	-	-
Kionyweni	2550	930	10/4/1970	Masii	Mwala	26/2/1974	29/7/1976	-	-
Nyaani	2226	621	15/2/1974	Muthetheni	Mwala	17/6/1977	2/11/1984	-	-
Kyethivo	1821	653	15/2/1974	Muthetheni	Mwala	-	6/3/1979	-	-
Ngamba	2266	912	15/2/1974	Muthetheni	Mwala	1/11/1983	23/1/1983	-	-

Kalyambeli	807	491	15/2/1974	Kibauni	Mwala	11/12/1978	19/12/1978	-	-
Itumbule	4249	484	-	Kibauni	Mwala	16/7/1977	16/1/1991	-	-
Kitile	2427	407	14/7/1974	Kibauni	Mwala	-	31/3/1988	-	-
Kalamba	2080	870	19/9/1969	Mbiuni	Mwala	18/1/1984	6/3/1989	-	-
Muisuni	1821	1302	22/7/1979	Kangundo	Kangundo	23/5/1973	22/12/1976	14703302	36445
Kangundo	1416	2162	22/7/1970	Kangundo	Kangundo	27/10/1974	19/5/1982	148499.80	38131
Bususyani	1821	1568	22/7/1970	Kangundo	Kangundo	24/10/1978	26/10/1978	150390.58	39927
Isinga	1416	1965	22/7/1970	Kangundo	Kangundo	26/3.1974	23/11/1977	151736.88	41910
Mbilini	1925	1686	22/7/1970	Kangundo	Kangundo	6/11/1970	6/11/1973	153631.98	41919
Katitu/Kangundo	2030	1793	22/7/1970	Kangundo	Kangundo	21/5/1973	20/12/1984	1566.44	46091
Kitwii	607	1983	22/7/1970	Kangundo	Kangundo	13/5/1976	29/1/1996	157895.87	47580
Kyevaluki	1416	2040	22/7/1970	Kangundo	Kangundo	2/5/1984	21/5/1984	159911.64	48552
Matetani	2226	2141	22/7/1970	Kangundo	Kangundo	23/5/1976	15/5/1990	1561911.6	500461
Kikambuani	567	1489	22/7/1970	Kangundo	Kangundo	25/7/1995	25/7/1975	110418.2	50682
Kyaume	1821	2138	15/2/1974	Matungulu	Matungu	-	28/8/1982	-	-
Sengani	2471	2128	30/4/1975	Matungulu	Matungu	-	30/5/1991	-	-
Katine	2427	2536	20/4/1975	Matungulu	Matungu	23/8/1984	31/10/1994	-	-
Katheka	1012	778	18/7/1979	Matungulu	Matungu	-	5/1/1994	-	-
Katanga	3237	1495	9/11/1973	Kalama	Kalama	-	11/3/983	-	-
Iiuni	2833	999	29/1/1971	Kalama	Kalama	19/5/1981	19/5/1982	-	-
Kiitini	3237	1771	3/5/1979	Kalama	Kalama	19/5/1981	12/4/1994	-	-
Kyangala	2833	2362	21/6/1979	Kalama	Kalama	-	4/9/1996	-	-
Kasinga	1052	2713	3/5/1973	Mutituni	Central	20/1/1987	20/6/1997	-	-
Kitunduni	1011.7	-	18/9/1975	Muputi	Iveti S	28/4/1982	-	-	-
Muumandu	3642	-	8/3/1978	Kalama	Kilome	13/10/1983	-	-	-
Nguluni	2844.5	-	10/4/1980	Matungulu	Kangund	24/7/1990	-	-	-
Mathingau	2479	-	27/1/1982	Kinyatta	Yatta	4/3/1987	-	-	-
Ikombe A	15200	-	27/1/1982	Kinyatta	Yatta	21/3/1983	23/5/1988	-	-
Kithimani	8400	-	28/1/1982	Matuu	Yatta	6/5/1994	-	-	-
Matuu	12800	-	28/1/1982	Matuu	Yatta	5/3/1987	5/3/1987	-	-
Kaliluni	1497	-	11/2/1982	Iveti	Iveti S	11/9/1984	-	-	-
Mbee	1821	-	30/4/1982	Mitaboni	Iveti N	20/7/1993	-	-	-
Ithaeni	1400	-	22/7/1982	Iveti	Iveti S	1/4/85	-	-	-
Kombo	1300	-	22/7/1982	Iveti	Iveti S	7/8/1990	-	-	-

Mumbuni/Ngoleni	2900	-	24/8/1982	Mitaboni	Iveti N	19/7/1991	-	-	-
Kathiani	600	1133	13/3/1983	Mitaboni	Iveti N	16/1/1984	-	-	-
Ngiini	748	2625	10/10/1983	Mitbaoni	Iveti N	29/6/1989	29/6/1989	-	-
Kaewa	1001	-	1/2/1984	Iveti	Iveti S	18/3/1993	-	-	-
Kaiani	850	-	28/6/1984	Mitaboni	-	14/11/1985	2/2/1995	-	-
Kithyoko	27950	-	24/10/1984	Matuu	Yatta	-	-	-	-
Ikatini	6465	-	25/10/1984	Matuu	Yatta	29/3/1990	29/7/2003	-	-
Ikombe B	5700	-	2/5/1991	Kinyatta	Yatta	2/9/1994	-	-	-
Ekarakara	11082	-	22/2/1989	Masinga	Masinga	-	26/9/1995	-	-
Kyua	8000	-	12/3/1989	Katangi	Yatta	12/5/1998	-	-	-
Syokisinga	6100	-	12/3/1991	Katangi	Yatta	28/11/2005	-	-	-
Kamuthwa	1586	-	30/10/1993	Kibauni	Mwala	-	-	-	-
Kangonde	-	-	11/10/1993	Masinga	Masinga	23/12/05	-	-	-
Ekalakala	-	-	22/2/1989	Masinga	Masinga	-	-	-	-
Kivaa	-	-	2/5/1996	Kivaa	Masinga	-	-	-	-
Kaewa	-	-	2/5/1996	Kivaa	Masinga	23/12/2005	-	-	-
Iiani	-	-	2/5/1996	Kivaa	Masinga	-	-	-	-
Kyondoni	-	-	2/5/1996	Kivaa	Masinga	-	-	-	-
Ngungi	-	-	2/7/1996	Ikalaasa	Yathui	-	-	-	-
Masinga	11600	-	22/2/1985	Masinga	Yatta	-	5/10/2001	-	-
Ndithini	-	-	17/6/1999	Yathui	Mwala	23/7/2004	-	-	-
Thinu	-	-	10/9/1975	Mitaboni	Kathiani	7/1/1982	-	-	-
Mitaboni	-	-	6/3/1975	Mitaboni	Kathiani	24/4/1982	-	-	-
Ngelani	182108	-	3/5/1973	-	Central	24/4/1979	-	-	-
Kawethei	22127	-	24/4/1975	-	-	25/7/1990	-	-	-
Kingoti	-	-	18/11/1974	-	Matungu	9/8/1980	-	-	-
Nziuni	-	-	-	Kalama	-	-	-	-	-

Source: Ministry of Lands, Department of Land Adjudication and Settlement, Machakos District as at 2007.

Table 19 Machakos District Settlement Schemes

	Name	**Division**	**Plot Number**
1.	Mua Hills	Central	319
2.	Kiima Kimwe	Central	51
3.	Mamba	Yatta	327

4.	Ngoliba II	Yatta	255
5.	Ngoliba IV	Yatta	615
6.	Nzukini Phase I	Masnga	155
7.	Nzukini Phase II	Masinga	542
8.	Nzukini Phase III	Masinga	265
9.	Nzukini Phase IV	Masinga	295
10.	Ndalani Phase I	Yatta	512
11.	Ndalani Phase II	Yatta	505
12.	Ndithini Phase I	Masinga	252
13.	Ndithini Phase II	Masinga	308
14.	Ithanga Basin	Masinga	221
15.	Ndalani/Vote Village	Yatta	101
16.	Ndalani/Ngei Village	Yatta	104
17.	Ndalani/Kenyatta Village	Yatta	106
18.	Kwandolo	Masinga	-
19.	Kitanga	Central	66
20.	Tumutumu	Masinga	

Source: Ministry of Lands, Department of Land Adjudication and Settlement, Machakos District, 2007.

3.2 Human Health and Environmental Health

Table 20 Common diseases influenced by environmental factors in the district

a) Rural

Disease	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Malaria	125,120	122,519	182,350	151,184	224,531	278,328	351,418
URTI	87,221	87,344	118,767	110,824	162,008	213,683	272,095
Skin Diseases	24,614	24,092	31,085	37,286	49,609	60,052	60,892
Diarrhoeal Diseases	21,583	25,157	29,699	26,572	35,661	46,734	51,686
Intestinal Worms	14,005	15,216	17,738	18,338	27,034	38,486	20,493
Pneumonia	8,360	9,658	13,366	13,917	17,008	22,149	20,493
Eye Infections	6,955	8,270	11,792	9,712	11,643	14,724	18,418

b) Urban

Disease	1999	2000	2001	2002	2003	2004	2005
Malaria	125,120	122,519	182,350	151,184	224,531	278,328	351,418
URTI	87,221	87,344	118,767	110,824	162,008	213,683	272,095
UTI	9,162	8,810	10,365	12,194	17,765	23,994	19841
Accidents	7,629	6,322	8,502	11,449	16,799	22,212	19,909
Ear Infections	3,748	3,861	5,372	6,468	7,859	10,924	11,322

Status and Trend of Common Environmental Diseases

The above diseases have been on an upward trend despite the intervention measures that have been put in place. This can be attributed to the dilapidating environmental measures and partly due to proper reporting and awareness on early diagnosis and prompt treatment**.**

Intervention measures to address the prevalence of the above diseases

- Environmental sanitation
- Environment Impact Assessment Reports
- Early diagnosis and treatment
- Provision of quality water

3.3 Pollution and Waste Generated from Human Settlement

Machakos district has many pollutants emanating from effluents from manufacturing processes, agricultural activities, domestic and commercial activities. Some of the problems experienced in the district in regard to the above are highlighted below:

Athi River Town:

- A fast growing town with so many unplanned structures especially at Mlolongo.
- Mushrooming of slums is also evident thus poor waste management including human excreta.
- Refuse management is under the docket of Mavoko Municipal Council. The council lacks an established Public Health department, which has contributed to poor waste disposal among other issues.

- There is no designated refuse disposal site hence indiscriminate dumping of refuse in any open space available.
- There is no public cemetery in the district
- Effluents from industries and leachate from decomposing garbage are also major sources of pollution in the town.
- Car washing along river Athi pollutes the river downstream

Machakos Town

- The town is partially connected on sewer system and parts of Kariobangi and Mjini are not.
- The town has a Municipal Council which has no established Public Health Department
- The sewage treatment ponds at Kariobangi pollutes Iiyini River and emits a foul smell to residents of Kariobangi and the nearby offices.
- The effluent from the treatment plant pollutes Mitheu river
- Refuse transporting vehicles are not completely covered thus spillage of waste along the road to the dumping site is common and especially the polythene papers.
- The dumpsite was poorly sited and method used is crude dumping. This has led to the presence of scavengers at the site including people.
- The environs of Machakos town has many coffee factories whose effluent is discharged to nearby streams.

Tala Town.

- Fast growing town with unplanned structures coming up.
- It has no refuse dumping site hence indiscriminate dumping
- Has no sewer line, wastewater is disposed to open grounds.
- Refuse management is under the docket of Tala/Kangundo Town Council
- The council has only one tractor which experiences frequent breakdowns.
- Many coffee factories which discharge their effluents direct to the rivers and streams

Matuu Town

- Fast growing town with unplanned structures coming up
- No designated dumping site, indiscriminate dumping evident

- No Sewer line
- Waste management under Matuu Town Council
- No refuse collection vehicle

Masii Town

- Fast growing urban centre
- No sewer line, liquid waste poorly managed
- No designated dumping site
- Building code regulations not carefully adhered to.

Wamunyu Town

- Fast growing urban centre
- No sewer line
- No designated dumping site
- Solid/Liquid waste not properly managed

Katangi Town

- Has no sewer line and designated dump site
- Waste management not well managed
- Lack safe drinking water
- Hard rock near the surface complicating pit latrines construction/use

Kathiani Town

- Has no designated refuse dump site neither sewer line
- Waste is not properly managed
- Division has many coffee factories which pollutes the nearby rivers and streams

Mwala Town

- Poor waste management of both liquid and solid wastes
- Fast growing town with unplanned structures and no designated refuse handling site.

3.4 Types of Pollution

Industrial

- Includes effluents from industries which are mainly chemicals
- Toxic substances (wastes) and Factory effluents e.g. coffee factories

Agricultural

- Fertilizers
- Pesticides, herbicides, fungicides and other chemicals

Domestic

- Both solid and liquid wastes (poor waste management)
- Poor siting of latrines, oxidation ponds, septic tanks and any other development that may emit pollutants
- Leachate from refuse dump sites

Natural

- Includes minerals, decayed vegetation
- Acid rain
- Water

Table 21 Percentage of households with access to water and sanitation services

Pond		Dam		Lake		River		Spring		Well		Borehole		Piped		Tank		Other	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
3920	2.1	10116	5.5	431	0.2	56728	30.6	39023	21	27925	15	8319	4.5	33910	18.3	1769	1	3412	1.8

Table 22 Sanitation Services (Households)

Main Sewer		Septic Tank		Cess Pool		Pit Latrine		Bucket Latrine		Bush Latrine		Other	
No.	%	No.	%	No.	%	No.	%	No.	%	No	%	No.	%
9478	5.1	2765	1.5	332	0.2	157801	85	611	0.3	13497	7.3	1069	0.6

Source: Analytical Report on Housing Conditions & Household amenities

Communication Networks

The classified road network of the district covers a distance of 1,562.9 km. The road network connects the entire major and most of the minor market centres and also provides access to the areas of both industrial and agricultural importance. Despite the extensive road network, its distribution within the district is not even and the condition of the road is also not good throughout the year. Tarmacked roads, which are passable all year round, include sections of the Nairobi – Mombasa, Nairobi – Garissa, Nairobi – Kitui, Nairobi – Kangundo and Kangonde – Embu. Other tarmacked roads are the major ones radiating from Machakos Town. These roads except for the Kangonde – Embu road have very heavy traffic flow.

The tarmac road network is linked by gravel and earth roads, most of which have sections that are impassable during the rainy season. The hilly terrain in Kangundo, Ndithini and Kalama divisions have some of the worst roads. Due to the extensive nature of the district and also the steep and rocky hill masses, the conditions of the roads deteriorate very fast.

Railway transport is available in the district at Athi River Town and Konza on the Nairobi – Mombasa line. The main products transported by the railway are cement from Athi River and maize to the Konza depot. The only airfield in the district is found in Masinga division. Water transport is mainly found on the dams along river Tana. Localized water transportation across the river and for fishermen is common. The district has endeavored and will continue to increase the coverage of telecommunication infrastructure. Several trading centers have been linked with telephone networks. The centers have also been provided with electricity which has spurred the growth of bureau services. Mobile telephone providers have also covered the districts while there are cyber cafes that are offering internet services.

Environmental Issues

- Poor drainage leading to soil erosion.
- Storm water.
-

Proposed Intervention

- Develop and enhance road maintenance management capabilities under the new KRB

- Regular maintenance being undertaken to control storm water.

CHAPTER FOUR

4.0 Industry, trade and services

4.1 Industrial sector

The industrial sector in the district has wide range of industries including cement EPZ woodcarvings Food processing and others. The factories are major sources of employment and cause of environmental pollution in major towns due lack of proper methods of handling waste produce.

Key Environmental Issues

- Waste water
- Gaseous emissions
- Solid waste
- Health and safety concerns for the workers

Table 23 Type and Impact of Industries on Environment

No.	Type of Industry	Raw Materials	Product maize flour	No. of People Employed	Wastes (Solid, Liquid and Gaseous)	Key Environmental Impacts	Mitigation Measures
	Food processing	maize	maize flour	many	Maize by-products	-Gaseous emissions and dusts	Maize by-products to be used as animal feeds.
	Cement process	Gemstone/marbles stones	Processed cement	many	Gasous, Dust,	Waste water	Poor disposal

Key Environmental Issues

- Waste water,
- Health and safety

Proposed intervention

- Use of soak pits
- Recycle, Need for the factory to carry out annual audits
- Provide workers with protective clothing

4.2 Trade sector

Trade in the district is also not well developed with the bulk of trade being carried out in the agriculture (sale of grains) and Livestock (sale of live animals). The rest of trade is dominate by retail of consumer goods and very limited wholesale. Consequently environmental impacts associated with trade are not very serious.

4.3 Services sector

The service sector is in its infancy hence has little impact on the environment. There are a number of classified hotels in the district .The few eating places available generate little waste that they able to dispose safely. There is also telecommunication network whose coverage is expanding fast. These are safaricom, zain and telecom wireless. Banking and Insurance services are also available.

4.4 Tourism

Type of tourism, attraction and potential

The district has a number of tourist attraction sites. But these have not been developed fully mainly due the poor road network, and inadequate finances. Some of tourist attraction areas could include:

- Iveti hills scenery
- Various rock catchments
- Many water springs
- Wood curving industries.

If these attractions can be improved, the district can earn a lot of foreign exchange.

4.5 Mining and quarrying

The district is well endowed with mineral resources that are valuable input to the building and construction industries. These resources are discussed in detail below:

4.5.1 Sand

Machakos District is mainly endowed with mineral resources which are useful to the building and construction industry. The rivers are a source of large quantities of building sand. Infact over 70% of the sand consumed in Nairobi comes from Machakos district. Sand harvesting usually interferes with the natural processes forming river channels which result in accelerated erosion. However due to excessive localized sand harvesting at certain rivers beds like Thwake, serious environmental problems have been evidenced. This has led to the formation of institutions to control the harvesting. Such institutions such as sand harvesting societies have been registered to control the problem of haphazard harvesting. However, since their formation, questions have arisen as to whether the purposes for which they were registered for have been achieved. The following are the divisions where sand harvesting activities are undertaken: Ndithini, Masinga, Kathiani, Mwala, Kalama, Kangundo. In these divisions several sand harvesting cooperative societies have been registered.

Construction Industry Materials

Apart from sand, the district has large quantities of building stones. Most of the quarries that produce building stones are found within Kangundo/Matungulu division, Central division especially Kimutwa area, Athi River division. The biggest issues here are the quarries that are left behind after the stones are removed. Environment Management plans for rehabilitation of these disused quarries should be put in place.

There are also large deposits of limestone which provide raw materials for East Africa Portland cement. Granite deposits are also found in Athi River division. These deposits are processed to produce tiles at the Saj Ceramics Factory within Athi River. Other construction industries materials are found within Athi River Division, this is especially for ballast. The following are the quarries found within Athi River that deal with the Construction Industry, these are Crescent, Quality Quarries, Kay Kay Construction, Kenya Builders and Concrete Ltd, AristoCrat Concrete Company Ltd, Mugoya Construction, Kirinyaga Construction, Dunga Quarry that deal with machine cut stones used in the building industries.

Impacts of Mining on the Environment

Sand is one of the most important resources in the district. The availability of sand in the district is occasioned by the nature of geological conditions prevalent in the district which is dominated by basement rocks overlain by volcanic rocks. Sand comes into the rivers through the process of erosion and even though the district has undertaken soil conservation measures seriously, some amount of sand has always found its way into the rivers. Sand harvesting from the district has concentrated along the Thwake catchment, which includes Thwake River amongst other rivers such as Ikiwe.

Serious environmental degradation due to sand harvesting has resulted in destroying the water sources. This is especially so as the sand is scooped and the riverbed is left bare resulting in lack of retention of the water sources. This leads to problems of water scarcity for domestic and livestock use.

The damage the sand transport lorries have done to the roads and to the terrain in some parts of the district itself testifies to how little revenue is being ploughed back into protecting the interests of the local people.

The effect of mining in the areas where it is carried out is manifold. The greatest effect is the disused quarry pits that pose a danger both to the human beings and the animals. The issue of dust is also an effect from this activity. The dust settles on the vegetative cover in the surrounding regions leading to a drying up of the same.

The issue of blasting is also an effect of the mining activity. The noise level is usually high that it affects the surrounding buildings through vibrations from the blasting process.

The disused pits also pose a danger when water collects and stagnates in them leading to a source of breeding grounds for the malaria vector (mosquitoes). The mining also reduces the area that can be used for cultivation purposes.

Issues Affecting Availability, Access and Use

A few individuals at the expense of the general populace at large exploit most of the minerals found in the district. Sand as a natural resource is the backbone of Masaku County Council. The council levies fees on the Lorries as they issue permits to the lorry drivers to transport sand.

Key Environmental Issues

- Noise Pollution – Most mining companies especially for stone mining use explosions to crush stones thus a lot of noise is produced.
- Dust/Particulate Matter – This is released through crushing of stones and explosions and thus affects the surrounding environment
- If the mining area has potential for crop production, then production becomes low due to the covering of the stomata pores by dust
- Vegetation Loss – Mining involves opening the ground especially for quarries thus vegetation cover is lost
- Land Degradation – Altering land through vegetation clearance, soil excavation etc makes the soil loose and susceptible to erosion thus leading to degradation.
- Landscape scarification – If excavated soil is not stockpiled back, the land becomes ugly and useless for any other meaningful purpose.
- Environmental Health – the depressions left as a result of the quarrying activities fill with water during the rainy season and become breeding grounds for various diease vectors such as mosquitoes.
- Occupational Health – Threats to workers health arises from air quality deterioration
- Formation of ponds with stagnant water – they become breeding grounds for various vectors
- Lack or scarcity of water and hence reduced sanitation standards at the quarry/mining area
- Drug abuse and increase in HIV/AIDS due to interactions between community and workers.

Proposed Interventions

- Awareness creation on proper mining methods
- Enforce EMCA regulations
- Rehabilitation of degraded and mined areas
- Enforce Labour regulations
- Re-afforestation

CHAPTER FIVE

5.0 Environmental hazards and disasters

Hazard: A potentially damaging physical event, human activity or phenomenon with a potential to cause loss of life or injury, property damage, social and economic disruption of life, environmental degradation among other effects.

Disaster: A disaster can be defined as a serious disruption of the functioning of the society causing widespread human, material or environmental damage and losses which exceed the ability of the affected community to cope using their own resources.

Environmental disasters in the district are mainly climatic and weather related and few are manmade. A few cases of destruction of livelihoods and environment have been reported in the district.

5.1 Extent and trends of Environmental Hazards and Disasters

The district experiences disasters that are either manmade or natural. The natural disasters experienced include drought and famine while the man made include landslides, accidents and industrial pollution.

Drought has become a common occurrence in the district. The semi arid areas of the district do not receive sufficient rainfall and therefore experience drought very often. As a result, farming which is the mainstay of the district economy is greatly affected leading to famine. Animals which provide the main coping mechanism for the people do not fetch enough prices to enable the families purchase food in the market. The phenomenon has become cyclic such that the district relies on relief food to sustain its people. During times of drought, the women are most affected as there is an increased burden of taking care of the family as the men travel to urban centres in search of casual employment. They also have to travel long distances in search of water for both domestic and livestock use. In order to manage the disasters, there is need to develop an early warning system to detect the droughts in good time so that coping mechanisms are put into place in good time. This would avoid diverting of resources from normal activities to manage the disaster. The district should also promote irrigation for both livestock and agricultural production and research on drought resistant crop varieties. Opportunities will also be availed for non farm income generating activities

while the district should increase the capacity of water dams and pans to ensure they store water for longer periods.

The district is hilly in most parts but has a very good basement rock. Agricultural and livestock production activities have, however, destroyed the rock and made the soil very loose and prone to landslides during the rainy seasons. The vulnerability of the district to landslides is exacerbated by sand harvesting activities. The harvesting activities have been uncoordinated making some of the rivers bare and causing lots of soil erosion during the rainy seasons. Where the activities have been carried out in underground caves, some have collapsed occasioning loss of life.

Key Environmental Issues

- Drought
- Floods
- Water scarcity
- Famine
- Poverty
- Soil Slumping

Proposed Interventions

- Afforestation
- Early warning systems
- Encourage planting of drought resistant crops
- Indigenous knowledge in food preservation

CHAPTER SIX

6.0 Environmental information, networking and technology

6.1 Overview

The Ministry of Education Science and Technology has developed a Curriculum in Primary, Secondary and tertiary institutions on Environmental Conservation. Pupils from class 1 are taught about their surroundings and the curriculum develops to upper Primary as a Science subject. The topics covered are water, Agriculture, Air and Soil Conservation and are examinable in National Examinations. After theory in class the students are taken through demonstration activities like soil conservation, good land use, waste disposals, recycling of materials, water conservation and trees planting. Other non-examinable areas are: Environmental Education related Programs (Wildlife Clubs Presidential Award and Science Congress, eco-schools) environment clubs in Primary Schools, tending of Tree-Nurseries and debates on environmental issues. The District has non-formal Educational Programs popularly referred to as co-curricular programs. Table 22 below shows the status of environmental programs in learning institutions.

Table 22: Status of Environmental programmes in learning institutions

No.		No. of Schools	Types of Environmental Programs	Remarks
1.	Primary	225	4K-Clubs, Debating, planting trees and disposal processes Teaching Science.	Virtually all Schools.
2.	Secondary	55	4K-Clubs, Wildlife Club, Agriculture, Geography, Science, Presidential Award, Science Congress.	The Subject is integrated or fused.
3.	Tertiary Village Polytechnics	2	-The Subject Agriculture is taught. The Tech. Institute covers woodwork and Mech. Engineering. -Environment & Wildlife Clubs	

Source; District Education Office, Machakos, 2006

Information is a fundamental resource in decision - making process. Information is required in defining objectives, setting targets and it guides in the implementation of programmes. In order to make an informed decision about policies and priorities, there is need to establish a strong, authoritative data gathering mechanism. Reliable and comparable information allows organizations to develop indicators and link them to other critical issues such as health and poverty.

Implementation of environmental education and dissemination of environmental information is fundamental to enhancing public involvement and participation in environmental management that leads to behaviour change resulting in responsible living and interaction with the environment.

Environmental information and networking technology has not received much attention and priority for many decades as compared to other sectors. Lack of capacity, poor coordination and linkages, documentation, utilization and preservation of indigenous knowledge are key issues affecting environmental information and networking at community, civil society, private sector, learning institution, government institutions and international levels. Information Communication Technology sector is vital for development. There is need for Telkom Kenya, Kenya News Agency and other service providers to enhance information communication through telecommunication services and e-mail facilities.

6.2. Environmental education

Information technology has become a powerful tool for environmental information dissemination. Environmental education among the Machakos population is critical for active involvement in conservation. Formal and informal education is helpful in changing people's attitudes and behaviour. It imparts skills and knowledge that enable people to strive for sustainable development through effective public participation in decision-making processes.

6.2.1 Public awareness and participation

Public awareness initiatives in the district are mainly through print and electronic media, barazas, commemoration of environmental days such as World Environment Day, workshops and seminars.

6.3. Technology

Cleaner production technologies have not been embraced in the district. Waste recycling firms have not been established either in spite of huge amounts of recyclable garbage. Scrap metals and high density plastics are collected by 'waste pickers' and transported to recycling plants outside the district.

6.4. Environmental information system

Environmental information refers to all forms of knowledge, which relates to the environment in one way or the other needed to understand or manage the environment. Main sources of information in the district include international organizations, research institutions and centres, educational institutions and civil society organizations.

6.4.1 Status of environmental information management system

Information on environmental related issues is easily available in the district. This is because institutions and organizations do share the information in workshops and seminars. Machakos Municipal Council, District Public Health office both have environment unit. The daily newspapers, which occasionally contain environment related information, are kept at the District Library and the District NEMA office. Despite the existence of valuable indigenous knowledge (IK) on environmental issues it still remains undocumented. IK is normally discussed in seminars and workshops. There is an urgent need to document this information so that policy makers can make good use of it.

Key players in non-formal environmental programmes

These include Community Based Organizations (CBOs), Farmer Field Schools, Faith Based Organizations (FBOs), women groups and youth groups. Other key players are NEMA, Ministry of Agriculture, Ministry of Water and Irrigation, Ministry of Forest and Wildlife, Ministry of Youth and Sports, Ministry of Culture and Social Services Office of the President (Provincial Administration) and Ministry of Livestock and Development. The donor community also plays a major role in non-formal education. The major development partners are EU, SIDA, FAO, UNDP and Netherlands government

Environmental issues in the non-formal programmes

- Afforestation- many CBOs and individuals are establishing private tree nurseries
- Soil Conservation- the community has put in place soil conservation measures such as terracing, building gabions in their farms
- Water conservation- most farmers are trapping surface run-off into their farms
- Wetlands conservation-informed CBOs are only doing fish farming on the wetlands

- Pollution from farm chemicals-some farmers are using farm yard manure and fallow cropping is becoming common
- Awareness creation programmes through clean ups and marking the World Environment Day celebrations

The Government's initiatives that relate to soil conservation and management include the establishment of the Kenya soil survey project, the arid lands resource management project, the National agricultural and livestock extension programme, seasonal paper No 6 off 1999 on environment and development, national action programme to combat desertification 2002, the national environment action plan (NEAP) of 1994, the enactment of environmental management and co-ordination Act 1999, the 8th National development plan (NDP) 2002-2008), the agricultural Act CAP 318) the water act 2002 and the Revised Forest Act.

Environmental education among the population is critical for active involvement in Conservation. Information technology has become a powerful tool for information dissemination. Formal and on-formal education helps to change people altitudes and behavior. It imparts skill and knowledge through effective public participation in decision making.

Status of environmental education

Types of environmental education

There exists different form of environmental education in the District. These include tree planting (afforestation), tree labeling, beekeeping, tree nursery establishment and management, soil & water conservation, Horticulture & animal husbandry, flower garden, rabbit keeping, fish rearing, and drama and arts, Exchange visits and ecotourism.

Key Environmental Issues

- Inadequate environmental information materials for distribution and reference
- Inadequate office space
- Inadequate facilities and equipment
- Understaffing of the environment office
- Inadequate documentation of IK

Proposed Interventions

- Develop and improve circulation of the materials
- Translation of scientific information into simple format for the general public
- Capacity building for the NEMA District Office
- Undertake documentation of IK

CHAPTER SEVEN

7.0. Environmental governance and institutional frameworks

7.1 Overview

Environmental governance in Kenya is through various legislations, standards and regulations together with institutions that implement them. Before the enactment of EMCA in 1999 as on overarching framework law, environmental laws were scattered in various sectors and some were conflicting to each other. Environmental Management and Coordination Act (EMCA, 1999) devolve administration of a number of environmental and natural resources management issues to communities. It recognizes community rights, benefit sharing, pastoral land tenure and equitable and sustainable access to land.

Environmental Management and Coordination Act addresses land use management issues including sustainable land use, land use planning, and ecosystems protection and management. The law identifies structures that oversee the equitable distribution of benefits and devolution of decision making on natural resources. Further EMCA empowers organised communities to formulate environmental actions and/or conservation and management plans, through NEAPC, PECs and DECs.

7.2 EMCA Structures for Environmental Management

Environmental governance in Kenya involves major players who are coordinated by National Environment Management Authority. There are also sectors of the government who have aspects of environmental management in their programmes and are referred to as lead agencies in the EMCA. Environmental Impact Assessment and Environmental Audit are tools used for planning for upcoming and existing projects respectively

Some of the Lead Agencies in the district

- Ministry of Water and Irrigation
- The Kenya Forest Service
- Water Resources Management Authority and related Companies and Boards
- Ministry of Works
- Ministry of Housing
- Ministry of Labour and Human Development
- Ministry of Education, Science and Technology Development
- Ministry of Medical Services
- Ministry of Public Health and Sanitation
- Ministry of Agriculture
- Ministry of Local Government
- Kenya Wildlife Services
- Ministry of Livestock Development
- Ministry of Fisheries development
- Ministry of Youth and Sports
- Ministry of Culture and Social Services.

Committees under EMCA

- Public Complaints Committee
- National Environment Tribunal
- District and Provincial Environment Committees

7.3. Other players in environmental governance

Environmental, NGO's CBO's/Private sector active in the district

NEMA has formed 4 clusters of CSOs based on areas of focus, each with its coordinator. These areas of focus include advocacy and lobbying, Environmental Education and awareness creation. The 4 clusters identified are:

- Waste Management,
- Education and Advocacy (lobbying, public awareness and training),

- Service Delivery (disasters, emergencies, relief, energy, transport, water and sanitation) &
- Governance (social and human rights)

Private Sector

NEMA appreciates the role of Private Sector in environmental management and it is already collaborating with this sector in the coordination and supervision of EIA and EA as required by EMCA, development of environmental standards, regulations and guidelines, commemoration of World Environment Day (WED), World Day to Combat Desertification (WDCD), World Wetlands Day, Clean up the World Day, National Tree Planting Day, development of environmental education and awareness resource materials

Development partners

There is several development partners involved in environmental management in the district. EU is also funding activities through Community Development Trust Fund and Community Environment Facility. Swedish International Development Agency (SIDA) is funding the National Agriculture and Livestock Extension Programme (NALEP). The programme has embraced environmental issues and the District environment Officer is a member of the District Coordinating Team (DCT). Food and Agriculture Organization (FAO) and the government of Netherlands are funding Agro-Biodiversity pilot project. Tables 23 below, show policies which impact on environment in the district.

Table 23: Policies which Impact on Environment

Title of policy	Year of formulation	Aspects of environment addressed by policy	Implementing agency	Coordinating mechanisms	Challenges in enforcement	Areas on overlaps & conflicts with EMCA

Forest policy	2005	Tree planting, poverty reduction, soil, water & biodiversity conservation, conservation of catchment areas, forest research, training	Forest Dept	Participatory community forest protection, participatory tree planting, reporting forest pest & diseases to KEFRI, research and disseminatio n of findings by KEFRI,	-Inadequate funds. -Poor coordination -political interferences - inadequate law enforcement	*Overlaps* -Research -training -public participatio n
Diagnosis , treatment & preventio n of malaria	2003	Prevention/contr ol of vectors	Ministry of Health	Seasonal calendar Data compiled at Medical Dept	-inadequate funds	

Source; District Public Health Office, Machakos, 2006

Table 24 below shows the legislation that impact on human health and environmental quality.

Table 24: Legislation that impact on Human Health and Environmental Quality

Title of legislation	Year of enactment	Aspects of environment addressed by Act	Implementing Agency	Coordinating mechanisms
Forest Act	2005	-Management of all state forests -Management of all provisional forests in collaboration with the owners -Protection of forests -Promotion of forestry education and training -Community participation	KFS	Formation of PFM Formation of user groups Education through barazas

		-Prohibited activities in the forest -Presidential protection of trees		
Water Act	2002	-Management and conservation water resources Protection of water catchments	Water Resources Management Authority	Formation of water users associations and river user associations
Public Health Act		-Sanitation and hygiene	Public Health Dept	
Agriculture Act		Soil conservation River bank protection	Agriculture Dept	
Pest Control Product Act	1984	Safe use of chemicals Disposal of containers & obsolete chemicals Quality control/persistence	PCPB	
The Local Government Act	1978 and revised in 1998	-Control factories/industries/which by smoke, chemical fumes, gases, noise, vibration to neighbors' -Control planning of specific areas e.t.c	Local Authority	

Source, District Forest, Agriculture, Public Health, Fisheries & Water Offices, Machackos, 2006

Table7.3 below shows the existing regulations and by-laws for managing environmental and human health.

Table 7.3: Regulations and by-laws for managing environmental and human health

Title of Regulations & Gazette Notice Number	**Year of Gazettement**	**Aspects of environment regulated**	**Implementing Agency**	**Coordinating mechanisms**	**Areas on overlaps & conflicts with EMCA**
The Local government (Adoptive-by laws) (Building (Amendment) order 1995 L./Notice No. 257 of 7/7/95	1995	Provision of drainage& waste water Sanitary provisions	Local Authority		*Overlap* Enforcement

Statute Law (Miscellaneous Amendments) act (No. 2 of 2002) in respect of Cap 242 & cap 254 penalties	2002	Enhancing environmental cleanliness	Public health dept	Supervision Prosecution	*Overlaps* Supervisions Prosecution

Source: District Environment Office, Machakos, 2006

7.4. Regulatory and management tools

Some of the environmental and regulatory tools being employed in the district include.

- Environmental Management and Coordination Act of 1999
- Environmental Impact Assessment regulations of 2003
- Environmental Audit regulations of 2003
- Water Quality Regulations of 2006
- Public Health regulations
- Local Authority Regulations
- Waste Management Regulations of 2006
- Access and benefit sharing for conservation of biodiversity 2007

7.5 Environmental restoration orders, conservation orders and easements

Environmental Restoration Orders

Part 9 -Sections 108-116 of EMCA, 1999 provides the legal mechanisms for the protection and management of the environment. Environmental Restoration Orders are issued by the Authority to any person to:

- Restore the environment as near as possible to the state in which it was before the damage.

- Stop taking any action which would or is reasonably likely to cause harm to the environment.
- Pay compensation to other persons whose environment or likelihood has been harmed by the damage.
- Pay a charge, which presents a reasonable estimate of the costs of any action taken by an authorized person to restore the environment to the state in which it was before the damage.

Environmental Easements and Environmental Conservation Orders

These two orders are issued by a Court of law and the purpose of Environmental Easement is to promote the principles of environmental management by facilitating the conservation and enhancement of the environment through the imposition of one or more obligations in respect of the use of land (burdened land) being the land in the vicinity of the benefited environment.

Why impose an environmental conservation order on a burdened land?

Section 112 (4):

- Preserve the natural contours and features of the burdened land;
- Preserve the quality and flow of water in a dam, lake. River or underground water;
- Preserve fauna and flora;
- Preserve scenic view;
- Preserve any special geological, physiographical. Ecological, archeological or historical features of burdened land;
- Preserve open space;
- Permit persons walk in a defined path across the burdened land;
- Prevent or restrict mining and working of minerals or aggregates on the burdened land;
- Prevent or restrict the scope of any agricultural activity on the burdened land;
- Create and maintain works on burdened land so as to limit or prevent harm to the environment; and
- Create or maintain migratory corridors for wildlife.

CHAPTER EIGHT

8.0 Implementation strategy

8.1 Overview

The District Environment Action Plan (D.E.A.P) Provincial Environment Action Plan (P.E.A.P) and National Action (N.E.A.P) preparation and implementation is guided by National priorities as contained in major policy documents including the ERSWEC, Vision 2030, the National Development Plans and the district Development Plans. The objective of this Environmental Action Plans is to integrate environmental concerns in the development planning and implementation.

Environmental concerns are cross cutting in nature and their impacts are felt at the village, location, divisional and district level. Their integration in development process at tall levels is essential hence the preparation of the District Environment Action Plans (DEAPS). The preparation and implementation is a statutory requirement under Section 38 of EMCA 1999.

Monitoring and Evaluation

In order to ensure that implementation of the plan is undertaken by all stake holders. It is important to ensure monitoring and evaluation of district Environment Action Plan is developed from village level to the district level.

The monitoring and evaluation of the implementation of D.E.A.P will be carried out using the participatory approaches where project committee together with technical team will be involved.Monitoring will mainly be undertaken on continues basis through meetings and field visits. Reports will be prepared and reviewed. Evaluation will be undertaken periodically after the end of every financial year

The purpose of monitoring and evaluation of D.E.A.P is to ensure there are efficient and effective implementation as well as ensuring that environmental concerns have been addressed and integrated in development process. It will involve documentation of cross cutting issues.

Table 24 IMPLEMENTATION MATRIX

Division	Location	Issue Category	Problem Statement	Action No.	Actions Needed	Stakeholders	Timeframe 2009-2013
District Wide	District Wide	Air	Air pollution	1	Control burning garbage	Min. of Public Health and Sanitation, Local Authorities	
				2	Promote recycling of waste	Local Authorities	
				3	Apply and enforce Public Health and Sanitation Act on disposal of dead animals	Min. of Public Health and Sanitation, Local Authorities	
				4	Sensitize communities on waste management	Min. of Public Health and Sanitation, Local Authorities	
				5	Afforestation and Reafforestation	KFS	
			High prevalence of T.B	6	Improve housing ventilation	Min. of Public Health and Sanitation, Local Authorities	
				7	Conduct air pollution monitoring	Min. of Public Health and Sanitation, Local Authorities	
		Climate & related environmental hazards	Frequent Drought /Famine	8	Irrigate crops where possible	WRMA	
				9	Plant drought tolerant crops	Min. of Agriculture	
				10	Plant early maturing crops	Min. of Agriculture	

			Frequent Drought /Famine	11	Afforestation and Reafforestation	KFS	
				12	Promote storm water harvesting e.g. construct water pans	WRMA	
				13	Extension of Yatta water channel	Min. Public works Water and irrigation Min.	
				14	Promote fish farming	Min. of Fisheries	
District Wide	District Wide	Climate & related environment al hazards	Flooding	15	Encourage on-farm water harvesting	WRMA/ Min of Agriculture	
				16	Afforestation and Reafforestation	KFS	
				17	Initiate appropriate soil conservation measures	Min. of Agriculture	
				18	Improve farming methods	Min. of Agriculture	
				19	Peg river banks	Min. of Agriculture	
				20	Regulate sand harvesting in the district	Min. of Agriculture	
				21	Introduce new crops such as cotton	Min. of Agriculture	
		Crop Production & Soils	High rate of soil erosion	22	Initiate appropriate soil conservation measures	Min. of Agriculture	
				23	Afforestation and Re-afforestation	KFS	
				24	Construct Check dams and sand dams	WRMA	
				25	Construct proper drainage on roads	Min. of Roads	
				26	Build gabions	Min. of Agriculture	
				27	Plant cover crops	Min. of Agriculture	

				28	Promote roof water catchment	Min. of Agriculture	
				29	Promote use of mulching	Min. of Agriculture	
			Poor crop yields	30	Promote use of certified seeds	Min. of Agriculture	
				31	promote timely land preparation and planting	Min. of Agriculture	
				32	Initiate appropriate soil conservation measures	Min. of Agriculture	
				33	Plant early maturing crops	Min. of Agriculture	
District Wide	District Wide	Crop Production & Soils	Poor crop yields	34	Enhance farmers Field schools for extension purpose	Min. of Agriculture	
				35	Practice crop rotation	Min. of Agriculture	
				36	Plant drought tolerant crops	Min. of Agriculture	
				37	Promote use of farm yard manures	Min. of Agriculture	
				38	Promote irrigation along developed water sources	Min. of Agriculture, WRMA	
				39	Promote Agro forestry	Min. of Agriculture	
				40	Promote indigenous crops	Min. of Agriculture	
				41	Sensitize communities to use certified seeds	Min. of Culture and social Services	
				42	Conduct frequent soil sampling	Min. of Agriculture	
				43	Encourage use of machine to prepare farmland /dry planting.	Min. of Agriculture	
				44	Diversify crops	Min. of Agriculture	
		Energy	Shortage of wood fuel	45	Promote planting of quick maturing trees	KFS	

				46	Promote use of energy saving devices	Min. of Energy	
				47	Promote use of alternative sources of energy eg biogas, solar	Min. of Energy	
		Environmental Education & Awareness	Low level of awareness on environmental education	48	Educate the public through electronic and print media, drama and songs	Min. of Information	
District Wide	District Wide	Environmental Education & Awareness	Low level of awareness on environmental education	49	Promote public participation in environmental plans, programmes and activities	Min. of Public Health and Sanitation, Local Authorities	
				50	Sensitize communities/opinion leads to abandon cultural beliefs that inhibit environmental conservation	Min. of Culture and social Services	
				51	Disseminate environmental information	Min. of Public Health and Sanitation, Local Authorities	
				52	Integrate environmental issues in Schools & Adult/Public Institutions and literacy Centers	Min. Education	
				53	Increased awareness on environmental laws through Barazas, seminars, workshops	Min. of Public Health and Sanitation, Local Authorities	
Masinga Division		Fish & Fisheries	Shortage of fish	54	Apply and enforce fisheries act	Min. of Fisheries	
				55			

				56	Promote fish farming	Min. Fisheries	
				57	Afforestation and Re-afforestation	KFS	
				58	Monitor and ban use of chemicals for fishing	Min. of Fisheries	
				59	Rehabilitate and restore water catchment areas	WRMA, Min. Agriculture	
				60	Apply and enforce Public Health and Sanitation Act to control pollution	Min. of Public Health and Sanitation, Local Authorities	
				61	Promote use of recommended fishing gears and methods	Min. of Fisheries	
				62	Construct ice plants/preservation	Min. Fisheries, min of Cooperatives	
				63	Protect fish breeding grounds	Mi. of Fisheries	
				64	Promote use of solar to substitute the oil lamps for fishing	Min. of Fisheries	
			Resource use conflict between Machakos and Mbeere fishermen	65	Establish an Masinga fishermen organization to address the conflicts	Min. of Fisheries	

				66			
				67	Capacity build sustainable utilization of fish resources	Min. of Fisheries	
District Wide	District Wide	Forests & Trees	Deforestation	68	Afforestation and Re-afforestation	KFS	
				69	Promote agro forestry	KFS	
				70	Conserve herbal medicinal plants	KFS	
				71	Promote use of energy saving devices	Min. of Energy, Min. of Agriculture	
District Wide	District Wide	Forests & Trees	Deforestation	72	Sensitize communities against traditional beliefs that hinder environmental conservation	Min. of Public Health and Sanitation, Local Authorities	
				73	Promote community education and awareness on good forestry practices	KFS	
				74	Plant drought tolerant crops	Min. of Agriculture	
				75	Gazette existing forests		
				76	Enforce the Forest Act	KFS	
				77	Promote public awareness on the need to conserve and protect forests and catchments	KFS	
				78	Establish tree nurseries	KFS	
				79	Identify hilltops prone to soil erosion and rehabilitate them	KFS, Min. of Agriculture	

		Health	Prevalence of waterborne diseases	80	Apply and enforce Public Health and Sanitation Act	Min. of Public Health and Sanitation, Local Authorities	
				81	Promote treatment of drinking water	WRMA	
				82	Protect water sources	WRMA, Min. Agriculture	
				83	Apply and enforce waste management regulations	Min. of Public Health and Sanitation, Local Authorities	
				84	Construct a proper drainage and sanitation facilities	Min. of Public Health and Sanitation, Local Authorities	
District Wide	District Wide	Health	Prevalence of waterborne diseases	85	Construct latrines	Min. of Public Health and Sanitation, Local Authorities	
				86	Create awareness on proper hygiene	Min. of Public Health and Sanitation, Local Authorities	
				87	Promote use of treated mosquito nets	Min. of Public Health and Sanitation, Local Authorities	
			Aflatoxicosis	88	Create awareness on proper food storage	Min of Public Health and Agriculture	
		Industry & Other Business		89	Apply and enforce Water quality and Waste	Min. of Public Health and	

		Activities			management regulations	Sanitation, Local Authorities	
				90	Enforce air control regulations	Min. of Public Health and Sanitation, Local Authorities	
				91	Promote use of environmentally friendly sources of energy	Min. of Energy	
				92	Promote use of cleaner production technologies	Min of Industry	
				93	Recycle polythene materials	Local Authorities, Min of Industry	
				94	Promote use of EFB	Min of Industry	
				95	Protect springs	WRMA, Min. Agriculture	
		Livestock & Grazing	Low livestock productivity	96	Control animal diseases	Min of Livestock	
				97	Fodder pasture and seed bulking	Min. of Livestock	
District Wide	District Wide	Livestock & Grazing	Low livestock productivity	98	Upgrading of indigenous cattle breeds/crossbreeding	Min. of Livestock	
				99	Undertake research on Ticks control	Min. of Livestock	
				100	Train the communities diagnosis of animal disease and prevention methods	Min. of Livestock	
				101	Train farmers on good animal husbandry	Min. of Livestock	

				102	Plant fodder crops/trees	Min. of Livestock	
				103	Construct water points	Min. of Livestock	
				104	Make hay for use during the dry season	Min. of Livestock	
				105	Reduce the stocking rate	Min. of Livestock	
				106	Promote zero grazing	Min. of Livestock	
		Mining & Quarrying	High incidences of accidents	107	Rehabilitate and restore mined areas	Mines and Geology Dept. Local Authorities	
			Open mining pits	108	Fence mining areas and pits	Mines and Geology Dept. Local Authorities	
		Settlements & Infrastructure	Diseases	109	Construct latrines	Local Authorities	
				110	Apply and enforce waste management regulations	Min. of Public Health and Sanitation, Local Authorities	
District Wide	District Wide	Settlements & Infrastructure	Diseases	111	Promote community education on good hygiene and sanitation	Min. of Public Health and Sanitation, Local Authorities	
				112	Apply and enforce Public Health and Sanitation Act	Min. of Public Health and Sanitation, Local Authorities	
			Unplanned settlements	113	Improve existing roads	Local Authorities	
				114	Promote land use planning	Min of lands	

				115	Prepare urban development plans	Min of Lands, local Authorities	
				116	Apply and enforce Physical Planning Act and Council By laws	Min. of Public Health and Sanitation, Local Authorities	
				117	Construction of sewerage system	Min. of Public Health and Sanitation, Local Authorities	
				118	Construct pit latrines	Min. of Public Health and Sanitation, Local Authorities	
			Poor sanitation	119	Apply and enforce waste management regulations	Min. of Public Health and Sanitation, Local Authorities	
				120	Designate waste disposal sites	Min. of Public Health and Sanitation, Local Authorities	
				121	Apply and enforce Physical Planning Act and Council bye laws	Min. of Lands	
District Wide	District Wide	Water Resources	Inadequate clean drinking water	122	Afforestation & Re-afforestation of water catchments including hill tops	WRMA, KFS	
				123	Treat drinking water	WRMA	
				124	Dig boreholes/shallow wells	WRMA	

				125	Protect and conserve water sources	WRMA	
				126	Promote roof water catchments	WRMA	
				127	Regulate river water abstractions	WRMA	
				128	Construct pit latrines	Local Authorities, Min of Public Health and Sanitation	
			Water pollution	129	Undertake Public education on good hygiene	Local Authorities, Min of Public Health and Sanitation	
				130	Construct latrines	Local Authorities, Min of Public Health and Sanitation	
				131	Promote proper waste management	Local Authorities, Min of Public Health and Sanitation	
				132	Treat drinking water e.g. Using chlorine	WRMA	
				133	Promote proper application of agrochemicals	Min. of Agriculture	
District Wide	District Wide	Water Resources	Water pollution	134	Undertake appropriate soil conservation measures	Min. of Agriculture	
				135	Enhance protection of boreholes through fencing	Min. of Public Works, WRMA	
				136	Construct sewage systems	Local Authorities,	

				137	Designate waste disposal sites	Local Authorities, Min of Public Health and Sanitation	
				138	Protect water sources	WRMA	
			Drying of water sources	139	Plant trees on the water catchment areas		
				140	Regulate sand harvesting		
				141	Provide piped water	WRMA	
		Wetlands	Degradation of wetlands	142	Regulate the usage of wetlands resources	WRMA, Min. Agriculture	
				143	Educate communities on the importance of conserving wetlands	WRMA, Min. Agriculture	
				144	Draw management plans for wetlands	WRMA, Min. Agriculture, Min of Lands	
		Wildlife, Biodiversity & Tourism	Human – wildlife conflict	145	Erect an electric fence around Masinga Dam	KWS	
District Wide	District Wide	Wildlife, Biodiversity & Tourism	Human – wildlife conflict	146	Strengthen District Compensation Committee	KWS	
				147	Sensitize communities to appreciate the importance of conserving wildlife	KWS	
				148	Involve the communities in wildlife management	KWS	

			Loss of biodiversity	149	Plant indigenous trees	KFS	
				150	Preserve indigenous tree species	KFS	
				151	Protect natural ecosystems	KFS, KWS	
			Untapped eco-tourism potential	152	Carry out an inventory of existing/potential tourism sites	Min. of Tourism	
				153	Apply and enforce EMCA	Min. of Tourism	
				154	Promote and market existing tourism activities	Min. of Tourism	
				155	Use media to promote local tourism	Min. of Tourism, Min of Information	

APPENDIX

PART IV OF THE ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT (1999) -ENVIRONMENTAL PLANNING

(EXTRACT FROM EMCA)

37. National Environmental Action Plan Committee.

1. There is established a committee of the authority to be known as the National Environmental Action Plan Committee and which shall consist of;

a) The permanent secretary in the ministry for the time being responsible for national economic planning and development who shall be the chairman;

b) The permanent secretaries in the ministries responsible for the matters specified in the first schedule or their duly nominated representatives;

c) Four representatives of the business community to be appointed by the minister;

d) Representative of each of the institutions specified in the Third schedule;

e) Five representatives of non-governmental organizations nominated by the National Council of Non-Governmental Organizations;

f) Representatives of specialized research institutions that are engaged in environmental matters as may be determined by the minister; and

g) A Director of the Authority who shall be the secretary.

2. The National Environmental Action Plan Committee shall, after every five years, prepare a National Environmental Action Plan for consideration and adoption by the National Assembly

38. Provision of the National Environmental Action Plan

The National Environmental Action Plan Shall:-

a) Contain an analysis of the natural resources of Kenya with an indication as to any pattern of change in their distribution and quality over time;

b) Contain an analytical profile of the various uses and value of the natural resources incorporating considerations of intergenerational equity;

c) Recommend appropriate legal and fiscal incentives that may be used to encourage the business community to incorporate environmental requirements into their planning and operational processes;
d) Recommend methods for building national awareness through environmental education on the importance of sustainable use of the environment and natural resources for national development;
e) Set out operational guidelines for the planning and management of the environment and natural resources;
f) Identify actual or likely problems as may affect the natural resources and the broader environment context in which they exist;
g) Identify and appraise trends in the development of urban and rural settlements, their impacts on the environment, and strategies for the amelioration of their negative impacts;
h) Propose guidelines for the integration of standards of environmental protection into development planning and management;
i) Identify and recommend policy and legislative approaches for preventing, controlling or mitigating specific as well as general adverse effects on the environment;
j) Prioritize areas of environmental research and outline methods of using such research findings;
k) Without prejudice to the foregoing, be reviewed and modified from time to time to incorporate emerging knowledge and realities; and
l) Be binding on all persons and all government departments, agencies, state corporations or other organs of Government upon adoption by the National Assembly.

38. Provincial Environmental Action Plans

Every provincial environmental committee shall, every five years, prepare a provincial environment action plan in respect of the district for which it is appointed, incorporating the elements of the relevant district environmental action plans prepared under section 40 and shall submit such plan to the chairman of the National Environment Action Plan Committee for incorporation into the National Environment Action Plan

40. District Environmental Action Plan

Every District Environmental Committee shall, every five years prepare a district environment action plan in respect of the district for which it is appointed and shall appointed and shall submit such plan to the chairman of the Provincial Environment Action Plan Committee for incorporation into the provincial environment action plan proposed under section 39.

41. Contents of Provincial and District Environmental Action Plans

Every provincial environment action plan and every district environment action plan prepared under section 39 and 40 respectively shall contain provisions dealing with matters contained in section 38 (a), (b), (c), (d), (e), (f), (g), (h), (I), and (j) in relation to their respective province or district.

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