



UNIVERSITY OF NAIROBI

**ENVIRONMENTAL DEGRADATION AND POLLUTION:
LET US REVERSE THE TRENDS!**

INAUGURAL LECTURE

BY

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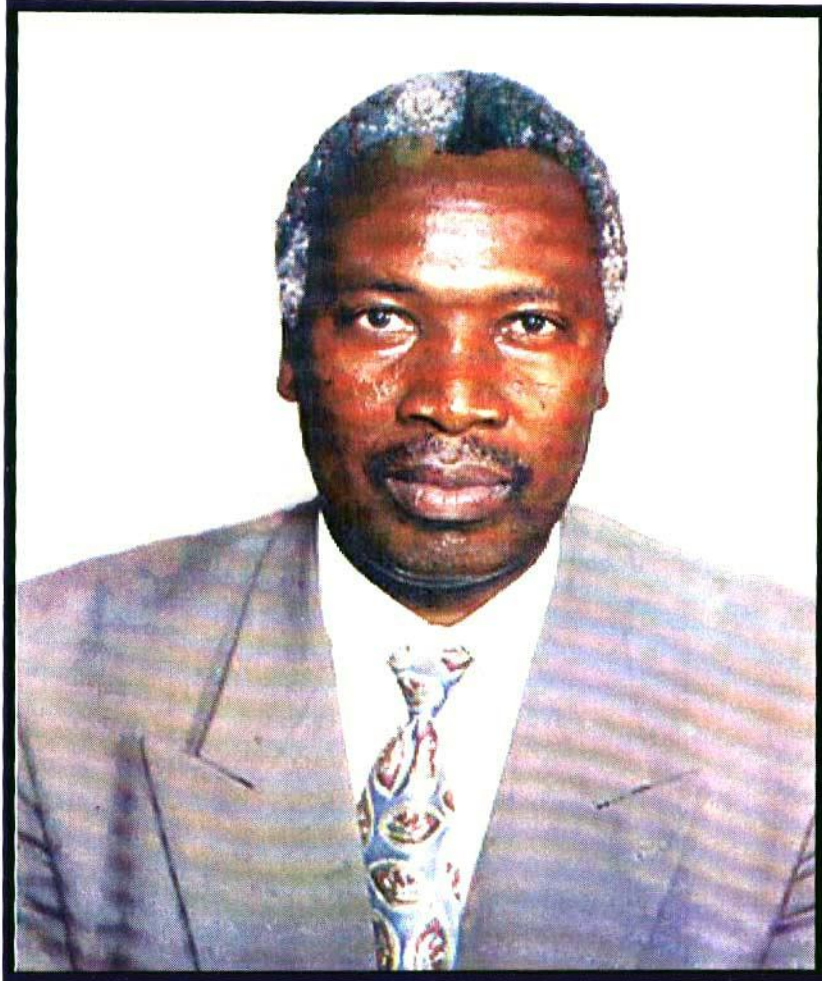
**Founding Vice-Chancellor
Jomo Kenyatta University of Agriculture
and Technology**

DEDICATION

This inaugural lecture is dedicated to my wife Nyabonyi and children Nyakundi, Amenya, Kemunto and Michieka.

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Professor Ratemo Waya Michieka, Ph.D., M.Sc., B.Sc., SS., EBS, Hall of Distinguished Fame, Rutgers University, New Jersey, USA.

- *He is the Founding Vice-Chancellor, Jomo Kenyatta University of Agriculture and Technology.*
- *Currently, he is the Director General of the National Environment Management Authority (NEMA).*

BIOGRAPHY

Professor Ratemo W. Michieka was born in April 1950 in Nyamagesa Village, Nyaribari Masaba, Kisii Central District. He was the 9th son in a family of thirteen children of the late peasant farmers Nyatero and Michieka.

Ratemo grew up in a rural setting and went to Ibacho Primary School, and later proceeded to then Government African School, Kisii where he completed his "O" Level and passed with Division II. His principal, a Mr. Bowles, was a strict disciplinarian who spoke softly with very few words during parade time. He was very time conscious, a trait Ratemo admired and acquired from him. It was from Mr. Bowles that he first heard and learnt that "time is money" (his sincere reaction then was literal). Upon completing secondary education, he immediately secured a job with Barclays Bank, Queensway Branch, Nairobi after a lengthy written and oral examination supervised by one colonial official, a Mr. Bird.

Professor Michieka left the Bank on principle grounds after about a year following disagreement with his immediate supervisor, Mr. Bird on loans awarded to unqualified, non-performing clients. Colonial rule had not quite subsided in 1969. Ratemo proceeded to the USA for further studies. He was admitted to Rutgers University in the USA in the College of Agriculture and Environmental Sciences, later named Cook College.

Professor Michieka pursued his courses diligently and attained his B.Sc., M.Sc. and Ph.D., between 1970 and 1978 in agricultural sciences specialising in Crop Protection – Weed Science. He received scholarships and research grants from various chemical companies. He attended and presented several papers in national and international fora.

Ratemo left the USA immediately after his Ph.D., in July 1978 for a Postdoctoral Fellowship in the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. This was the beginning of a return home journey. He conducted several research programmes in his area of discipline while in Nigeria and was persuaded to return to Kenya and take up a teaching post with the University of Nairobi. He interacted with visiting Kenyan scientists at IITA notably Professors Reuben Olemba, Shellemiah Keya, Chris Karue, David Ngugi, and Daniel Mukunya who insisted that he returns home to work in our public university.

Prof. Michieka's work in Nigeria involved weed research. He worked with Dr. Okezie Akobundu on ways of managing several hard-to-control weed species like *Rottboelia exaltata*, *Panicum maximum*, *Pennisetum purpureum*, among others. Obviously, the biodiversity in the deep tropical forests has its own survival mechanisms.

Ratemo excelled in research involving screening of numerous herbicide compounds, some of which are very important in the world today. Glyphosate (Roundup) which is commonly used in our plantation crops is one example. Others include those in dinitroanilines, triazines and carbamates. His major Professors Richard Ilnicki, Cecil Still, Roger Locandro and Milton Sprague gave him a solid and disciplined academic and research foundation for which he is grateful.

He visited Ibadan in August, 2004 and realized that little if any, has changed in all spheres of human, animal and plant lives 24 years later, but for the population which has shot up from 85 million in 1980 to 130 million in 2004.

Ratemo interacted with reputable scientists at IITA like Prof. Bede Okigbo, Shastry, Terry, Hans Herrens, William Gamble, B.T Kang, Tony Juo, Rattan Lal, Louis Jackai and Jonathan Braide. This later contributed to networking in donor funding. He supervised MSc and PhD candidates while at IITA including Dr. Stephen Utulu, Raymond Unama and Dr. Albert Ayeni.

Professor Michieka resigned from IITA and accepted a post of Lecturer at the Department of Crop Science, University of Nairobi. The salary was nowhere comparable to that he had in Ibadan.

Ratemo embarked on teaching, research and field work as he supervised several M.Sc. and Ph.D. students. He was promoted to Senior Lecturer, Associate Professor and Full Professor between 1984 and 1999. As a Chairman of Crop Science Department, Professor Michieka attracted research grants, student scholarships and young scholars who later took up teaching posts.

In December 1989, Ratemo was appointed as the Deputy Principal, Academic Affairs, of the then Jomo Kenyatta College of Agriculture and Technology, Juja, and became a Principal in 1992 and eventually the Founding Vice-Chancellor of the vibrant Jomo Kenyatta University of Agriculture and Technology (JKUAT) in 1994. Ratemo was responsible for major academic

and administrative developments which culminated into a generous Japanese support for several years. He led JKUAT in developing academic programmes relevant to the Kenyan needs. He also oversaw major capital investment by JICA with hundreds of Ph.D. trainees in Japan. He is the brainchild behind the construction of the prestigious African Institute for Capacity Development (AICAD) for which he signed a Kshs. 1.0 billion grant towards its establishment and equipment.

Realising the very high demands of education in Kenya, Ratemo explored ways and means to extend education to those who might have just missed University entrance. He initiated an ambitious programme by introducing 18 University accredited Campuses all over the country in which many students enrolled saving enormous foreign cash outlay. The fruits of such programmes are being realized and appreciated now after scathing attacks at the introduction stage.

A two times Chairman of the Vice-Chancellor's Committee, Michieka witnessed the growth of JKUAT into a vibrant university with links to several international universities. He believes in human capacity development at the highest levels.

Professor Michieka's pride while at JKUAT was when he installed two Heads of State as Chancellors, and awarded them Honorary Degrees, the retired President Daniel Arap Moi in November 1994 and President Mwai Kibaki on March 25, 2003 just before he was appointed the Director General, NEMA. The abolishment of Head of State as Chancellor of Public Universities was effected thereafter. He saw Kibaki become the shortest serving Chancellor of JKUAT. The 1990 to 2003 graduates of JKUAT constitute a very large cohort to whom he pays tribute. Their programmes were finished on schedule and lucky ones had a life-time advantage. That was Michieka's utmost academic satisfaction.

Ratemo was appointed the Director General of NEMA on March 25, 2003, a post he still holds. NEMA is a powerful parastatal in the Ministry of Environment and Natural Resources (MENR). Over just about a year, he has made tremendous progress in educating the public on the need to conserve and preserve our environment. The Authority is now felt in every corner of this Republic giving continuous guidelines on how to save our country from pollution.

Professor Michieka's national contributions are many. He was the Chairman of the Kenya Agricultural Research Institute (KARI) for several years, a Board Member of the Kenya Marine and Fisheries Research Institute (KEMFRI), National Council for Science and Technology (NCST), a Fellow of the Kenya National Academy of Sciences (KNAS), Chairman of the Advisory Board, Kenya National Cleaner Production Centre (KNCPC), Member of the Governing Board of the Africa Centre for Technology Studies (ACTS), and a Commissioner, Commission for Higher Education (CHE).

He chaired the Technical Sub-Committee of CHE for the accreditation of the University of Eastern Africa at Baraton, Scotts Theological College, Catholic University, Daystar University, United States International University (USIU), Nazarene University as private universities. The Commission also issued letters of Interim Authority to Kenya Methodist University (KEMU), Kabarak University, Keriri Women University (KWU), Strathmore University and Aga Khan University. He chaired marathon meetings of a sub-committee of Vice Chancellors in 1990/91 on admissions, which over-saw the establishment of Maseno University and Chepkoilel, Laikipia and later Kisii campuses.

He has been the external examiner to a number of universities, chairman of the Weed Science Society of East Africa, and member Board of Crop Protection of the Food and Agriculture Organisation (FAO). He chaired and coordinated the revitalisation of the Inter-University Council of East Africa (IUCEA), one of the longest surviving organs of the community.

Ratemo has written a book on Weeds of East Africa translated into Kiswahili and published over 50 papers in several refereed journals. He is a strong proponent of Swahili use in Kenya and East Africa and has written a book for publication.

Prof. Michieka has taught and supervised MSc and PhD students even when he was a Vice-Chancellor at JKUAT. He has undertaken a number of consultancies with the International Development Research Centre (IDRC), World Bank, CARE Kenya, United States Agency for International Development (USAID), Swedish International Development Agency (SIDA), and Canadian International Development Agency (CIDA), among others.

As a recognition by the State, Prof. Michieka was awarded two State Commendations – The Shinning Star (SS) and the Elder of the Burning Star

(EBS). He has also received the "Hall of Distinguished Alumni Award" by the Rutgers University.

Philosopy in Life: As a scholar, he wants and prays for a society of men and women of integrity, a society with norms, a society one can count on, a society that can appreciate its people and time. Time is not stagnant. Men and women who neglect it regret its loss when it is past (Zading, 1974). High caliber training of all cadre would perhaps mitigate this repugnant characteristic and enable us start dreaming of 2020 industrialization!

He pays tribute to the following Vice Chancellors with whom he worked during the most turbulent times in public universities, particularly student riots and Joint Admissions Board (JAB) meetings: Professor Philip Mbithi, Philip Githinji, Richard Musangi, Shellemiah Keya, Justin Irina, Francis Gichaga, George Eshiwani, William Ochieng (Principal Maseno), Raphael Munavu, Japheth Kiptoon, Frederick Onyango, David Some, Ezra Martim, Crispus Kiamba and Everit Standa.

Professor Michieka, one of the longest serving Vice-Chancelors and Founder of JKUAT is married to Nyabonyi with whom they have four children, Nyakundi, Amenity, Kemunto and Michieka.

1. INTRODUCTION

Pollution is the presence of contaminants in the environment in quantities, characteristics and duration such as to be injurious to human, animal and plant life or which unreasonably interferes with comfortable enjoyment of life.

Degradation of land and ecosystems results in loss of productivity – qualitatively and quantitatively. Degradation could be due to mismanagement by various human activities including physical, biological as well as chemical processes. In addition, natural disasters such as floods cause degradation through erosion and loss of soil nutrients, essential chemicals and fertilizers.

There is so much information about cases of worrying levels of pollution in the news media everyday. For example, there are frequent reports of our municipal authorities discharging raw sewage often containing toxic materials and bacteriological matter into rivers, lakes, and the sea. There are increasing reports of outbreaks of diseases like typhoid in some urban centres as well as mass deaths of fish and birds in some rivers and lakes. Some rivers flowing through our towns have been poisoned to extremely dangerous levels, while spillage of oil into the sea, lakes, rivers and other water bodies have wiped out thousands of aquatic fauna and flora. We no longer drink tap water, while stream water is now considered dangerous to health. Solid waste have not only severely damaged the beauty of our landscape, but many types of such waste are dangerous to health. There are many reports of livestock dying after ingesting plastic and polythene materials which commonly litter almost everywhere on our landscape. The consequences are there for all of us to see. All these were non-issues 20 years ago.

We are all aware of unsuccessful efforts so far to control the dangerously high noise levels in urban centres or within certain industrial concerns. The hearing ability of some of our people may be lost or have already been lost. Noise is indeed a dangerous form of pollution. Many other diseases have come about as a result of air pollution due to inhalation of toxic gases such as carbon monoxide and sulphur dioxide, just to mention a few which are emitted into the air.

Evidence of land degradation is widespread and commonly reported in the news media. For example, in the last 25 years, our forest cover has been reduced

by about a third - from 2.9% to 1.7% of total land cover. Illegal logging and clear-felling of trees and other forms of vegetation, especially on steep slopes have been followed by massive soil erosion and landslides. These are evidence of poor management of water catchments. The result has been massive removal of the rich topsoil, flooding and loss of lives. The consequences include inability of the land to yield sufficient crops to feed our people, deaths and destruction of property due to flooding, deaths due to landslides, and extreme cases of poverty, hunger, diseases, and great suffering by many rural families. The severity of some of these cases are equally evident during times of drought.

Weed Research (Science)

This is a rare discipline which touches on biodiversity, agriculture, chemistry, health, taxonomy, soils, water, air and most importantly, the balance between environmental destruction versus crop protection. A weed scientist would wish to discriminate between useful and non-economic plants for human and animal utilization. A weed is a plant which has no value at one point, or place in time. The value determines and dictates its importance. We use all types of control measures to manage the unwanted plant from the growing media. Biological, mechanical, and chemical weed control methods are employed, among many other methods. Each method has its own merits and demerits.

In my speech, chemical control is perceived as the most critical since soil, water, air, plants and animals are bound to be exposed to all types of chemical sprays found worldwide. Sheer awareness on what happens with a compound is deceitful since our environment (including our bodies) will have to “detoxify” or eliminate the concentrates (biodegradation).

This paper reviews impacts and possible trends of degradation and pollution with regard to land and ecosystems, water and sanitation, solid waste, chemicals, and emissions. The *National Development Plan, 1979-1983* stressed the need for environmental inputs in the national planning process pointing out that environmental considerations must pervade development decisions at every level.

2.0 NATURAL RESOURCES

Degradation of soils, plants and water resources and loss of biological productivity greatly reduces the ability of land to support human, animal and plant life. Land and ecosystem degradation in Kenya is due mainly to soil erosion, declining soil fertility, salinity and alkalinity, vegetation degradation (due to overgrazing, and uncontrolled burning) and deforestation for fuel wood and charcoal. Outstanding cases of land and ecosystem degradation include soil degradation, inappropriate agricultural practices, and climatic threat, especially in arid and semi-arid lands. It is a challenge to sustainable development, and a major threat to sustainable management of biodiversity and ecosystems, which contribute to poverty, food insecurity, ignorance, and dominance of some geopolitical regions over others.

Soil Degradation: A degraded soil is one that has lost the quality, ability and capacity to produce economic goods and services, and capacity to perform environmentally regulatory functions. Soil degradation processes include physical deterioration, chemical deterioration, fertility depletion, leaching of bases, acidification, salinization, sodification and contamination/pollution. Similarly, biological deterioration include decline in biomass carbon, reduction in organic matter content, decrease in biological population activity, decrease in species diversity and alteration in biological processes from favourable to unfavourable situations. These processes affect a large area and cause irreversible damage to the land.

Rill, gully, sheet and wind erosions are the most serious types of soil erosion. Gully erosion, which is widespread in Kenya, is associated with stock tracks and footpaths, denudation and runoff from grazing land, down cutting and entrenchment of watercourses, uncontrolled runoff from roads and built-up areas, failed conservation structures, and unstable soil. Wind erosion occurs due to destruction of vegetation cover by overgrazing and drought.

Cultivation: Farmers migrating from high and medium potential areas to marginal areas bring with them farming technologies that are inappropriate causing soil erosion, deforestation, and loss of biodiversity. Cultivation of steep slopes and hills without appropriate soil and water management has accelerated the rate of soil erosion, decline of soil fertility and water pollution. Cultivation of riverbanks has increased the rate of erosion, while continuous cultivation of

farms without any application of manure or inorganic fertilizers has led to a decline in soil fertility and decreased agricultural productivity.

Overgrazing: In some areas, farmers keep more livestock than the carrying capacity of the land. This causes the animals to eat the grass and other vegetation leaving the ground bare. The exposed soil is dried by the hot sun. The dry top soil is easily eroded by the wind. When the rains come, the bare soil is lost through sheet and gully erosion, and loses its nutrients through leaching. Soil compaction by livestock and farming machinery decreases the rainfall infiltration rate and increases surface run-off.

Deforestation: Cutting of trees in cultivated lands for fuel wood, timber and other construction materials is causing alarm. Deforestation that has occurred in water catchments forests have negatively affected our country. The ability of the water catchments to regulate run-off has been reduced with subsequent flooding. The demand for charcoal, especially in urban centres has caused severe deforestation, particularly in arid and semi-arid lands (ASALs) - which have become the main sources of charcoal. The magnitude of the sale of charcoal along major highways gives an indication of the rate of deforestation in the ASALs.

Examples of Inappropriate Land Use Practices: Some of the negative impacts of inappropriate land use practices, include:

- Introduction of the invasive plants such as *Prosopis* spp, which is a major threat because of its dominating nature in dry lands ecosystems. This nitrogen-fixing legume is adapted to deserts and ASAL. Since its introduction in the early 1970s, it has caused untold suffering to the pastoralists of Northern Kenya including human and animal deaths through poisonous and injurious effects from pods, seeds, foliage and sturdy thorns nicknamed "msumari wa NORAD". *Prosopis* colonizes an area and literally 'wipes' out any other vegetation through its allelochemic properties. The negative impacts of *Prosopis* are worse than those of the dreaded water hyacinth in Lake Victoria. It will cost this country a fortune to eradicate it. It is a top priority environmental concern, which must be eliminated before it invades and colonizes our national parks and displaces our game.

- Flooding in Bundalangi in Busia district, lower Tana River and Kiroe area in Kiambu district due to deforestation in the water catchments in Mt. Elgon, Mt. Kenya Forests and Kikuyu forest respectively.
- Siltation of dams, rivers and lakes, e.g. Sasumua dam in Kiambu, Ndakaini dam in Maragua district (both of which supply water to Nairobi city that has current water shortage). Lakes Baringo and Bogoria are threatened by sedimentation from their degraded water catchments.
- Landslides and mudflows due to cultivation of steep slopes has killed people, for example, in Meru Central and Muranga districts.
- Drying up of rivers, due to deforestation and inappropriate land uses at the water catchments, for example, Njoro River in Nakuru district.
- Water pollution by chemicals from agricultural activities, e.g. flower farming around Lake Naivasha.
- Gully erosion in farms adjacent to roads caused by run-off from the roads, e.g. Kiambaa-Muguga gully, Kinoo gully, and Gitaru gully all caused by run-off from Nairobi-Nakuru highway.

Climatic Threats: Arid and semi arid lands (ASAL) constitute 88% of Kenya's land surface and is home to approximately 10 million people. These areas support over 50% of the country's livestock and 70% of the wildlife. These drylands face a number of challenges, including threats of desertification as a result of human activities, over-cultivation, overgrazing, deforestation, charcoal burning and other unsustainable practices. The situation is aggravated by the occurrence of frequent and severe droughts, which are normally cyclic, but difficult to predict. It is estimated that major droughts occur after every ten years and minor ones every three to four years, while yearly droughts occur in the northern districts of Kenya (UNEP and Government of Kenya 2000).

Drought causes loss of ground cover as the crops and other vegetation dry before the rains. When the rain comes, the ground is bare and prone to serious soil erosion having been stripped of vegetation cover and compacted by livestock as they graze close to the roots of grass and shrubs. Soil erosion takes away the topsoil that is suitable for agriculture and livestock production, and reduces the land capability to support life.

When severe drought is combined with poor land use and inappropriate agricultural practices, it results in loss of productivity and eventually land degradation. Furthermore, the situation in ASALs is exacerbated by the increasing needs of the rising population due to high natural increase and massive migration of people from high and medium potential areas in search of more land for farming and development.

Civil Disturbances and Unrest: The regional disturbances in Ethiopia, Somalia, Sudan, Uganda, Rwanda, Burundi and Democratic Republic of Congo have caused people to migrate to Kenya where they are settled in Kakuma and Daadab refugee camps. The refugees need construction materials, fuel wood and water. The cutting of trees around the camps has caused deforestation, soil erosion and decrease of fodder for livestock. This has increased the rate of land degradation around the camps to a radius of about 50 km. Supply of food with lorries by United Nations High Commissioner for Refugees to Kakuma refugee camp in Turkana district has created suitable environment for transportation of charcoal to Kitale and Eldoret towns. This means that more trees are cut to supply the ever-increasing market for charcoal within and outside Turkana district.

Addressing the Challenges of Land Degradation

Data on the rate, degree, and extent of land degradation and the cost of rehabilitating it in the country are scarce and in some cases lacking. Social-economic analysis data and information are crucial for decision-making by policy-makers and farmers for the adoption and promotion of appropriate remedial technologies.

Policy Frameworks: A major underlying cause of land degradation has been inadequate national policies, institutional capacities and legal instruments. Land management in Kenya has been characterized by sectoral policy instruments, most of which are conflicting and not consistent with the current changes of economic development, particularly the land tenure systems. Lack of a land use policy is indeed the key factor that has contributed to the existing poor development of the ASALs. Land-use is generally controlled by the numerous sectoral laws, with many of them having only regulatory and revenue-generating roles. Land use practices have not taken into account actual potentials, carrying capacities, and limitations of any ecozone or habitat. Population pressure has

led to haphazard land use practices causing environmental degradation everywhere.

The present set-up in biodiversity conservation is sectorally determined; with the basis of the demarcation of interest as forests, wildlife, crops, seeds, etc. The government has also established new institutions to carry out certain functions because of urgent and unique needs without scrapping or reshaping existing ones.

Agricultural policy has affected land used for production of crops like coffee, maize, cotton, and sorghum. Due to poor coffee policy, farmers have neglected land under coffee causing destruction of terraces, serious soil erosion and invasion of noxious weeds. Maize production fluctuates every year due to poor marketing policy. At times farmers are unable to buy enough fertilizers to improve their production. This leads to low crop density and productivity and decreased soil fertility. Poor marketing and promotion of sorghum has caused the crop to be grown in poor soils and under poor management. This results in soils deteriorating and erosion. Thus, policy issues have caused land and watershed deterioration.

Research Agenda: To tackle land degradation problems, there is a need to answer vital questions such as: What is the motive/reason in human behaviour that makes people degrade their own vital resources? Why do we overexploit the land? Why do we destroy our forests? Why do we waste the water? Why do we pollute our environment? Why don't we take the necessary actions to restore what we have destroyed? Why can't we respect and protect what we have? What will future generations enjoy?

The answers to the above questions are the root causes and the primary driving forces to land degradation, which are: Policy distortions; institutional distortions; failures in public sector to appreciate land values and lack of firm and continuous environmental education and attitude.

The responses to stop or reverse the situation include:

- Earnest implementation of the National Environment Action Plan (NEAP) by all Kenyans;
- Development of national policies addressing inadequacies, overlaps and contradictions in land use and tenure;

- Concerted efforts to change our attitude and behaviour through every means possible, including education.
- Rationalizing institutional mandates, the roles they presently play, and mechanisms for collaboration between them at national, regional and local levels.
- Research on various cropping systems, pest control, chemicals and fertilizer use, land uses, soil and water conservation, agro-forestry, forestry, and improved extension services;
- Promotion of private sector involvement in land management.
- Environmental education and awareness creation on the need and importance of environmental conservation, protection and management.
- Develop a national action plan and implementation strategy for the United Nations Framework Convention on Climate Change (UNFCCC).
- Development of a an implementation strategy for combating desertification through the National Action Programme (NAP); and
- Development of an implementation strategy for the protection of our national biodiversity.

2.1 Water and Sanitation

Water and sanitation have been prioritised in sustainable development and poverty reduction strategies as they are related to environment, health and biodiversity. Water uses include domestic, livestock, agriculture, hydropower generation, industry, recreation, and biodiversity conservation. It is life.

The rapid urbanization, industrial, commercial and agricultural developments have resulted in the generation of vast amounts of effluents originating from domestic, municipal, agricultural, industrial and trade activities. Some effluents are hazardous and have the potential even in low concentrations to have adverse impacts on public health and the environment due to their toxicity, chemical and physical characteristics. Such effluents may be corrosive, carcinogenic, flammable, explosive, radioactive or infectious.

In the rural areas, the biggest problems are associated with agro-chemical pollution resulting from the use of fertilizers, pesticides and agro-processing industrial effluents from small and large scale industries. Wetland destruction, mining, quarrying, marine and aquatic disasters, oil spills, and landslides contribute significantly to soil degradation and pollution. Major pollutants include pathogens, nutrients, organic matter, heavy metals, suspended matter and salinity.

The major disposal methods of effluents include: discharge into water bodies, sewerage systems, release to open drains and sewer lines, and emptying into the land. The level of treatment of effluents in many parts of the country before discharge is far below acceptable standards. Domestic sewage and industrial effluents are poorly maintained under anaerobic conditions leading to high loads of chemical and biochemical oxygen demand (COD, BOD) respectively.

The continued indiscriminate disposal of effluents has serious pollution effects on the environment. Contamination of streams, rivers, lakes, oceans, and agricultural lands are some examples which need urgent attention.

Industrial Waste: Industrial effluents may be discharged from industries such as food, textile, paper, petroleum, chemical, and engineering works. Effluents from food manufacturing industries such as canning, brewing, dairy, meat, sugar, coffee, tea, fruit, vegetables and miscellaneous processing usually consist of biodegradable organic wastes with no toxic components. Discharge from textiles, leather and paper industries have the following common pollutants: alkali which causes pH to rise, suspended solids and toxic metals such as chromium. Effluents from petroleum refineries comprise of phenols, oil, grease and suspended solids, while those from chemical industries contain various chemicals like fertilizers, pharmaceuticals, preservatives and dyestuffs. Its pollutants include phenols, solvents (acetone, benzene and alcohols), acids, alkalis, ammonia, biodegradable wastes, chromium and other metals. Effluents from engineering works include metal finishings and transport systems and their pollutants consist of acids, suspended solids, cyanide, chromium and other metals.

Municipal (Urban) Wastes: Municipal wastes originate from domestic activities, institutions such as schools and hospitals as well as runoff from pavements. Municipal wastewaters have reasonable concentrations of suspended and

dissolved organic and inorganic solids. They contain oil and grease from domestic wastes and ammonia from domestic sewage. Among the organic substances present in domestic effluents are carbohydrates, lignin, fats, soaps, synthetic detergents and their products. Municipal wastes also contain a variety of inorganic substances from domestic and industrial sources. Some of these are potentially toxic such as arsenic, cadmium, chromium, copper, lead, mercury, and zinc.

Agricultural Wastes: Agricultural waste contain agro-chemicals such as fungicides, insecticides, herbicides, acaricides, wastes from animal feedlots and runoff containing fertilizer. All these have a polluting effect on the receiving waters resulting into eutrophication in water bodies. Modern intensive methods used in raising cattle, poultry and pigs produce significant wastes which when released to waterways have a number of adverse effects including depletion of dissolved oxygen and an increase of nitrogen contents. Runoff from fertilized land may contain a variety of chemical substances including nitrates and phosphates, which are potentially destructive.

Impacts: Indiscriminate disposal of effluents has had serious effects on many water systems, affecting the quality and usefulness of such waters. Some of the effects include: oxygen depletion, toxicity, and sources of disease vectors. Health related problems are costly.

The principal causes of oxygen depletion in water are organic wastes from raw or partially treated sewage, which decay in water and uses up oxygen. As the oxygen dissolved in water decreases, aquatic life is affected and may eventually die. When all the dissolved oxygen is used up, anaerobic microorganisms convert sulphur into hydrogen sulphide and the water takes an offensive foul-smelling characteristic rendering it useless for many productive or recreational purposes. That is a common feature in our water bodies.

Effluents containing phosphates and nitrates cause excessive weed and algal growth, which affect water movement and inhibit the dissolving of oxygen from the air. As the growths decay they consume oxygen and in its extreme form leads to eutrophication of lakes and slow moving water bodies.

Some of the toxic materials often discharged into water include: chromium from tanning or plating processes; cyanide from metal finishing; boron compounds from detergents which have deleterious effect on waters used for irrigation; pesticides and fertilizer from agricultural runoffs; acids and alkalis

which are often lethal to plant and animal life; radioactive nuclides discharged from laboratories and hospitals; and wastes having significant heat content which can quickly change the temperature of the receiving waters and alter the biological balance.

Raw or partially treated sewage when discharged into water bodies or soil may cause diseases such as cholera, typhoid and dysentery which are often reported in congested areas.

Challenges: Constraints to effective waste management are many, and they include: lack of discharge standards and methods for measuring the quality and quantity of effluents and accordingly fining the polluter; inadequate sewerage networks and treatment facilities; and lack of incentives to adopt recycling technologies. The most serious constraints affecting proper management of effluents are population, poverty, urbanization, haphazard industrial planning and water scarcity.

Urbanization, agricultural and industrial growth have resulted in increased water demand and in generation of effluents whose quantities in most cases exceed capacities of receiving bodies and treatment facilities. Wetlands, which act as pollution filters, have been encroached hence reducing their treatment capacity. Most water and sewerage departments in local authorities have insufficient financial resources to address sewerage operation, maintenance and additional development demands. Plans to supply additional water are not matched by equivalent wastewater disposal plans. Unplanned settlements present complications even where plans for disposal exist. The aforementioned shortcomings are aggravated by poor enforcement mechanisms. The major challenge is to develop standards, guidelines, criteria and procedures for monitoring and enforcing quality standards.

Various pieces of legislation dealing with the management of effluents in Kenya are not effectively harmonized. Penalties are usually too low to be effective deterrents. The statutes include: the Water Act; Public Health Act; the Pest Control Products Act; the Radiation Protection Act; the Mining Act; and the Factories and Other Places of Work Act.

Addressing the Challenges of Water and Sanitation

Wastewater management is not widely adopted among industries in Kenya. This is because the costs involved are high and the direct benefits to the manufacturer are considered minimal. With appropriate research and development, some useful materials can be recovered from wastewaters and re-used.

The country suffers heavy social, economic, public health and environmental costs due to poor effluent treatment and discharge practices. It is therefore necessary that greater effort is given to public education and awareness creation, voluntary compliance as well as harsh and punitive measures.

A low-input method of treating liquid wastes, which is increasing in popularity, is the constructed wetland. Raw sewage mixed with bacteria is passed through vegetation and under the surface. Then it passes through a number of pools bordered with vegetation. The bacteria and plants remove the pollutants. Some priority actions are proposed and include:

- Monitoring, auditing and evaluating current effluent management systems.
- Promoting inbuilt effluent management infrastructure in processing and manufacturing.
- Building capacity of municipal and local authorities on effluent management
- Promote adoption of innovative, cheap and low input method of treating liquid waste such as constructed wetland.
- Review and harmonize existing laws on effluent management.
- Promote the use of economic instruments to encourage adoption of clean production technologies through reduction, reuse and recycling.
- Promote public awareness and education on proper effluent management.
- Constantly review and update the water standards regulations.
- Review penalties under the law with a view to making them more deterrent.

- Improve industrial operations and use raw materials with a high rate of conversion to products in order to reduce the amount of waste.
- Rehabilitate existing wastewater treatment systems that are inefficient and/or inadequate.
- Provide funds for the sustainable maintenance and operation of treatment facilities.

3.0 POLLUTION

3.1 Solid Waste

The rapid population growth has increased the demand for urban, agricultural and industrial goods and services thus leading to generation of vast amounts of wastes. Solid waste is any material regarded to have lost its usefulness and is cheaper to discard than utilize. Most wastes are produced by industrial, agricultural, institutional, domestic, construction, mining and processing operations.

Waste generation is commensurate to population pressure, the level of a country's development, production and consumption patterns. High-income areas have higher per capita waste generation and diversity in the composition of waste than low-income areas.

An important source of waste is mining. It is physically destructive, producing various sizes of pits and heaps of waste. Quarrying is a very widespread open cast mining method in Kenya. Shaft mining goes deep into the earth's crust and is only noticeable on the surface due to waste product disposal heaps. The major impact on the environment is normally felt when these mines collapse or humans fall in them.

Discarded plastic and polythene products, especially packaging materials make-up a growing portion of municipal and solid waste. Blockages of sewers are increasingly being attributed to these materials. Farmers also have complained about many of their livestock dying after ingesting plastic or polythene materials. Resistance of plastics to degradation compounds their negative impacts on health and the environment.

Impacts: Some solid wastes are hazardous and have the potential even in low concentrations to have adverse effects on public health and the environment due to their inherent toxicological, chemical and physical characteristics. They may be radioactive, toxic, explosive, corrosive, flammable or infectious. Improper disposal of solid wastes block sewer lines and drainage channels, attract scavengers: humans, birds and other animals. They also become breeding grounds for many disease vectors (mosquitoes, flies, rats, snakes etc.), produce bad smell and smoke, become causes of public health risk, pollute ground and surface water as well as soil.

Management Shortfalls: Solid waste management (SWM) cycle include generation, handling, storage, transport, treatment and final disposal. Most local authorities in Kenya collect and transport about 40% of solid waste generated in their areas of jurisdiction due to limited finances. The frequency and thoroughness of solid waste collection is poor. Frequency of collection is not based on storage capacity but on the availability of functioning vehicles; priority is given to central business districts and high-income residential areas. Least effort is given to the low and middle-income areas and slum settlements.

Most institutional and domestic wastes are mixed. This exposes the workers to risks, as they may not be aware of the dangers inherent in such wastes. In most hospitals and some research institutions, some of the solid wastes are burned, against current accepted air pollution management practices.

Solid wastes in our urban areas of Kenya is disposed of in open dumps or crude sanitary landfills; burned; or composted. In low income areas, collection service is very poor, the most common mode of disposal being dumping along streets, play fields and between houses. Most local authorities prefer disposing solid waste in crude sanitary landfills, a technique that approximates dumping. The costs involved are nominal, hence the preference given to this technique.

Burning is practised in the estates, often after separation of combustible materials, usually plastics and paper. By so doing the residents usually increase the time taken for their bins to fill up. Composting is generally practised in estates that have large compounds and within the rural areas.

Addressing Challenges of Solid Waste

Cost Analysis: The socio-economic, public health and environmental costs due to the impact of inadequate waste disposal systems are enormous compared to the cost of proper disposal or recycling. These are issues of national concern and need urgent attention.

Regulations: The Local Government Act provides for the establishment of local authorities with powers and duties to provide clean and sanitary services in their areas of jurisdiction. The Act empowers local authorities to make by-laws deemed appropriate in its management. The by-laws and regulations are currently outdated and too weak in penalties to deter offenders and there is also poor enforcement, if any.

The Public Health Act considers solid waste management only in the context of public health and not expressly on the environment. With the growth of medical centres especially in urban areas, their wastes end up in dumpsites instead of following guidelines and provisions of the Public Health Act.

Disposal operations are poorly supervised. The method of collecting wastes is dangerous as disposal sites are open to the public and animals, creating a dangerous health situation. Currently, private firms use disposal sites without a fee, while most local authorities allow refuse at most disposal sites without proper handling procedures.

Responses: The Environment Management and Coordination Act (EMCA) of 1999 has provisions for solid waste management. The provisions prohibit discharging, disposing of or transporting any wastes by any person whether situated within or outside Kenya in such a manner as to cause pollution to the environment or ill health to any person. The provisions further prohibit anybody from operating a waste or dump site without a licence. The law prohibits dangerous handling and disposal of wastes. Some priority actions include:

- Separation of waste at source - this has no cost implications;
- Record keeping of sources and dumpsites;
- Training of personnel, public participation, education and awareness creation;
- Monitoring, auditing and evaluation;

- Research to introduce cleaner production techniques through reduction, recycling, reuse and composting; and
- Promote involvement of private sector in solid waste management. Currently privatization has not been fully embraced by local authorities in Kenya.

3.2 Chemicals

Chemicals are used in our everyday lives. Modern fertilizers and pesticides have been a boon to agriculture for years. Chemicals have served medicine in many ways, ranging from pharmaceuticals to the equipment and materials used in hospitals. Our quality of life would not be the same today without a healthy chemicals and manufacturing industry.

Today, there are some 70,000 different chemicals on the market with 1,500 new ones introduced every year. Demand for increased food production and advances in technology has provided materials, and new industrial processes resulting in increased production and use of chemicals. Chemicals released into the environment may pollute the air, water and food. They may also have an adverse impact on forests, soils, and aquatic life. Therefore, industrial development, including production, storage, transport and trade, has significantly increased the number of people at risk to chemical hazards. Chemicals can be classified into four broad categories: industrial, agricultural, household and body care, and pharmaceuticals.

There is a strong belief that chemicals will be required if poverty trends are going to be stopped and reversed. Pesticides have been in use in Kenya since 1908. By the 1940s various copper compounds were in the market, including the DDT, lindane, dieldrin, aldrin, endrin, endosulfan and heptachlor. All these are now classified as persistent organic pollutants and slated for banning or restriction under the Stockholm Convention on Persistent Organic Pollutants. There is now enough data and information to support the ban.

Table 3.1 gives the amount of pesticides imported into Kenya in 1990s according to their toxicity. About 38% of all pesticides imported are fairly toxic. This has necessitated restrictions and outright ban of some of the chemicals (Table 3.2). The most commonly used or those commonly mentioned by farmers are shown in Table 3.3. On average, 6000 tonnes of pesticides are imported annually into

Kenya. Only 5% of these are re-exported as follows: fungicides 50%; insecticides 20%; herbicides 18%.

Table 3.1: Amount of pesticides imported into Kenya in 1993 by toxicity class

WHO Toxicity Class	Amount (tonnes)	Per cent of total
Extremely Hazardous	79	2
Highly hazardous	92	2
Highly hazardous volatile fumigants	422	11
Moderately hazardous	815	22
Slightly hazardous	906	24
Unlikely to present Acute Hazard	929	25
Not classified by WHO	103	3
Unidentified	373	10
Grand Total	3725	100

Table 3.2 Status of banned/restricted pesticides in Kenya

Substance	Use (restricted/banned)
Dibromochloropropane Ethylene Dibromide 2,4,5,T Chlordimeform Hexachloreychlohexane (HCH) Chlordane, Heptachlor,	Banned in 1986
Endrin, Toxalphen	
Parathion	Banned in 1988
Captafol	Banned in 1989
Lindane:	Restricted to seed dressing only since 1986
Aldrin:	Termite Control in the Building Industry
Dieldrin:	
DDT:	Restricted use by Public Health

Table 3.3 The characteristics of the most frequently used pesticides

Product name	Active ingredient	Common usage	WHO Hazard classification*
Copper (various)	Copper	Fungicide	III
Lelaycid	Fenthion	Insecticide	II
Sumithion	Fenitrothion	Insecticide	II
Gramoxone	Paraquat	Herbicide	II
Ambush	Permethrin	Insecticide	II
Karate	Copper	Fungicide	II

*I = Lethal dose (LD50) less than 10 mg/body weight

*II = LD: 11mg – 50mg/bw

*III = LD: over 50mg/bw

The dirty dozen that some of you may have heard of include DDT, toxaphene, chlordane, aldrin, endrin, dieldrin, mirex, heptachlor, hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) dioxins and furans. Some of the general properties of persistent organic compounds include:

- High toxicity at low concentrations for example a single molecule of the compound can attach to a receptor site in a cell and trigger numerous effects.
- They resist photolytic, chemical and biological degradation
- They are of low water and high lipid solubility hence, bio-accumulating in fatty tissues of living organisms.
- Their ability to be magnified by factors of many thousands as they work their way up the food chain.
- They are semi-volatile and can be carried long distances in air and water currents – subject to global distillation, (migration from warmer to colder regions).
- They can bind with organic components in the soil and marine ecosystems from where they enter the food chain
- They take a long time to degrade; if they degrade at all.

Impacts: The wide dissemination of chemicals in the environment and their negative impacts to health are increasingly bringing the issue of sound management of chemicals into sharp focus. An understanding of the causes and effects of the of chemicals is urgent especially for developing countries. Above all, the methods to address mitigation measures are even more crucial in human, environmental and food safety.

In the manufacturing sector, workers and users handling chemicals can be exposed to serious health risks. Problems arise due to lack of procedures on disposal of unwanted and expired chemicals; or to improper packaging, labelling and storage. Transportation by air, rail, road, or sea also presents possibilities of hazards arising from accidents. The use of mercury in small-scale gold mines along rivers and lakes poses health risks both to the miners and water users. Mercury accumulates in animals and human tissues, leading to long term poisoning.

Local and regional chemical contamination of air, water and soil arises from three basic mechanisms: release of the pollutants at the source or emissions; dispersion and chemical transformation of the pollutants in the air, water, soil; and the concentration of the compound and finally its metabolites.

Some chemicals have been cited as causing various disorders and diseases, including cancer, birth defects, neurobehavioral disorders and impaired immune functions. Thousands of cases of accidental poisoning result from the inappropriate use of highly toxic formulations, or their use in locations where protective equipment is unavailable or unused. Pesticides introduced into the environment can cause serious environmental damage through leaching, volatilisation, and accumulation in humans and wildlife. There is inadequate data on some of the chemicals in use today to understand their risks. Furthermore, basic protection measures for consumers, workers and the environment are often lacking and in most cases not disclosed. Increasingly, the manufacture of chemicals is shifting from developed to developing countries where the capacity to provide such protection is limited.

The negative impact of some chemicals has been investigated and documented. A survey of poisoning cases affecting very poor subsistence farmers growing maize and beans in Nicaragua presents a situation almost typical of Kenya. The survey, conducted in 1999 was concerned about the high levels of under-

reporting of poisonings and the inadequate reporting procedures. The survey assessed records covering the period 1995-98 and carried out interviews with health and agriculture professionals, pesticides retail outlets and staff of local government and civil society organizations, in order to get a better understanding of the pesticide exposure situation.

Total acute poisonings recorded over the four-year period were 202, increasing from 24 in 1995 to 73 in 1998, indicating a disturbing 200% increase. It was estimated that over a quarter of actual poisoning cases do not enter the official records, although they may be treated at local hospitals or health centres.

Organophosphates accounted for most fatalities followed by herbicides and carbomates. One of the products named as being responsible is gramoxone (Paraquat). It was rated at the top with 24 poisonings directly attributed to its use followed by gastoxine (phosphine) with 21 cases. It was estimated that six out of every ten cases were not recorded in the national epidemiological vigilance database or in the health ministry's pesticides programme register. Let me advise that the labels on the said compounds are very clear. However, small amounts of these chemicals can cause death if not properly used or if the labels do not clearly specify dangers associated with improper use.

As I finish discussion on this particular section, let me give you some statistics on the current status of pesticide disorders to date:

- 118 active ingredients are endocrine disruptors
- 60 active ingredients are classified as carcinogenic to some degree
- 129 are defined as extremely or highly hazardous by WHO (Class 1a or 1b)
- 111 are organic pollutants

(Source: FAO Pesticide disposal series No. 10)

Addressing Challenges of Chemical Pollution:

Toxic chemicals which find their way into the environment contribute to pollution. A significant number of chemicals persist in the environment for many years, often causing irreversible damage. Constraints to proper management of chemicals is due to inadequate national standards on safety;

inadequate trained manpower to enforce laws; inadequate equipment and laboratory facilities; and inadequate guidelines on disposal of expired drugs or agro-chemicals and drugs; and management of non-biodegradable products such as plastics.

In Kenya, there is inadequate awareness, ineffective enforcement of law and inadequate technical information on how to protect human health and the environment against dangers inherent in the use, handling, and disposal of chemicals. As a result, the pharmaceutical manufacturing companies and other industries dispose of their chemical waste into sewers without due consideration of their impact. In rural areas, users apply agro-chemicals (fertilizers and pesticides) without proper consideration of the quantities and time of application. Furthermore, direct application of chemicals on water courses for the control of disease vectors is often done without adequate consideration of other impacts.

Legislation on the use of chemicals are scattered over many acts. The main legal instrument for managing chemicals is the Food, Drugs and Chemical Substances Act Cap. 254. The Public Health (Standards) Board Act, Cap. 254, controls potentially dangerous and harmful chemicals. However, the Act is not clear on the licensing and registration of foods, drugs and chemicals; and fails to identify the lead institution to coordinate chemical management. The Pharmacy and Poisons Act, (Cap 244) is used to manage pharmaceutical products, while the Pest Control Products Board registers and monitors a number of products.

There has been a proliferation of measures at the global level to address chemicals safety across sectors and societies. These measures include: conventions, codes of conduct, guidelines, risk assessments, information transfer, capacity building, etc. The measures have been translated at operational levels through legislation, banning, regulations, safe use campaigns, integrated pest management strategies, etc. These initiatives provide a link between collective management and ability of individuals or communities to contribute to management efforts. Barriers to development of these abilities need to be removed. These barriers include:

- Mismatches in information and knowledge flows as well as experience between individuals and institutions.

- Taking action when there is uncertainty on safety of a chemical or formulations.
- Matching capacities and institutional expertise with the needs of the country.
- Appropriate labelling for semi-literate users.

Increasing globalization and the enormous market for chemicals means that safety programmes must be strengthened and steps taken to place them in the mainstream of sustainable development concerns. Such an approach should provide a policy and procedural framework for addressing both ongoing and emerging issues of concern, as well as helping to interweave policy, coordination and sustainable development objectives. Emission control should be achieved through discharge standards, cleaner production practices, pollutant substitution and prohibition. Some key initiatives are being undertaken to address such constraints. They include: improved financing programmes, developing a clear policy on chemicals management, setting up chemicals safety coordinating bodies, improving literacy levels of farmers to enable them understand labels and use instructions, and reducing taxes on protective gear.

Pollution control is multidisciplinary. Decisions relating to transport, energy, land-use, agriculture and finance have a determining influence on the future trend of pollutants. Health and environment, therefore can only be protected if the agencies in charge of transport, energy, land use, agriculture and water work together.

Kenya has an active and growing programme to help stakeholders build their capacities to manage chemicals safely. The general approach is to provide awareness, legal and policy framework and training in chemical safety elements, usually in support of the Rotterdam or Stockholm Convention. These activities are part of a rapidly growing portfolio on persistent organic pollutants (POPs) and persistent toxic chemicals.

The projects are wide ranging, including activities to develop inventories and management plans of stockpiles of obsolete pesticides; find and use alternatives to POPs pesticides; and participate in the chemical information exchange network as well as non-chemical alternatives to chemicals such as DDT used in the control of malaria breeding mosquitoes.

3.3 Emissions

Major sources of air pollution are domestic heating, electric power generation, refuse burning, industrial fuel consumption and emissions, and by-products. These pollutants are injurious to life and property when they exceed certain levels. Major variations in climatic change have been affected by these sources.

Increasing atmospheric concentrations of various gases such as chlorofluorocarbons, have contributed to the depletion of the ozone layer and threaten to bring about climatic changes including global warming, consequences which are detrimental to life on earth.

The ozone layer is found in the stratosphere, between 10 and 50 km above the Earth's surface. The layer filters and prevents most ultraviolet radiation from reaching the Earth. The life-protecting role of the stratospheric ozone stems from its ability to absorb dangerous ultraviolet radiation with wavelengths shorter than 320nm. The damage to the protective ozone layer would have harmful effects on human health, animals, plants, microorganisms, and air quality.

In the 1970s, scientists first raised concern that certain chemicals could damage the Earth's protective ozone layer. Shortly thereafter, scientists reported the existence of an ozone hole. World leaders formulated the Montreal Protocol on Substances that deplete the ozone layer, whose major aim is to reduce and eventually eliminate the production and consumption of man-made ozone depleting substances (ODS). The protocol identifies chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl chloroform, hydrochlorofluorocarbons (HCFCs) hydrobromofluorocarbons (HBFCs) and methyl bromide as the major ODS. The Protocol has also established a timetable for their eventual phase out. Since 1987, many nations have signed and or ratified the protocol.

Kenya has ratified several Conventions and Protocols for the protection of the ozone layer. The country has further reduced the importation of all ozone depleting substances and approximately sixty percent of CFCs' have been phased out.

Kenya's serious air pollution cases arise due to the massive release of pollutants due to the high and unsustainable consumption of energy, transport and industrial resources. The causal agents in order of importance are vehicular emissions, biomass burning, industries and natural causes.

Greenhouse gases in the atmosphere are increasing rapidly and disrupting the Earth's radiative balance. This disruption could result in an unprecedented global warming leading to climate changes. Climate change could have significant effects, particularly in the arid and semi-arid lands where rainfall is very variable and unreliable. Additionally, the rise of the sea level as a result of global warming could adversely affect coastal settlements, agricultural activities, the beaches, and infrastructure along parts of the coastal strip.

The large amounts of carbon dioxide released into the atmosphere through vehicular emissions also contains lead. Lead is added to gasoline for the purpose of enhancing combustion in motor vehicles. Lead contamination due to vehicular emissions is high in soils, vegetables and human blood in urban areas like Nairobi, but decreases with distance from urban areas. Studies have demonstrated that leaded gasoline has serious negative effects on human health. When ingested in high concentrations lead poisoning causes increased blood pressure, damages the liver and kidneys, impairs fertility, reduces intelligence in children, impairs reading and learning abilities, causes hyperactivity, impaired growth, and hearing loss.

In view of the above negative impacts on health, all developed countries have phased-out leaded gasoline, while developing countries are in varying stages of phasing it out. However, in Kenya there will be technical and social-economic issues that must be addressed first in regard to the oil refinery before a final decision is made on phasing out leaded gasoline. Meanwhile, disorders continue to occur.

Emerging Issues: There are emerging issues which are likely to have an impact on management of radiation substances and materials, including: dumping of obsolete equipment, illegal trading on ozone depleting substances, new substances with ozone-depleting potential are emerging in the markets, but are not controlled under the Montreal Protocol.

Damage caused by harmful ultraviolet radiation to the environment, human and plant health impacts on the economy of the country. Crop yields will decrease, while an increase in skin cancer and eye cataracts will constitute increased medical costs. Some of the obvious medical problems that manifest due to emissions include, recurrent pneumonia, asthma, frequent obstruction of airways (bronchitis), cancer, eye, nose and throat irritation (ENT).

Responses: As a country, Kenya has to adopt new ozone friendly technologies; and identify alternatives that are viable, and cost-effective. It is prudent to promote practices that would not degrade the ozone layer and hence minimize risks to human health. It is necessary to formulate strategies for phasing out ozone depleting substances and develop regulations for managing them. The strategies and regulations should aim at: building capacities in friendly technologies, collecting data and information for use in monitoring compliance with the existing protocols; raising public awareness on the problem of ozone depletion and climate change; and liaising with scientists to identify suitable alternatives.

3.4 Noise

The word noise is often used to mean sound that is unwanted, irritable or undesired. Urban noise is usually caused by a combination of: machinery in factories; juke-boxes and discotheques; loud speakers including those in passenger vehicles e.g. matatus; matatu touts shouting; motor traffic; aircraft; and quarrying and mining. Kenya's pace of industrialisation and the increase in traffic volume has worsened the problem of noise.

The noise from industrial premises may cause a nuisance not merely from intensity level but because of its special features such as continuous volumes or hums or from irregular bangs and clanks. The attitude of both workers and management in industry has been to accept noise simply as part of the job because they are unaware of its dangers.

The daily barrage of noise which the ear sustains is transformed into shock waves of fluid inside the ear; the hearing mechanisms get damaged; and this damage results in impaired hearing ability and cannot distinguish between beautiful voices and noises.

Other harmful effects on health by noise include headaches, nausea, stress, sleeplessness and general fatigue. One of the difficulties inherent in any consideration of the effects of noise is the fact that in most instances, the effects only occur after relatively long period of exposure. A person exposed for several hours a day to noise levels above 120 DBA would have permanent ear damage in a few months, although some people may even be permanently damaged by noise levels of 90-100 DBA, depending on their disposition.

The impact of noise must be well understood and appropriate management measures formulated and implemented. Noise pollution could be managed by creating awareness and educating the public about the causes. Equally, education should focus on enforcing compliance with standards on decibel levels.

4.0 CAN WE REVERSE THE TRENDS?

Kenya is a country with diverse environmental and climatic systems. Each characteristic calls for a specific way of living with regard to conservation practices. The country has adequate laws to use for effective environmental management. The Environmental Management and Coordination Act no 8 of 1999 has provisions for managing all aspects relating to the environment. Institutional and human capacities are being developed and strengthened for efficient environmental management.

Agriculture is the mainstay of our economy on which a large proportion of our people depend on. Improving agricultural production and related waste management would drastically reduce the amount of pollutants and save on soils.

Some small and large scale industries produce goods using technologies which are both expensive and wasteful. Current efforts of developing environmental quality standards and regulations would promote adoption of efficient technologies which minimize waste generation. Additionally, the available cheap labour and the well developed capacity in environmental education would be used in developing and implementing NEMA's environmental education and public awareness strategies. These resources and capacities should contribute enormously to changing of attitudes and practices with a view to transforming our country into a first class world with regard to environmental conservation. It is not too late to change and acquire new attitudes and behaviour. Conservation of our raw material, available water and recycling of garbage, for example, would change the architecture of Kenya into a haven worth admiring.

Development of culture starts with the earliest possible education to a school going child. The inculcation of culture at an early age would develop a responsible individual. African customs and cultures vary but they all tend to promote respect for wholesome living, independence and survival.

Current developments, especially globalisation and monetarisation of the economy have promoted unsustainable consumption practices which threaten these values. The Authority, through its education and public awareness programmes will endeavour to enhance the importance of environment resources in sustainable development. Efforts will be made to change attitudes that environmental resources are inexhaustible commodities: water, greenery, sunlight, air, perfect coastlines, and undisturbed ecosystems. Memories fade with fading fauna and flora as generations come and go. It may be costly to change attitudes now and save what is left as approximately 10 per cent of our fauna and flora is gone and a bigger proportion is on the endangered species list. Inculcation of appropriate culture is not costly but lack of it could be devastating.

5.0 CONCLUSION

Our country has all it takes to be a haven, a paradise and liveable. Issues on environment have been taken for granted. The air we breathe, the greenery we enjoy, the falls, cataracts, rivers, streams, seashores, lakes, mountains, swamps, valleys, fauna, flora and wild game we proudly talk about as world attractions are but a threatened beauty.

We can counteract these threats through urgent education and information campaigns, regulatory and economic incentive mechanisms and proper urban planning. The Environmental management and Coordination Act has provisions for effective management of our country. The provisions enjoin lead agencies in the proper management of the environment. The Act entitles each and every one of us to a clean environment and also makes it our duty to enhance the quality of the environment. The Act gives each person the right to seek redress if these rights are denied us. The polluter pays principle obliges us to pay for any of our actions which pollute the environment. We have enough instruments to conserve our environment through assessments and audits before licencing firms.

Colleagues, my administrative roles in public and the current position of overseeing our environment, gives me a chance to reiterate my sincere and humble call for public awareness and education. My modest research contributions to Kenya and the academic world opens new avenues of being aware that

biodiversity is not static. Weed research has got vast unforeseeable implications on the environment. Depletion of our resources is imminent and it behooves us to take care and mitigate the consequences.

Some of the obvious mitigating factors which may not require large financial input include firm execution of urban and town planning development laws to avoid haphazard informal settlements, limit and if possible reverse rural to urban exodus by introducing various types of attractive development activities in rural areas. Inducements to rural set ups, appreciation of nature's gift and benefits through formal and informal education and expending money to correct what has already been polluted. This is unavoidable. Change of individual attitude toward environmental conservation cannot be emphasized.

We can monitor the deleterious effects of our activities through state of environment reports which provide for ways of mitigating damages.

We can indeed correct and reverse the continuous environmental degradation; the trend is reversible and actions must be taken by all of us now. Let future generations also enjoy part of the abundant beauty of nature that we have enjoyed.

LIVE AND LET LIVE.

I thank you all.

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