Ecologically Sustainable Natural Resource Management (NRM) for National Development

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Abstract—Ecologically sustainable development is the environmental component of sustainable development. It encompasses the concepts of sustainability, intergenerational equity and ecological integrity. Ecologically sustainable Natural Resource Management harmonizes land use planning, water management and biodiversity conservation. This paper examines the throughput of Natural Resource Management in all its ramifications; Stakeholder analysis and participation, Management approaches (e.g. Integrated Natural Resource Management) as related to biodiversity conservation operating on the precautionary principle, Land management regarding fundamental ecological guidelines relating to landscape, disturbance, species and time. The paper then gives a number of recommendations for uplifting the practice of Natural Resource Management for a better quality environment; boosting food security built on the pillars of availability, access and use, Agroforestry, sustainable fisheries, mixed farming and polyculture (sustainable agriculture). It also recommends improved sustainable vegetation resources through bioregional policy or legislation on forests as well as creation of reserves and national parks. On sustainable mining it urges judicious utilization only with little damage to the environment while avoiding accidents and minimizing hazards. It suggests wildlife conservation methods that uphold the standards for effective maintenance of game reserves and national parks while banning poaching and illegal trade on endangered species, as stipulated by the Convention on International Trade in Endangered Species (CITES).

Keywords—Natural resource management, Ecology, Sustainable development, Biodiversity conservation.

I. INTRODUCTION

Ecologically sustainable development is the environmental component of sustainable development. It can be achieved at least partially through the use of the precautionary principle, meaning that if there are threats of serious or irreversible environmental damage lack of full scientific certainty should not deter or cause the postponement of measures to prevent environmental degradation. Also important are the concept of sustainability and the principle of intergenerational equity, implying that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for their benefit as well as for future generations. Natural Resource Management (NRM) refers to the management of natural resources such as land, water, plants and animals. Natural resources exist in diverse forms and may be classified on the basis of:

1. Source of origin, as biotic resources (e.g. plants, animals and fossil fuels)
2. Stage of development, as (a) Potential Resources – e.g. untapped petroleum; (b) Actual Resources (presently in use) (c) Reserve Resources for the future or (d) Stock Resources that are yet to be used due to lack of technology
3. Renewability, as either renewable (e.g. sunlight, air, wind, etc.) or non-renewable resources (e.g. fossil fuels).

Since NRM deals with the way in which people and natural landscapes interact, it will unite land use planning, water management and biodiversity conservation in such a way as to safeguard the future of industries like agriculture, mining, tourism, fisheries and forestry. This is because the concept of NRM overlaps that of sustainable development vis-à-vis land management and environmental preservation. [18]

II. STAKEHOLDERS AND NRM

NRM must endeavor to manage various stakeholders and their interests, their geographical locations, policies, socio-economic status, etc. Effective involvement of stakeholders in the participatory processes of NRM is quite essential. But stakeholder analysis is required to identify relevant interest groups and facilitate clear and transparent policy formulation as well as allow stakeholders to recognize conflicts of interest and how to resolve them. [6] However, care must be taken to avoid congesting the scene with too many stakeholders or marginalizing others. Alternatively, complementary forms of analysis e.g. social network analysis may also be employed. [1]

A. MANAGEMENT APPROACHES

After the United Nations Conference for the Environment and Development (UNCED) held in Rio de Janeiro in 1992, most nations subscribed to new principles for the integrated management of land, water, and forests. Although management program names may vary from nation to nation, all of them express similar aims. Various approaches are applicable to NRM but the following three suffice for effective ecologically-sustainable development:

1. Regional or community-based NRM
2. Adaptive management
3. Integrated NRM
a) Regional or Community based NRM
Regional and community-based NRM is an approach that combines conservation objectives with the generation of economic benefits for rural communities. It is based on the observation that people generally tend to conserve a resource that is linked directly to their quality of life. [18] Therefore, enhancing their quality of life will enhance their efforts and commitment to ensure the future well-being of the resource. [16] This strategy assumes that local people are in a better place to conserve natural resources when the benefits exceed the costs of conservation. This is why the United Nations advocated the community based approach in the Convention to Combat Desertification and the Convention on Biodiversity. One problem of community-based NRM though is the difficulty of harmonizing or reconciling the objectives of biodiversity protection, sustainable resource use and socioeconomic development. [11] The role of non-governmental, national and international organizations is to extend environmental and social benefits such as revenue sharing and employment. [17]

b) Adaptive Management
Adaptive management is both a social and scientific process that employs organizational strategies while implementing experimental management techniques. It is also a pragmatic “learning by doing” method which involves hypothesizing about the nature and functions of ecosystem and then testing the hypotheses by implementing different management strategies. Therefore, socio-economic and political priorities do influence adaptive management decisions.

c) Integrated NRM (INRM)
This is a systematic process of managing natural resources which includes multiple aspects of natural resource use (biophysical, socio-political, and economic) and meets production goals of producers, other direct users and the wider community through programs and welfare packages such as food security, poverty alleviation, environmental conservation, capacity building and risk management. It focuses on sustainability as well as the goals of future generations, and tries to incorporate all possible stakeholders from the planning level through implementation and completion so that any future conflicts may be resolved or at least minimized. [13] [9]

B. BIODIVERSITY CONSERVATION
Biodiversity conservation is an important element in NRM. Biodiversity is the extent of natural diversity or the variety of life. A number of threats tend to undermine biodiversity and disturb the natural balance in ecosystems, e.g. habitat fragmentation, deforestation, climate change and the invasion by alien species [4] These threats can be overcome by the precautionary management of biodiversity but precaution relies only on categorical evidence and demands an ecosystem rather than single-species approach to management [4] Thus adaptive management coupled with environmental impact assessment can be used to tackle the uncertainty and dynamism of complex (eco)systems.

C. LAND MANAGEMENT
To achieve a sustainable environment through effective land management strategies, one must try to understand the processes of nature operating in ecosystems, adopt appropriate management systems in and share knowledge and skills with professionals, experts and even local people in the area. The land manager should also imbibe fundamental ecological principles [5] or guidelines that relate to the landscape, disturbance, species, and time.

D. WATER MANAGEMENT
Water management is an important aspect of environmental management. Ideally, water resource management planning seeks to equitably supply water to satisfy all quests and needs. But presently up to 35% of human water use is unsustainable, with potential to rise with increasing levels of impact. [3] Agriculture is the largest consumer of the world's freshwater resources (70 %) This is why the World Bank targets agricultural food production and water resource management as increasingly global issues. [2] Actually, more than 1.2 billion people (1/5th of the world’s population) are living in areas of physical water scarcity. Another 1.6 billion are also living in areas with economic water scarcity [8] Humans must therefore try to avoid a global water crisis, by increasing productivity in order to meet growing demands for food, while the industrialization and urbanization movement strives to find ways to use water more efficiently. It is worthy to note that currently up to half of the world’s people now live in towns and cities. The figure is expected to reach two-thirds by the year 2050, putting further strain on the dwindling water supply of the world [14] [15]

E. FOOD SECURITY
The World Food Summit of 1996 defined food security as “[the condition] when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”. The concept of food security includes both physical and economic access to food. Food security is a complex issue because feeding more than 7 billion people will
draw heavily on the Earth’s resources in terms of land appropriation, water management, food packaging and retail. It is also linked to health through malnutrition, but also to sustainable economic development, the environment, and trade. In many countries, health issues related to food such as malnutrition and food-borne diseases (e.g. diarrhea) are becoming serious problems. Fortunately, scientists have been working to find ways to reduce food contamination via the multiple-barrier approach, whereby the food production process is analyzed right from crop-growth through their marketing to their consumption. Agriculture remains the largest crucial sector for ensuring a country’s food security.

F. SUSTAINABLE AGRICULTURE
Sustainable agriculture is the sustainable economic development objective of any nation. It comprises of environmentally-friendly methods of farming that allow the production of crops or livestock without damage to human or natural systems. As a strategy, it would prevent any adverse effect of the practice on the soil, water, and biodiversity in general. The concept of sustainable agriculture subsumes that of intergenerational equity; in relation to passing on to future generations, a conserved, improved natural resource and economic base that are neither depleted nor polluted.[7] The elements of sustainable agriculture include agroforestry, mixed farming, multiple cropping (polyculture) and crop rotation.

G. SUSTAINABLE FISHERIES
Overexploitation of the world's natural resources, such as fisheries and forests, has greatly exceeded the rate at which they can recover. For example, 12 out of 13 largest oceanic fisheries of the world are devastated. The problem of overfishing is shown by modern fishing techniques, such as those using huge fishing nets that virtually remove everything in their way; including tons of fish and invertebrates of no commercial value. This often leads to the destabilization of the ecosystems for fish, invertebrates, turtles and frogs. Overfishing, pollution, habitat change and the introduction of exotic species all pose serious threats to the biodiversity of lakes and rivers.

H. SUSTAINING VEGETATION RESOURCES
Vegetation Resources comprise of Forests and Grasslands as in the case of Sub-saharan Africa. Vegetation Resources are economically valuable by providing food, fruits, leaves and traditional medicines. They also perform ecological functions by regulating climate, conserving soil and water resources as well as providing habitats for fauna and flora. Human impact due to population increase has greatly devastated forest or vegetation resources. The result is deforestation on a massive scale as shown by the replacement of climax vegetation by scrub vegetation. For example, the destruction of forests in Africa had reached 5 million hectares in the period 1990-2000.[12] Other human activities like economic development schemes, plantation agriculture and construction of man-made lakes or dams have also depleted forests. Effective measures must be taken to protect our forests by creating forest reserves, national parks and resorts, preventing encroachment, indiscriminate felling of trees and fuel wood consumption, overgrazing, bush burning, etc.

I. SUSTAINABLE MINING
Mining operations are some of the main sources of environmental degradation. Social awareness of this problem has led to government legislations and international agreements for the prevention of activities and events that adversely affect the environment. Mining is a hazardous occupation and the safety of mine workers is an important aspect of the industry. Mining accidents are the result of human error and 60 to 75% of them are avoidable. The mineral resources include mineral fuels e.g. crude oil, coal and natural gas; industrial minerals e.g. limestone, gypsum, graphite, feldspar, gravel and sand; metallic minerals such as ores of iron, tin, copper and zinc; and precious metals e.g. gold, silver, diamond and gems[12]. Since mineral resources are finite (non-renewable) resources, they should only be used wisely or judiciously so that they can last as long as possible. In addition, the income from their sales should be utilized in developing other resources that are renewable, e.g. forests, land and water resources.

J. WILDLIFE CONSERVATION AND MANAGEMENT
Generally, wildlife is facing threats that include pollution from agricultural and industrial sources, habitat loss from forest clearance, agriculture and poaching. As a result, wildlife habitats are shrinking and corridors linking habitats are being severed while the survival of many species is becoming more and more uncertain. That is why Conservation of wildlife within reserves received high priority. The poaching of big game animals, particularly elephants, which are killed for ivory had been a sore for conservation initiatives in Africa until the Convention on International Trade in Endangered Species (CITES) voted to enforce a total ban on the ivory trade in 1989. Since then Governments have increased efforts to restore the endangered African elephant and black rhino populations, and mounted an aggressive campaign against poachers.
III. CONCLUSION
Mismanagement of natural resources must be halted. The rising human population figures in many countries implies increasing interference and increasing negative human impact on the environment all leading to the depletion of the earth’s natural resources. This shows the necessity of putting in place at any given time, effective NRM schemes.

IV. RECOMMENDATIONS
Training and retraining of personnel in environmental and conservation initiatives as a continuous exercise

Promoting functional policies on environment with strong implementation mechanisms e.g. bioregional policy on forests and safety principles in the work area

Embracing mass education or public enlightenment about resource conservation and the environment in general

Establishing Poverty alleviation packages for both the urban and rural poor to reduce overdependence on the environment

Revitalizing and managing urban and industrial water demand while empowering the rural poor and women in water resource management.

Improving stakeholder participation and sustainability principles in polyculture, agroforestry and fisheries to boost food security.

REFERENCES