lyonia
a journal of ecology and application

Volume 8(1)

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Conflictos en el uso de la tierra y manejo integrado de bosques en áreas montañosas: Estrategias para la conservación de bosques montanos en África

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July 2005
Download at: http://www.lyonia.org/downloadPDF.php?pdfID=2.365.1

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In Africa, land use and sustainable management schemes in highland areas and mountainous forest have become increasingly important and timely, as these areas, like the lowland forest, have come under serious exploitation and constant threat of disintegration, following the depletion of the majority of the lowland forest. Mountain forest, like most ecosystems, have been exploited and degraded mainly by anthropogenic activities either directly (through vegetation cover removed for timber/wood, construction, agriculture and other purposes) or indirectly (through pollution by environmental stresses such as hazardous gases/oils, global warming effects, heavy metal bioaccumulation and toxicity). These areas have also had their share of forest wildfire and defoliation, forest damage and decline by natural disasters and adverse climatic conditions. In order to arrest the situation, this paper suggests that appropriate and sustainable integrated forest management techniques be implemented and executed uncompromisingly. In this regard, geographic information system and remote sensing technologies should be employed along with appropriate methods of educating the rural populace in renewable resources utilization involving not only physical utilization of the forest resources, but also other areas of forest use peculiar to mountain forest such as profitable, sustainable ecotourism.

Resumen

En África, el uso de la tierra y esquemas de manejo sostenible en áreas de altura y bosques montanos son cada vez mas importantes, ya que estas áreas, de la misma manera que los bosques húmedos, están bajo de constante explotación y de desintegración, después de la destrucción de los bosques de la zona baja. Los bosques montanos han sido explotados y degradados especialmente por actividades antrópicas de manera directa (destrucción de la capa vegetal para madera, construcción, agricultura y otros usos) o indirecto (contaminación del medio ambiente por aceites, gas, calentamiento global, acumulación de metales pesadas, toxicidad). Estas áreas fueron afectadas por fuego, defoliación, y destrucción de bosques por desastres naturales y condiciones climáticas adversas. Para remediar esta situación, este trabajo sugiere el implementar técnicas apropiadas e integradas al manejo del bosque. De esta manera se aplica el uso conjunto de sistemas de información geográfica, con métodos propios para la educación de la población rural sobre uso de recursos renovables y uso de los recursos forestales por actividades comerciales como el ecoturismo.

Introduction

Mountains and hills cover about a third of the globe's landmass. Mountains are highland areas found at great heights on the earth's surface, many of which are covered and carpeted by a lush of green vegetation of trees, shrubs, herbs and grasses. Some mountains are adorned with white snowflakes especially at higher peaks while some are bare with smooth rocky surfaces. At times, plant species of the Bryophyta, Thallophyta and Pteridophyta colonized these surfaces, forming distinct micro-ecosystems.

Mountain forest ecosystems, like their lowland counterparts may possess the entire canopy strata and grades. Both plants and animals species flourish adequately well by virtue of the natural resource availability, especially in the lower slopes and upper valley planes. Most mountain ecosystems throughout the world exhibits similar patterns and characteristics, with the major structural feature being the tree line - the point on the upper slopes of mountains where the climate becomes too harsh to support trees and an alpine vegetation prevails.

Prolonged and extreme climatic conditions coupled with excessive and perturbing anthropogenic activities have made mountain forests, in many parts of Africa depreciate in both quality and quantity. For sustainability, an integrated forest management programme is necessary. This programme, which will include adequate forestry training for the local people and their immediate community, will contribute immensely to the preservation and the overall conservation efforts of these precious forest resources in Africa.

This paper presents a number of pertinent recommendations that could contribute immeasurably to land use and integrated forest management in the mountainous regions of the African

continent.

Methods

Both primary and secondary data were gathered. While most of the work was based on the secondary data collection and analysis through desk research work, the primary data gathering was basically through reconnaissance visits to certain specific highland sites and cloud forests in Nigeria (e.g. Jos, Plateau) and Cameroon (e.g. Buea, Mount Cameroon).

Results

Ecology of mountain forest and their unique features

The climates of mountain forests are typically cool and humid. They are seldom warm due to high altitudes and hardly ever dry because of the ample supply of precipitation. Mountain environments have different climatic conditions from that of the lowland regions, hence the vegetation differs as well. The differences in climate result from two principal causes: altitude and relief. Altitude affects climate because atmospheric temperature drops with increasing altitude by about 0.5 0 C to 0.6 0 C per 100m. Relief of mountains affects climate because they stand in the path of wind systems and force air to rise over them. As the air rises it cools, leading to condensation and ultimately higher precipitation on windward mountain slopes (orographic precipitation); as it descends leeward slopes, it becomes warmer and relative humidity falls, reducing the likelihood of precipitation and creating areas of drier climate (rain shadows). Altitudinal modifications of vegetation are clearly discernible on the high East African peaks near the equator such as Kilimanjaro (the highest peak in Africa - 5, 895m) and Mounts Kenya (3, 100 m) and Elgon.

The mountainous forest, especially those at great proximity to water bodies, are unique in that they receive a steady and an abundant supply of rainfall from the nearby lakes, rivers and oceanic seas. Some of these regions are considered to be the wettest areas in the world. Three of such places are Debunsha, Cameroon; Cherrapunji, India; and Mount Waialeale, Hawaii. Debunsha village is at the foot of Mount Cameroon (peak - 4,095m) with a mean annual rainfall of more than 10,000mm. Cherrapunji is noted for having the world's second highest recorded average annual precipitation of 11,430 mm over a 74-year period. Mount Waialeale holds the highest record of precipitation (11, 684 mm). The consequence is nothing but a great variety of biological resources. This is especially true in tropical mountain forests. Biu (800m), Mambilla (1000m) and Jos (1,500m) Plateaus in Northern Nigeria, as well as Buea in Cameroon, the Mounts Kenya and Kilimanjaro in East Africa are among the many examples of highland areas with a rich biological diversity. The effect of climate on vegetation in mountainous regions is often masked by edaphic and biotic factors.

Mountains and highland forest in Africa are noted for a variety of notable natural and man-made disturbances, such as acute climate, forest fires and deforestation. The impacts of these have led to forest defoliation and decline. Fire sources in mountain areas include volcanoes, lightning and intentional as well as accidental fires caused by humans (Horn, 1998). Because they are already under a great deal of environmental stress, mountain ecosystems cannot easily cope with further anthropomorphic perturbations, such as the introduction of exotic species, over-grazing, atmospheric pollution and other forms of misuse.

Threatened mountains forests

The rich biological diversity in many highland forests in Africa is threatened. The cause of this is not farfetched. Apart from adverse climatic stress, increased human population and the insatiable demand for more natural resources including land, forest and food are major factors contributing to natural resources depletion and losses in biodiversity (Arimoro et al., 2002; Okali, 1985).

Mountain forest floors in Africa are extremely rich in mineral nutrients. The volcanic soils, which are particularly fertile and highly suitable for plant growth, soon become impoverished after intense exposure to wind, solar energy and on-going arable, monoculture farming system. Having seriously exploited and utilized the resources found in the lowland areas and valley planes, more and more people have started to shift base uphill (Sanwo, 2002). With the same anthropogenic paraphernalia and activities used to devastate the lowland ecosystems, man has started to perturb, to a large degree, the mountain forest and it's resources. His climbing up this former haven of great beauty and delight has resulted in a great shift/change in land use. The Holy Bible seems to support the climb upwards if one considers the passage in Haggai: Chapter 1 verse 8: "*Go up to the mountain to get the wood. And build the temple. Then I will be pleased with the temple and I will be honoured."* This great demand and excessive exploitation of land resources has been part of the product of

land use conflict observed during and in the course of man's perturbations of mountain forests. In the long run both renewable resources and non-renewable resources are degraded and depleted in an unprecedented scale. If left unchecked, wastelands, unproductive soils and desert encroachment are usually the final outcome (Arimoro, 2001). In many African countries, forested highlands are stripped off their natural vegetation without proper environmental impact assessment studies (EIA). The land is then divided up and utilized for the following major unsustainable human uses: poor arable farming and terracing, monocropping and livestock grazing; extensive archaeological, mining, quarry and other exploration activities; and huge construction of buildings, roads, bridges and other infrastructures. Such areas of land use associated primarily for economic activities and pursuits create serious challenges for conservation and good management strategies (Zimmerer and Young, 1998).

This is particularly noteworthy in many mountain forests in developing countries and the African sub-region. Some Afromontane forests as the Manengouba forest in Cameroon have shown indicators (e.g. presence of the date palm, *Phoenix reclinata*,) of undesirable encroachment due to cultivation and firewood collection, which has endangered several endemic birds, amphibians and rodents (Decoux et al., 1991). Other examples of such land use changes are found in Asia, East and West African countries including Nigeria. The forest landscape of the Sagarmatha 'international' Park on the Mount Everest's southern plains (earth's highest peak - 8, 848m) has been reported to be at risk from human encroachment and activities such as woodcutting, livestock grazing and uncontrolled tourism.

In Nigeria the vegetation of the Jos Plateau (1,500m) has been so devastated by human interference that little can be inferred from it to aid classification of the original vegetation. The greatest environmental abuse factors in Nigeria can be summarized as human activities resulting in drought and desertification, dissicating winds, forest fires, erosion and harsh climatic conditions (Okali, 1985; UN, 1977). According to Okali (1985), human abuse of the environment is driven by motives that are often outside the competence of ecological science to handle, this is because they are driven by "prevailing economic perspectives by technology, industrialization, urban development, inadequate planning and cultural attitudes". An example is the need to produce food and other materials for sustenance or economic gain that drive people to use ill-advised techniques on the forest land to exhaustion even though all along, they could see yields declining, forest disappearing, erosion and land wasting.

The highland areas of Nigeria have particularly experienced high population growth rate and accelerated urbanization. This has led to a considerable increase in the demand for wood and other forest products. To ensure a sustainable supply of these products, there was the need for better forest management and balanced land use planning based on adequate knowledge and information about the country's high forests and plantation estates. Consequently, a national forest resources study was put in place with the overall objective of enhancing industrial forestry development in the country, which will aid in facilitating the management of the remaining forest resources in an efficient and environmentally sound manner (FORMECU, 1999). Forest management objectives in highland areas of Plateau, Nasarawa, Taraba, Adamawa and Benue States were designed to manage forest resources in a sustainable way and to ensure a continuous supply of timber and non-timber products, the provision of employment opportunities, and the maintenance of a stable environment in these and other States of the Federation.

Sustainable integrated forest management

Sustainability has recently become a fashionable concept in relation to everyday life (Gane 1992), the management of renewable resources including forests (Sanwo 2002; Jerkins et al, 2000; Gane, 1992) and human development (U.N, 1997). Gane (1992) describes sustainability as finding a path of economic progress that does not impair the welfare of future generations. UNEP further describes sustainable living as the lifestyle of an individual who feels the obligation to care for nature and every human individual who acts accordingly. Sustainable human development therefore takes care of the poor urban and rural dwellers in Africa by not only generating economic growth for them but also by distributing its benefits equitably and by regenerating the environment (Sanwo, 2002).

A sustainable forest management approach to the conservation of mountain forest resources will greatly contribute to human welfare in Africa. The most recent innovation and key factor in forest management which conforms to a sustainable forest management, is the use of new forest practices that will enhance the maintenance of forest ecosystem in a sustainable way. In other words, human activities in the forest should not negatively affect the ability of the forest to continue in the way it was originally (Franklin, 2001). This can only be achieved through the promotion of self-reliance amongst the rural people through their active participation in natural resource and forest activities including

ecotourism (FAO, 1985; Sanwo, 2002).

The field of ecotourism emerged in the mid-1990s and it is increasing in popularity within the context of economic growth, development and natural resource sustainability. Ecotourism, unlike uncontrolled and exploitative tourism, is being developed with the aim of helping indigenous people to disengage from subsistence practices that degrade the environment and cause biodiversity erosion (Sam, 1999). This form of ecological and economic tourism as well as controlled recreational and educational exploration aims at sustainability. Thus, ecotourism promotes the progressive economic growth and development of a nation without stressing or degrading environmental resources. The activity helps to contribute to biodiversity conservation, wildlife inheritance protection and the preservation of the cultural heritage of natural landscapes and aesthetics. Ecotourism is essentially defined as tourism practiced in relatively undisturbed natural areas, for the main purposes of admiring and learning more about them. Hence, ecotourism must be accomplished with the view to producing minimal impact on and in the area visited. The European Federation of National Parks also defined sustainable tourism in natural areas as: "all forms of tourism development, management and operations which maintain the environmental, social and economic integrity and well-being of natural, built and cultural resources in perpetuity" (Yunis, 2001). Developing countries in Africa and beyond continue to experience increases in the ecotourism market, exposing more visitors and recreationists to their cultural heritage, no doubt boosting the local economy. Integrating sustainable ecotourism in mountain environments, therefore, benefits host nations both economically and ecologically.

An integrated environmental management technique will make use of the other necessary workable management techniques available to preserve and conserve forest resources. An efficient sustainable integrated forest management (SIFM) strategy aims at environmental friendliness and sustainability. It is one that will enhance proper forest resources utilization and optimal land use schemes. The application of SIFM strategy is not limited to researchers, policy makers and governments alone. Rural and urban dwellers and other stakeholders are all part of the process. Co-operation between them is also needed. The bottom-up approach method of actively involving community dwellers in community-based development programmes are of utmost importance as this is now achieving greater success in sustainable environmental management and ecosystem conservation methods (FAO, 1985; FORMECU 2001; Lusigi, 2001). Various SIFM methods are working for mountain forest in Africa by regenerating and rehabilitating forest areas. Regions in the developing countries of Latin America, Asia and Africa such as Cameroon, Tanzania, Kenya, Zaire, Nigeria, Venezuela, Peru and Nepal where forested highlands are being devastated are encouraged to employ more of these techniques as the case may be (Noss, 1999).

An integrated forest management approach that will enhance sustainability, however, will incorporate viable facets to proper land use schemes. The management may allow for the establishment and maintenance of the following: secondary/high forests; afforestation/plantation; agroforestry/alley cropping; aesthetics and ecotourism; and national parks/sanctuaries and game/forest reserves.

The execution of *in situ* and *ex situ* conservation methods is of utmost importance for sustainable management and development. *In situ* conservation involves the maintenance of biological diversity in their wild state and within their exiting range. On the other hand, *ex situ* conservation is the maintenance of biodiversity in cultivation or captivity. Plants may be maintained in seed banks or germplasm collections. *Ex situ* measures include the conservation of species in botanical gardens, game farms, zoos and gene banks, where possible. In addition, bioremediation techniques could be applied at appropriate stages during ecological restoration programmes. Bioremediation is a principle as well as a technique whereby biological resources are utilized to restore a degraded area to its original state (Arimoro, 2001).

The role of remote sensing and geographical information systems

The role of remote sensing and geographical information system (GIS) technologies as well as other computer models in ecosystem management is indispensable. These are proficient, analytical and evaluation tools in forestry and other environmental sciences. Their contribution to efficient forest assessment, monitoring and management in developed countries is inestimable. Hence, their application and optimum utilization in integrated forest management for mountain forests in the Africa are highly recommended. It has, however, been shown that their application in the developing world is quite limited due to inadequate information, facilities and technological know-how. (Arimoro et al., 2002).

Remote sensing is a procedure for collecting data about features and targets on earth’s surface, often in the form of photographs and images. It involves the detection, recognition, and evaluation of

objects by mean of distant sensing or recording devices. It is indeed one of the most powerful tools available for collecting, collating, analyzing, monitoring, quantifying and mapping environmental data and their associated changes (Franklin, 2001). It is effectively modified and designed to support sustained forest management especially in presenting and reporting criteria and indicators of sustainable forestry and land use (FORMECU, 1998; FORMECU, 1999).

GIS is a computer-based system for the digital entry, storage, transformation, analysis and display of spatial data (spatial data will include maps of vegetation types and land use; point observations of rainfall; images from satellite a data or remote sensing; and tabular data associated with geographical areas such as demographic reports). The synergy between remote sensing, GIS and other scientific application and models has resulted in the formation of the geographic information science (GIScience). GIScience has thus become a masterpiece set of tools for integrate management of mountain forests (Franklin, 2001). Institutional capacity building through training, education and technology transfer especially at the grass-root level will crown the process of a good mountain forest management strategy. All parties need training on new techniques for continuity and maintenance. The necessity for stakeholders, government agents and the rural dwellers to be trained and educated in modern forest skills is especially essential in Africa, where the level of illiteracy is high and modern tools and equipment are lacking. This is mandatory, if the needs of the people and the sustainability of the forests are to be met at the same time.

The use of these modern techniques have been clearly demonstrated and successfully applied in Africa. Between 1976 and 1995, using satellite imagery and GIS technologies, changes in the land use and vegetation was mapped, analyzed and recorded for most parts of Nigeria. For example, Table 1.1 (under the list of attachments) shows that some changes in the land use and vegetation of Nigeria did occur over a 20-year period.

This regional data [[(Table 1.1)]]on the national development (FORMECU, 1998) reveals that there is a general decrease on forested areas that are not located on highlands. A general increase can be seen in the size of agricultural and grazing lands, suggesting encroachment on the plane lands by bad agricultural practices.

Table 1.1: National Area Increase/ Decrease between 1976/78 and 1993/95

Category	%Change Increase	% Change Decrease	New Area Involved km2
Intensive (crop agriculture)	5		42,697
Extensive (grazing) agriculture	3		20,910
Agriculture within denuded area	0.6		5,688
Floodplain agriculture	1.3		11,467
Savanna: Guinea		8	69,907
Sudan		3.5	32,186
Sahel			No change
Forests: Undisturbed		1.6	13,837
Disturbed	0.5		4,417
Riparian		0.2	2,148
Montane: Forest			No change
Grassland	0.1		1,373
Grassland: Continuous	0.8		6,955
Discontinuous	0.5		5,111
Floodplain: Swamp	0.1		7,651
Grass marsh		0.5	4,011
Coastal: Freshwater		0.9	7,651
Mangrove			Negligible
Tidal flats saltwater swamp	0.1		541
Exposed Areas: Gully Erosion	2.0		18,395
Sand dunes	0.4		4,017
Rock Outcrops	0.1		1,208
Reservoirs	0.1		1,561

Source: FORMECU, 1998

Similarly Tables 1.2 and 1.3 show changes in land use in the lowland as well as highland areas of Adamawa State (with a total land area of over 36,000 km2) and Bauchi State (with a total land area of about 66,000km2).

[[Tables 1.2]] shows that some changes did occur in the forested areas of Adamawa State. Before 1976 there ware apparently no disturbed forest ecosystems, however due to perturbation this area increased to 1,543 km2 of the total land area of the State in 1995. It is also important to note that the montane ecosystems (especially forest and grassland) have not been seriously encroached

during this period. However, with increased population moving upland in the recent times, in search of 'fresh' natural resource including land, these areas and their ecosystems are in danger of serious and irreparable depletion.

[[Table 1.3]] shows that intensive and extensive agricultural practices by man have reduced the natural vegetation and undisturbed forests to less than 1% of Bauchi State's total land area of 66,000 km2. The degradation has lead to the formation of gullies and disturbed forest ecosystems. This illustrates the urgent need of a more sustainable management practice that will promote proper natural resource utilization, hence, protecting and conserving the valuable biological resources for the benefit of both the present and future generations.

GIS and remote sensing tools allow for the generation and mapping of these pieces of information as well as monitoring and future research work with a view to updating such information for further analyses and assessment.

Table 1.2: Dominant Vegetation and Land Use Classes in Adamawa State, 1976/78 and 1993/95.

Vegetation & Land Use Categories	**Area (km2) 1976/78**	Percent of State **1976/78**	**Area (km2) 1993/95**	**Percent of State 1993/95**
Extensive (grazing) Agriculture	9291	25.4	10928	29.8
Shrubs/Grasses	11723	32.0	10062	27.5
Intensive (crop) Agriculture	8487	23.2	8082	22.1
Trees/ Woodlands/ Shrubs	4361	11.9	2319	6.3
Disturbed Forest	0	0	1543	4.0
Floodplain Agriculture	348	1.0	1120	3.1
Montane Grassland	0	0	614	1.7
Montane Forest	281	0.8	573	1.6
Rock Outcrop	5	<0.1	169	0.5
Shrub/Sedge/Graminoid Fresh water marsh/Swamp	679	1.9	129	0.4
Undisturbed Forest	1022	2.8	119	0.3

Source: FORMECU, 1998

Table 1.3: Dominant Vegetation and Land Use Classes in Bauchi State, 1976/78 and 1993/95.

Vegetation & Land Use Categories	Area (km2) 1976/78	Percent of State 1976/78	Area (km2) 1993/95	Percent of State 1993/95
Intensive (Crop) Agriculture	20,026	30.3	27,338	41.4
Shrubs/Grasses	14,833	22.5	15,593	23.6
Extensive (grazing) Agriculture	11,049	16.7	12,050	18.3
Trees/Woodlands/Shrubs	14,754	22.3	3,571	5.4
Gullies	0	0	1,403	2.1
Disturbed Forest	0	0	1,322	2.0
Grassland	0	0	470	0.7
Undisturbed Forest	2367	3.6	125	0.2

Source: FORMECU, 1998

Discussion

In order to avoid increasing deterioration of the mountain forests of Africa and the fertile land on which they stand, sustainable integrated forest management programmes should be implemented and applied. Integrated forest management methods will contribute to the many efforts to conserve the ecosystems and protect the global environment as a whole. Integrated forest management for mountain ecosystems in the developing world of Africa would be sustainable and environmentally sound if implemented, administered and executed in the appropriate ways, bearing in mind the peculiarities of the forest to be managed, the foresters and communities concerned. For greater successes in mountain forest management procedures, therefore, the following recommendations will be of great benefit to forest managers and all stakeholders, especially the rural communities (Sanwo, 2002; Arimoro, 2001; FAO, 1994):

Conservation techniques should include the maintenance of large establishment of reserves, sanctuaries and parks for sustainability and ecotourism development.

Private, communities/groups could promote forest development initiatives such as individuals establishing plantations, orchards or wood lots and planting trees on the farm or compound.

In situ and *ex situ* conservation should be reinforced.

Sustainable ecotourism should be implemented. Influx of peoples during educational and recreational activities of exploring and appreciating natural landscapes and aesthetic areas should be adequately controlled. While income is being generated through ecotourism, the environment should be adequately protected from population pressure, stress and disturbance

Proper and sustainable utilization of forest resource products for food and medicine (such as fruits, nuts, barks and leaves) should be implemented. Teaching the rural communities the simple act of forest management and positively changing their life styles towards a care for nature should prevent over-harvesting of food and cash crop. It is essential that outside inputs be injected into rural forest areas such as extension, training, guidance, technical assistance and financial aid. Overgrazing should be stopped. Controlled grazing at particular areas designated for such will prove more sustainable. Practice bioremediation techniques to help restore wastelands, eroded habitats, degraded communities and other ecologically sensitive zones. Fast growing trees (e.g. Teak, Eucalyptus and Gmelina sp.) native shrubs and leguminous plants could also be grown to help rehabilitate the area and increase soil fertility.

Indigenous knowledge, community participation and cooperation should be developed and strengthened among all concerned. Forestry seems to be a male-dominated profession in both public and private sectors. There is a need for gender sensitizing at all levels and the recognition of the traditional and potential important roles played by women in resource management. Genuine and proper conduct of Environmental Impact assessment (EIA) process before, during and after proposed projects should be seriously advocated and executed. Land use policies should be reviewed carefully

to ensure that they do not lead to negative impacts to vital forest resources through land use conflicts. Training and technology transfer between and among researchers, extension agents and the community dwellers are vital for sustainable development and progress. There is an urgent need for extension education and training (for adults and youths, male and female) to help people develop sustainable forest management procedures and maintain them. Researchers will also benefit from the traditional knowledge of the rural populace.

The use of GIS, remote sensing and other models for collecting, analyzing, assessing, and monitoring forest activities will boost mountain forests management in Africa.

[[Acknowledgments]]

We express our gratitude to all that supplied us with information and contributed to the success of this work.

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