Assorted Short Contributions

1. Gully Erosion

An Environmental Hazard to Sustainable Land Use in Southeastern Nigeria

Dr. F.O.R. Akamigbo

Department of Soil Science
University of Nigeria
Nsukka, Nigeria
E-mail: misunn@aoi.com

Gully erosion is one of the greatest environmental hazards afflicting part of southeastern Nigeria. The causes are both natural and anthropogenic but previous research works have exclusively considered on the natural causes. The objective of this study was to investigate the ways in which man aids gully erosion hazards in this region in order to suggest workable methods of creating awareness of his destructive tendency and misuse of the land.

Relevant physical factors and socio-economic conditions that make the area susceptible to gully erosion menace are reviewed. Questionnaires were used to record interviews with different land users. Field identification and enumeration of gully complexes were undertaken in Anambra and Enugu States with a land area of 17,575 Km2.

Results showed a staggering number of 660 gully complexes of varying sizes spread over, scattered in 50% of the 441 autonomous communities. About 76% of these gullies were either initiated or aggravated by road construction works among other causes. Local preventive and control measures were minimal and respondents were unaware of their contribution to gully erosion. The impact of gully erosion on the environment and the influence of the people with respect to their socio-economic, educational, political, spiritual and psychological attitudes thereon are tremendous and difficult to quantity in monetary terms.

Prevention and control of gully erosion in the region cannot be effective if the populace is not enlightened adequately, and efforts at sustainable land use will continue to remain futile. Sustained mass education is recommended among others. Conservation measures should be backed by enforceable legislation and any statutory body empowered to manage the environment should interact with both national and international agencies concerned with the protection and management of the environment.

2. Application of Multi-Date Remote Sensing and Geo Spatial Maps for Sustainable Coastal Zone Management

Swarna Subba Rao

Superintending Surveyor
Survey of India
India

Sustainable land development calls for appropriate management plans. Mapping of physical and cultural features of a given region help to understand the nature of evolution, resource potential and problem areas which are important inputs for planning.

Remote sensing techniques provide accurate remote sensing and up-to-date Geo-spatial information. This is particularly so in mapping the features of coastal zones which exhibit either low or no relief (hence not discernible otherwise) but serve as important indicators for understanding coastal evolution and dynamics and the resource potential of these fragile environments. Further analysis of multi-date maps, air photos and satellite imagery aid in understanding the over-all pattern of deposition and erosion through time, along a given coastal zone, thereby provide vital information for planning coastal structures and related human activities.

A few remote sensing studies made along certain sections of the east coast of India demonstrated the significance of R.S. & thematic maps for analysing coastal land forms and processes through space and time. For instance, mapping of land forms such as beach ridges, abandoned/buried river courses and dried up swamps/marshes in the major east coast deltas of Krishna, Godavari, Mahanadi and Pennar have indicated the existence of former shoreline deposits upto 35 km inland and the changing river mouth positions in the evolution of these delta coasts during the Holocene. (1000 yrs & BP). Further, these land forms indicate the nature of soil and ground water resources, the knowledge of which is useful for agricultural planning. Similar studies of the sequential development of these zone features through multi-date records have brought to light the nature of the development of barrier spits and lagoons during the progradation of the Krishna, Godavari and Mahanadi deltas, sedimentation patterns along the Machilipatnam Coast that resulted in the closure of its port, and erosion and deposition along different sections of the Pennar delta during the past decades. These again, provide invaluable inputs into coastal zone development activities. This emphasises the importance of R.S. for Geo-information towards sustainable land management.

3. Geo-Informatics in Flood Hazard Zonation

The Major Key Factor for Planning Sustainable Land Management in Bangladesh.

A.T.M.Asaduzzaman

Deputy Director
Geological Survey of Bangladesh
153, Pioneer Road
Dhaka 1000, Bangladesh
Fax: 880-2-93 44 132

Most of Bangladesh is an active delta, flood is an normal annual feature, inundating 20% of the country in the monsoon season. Crops, cropping patterns and cropping practices are well adapted to this flood. Floods become hazardous when flood peaks of the main rivers synchronise and backwater effects occur at the confluence of the major channels. The great Ganges-Brahmaputra-Meghna river system, cuts across several international boundaries and controls the flooding of Bangladesh and surroundings. The 1988 flood was caused by an unprecedented flow of the Brahmaputra synchronising with very high flows of the Ganges and the Meghna rivers, and high tidal backwater effect at the confluence. An flood area of 81,831 sq.km. (57% of the country) included parts of the Capital City affected 47 million people, damaging properties worth US$1300 million and claiming 1800 human lifes. The 1987-flood engulfed 56,600 sq.km. area, damaging properties worth of US$ 500 million at the cost of 1657 human lifes.

The necessity of flood hazard assessment and zonation became clear to all, after devastating floods normally occurring in 50-years and 100-years intervals occurred in the two successive years 1987 and 1988. Flood hazard assessment and zonation is essential for planning sustainable land management in Bangladesh. In this study a Geomorphic Approach to flood hazard assessment and zonation has been chosen to integrate both geomorphic data with direct and indirect flood data, gathered from different sources. In this study a huge volume of data has been considered. It was very difficult to handle all those data without the help of the ILWIS Geographic Information System (GIS).

The use of Remote Sensing imagery is vital to this study because it: 1. Facilitated Geomorphic mapping and monitoring of the spatial distribution of the flood, and 2. Provided indirect relative elevation data and 3.
Allowed to cross-check the Geomorphic Model with actual flood data. The Geomorphic Model producing the flood hazard zonation can be refined if (in time) snore floods with different recurrence intervals are brought into the model. In GIS the different data sources are combined and the spatial data is linked to a large relational data base. This data base can very well be used in other flood studies also, for instance for flood hazard instigation, drainage assessment, disaster preparedness, and planning of emergency relief operation.

Geo-informatics can provide processed data instantly, and generate derivative maps and analyses as per need of the users, for the benefits of planners and to convince policy makers. Using this user-friendly system in land management planning in Bangladesh, in conjunction with a large database, can produce efficient plans for sustainable development.

4. Researches on the structure and features of Red Soil Watershed Ecosystems in the South of China

A case study on Fangxiadin Watershed of Jinhua City, Zhejiang Province

Miao Zewei

Agroecology Institute
Zhejiang Agricultural University
Hangzhou 310029, P.R. China

The study areas in southern China cover 160 km^2, 70-80 percent of which are hilly with red soils. The areas are predominantly used for rain-fed farming and are spread over a large number of small catchments. In view of the ongoing eco-environmental destruction and lack of natural resources, watershed management, based on a natural landscape units, has become urgently needed.

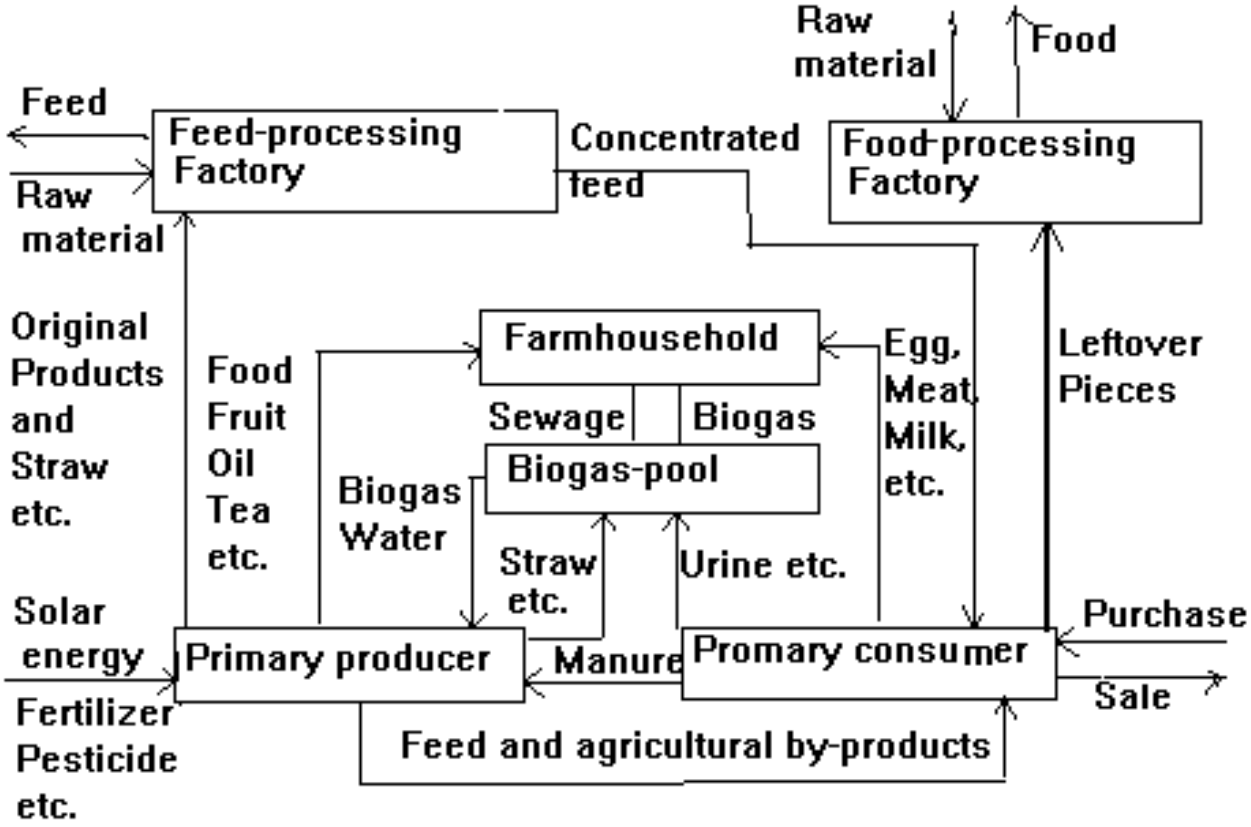
By means of GIS (software packages SPACEMAN and CITYSTAR designed by Peking University) and systems analysis approaches, a study of the Fangxiadian Watershed of Jinhua City, Zhejiang Province, was undertaken. An analysis of the agricultural status of the red soils watershed area was made as follows:

- In the watershed, waste land and low yield fields occupy 34.75 and 40.76 percent of the total area respectively. The potentials of the watershed are still to be fully exploited.
- Within the watershed, the structure of the ecosystems is dominated by cropping and animal-raising. Crop production is mainly for food production.
- The basic income stems from cropping and animal husbandry.
- Food and animal products of the watershed are mainly utilised within the ecosystem.

After researching its status, existing problems and development potentials, some strategies for management of the red soil watershed areas were put forward as follows:

- To develop and utilise watershed resources (including natural and social resources) completely and rationally;
- To adjust and optimise the agricultural structure of the watershed;
- To establish an integrated “cropping-livestock-processing-biogas-business” eco-system model.

In summary, because of the complexity of the watershed ecosystems, measures for integrated watershed management must be carried out in a systematic way.



Proposal model of "Cropping-raising-processing-biogas-commerce" for the watershed

5. The Erosion Control System for Sustainable Land Use on Hilly Relief of Lithuania

Jankauskas B.

Kaltinènai Research Station of Lithuanian Agricultural Institute

The last glacier (about 12 thousand years ago) left a thin layer of glacial clay loam moraine on the old basis of the Zemaiciai upland (Western Lithuania). This is an erodible moraine. The relief is exposed of erosion processes, since it is either steeply dissected hills with gullies or rolling areas on the central watershed part of the upland, or rolling-hills and undulating plains on the outskirts of it. There are 53.2% of rolling and hilly land in Western Lithuania. The abundance of precipitation and its intensity induces water erosion as well as the soil podzolization. The average annual precipitation over 800 mm (average annual maximum 858) is the central part of Zemaiciai upland and 750-800 mm is in the lower parts of it.

According to the average research data of 24 tests (number of treatments x number of years) of field experiments in 1983 - 1994 the heavy losses of soil due to water erosion on slopes of 2-5°, 5-10° and 10-14° were determined as follows: 3.5-10.8 m^3 ha^{-1} under winter rye, 11.7-38.0 m^3 ha^{-1} under spring barley, 28.8-118.6 m^3 ha^{-1} under potato. The grasses completely stopped soil erosion. The losses of arable soil under ingenious application of anti-erosion agrophytocenoses decreased by 76.8-80.8%.

The soil fertility on slightly, moderately and severely eroded slopes has decreased by 21.7, 39.7 and 62.4 percent respectively. The decreasing of soil fertility of eroded soil was due to the deterioration of physical and chemical properties. The dry bulk density and percent of clay-silt and clay fractions increased, the percentage of total porosity and water field capacity decreased. Strong acidity of E, EB and B1 horizons and increase of acidity throughout the whole soil profile of eroded Gleyc Podzol soils is a characteristic feature of agrochemical properties. The annual productivity of hay meadow stands during a 6 year period was 7.86-9.15 t ha^{-1} of dry matter. The productivity of pasture grassland was 5.56-7.07 t ha^{-1}. The amount of metabolizable energy accumulated in antierosion grass-grain crop rotations were 88.9-103.4 GJ ha^{-1} or 14.1-32.7% higher than in field crop rotation and 11.8-27.7% higher than in grain-grass crop rotation.

The herbicide utal and chisel tillage can be used instead of stubbling and deep mouldboard ploughing in the autumn cultivation system. Differentiation of fertilize rates on various parts of hilly-rolling relief and combination fertilizing with liming on eroded acid soils are important part of erosion control system, too.

6. Use of remote sensing and GIS for increasing environmental awareness in Tanzania

K.M. Rwiza

University College of Lands and Architectual Studies (UCLAS)
P.O. Box 35176, Dar es Salaam, Tanzania

This is a project executed under the Mbulu District Rural Development Programme funded by The Netherlands.

Mbulu district epitomizes the challenges confronting conservation and development efforts in much of the dry-land in Tanzania. It is a microcosm of the issues, constraints, and opportunities requiring consideration in attempts at environmental conservation, social economic development and cultural preservation. Within Mbulu district a range of social, economic, and political factors have profoundly influenced the land, its resources and people. The main factors are conflicting land-uses between the hunting and gathering, pastoralism and agriculture.

Before the land users and decision-makers (planners and policy makers) feel that there is a need for mitigation measures, they have to be aware of the existence of a non-sustainable land uses.

Satellite-based Remote Sensing with auxiliary geographical data is certain one of the most appropriate methods for the documentation and analysis of land degradation. The project makes use of multi-temporal satellite images and GIS technology in order to detect changes and presents the findings in a simplified form to decision makers and land users.

The project is divided into three stages:

- Multitemporal satellite image interpretation and analysis
- Integration of raster data with already existing GIS files
- Presentation of the end result

In this project the following satellite images were used:

- Landsat TM image of 3rd September, 1984
- Landsat TM image or 3rd March, 1991 and
- Landsat TM image of 2nd September, 1995

7. Forest/Vegetation Mapping using Remote Sensing Techniques for Managing Fragile Ecosystem of Patnitop Development Area, a Part of Kashmir Himalayas, India

SAXENA, M.R., NAGARAJA, R., RAVI SHANKAR, G., REDDY, K.R., and GAUTAM, N.C.

Scientists, National Remote Sensing Agency, Govt. of India, Dept. Of Space, Hyderabad - 500 037, A.P., India

An area of 64979.81 hectares covering the districts of Udhampur and Doda of Jammu & Kashmir state has been selected to study the different vegetation types for better forest management. The area also encompasses Patnitop Development Area (PDA) known for its natural beauty and having similarities with Kashmir valley, covering an area of 27540.60 hectares.

Visual interpretation of SPOT (MLA) imagery of 1988 on 1:25,000 scale is used for identification of different vegetation types, using standard interpretation techniques. LISS-II data of the Indian Remote Sensing Satellite (IRS-1B) of March, 1994, was also used for the study. Visually interpreted maps covering 9 plates were digitized using GIS system. The major vegetation types identified include, Chir pine/Blue pine, Deodar, Oak, Fir, Karau, Banj, and mixed types, alongside agricultural land, wastelands, water bodies and others were also identified. The vegetation types identified and mapped are divided into 4 density classes depending on canopy cover. Based on the resource map prepared using satellite data, the socio-economic conditions of the area and keeping the environmental conservation need, a strategy was developed for forest management without disturbing the eco system.

8. Rational Use of Water Resources for Soil Salinity Control in Irrigation Areas

Fang Sheng andChen Xiuling

Hebei Institute of Hydrotechnics, 28 Lingyuan Street, Shijiazhuang, P.R. of China

In the arid, semi-arid and semi-humid regions of northern China, the soil salinization occurs in (river-water) irrigation districts due to excessive irrigation water use (exceeding water deficiency by 1-6 times) which caused the groundwater level to rise and intensified evaporation and salt accumulation in the surface soil. The basic problem in soil salinity control in irrigation areas is rational use of water resources. Irrigation water should be used according to agricultural demand (weighted average of evapotranspiration in cultivated and non cultivated lands is 550-650 mm in the Haihe River Plain north of Yellow River). Salinity in the root zone of the soil should not exceed the crops' salt tolerance and the groundwater depth should be controlled. (i.e. in semi-humid regions, the water table must be kept at 2-3 m in dry season, 4-6 m before the rainy season, and not shallower than 0.5 -1.0 m in the rainy season). The practice in Huang-Huai-Hai plain, Henan People's Victory Canal, Shaanxi Jinghuiqu Canal and Xinjiang Wujiaqu Canal irrigation districts show that conjunctive use of surface and groundwater is the basic approach for soil salinity control in irrigation areas and allows to use the water resources in the best way. It is recommended to just meet the agricultural water demand by carefully reducing the water volume at the Yellow river inlet points, and to properly dimension the irrigation areas in the Inter Mongolia and Ningxia irrigation districts. Pure well irrigation can be introduced to other areas in the Huang-Huai Plain south of the Yellow river. There are favourable conditions for groundwater recharge in river-water irrigation districts as the exploitable groundwater resource is 252 x $10^8 m^3$ in Xingjiang. Optimising the use of groundwater for irrigation, not only permits to water crops in time, lower the groundwater depth to prevent salt accumulation, but also enables to reduce river-water use.

9. A model GIS laboratory for higher education in a developing country: the example of the GIS Lab., University of Ibadan, Nigeria

Sylvester Abumere, Olusegun Areola & Bola Ayeni

Department of Geography
University of Ibadan
Ibadan, Nigeria

A major problem facing the development of GIS in higher education in developing countries of tropical Africa is the lack of foreign exchange to purchase the necessary hardware and software. Yet another problem is that of equipment maintenance and the purchase of necessary spare parts and consumables once the systems are set up. The GIS Laboratory at the Department of Geography, University of Ibadan, Nigeria provides a model of how these problems can be overcome through well-articulated bilateral agreements and relationships between institutions in developing countries and in developed countries. The laboratory has been set up and supported thus far through the Universities Development Linkages Program (UDLP) funded by the United States Agency for International Development (US AID). This program (now discontinued since the de-certification of the Nigerian government by the USA) links four higher institutions in the State of Iowa, USA, with four institutions in southwestern Nigeria. The Iowa institutions are the University of Iowa, Iowa State University, University of Northern Iowa, and Des Moines Area Community College. The Nigerian institutions comprise the University of Ibadan, the Obafemi Awolowo University, Ile-Ife, the Nigerian Institute of Social and Economic Research and the Ibadan Polytechnic.

The establishment of the GIS Laboratory began with two full years of capacity building involving:

- Awareness and training seminars locally to identify research priorities in the areas of spatial decision support systems and environmental monitoring and management and to establish the need for GIS technology as a decision-making tool in a problem-solving environment
- Training and refresher courses for local staff both locally and in the participating institutions in Iowa with a view to drawing up realistic configurations of both hardware and software and peripherals for the proposed GIS Laboratory - local staff had the opportunity to practice with various types of software and got briefings on the capabilities of individual systems and software
- The provision and adequate furnishing of laboratory space locally
- Actual purchase and installation of equipment. The choice of software is aimed at establishing a system that allows integration of various software, fit to handle vector and raster data with import/export capability. This gives a full GIS capacity. The major installed software in this integrated system include ATLAS GIS, ArcCAD/AUTOCAD, IDRISI and ALEXANDER. Other software packages purchased are MAPINFO, TRANSCAD, MAPTITUDE and ArcView.

The potential for research is enhanced by the continuing cooperation of the eight institutions and the wide spectrum of research interests they represent. In order to ensure effective utilization of the faculties, the laboratory has embarked on the training of post-graduate students most of whom are drawn from government agencies and institutions in the private sector. In an environment where awareness is still rather low this is considered conducive to the adoption and development of GIS in both government and non-governmental agencies in Nigeria.

10. Factors Hindering the Adoption of Sustainable Land Management in Karatu District, Arusha Region, Tanzania

E.G. Kaitaba

National Soil Service
P.O.BOX 5088
Tanga, Tanzania

Land is one of the natural resources under strong pressure; quality and productivity are continuously deteriorating in most places in Tanzania. Participatory Rural Appraisal (PRA) in combination with 'Villages Land Resource Survey' was conducted. Some of the objectives were evaluation of farmers' awareness of the effect of land degradation and to investigate the best approach to making farmers practice sustainable land management. Four village were selected, from each village 20 farmers were interviewed. In each village four demonstration plots were established. In all four villages farmers were aware of the effect of land degradation. However, they are still cultivating fragile land because they do not have any alternative. The number of livestock is above the carrying capacity, during the dry season animals are grazed on crop residues in cultivated plots. The high population growth rate (2.5 % in 1948 and 3.8 % in 1995) has created a chain of problems associated with land resources utilization. The majority of the farmers does not use chemical fertilizers on account of their low income. Plant nutrients are declining due to continuous cultivation (nutrient mining) without replacing the amount used up. Therefore most cultivated lands where erosion is also taking place nutrient balance.

Since the great majority of the rural population will depend on the land throughout the coming decades, there is a need to find ways of utilising land resources in a sustainable approach. To achieve sustainable land management, farmers' opinion should be given consideration. Farmers lack knowledge on sustainable land management practices, to educate them is essential especially on how to increase productivity per unit area while maintaining the quality of the land so that human needs can be satisfied not only for the present but also for future generations.

11. Socio-Economic factors influencing agricultural land use alternatives in a watershed - A farm level study in India

S.T. Gaikawad and S.C. Ramesh Kumar

Land use planning Division
National Bureau of Soil Survey and Land Use Planning
Amravati Road, Nagpur
Maharashtra-PIN-440010, India

In prioritizing land uses, besides the physical factors, their is need for considering the socio-economic factors and their influence on land use alternatives. Priority setting is a process that helps farmers to select the best portfolio of land use alternatives in a particular socio-economic situation or system. An attempt was made to study the influence of socio-economic factors on prioritising agricultural land use alternatives in Saongi watershed in Maharashtra (India). The data were collected with 40 sample farmers through personal interviews in the crop year 1995. Priority ranking was done based on maximum area in each land use category for different socio-economic variables.

The results indicated that young farmers (< 35 years) are ready to take more risk by bringing more area under commercial crops when compared to the old age (> 50 years) group. As the level of education increases from illiterate to college level, the priority for land use changes from cereals to commercial crops. Institutional participation influences farmers to change the land use from cereals to commercial crops like fibre, fruits and oilseeds. The economically poorer groups were allocating more area for subsistence crops like cereals and pulses and relatively upper groups are allocating more area for commercial crops. Farmers who undertake agriculture as their main occupation are allocating more area under commercial crops when compared to non-agricultural occupants.

As the size of the land holding increases from small (< 5 acres) to large (>10 acres), the priority changes from cereals and pulses to commercial crops. The farmers who have irrigation facilities allocate more area for commercial crops then farmers who grow cereals and pulses. When capital and labour availability increase, the priority land use changes from cereals and pulses to commercial crops. Farmers allocate more area for commercial crops on their own land than on leased in land. Results have clearly brought out that socio-economic factors should be taken into consideration when suggesting sustainable land use plans.

12. Planning for sustainable land management: user needs and possibilities

Dejene Wolde

P.O. Box 103
Hossaena, Ethiopia

Sustainable land management means putting land under productive, effective, environmentally sound, etc. uses so as to generate maximum benefits at the same time maintaining its fertility and natural balance.

In many developing countries, including Ethiopia, many problems are associates with the identification of sustainable land management practices. Among these problems are some implications of national policies such as: absence of clearly defined policies for land use, rapid population growth and the associated reduction of individual land holdings over time, inadequate professional assistance and extension programmes, seasonally changing political situations and lack of political stability, fragmentation of holdings, distribution of land for many uses, a variety of crops due to food security reasons, shortage of proper land management skills, lacking awareness of environmental and natural phenomena like droughts.

This study was conducted in the Hadiya Zone of the Southern Region of Ethiopia, where the aspect of land management is directly influenced by the above indicated multiple problems. Land users are in doubt how to manage their land on a sustainable basis mainly due to lack of complete ownership of the lands they farm. Their aim is then only to obtain as much benefit as possible in a short period of time (years) without paying any attention to sustainable usage and soil conservation practices.

In view of all these complications, planning for sustainable land management is very difficult. Accordingly the following conditions should get proper attention as a precondition for sustainable land management.

- Attention must be given to identification of the needs, objectives and socio-economic setting of land users
- The national government should revise its policies on land
- Efforts are to be made to fill the gap between the day to day users needs and their need for sustainable land management.

13. Salt affected soils in the Oasis of Nahal irrigated with saline water (South of Tunisia)

Mtimet and A. Saied

Direction des Sols
Ministère de l'agriculture
17 rue Hédi Karray
2049 l'Ariana – Tunisia
Tel.: 216-1-700 940
Fax: 216-1-718 208

The purpose of this project, started in October 1995, is to determine the effect of saline irrigation water (3g/l) will high concentrations of chloride, sulfate and magnesium, on soils of some oasis in the south of Tunisia, that are used for market-gardening.

The experimental procedure is based on the following:

1. Preliminary analysis of the soil (representative profile)
   Monitoring the level of the water-table and the salinity of its water (6 check points)
   Deep ploughing and installation of a drainage system
   Applying chemical and organic fertilizers
   An experimental design with 36 units
   Preliminary irrigation
   Plantation of tomato, onion and lucerne
2. Monitoring of the electric conductivity (EC) every 20 cm, up to one meter-depth, in two sites: one well-drained and the other not drained. The measure of the EC was made on October 1995 and March 1996. The results are as follows:
   - In the drained parcel, (A) the salt profiles of 9 profiles showed that, the ECe was about 5.5mS/cm in the surface layer and 20.33 mS/cm in the deeper layers.
   - In the non drained parcel, (B) the values of ECe varied between 6.72 and 25.35 mS/cm, from the top down. The level and salinity of the water-table were respectively 1.3 m and 15.5 mS/cm on September 1995, and 0.8 m and 12.86 mS/cm on March/April 1996.

It should be noted that rainfall in the year 1996 was exceptional (more than 566 mm), in view of the long term average annual rainfall in Gabès of 178 mm. This means that rain water is likely to have caused leaching of the soil.

In the next step of the project we will study the relation between crop yield (3 crops) and the salinity of the soil in the previously described situations.

In the year 1996, the salinity evolution, based on nine control points, was as follows:

- Plot A: salinity decreases along the profile from 15 to 5 mS/cm.
- Plot B: salinity is irregular over the profile, with values between 6 and 15 mS/cm (between 20 and 60 cm).

It should be noted that the moisture content varied from 26% in October 1995 to 10% in July 1996 (cropping season). As for the effect of manure, on the yield, a response was observable only for tomato when drainage was satisfactory. Likewise, it is surprising that the yield is better in the second case (badly drained plot) and without manure application.

14. Extraction Of Land Use/Land Cover Information By Digital Processing - A Case Study In Calcutta Environs, India

P.K. GUHA and S.K DE

Geological Survey of India

Mapping of land use and land cover classes is a pre-requisite for development planning. Extraction of land use land cover information over an area of about 300 sq km in the neighbourhood of the city of Calcutta by digital processing of multi-spectral SPOT data has been attempted with different band combination functions, image enhancement techniques and supervised classification utilising ERDAS-Imagine software.

Study of individual band images, standard and hybrid false colour composites, band ratio and principal component images revealed that individual images can not give all the required information for mapping of land use/land cover classes. Various band combinations with suitable enhancements proved to be useful in enhancing subtle spectral differences between the land use and cover classes. Non-linear contrast stretch (histogram equalisation) of standard FCC proved to be useful in discriminating broad land use/land cover classes e.g. dry agricultural land, moist agricultural land, crop land (paddy), settlements with homestead garden, and surface water body. However, cropland interspersed within settlements with homestead gardens is not very clearly distinguishable due to the similarity in colour in standard FCC. A false colour composite generated from three PC images with PC-1 (Blue), PC-2 (Green) and PC-3 (Red) proved to be the best output for discriminating cropland from settlements with homestead gardens.

Supervised classification was attempted with selected training sites in five broad land use/land cover classes viz. dry agricultural land, moist agricultural land, crop land, settlements with homestead garden and surface water bodies utilising random likelihood decision rules. The resulting supervised classification map matches quite well with the visually interpreted classes validated by ground check. However, there appear to be some misclassifications particularly in cropland (paddy) located within moist agricultural land. Very small cropland (paddy) interspersed within settlements with homestead gardens is clearly brought out in the classified image.

15. Ecodevelopment, With Emphasis On Sustainability Of Agro And Forest Ecosystems: A Case Study Of Kumaun Himalaya

M.L.MANCHANDA,A.K.TIWARI AND M.KUDRAT

Regional Remote Sensing Service Centre
Indian Space Research Organisation
4, Kalidas Road, Dehradun- 248 001, INDIA

Massive deforestation in the Himalayan region for commercial purposes in the past and continued dependence of agro-ecosystems on forest resources pose serious threats to the sustainability of these systems. It is thus, necessary to i) examine the pattern of dependence of agro-ecosystems on forest resources, and, ii) to develop a comprehensive development plan, to make the agro and forest ecosystems sustainable.

The present study was carried out in Pithoragarh block, Pithoragarh District, Uttar Pradesh, India. The consumption pattern of agro-ecosystems and the dependence on forests was analyzed based intensive field surveys. The analysis indicated that the net productivity of forest resources in the form of fuel, fodder and litter is not adequate to sustain the dependent agro-ecosystem. A development plan was generated for the area using Remote Sensing and Geographical Information System technology. The Indian Remote Sensing Satellite (IRS) LISS II geocoded images for three seasons and topographic maps were used for the generation of Landuse maps. Spatial information on a number of themes like slope, aspect, soil, geomorphology, ground water potentials and socio-economics, generated by various experts was used to find the best alternate landuse or ecodevelopment activity with a view to ecological balance. All themes were integrated through a GIS, using decision criteria developed on the basis of existing literature, field experience and discussions with local inhabitants to generate an action plan map for eco-development. The eco-developmental activities include forest crown cover improvement (gap filling), agroforestry, agro-horticulture, horticulture and plantation of soil binding grasses/trees.

An analysis of potential production and consumption patterns has revealed that implementation of the action plan to 50 percent satisfaction will bring about equilibrium within 7 to 10 years, with the current socioeconomic conditions, and population growth. However, the development activities and the consumption pattern need to be evaluated periodically to sustain the Himalayan ecosystem.

16. Project research: "Development of planning methods and spatial concepts for the design of sustainable ecological networks"

Pablo Perovic[2], Patricia Marconi[3], Daniel Somma[1,3]

[1]. Wageningen Agricultural University
[2]. University of Salta (UnSa), Argentina
[3]. National Parks Administration (APN), Argentina

Objectives

General: To research the application of sustainable spatial concepts (ecological networks and frameworks) and their potential to mitigate the effects of fragmentation of natural landscapes.
This includes:

- analysis of land use patterns in a multiscale spatio-temporal approach for relationships with processes in the agricultural matrix.
- design of the ecological network through an species-specific habitat availability assessment based on the analysis of spatial patterns of biotic and abiotic variables. It will take into consideration the requirements of an umbrella species (Leo onca: Jaguar).

Specific objectives:

- Development of the design methodology
- Connectivity analysis
- Determination of ecological infrastructure elements: core areas, connecting zones, buffer zones and corridors

The study area is the Argentinean sector of the Yungas (a tropical rainforest of some 1,500,000 ha). Some 1,250,000 hectares were converted to agriculture in the period 1975-1988 in the ecotone West Chaco – Yungas. It is affecting carnivore species (i.e. jaguar) that could serve as an umbrella species for the network design process.

Project background

A spatial strategy is necessary in the Yungas region because different activities (nature conservation, farming, recreation, forestry, water supply, etc.) are all requiring space. Some spatial concepts: frameworks and ecological infrastructure can be useful in the search of suitable strategies for regional analysis. It would constitute a planning answer to habitat fragmentation. An increasing habitat fragmentation process is occurring in the "Yungas" region. If connectivity can be defined as the relative degree to which individual animals, and genes, can move across a landscape, then the principal problem would be one of maintaining current levels of connectivity or to mitigate the effects of increased fragmentation by restoring past levels of landscape connectivity.

The establishment of an ecological infrastructure for an umbrella species is one of the management answers that could positively influence the survival of the metapopulation of this and other species. Umbrellas are species with large area requirements, which if given sufficient protected habitat area, will bring many other species under protection. Usually, they are carnivores. In the Yungas project, the jaguar would be the candidate for the umbrella role. The Yungas project has not only academic value. This project constitutes a priority in the nature conservation policy for the Northwest of Argentina. Moreover, an ecological network itself can be

considered as a way of developing scenarios based on the mutual relationship between nature and society.

Methodological approach

The fragmentation of a landscape into small pieces may disrupt ecological processes and availability of habitat. Such fragments may be too small to maintain viable breeding populations of species. Distances between landscape fragments can interfere with pollination, seed dispersal, and wildlife movement between patches of forest or grassland, and breeding. In areas converted to agricultural land, remnant fragments of the original landscape may provide refuges for many components of the original diversity. The re-connection of these remnant fragments by a net of dispersal corridors in a landscape framework could mitigate the impact of fragmentation in a region. Two components of the problem (habitat availability and land use) will be highlighted through the research. A third component (sustainability assessment) is considered as a further expansion.

Habitat availability assessment: or How to grasp the edge effect beyond the “structural variables”.
The designing of an ecological network leaving adequate perspectives for agriculture and avoiding unwanted consequences requires tailor-made regional (and/or local) plans. It would need basic landscape structure information (number, shape, types and size of landscape elements: patches, corridors, matrix) but also the so called dynamic variables (i.e.: wind velocity, species behavior, border effect, etc.). The information on habitat and its assessment is critical. However, organisms are often limited by abiotic conditions even in a so-called ‘structurally suitable habitat’ (structurally suitable habitat would be the type of vegetation suitable for a herbivorous species, the type of soil apt for some tree species, etc.).

The core of habitat availability assessment would be to characterise the ecological and geographical requirements of the umbrella species.

Multiscale, Land use pattern analysis: or the need to consider the land use and connectivity by a multiscale approach
If ecological systems are indeed characterised by critical dynamics influenced by processes that occur at many scales, then the ability to predict nature without multiscaled models will be limited.
This multiscale pattern analysis would serve as basis for:

- differentiating the land use types according to their dynamics and to study the correlation with physiographic conditions: the basic requirements for the framework design.
- performing a connectivity assessment.

Both analyse (land use dynamics and connectivity) developed in a multiscale fashion will constitute the bases for the ecological infrastructure design process. These analyses will be central in this research.

Research stages

- Identification of species that can perform roles as “umbrella” and connectivity indicators species: this has already started. The Jaguar will be the principal species to analyze. There is a habitat characterization and interest sites were identified by Pablo Perovic.
- Habitat suitability analysis
- A multi-scale study of spatio-temporal land use patterns
- A connectivity analysis using percolation theory and graph theory
- The design of a landscape framework

17. Assessment of land degradation in the Niger Delta using SPOT Imagery: Prospects of sustainable management with GIS.

Dr. Isi A. Ikhuoria

Department of Geography & Regional Planning
University of Benin,
Benin City, Nigeria.

The Niger Delta covers an estimated area of 70,000 kM2. It consists of a number of distinct ecological zones: coastal ridge barriers, mangroves, fresh water swamp forests and lowland rain forests. The Niger Delta is experiencing considerable changes as a result of coastal erosion, resources exploitation (principally petroleum oil operations), deforestation and population pressure. The impact of these factors on the ecology of rural lands and communities was investigated. 1996 SPOT imagery, supplemented with TM data, and biophysical - chemical data on soil, water, and vegetation, as well as settlement socioeconomic data were used to assess land degradation in Opuekeba and Moiume communities in the Niger Delta. The results showed that an area of 34,225 ha (342 km^2) is severely degraded. Coastal erosion, oil exploitation and canalisation have induced intrusion of sea water and acids into the area. Their effects are manifest in the destroyed fresh water mangrove swamp vegetation, and deteriorating productive and sustainable capacity of the soils and creeks.

18. Traditional Agricultural Land Use System and a search for sustainability in the Hill and Mountain region of Nepal

D.P. Sherchan

Pakhirbas Agricultural Centre
c/o BAPSO, P.O. Box 106
Kathmandu, Nepal

The hill and mountain region of Nepal is characterized by steep slopes with very high relief and very narrow valleys. The agricultural land is only 17% of the total geographic area. The majority of the people are engaged in agriculture, which is semi-subsistence in nature.

The traditional agricultural land use has been accepted as appropriate looking at the fragility of the land and the resources available to the land users. Agricultural production is based on low inputs and focuses on soil conservation. But the increasing population (2.1% per annum) has forced the people to go for more intensive land use to meet the food demand. As a result there is evidence of unsustainability especially in the hilly areas because of over exploitation of natural resources. To some extent infrastructure development has augmented land degradation, notably roads construction and unscientific utilization of fertile agricultural land for other purposes.

It has been indicated that the technologies which are of a long-term nature are less attractive to the people.

In the hills and mountain region the dynamics of land use are still poorly understood. There is a need to look into the effects of the changing circumstances and to look for alternative strategies. However, development of a technology which combines traditional and modern knowledge, with due attention for the economic situation would be appropriate. The present approach to increase cropping intensity as a means to improve on food production in the hills should also be reviewed. Sustainability requires a sound and balanced management of land and natural resources thereby meeting the people's daily needs as well.

19. Land Management with the help of Geo-Information Infrastructure in Lindi Region, Tanzania

Mr. Majura M.C.W.

Lindi Region, Tanzania

Any aspect of land use planning, regardless of scale and purpose, requires some relevant data. Land use planning, which in turn can guarantee sustainable land management, is in its infancy in Tanzania due to limitations of data availability and poor processing techniques.

There is a dire need to manage land in order to ensure effective and economic use of available good lands, which are in themselves limited in relation to demand. Apart from managing virgin lands effectively there is a strong need to conserve the land.

The Office of Regional Lands, Lindi, has at its disposal only limited resources to perform necessary planning exercises. These include topographical sheets at a scale of 1:50,000, survey plans and land use planning drawings and in some few cases aerial photographs. One big common disadvantage of all these resources is that they are old and hence in most cases outdated.

With the help of these scarce resources, base maps are prepared using enlargement to scales of 1:25,000 to 1:10,000 depending on the intended purpose of the plan under preparation. Once empty mosaics of this nature are ready they are improved further by interpolation of contours and fitting in new landmarks such as buildings, roads, farms etc.

The actual planning process commences with the help of socioeconomic and theoretical base data available in the office. Through this planning approach a lot of planning exercises have been attempted which could hitherto not be accomplished because of the abounding financial crisis.

Sustainable land management has been achieved by instructing land surveyors to select land details in the company of land use planners. In the final analysis each interest group prepares its plan using the same data and site operations. That means that survey plans and land use planning drawings are prepared and forwarded to appropriate authorities for approval and execution. In this way sustainable land management has been introduced to Lindi Region for all purposes.

20. Land Use Surveys for District Resource Planning (Busia District, Kenya)

Simon Mumuli Oduori

DRSRS - Office of the Vice President and Ministry of Planning and National Development, P.O. Box 47146, Tel.: 502 223/6, Fax: 504 777, Nairobi, Kenya

Population pressure calls for increased production of agricultural products. Subsequently, there is a great need to assess the potential of the land to sustain this increase in population. Land use information, in this regard, is urgent and important. Information on the current land use forms the starting point in land evaluation.

The department of Resource Surveys and Remote Sensing (DRSRS) is mandated with the function of supplying information on land use in the high potential agricultural districts. In this respect, DRSRS has been conducting land use studies since 1982 when the first national land use mapping exercise was done.

A land use study was carried out in Busia district. The materials/methods used in the study are Sample Vertical Aerial Photographs and field checks accompanied by personal interviews and questionnaires. The photographs were taken every 2.5Km along the Universal Transverse Mercator (UTM) grid system. The transects were spaced 5 Km apart. The photographs were analysed by projecting them onto a gridded screen, with 100 randomly placed points.

The results of this exercise include land use/land cover for the whole district in 1994 and detailed land use/land cover information for Funyula division. It is important to note here that the land use/land cover patterns for the district compare well with those given for Funyula division. For example, the districts average for grazing as a land use/land cover is 44.3% whereas that for Funyula division is 44.8% (mean over 7 years). Similarly, maize covers about 10% in the district whereas it covers about 11% (mean over 7 years) in Funyula division. Most of the land in the district has been left uncultivated; 74% of the total land in Funyula division is uncultivated and only 17% is cultivated. The district figures stand at about 63% uncultivated and only 29% cultivated in 1994.

The crop yields were found to be low in the district, with reasons being drought, low agricultural inputs, low level of technology used, lack of finance and poor extension services. Most of the agricultural production is at subsistence level.

21. Land evaluation report of Polilio Island, The Philippines

Nancy D. Vasquez

LRD, RSRDAD, NAMRIA
P.O. Box 36
Fort A. Bonifacio, Makati City
The Philippines

Pololio Island in the Philippines is geographically located at latitude 14°37' to 15°05' North and longitude 121°47' to 122°05', East. The island has been subject to extensive improper land use. The island, identified by the Philippine Government as a growth center within the zone, has a total land area of 74,248 hectares (including islet barangays) of which 34,078 hectares or 45.9% is classified as forest. The island with a total population of 24,616 (source: 1995 NCSO, Manila) comprises 3 municipalities namely: Burdeos, Panakulan and Polilio. It is also here where the Region's Integrated Social Forestry (ISF) Projects, a community-based forest programme of the government, are located.

A Land Evaluation was done only for the areas classified as forest. These cover an aggregate area of 34,078 hectares composed of 15.309,35 (44.92%) certified timberland; 9,898 hectares (29.04%) Unclassified Public Forest, 7,353.65 hectares (21.58%) Forest Reserve (either as Watershed Areas, Communal Forest, Mineral Reservation, etc.) and 1,516.35 hectares (4.37%) Mangrove Forest Areas.

Decisions on recommended landuse types were defined only after consolidation and analysis of the biophysical factors, and for areas without occupants. In cases where individual land units were with forest occupants, using the area for crop production, the unit was evaluated for biophysical (ecological compatibility), economic and social considerations (economic feasibility and social acceptance). The resulting suitability ratings were entered in a 'Suitability Evaluation Table', which was interpreted for consistency or any inconsistencies in the ecological, economic and sociological ratings for each land unit to establish provisional suitability ratings. The Provisional Suitability Ratings, are then entered into another table. This table is used in the identification of 'proposed land uses' for each land unit (map unit) by comparing requirements of the land utilization types with the bio-physical, economic and sociological characteristics of the land unit or groups of land units. Care was taken in the assigning of proposed land uses so as to minimize possible conflicts of land use. A summary table, Acceptability Table for Land Use Suitability, was then prepared to show the relationship between current use, current provisional suitability for each of the land units and alternative land utilization types under consideration. The process' outputs are maps and tables. These maps and tables were presented to an assigned committee (Regional Directors, or their representatives of the Department of Environment and Natural Resources, Agriculture Department, National Economic and Development Authority, Housing and Land Use Regulatory Board, Local Leaders, etc.) for review. Here, the Committee had the opportunity to potentially alter the provisional evaluation ratings by taking into account their knowledge of the ecological, economic and social situations of the subject area. Conflicts on proposed land uses were discussed to secure consensus. Once consensus was reached, maps and tables were changed, as needed and a report of the findings of the investigation prepared. The purpose of the report is to provide data and information on which to base decisions on land use, management and monitoring.

As a result of the evaluation and analysis of Polilio Island, with due consideration of the ecological feasibility and social acceptability, five (5) categories of recommended land use types were namely:

- Agro-forestry areas with 22,084.22 hectares or 64.8% of the total classified forest area
- Protection Forest Area with 7,885.12 hectares or 23.14% of classified forest
- Production Forest Area with 2,742.85 hectares or 8.05% of classified forest
- Agricultural lands composed of 1.147.5 hectares or 3.37% of the classified forest
- Mineral lands composed of 218 hectares or 64% of the Island's classified forest.

22. Simplified System of Soil Variability investigation as a tool to sustainable land management

A case study from lower Omo southern Ethiopia

Teshome Afrassa

Variability exists within pedons and among soil horizons, whilst even intra-horizon variations may be significant in terms of crop root performance.

No one has yet touched on this area in terms of the effect that soil variability has on land use planning, management and the productivity of the crops.

There is an urgent need to investigate soil variability and its effect if soil and land resource planning is to be used optimally. There are many statistical and cartographic methods to investigate soil variability ranging from simple mean, median, mode random transect to complicated computer programs and model oriented geo-statistics. Most of them are not in a simplest form to be used by farmers in developing countries.

In Ethiopia, the soil surveyors and land use planners are working under stress, with limitations of land configuration, time and budget in the way of planning sustainable land use systems. Besides there is a complication in communication with non-technical or technical but non-pedologist land use planners.

We felt that there won't be a sustainable land use system unless we plan land use systems as a function of soil variability to best fit not only the users but also knowledge of the users.

Hence the following simple methods have been developed:

- "Soil variability analysis" to examine the effect of individual limiting factors and their impact on sustainable land use planning
- "Adjustment cost effect method" of variability analysis and its application in sustainable land management
- "Weighted score and point scale method" of variability analysis and its application in sustainable land management

23. Sustainability of Irrigation Schemes for Small Scale Farmers

A Case Study of Furrow Irrigation Scheme at Buleya Malima, Gwembe Valley, Zambia

R. Masinja, BSc, MSc

This study was carried out to determine factors that influence the sustainability of smallholder irrigation schemes in Zambia. This was against the background that many schemes have been opened by the government to resettle people and have operated smoothly under its management. But upon withdrawal, farmers have failed to manage these schemes.

The study was carried out in the Buleya Malima smallholder irrigation scheme. The objectives of study were: (a) to evaluate the schemes using technical and socio-economic parameters inherent in the scheme, (b) to assess the current practices and, (c) to make recommendations for improving the performance of the scheme and management practices.

1. The average results of the technical study were: 26.4%, 64.5% and 9.2% for application efficiency, tailwater ratio and deep percolation ratio respectively. The results revealed that there was a waste of water by farmers through tailwater runoff. Thus, the system was performing poorly, and could not be sustained at these levels of water loss.

2. The study of socio-economics revealed that irrigated farming could be sustainable if properly designed and planned with the involvement of the farmers. The big problem was lack of managerial ability and innovativeness by the scheme management to provide farmers with their own viable organisations which could warrant the continuity of the scheme even after the government had withdrawn.

3. Farmer participation in planning, decision-making and implementation of these decisions is advisable in order to sustain the scheme operations. Management should create a suitable environment for farmers to form viable associations through which farmers and management would co-ordinate their operations. Formal and informal training in technical operations of irrigation infrastructure and new agricultural practices should be provided, so that farmers are able to operate the irrigation system with minimum dependence on management. Therefore, provision of well trained management personnel to impart appropriate knowledge on the operations and maintenance of irrigation system is advisable.

24. Role of geo-engineering mapping in sustainable land management:

A Case Study of The Santoli Gad Basin, Garhwal Himalaya, India

Dr. V.C. Jha

Reader & Co-ordinator Remote Sensing Unit
Department of Geography Visva-Bharati University
Santiniketan, India

Increased food production in third world countries is essential to feed the rapidly growing population. Increasing desertification, wastelands and slope failures as well as intensification of agriculture have resulted in drastic changes in landuse / landcover and space use patterns directly affecting denudation processes. Geomorphological hazards, particularly excessive overland flow, landslides, rill, gully and soil erosion, have become common problems. The role of past and present climatic conditions in the development of regoliths, and the relationship between weathering regoliths and vegetation are very significant in the Himalayas. Mobility and fixation of elements during different states of weathering regoliths development depend upon geo-engineering properties, joint spacing and compressive rock strength of the parent materials. Sustained Land Management can only be maintained if these problems are identified, understood and solved.

An attempt has been made to prepare a geo-engineering map of the Saintoli Gad Basin of Garhwal Himalaya, India in support of land management. The geo-engineering map provides geographical information for three main aspects, namely (i) the physical environment, (ii) its relation with various geomorphic processes, and (iii) its significance for human use.

The Saintoli Gad Basin has been mapped with the help of remote sensing, field and laboratory techniques. The engineering properties such as landforms, rock units, tectonics, soil units and geomorphic processes (mass-movement, weathering and erosion) have been examined. The investigation also examined the joint spacing and rock mass strength of various rock types found in the basin.

After superimposition of all above data a geo-engineering map for the Saintoli Gad Basin could be prepared. It is noted that the basin is characterized by four terrain stability units such as low, medium, high and very high characterized by joint spacings of 5-10, 10-25, 25-50 and 50-100 cm and compressive rock strengths of 650,1100,1350 and 3400 kg/cm^2 respectively.

25. Land Use in Kwale District, Kenya

A contribution to sustainable land management

Dr C.H.K. Muchoki

Deputy Director, DRSRS, Nairobi

In order to produce data for planning purposes, a combination of methods were used in Kwale district land use study which included Remote Sensing, Systematic Reconnaissance Flights, Questionnaire and field checks. Results indicate that Rangeland is the dominant land use type with 529,026 ha located mainly in Msambweni and Kinango Divisions. These rangelands are experiencing severe land degradation. Most livestock and wildlife species live in rangelands. The district has a population of 113,783 cattle with a density of 13.77 heads/km^2. Dominant wildlife species include Burchell's Zebra and Impala with a population of 3,879 and 3.424 respectively.

Dominant crops in terms of area covered include Maize (11,648) ha, Coconut (8,540)ha, and Cashewnut (6.832)ha. Other crops are Beans, Sugar cane, Mango, Cassava, Rice, Citrus, Banana and Bixa. Livestock and wildlife resources in this District can further be developed through provision of better Veterinary Services, water and other infrastructural facilities like marketing. A multistage data gathering approach can generate detailed natural resources data required for development planning in order to avoid environmental degradation.

26. GORS Activities in the Field of Remote Sensing Application to Land Management

Dr. Eng. Hussein Ibrahim, Ag. Eng. Abdul Rahim Loulou and Hydrol. Marwan Koudmani

GORS was constituted in Syria in 1986. Located in Damascus, GORS cooperates with some government bodies, all Arab countries, foreign countries and international bodies. GORS carries out studies and projects on remote sensing applications in geology, hydrology, hydrogeology, agriculture, urban planning, environment, meteorology and archeology by using Landsat and SPOT images. GORS published a space atlas of Syria, a glossary of remote sensing terminology and journals of remote sensing. Further GORS organizes courses and an international symposium.

GORS has completed several studies on remote sensing application to land management, such as land cover mapping, land use classification, soil survey, land degradation and land rehabilitation. GORS also embarked on a study of “Remote Sensing Application to Rangeland Management”.

The study aimed at identifying appropriate soil and water conservation measures and the need of water distribution for rangeland rehabilitation in southeast Palmyra in the Syrian steppe. To achieve the objectives of the study, soil conservation and surface drainage network maps were prepared using Landsat T.M. images. The maps were checked and integrated with fieldwork.

Based on the images interpretation and field information, suitable rangeland rehabilitation, water conservation and water distribution measures were recommended. These include strip planting, reseeding, pond deepening, rivulet development and dyke building. All sites for land rehabilitation and water conservation measures were allocated with the aid of the prepared maps.

27. Population and its Influence on Land Use Planning and Land Use Systems in Kirinyaga District, Central Province of The Republic of Kenya

Esther M. Mathenge

Forestry Department
P.O. Box 22 Kerugoya, Kenya

Kirinyaga District is situated in the highlands on the Southern slope of Mt. Kenya. It has an area of 1437 sq.km. It is subdivided into three agro-ecological zones: high potential, medium potential and marginal according to elevation and amount of rainfall. The major economic activity in the District is Agriculture.

With a population of 487,773 (as per 1996 data) and 96 938 households, Kirinayaga District is one of the most densely populated Districts in Kenya. Population density follows the same pattern as the agro-ecological zones, with the high potential zone having the densest population. Land use systems also follow the pattern of the zones.

Internal migration is considerable. People have been moving from the densely populated high potential areas to the sparsely populated marginal areas. All this is a major determinant to the land use systems and land use planning in this District.

High potential agro-ecological zone
The soils here are mainly loam soils, rainfall is generally quite reliable and the zone is quite productive. Farm sizes are generally very small (an average of one acre) due to many subdivisions (as a result of population pressure). This has a significant effect on land use planning. Most people in this zone practice intensive farming whereby mixed cropping is common. Most people also have zero grazing units, but those neighbouring the forests take their livestock there for grazing, small areas are set aside for Tea growing, but these vary from farm to farm depending on the farm size.

Medium potential agro-ecological zone
Population pressure here is not as high as in the high potential zone, hence farm sizes are generally larger, but intensive farming is still done, mainly on loamy - sandy soils. Cash crops such as coffee and tea are grown.

Marginal agro-ecological zones
These constitute the wetlands of the District. Soils here are mainly black cotton soils though there are several pockets with red sandy soils. Population density is generally low and people are confined to villages. Large scale rice growing is carried out in this area using irrigation water. Except for the rice fields, the cropped fields rely on the low rainfall in this area and are usually of low production. Food crops such as maize, beans, bananas, green grams and cow peas are grown.

28. Does Traditional Agroforestry Have a Role in Erosion Control in the West Usambara Moutains?

Abiud L. Kaswamila and Tenge A. Mkavidanda

Mlingano Agricultural Research Institute
P.O. Box 5088
Tanga
Tanzania

A study was conducted to identify why the traditional agroforestry farming practice is being abandoned in the west Usambara Mountains despite its effectiveness in controlling soil erosion. The study area was in the tropical highlands of Northern Tanzania in Lushoto district located between latitude 4° 20' - 5° 10' S and longitude 38° 10' - 38° 40' E at an altitude of 200-2000 m asl.

Intensive interviews, meetings and informal discussions were used to collect data from farmers and extension agents. A total of 181 farmers and 6 extension agents from nine selected villages were interviewed using a standardized questionnaire, which mostly contained closed questions. Afterwards, village meetings and informal discussions were held to discuss general problems facing the farmers particularly in traditional agroforestry practice.

Data from standardized questionnaires were analyzed using descriptive statistics and the chi-square method.

Results indicate that traditional agroforestry can significantly reduce soil erosion and increase crop yields and that the decline of the traditional agroforestry system in the Usambaras is attributed to a change of weather, introduction and enforcement of new soil conservation measures, inappropriate crop-tree combinations, lack of seedlings of traditional trees and high population pressure leading to land scarcity.

In order to achieve sustainable (traditional) agroforestry in the West Usambaras it is recommended to conduct research on appropriate crop-tree combinations, tree species' ability or inability to conserve moisture, improve soil fertility or drain the soil.

29. Land use patterns in the Mtera Reservoir Catchment Area

Isaria Masam

Mtera reservoir is the largest manmade Lake in Tanzania. It is economically important because its regulated waters power the largest two Hydropower Plants in the country, namely Kidatu and Mtera. At full operation Mtera produces 80 MW while Kidatu produces 204 MW of hydropower. By all standards it is the lifeline of Tanzania's electric power supply.

The existence of the Mtera dam depends mainly on the Land Use Patterns of the Mtera Reservoir catchment area. It is due to some of these land use patterns that the Mtera dam cannot perform as expected. These land use patterns include cultivation, pastoral activities, settlements, game conservation, fishery etc.

Mtera reservoir catchment area is facing several problems threatening its own existence. Some of these are soil erosion, deforestation, poor cultivation practices, overgrazing, cultivation at the water source sites, insufficient knowledge of people on appropriate land use planning, inadequate education on environmental conservation and the inability of relevant authorities to identify, prioritize, plan, implement and monitor proper land use in the Mtera catchment area.

These problems have led to water sources drying up, decrease of the water quantity in rivers, and finally decrease of water level/volume in the Mtera reservoir. The decrease of the water level behind the dam has led to insufficient production of hydroelectric power and thus affected the economy of the country.

However, the government is trying to take measures to arrest the situation. Some of the measures taken, though to a little extent, are awareness raising of the villagers on environmental conservation and training of villagers on land use planning, aforestation, catchment forest protection and other areas of environmental conservation.

Community participation in the planning and implementation of activities related to land use planning and Land Management will ensure sustainable environmental protection.

30. GIS Projects in Developing Countries

The Role of Infrastructure in the Case of LBDA's Data Centre Project in Kenya

Joseph Okotto-Okotto

The Lake Basin Development Authority (LBDA) is a quasi-government institution charged with the responsibility of identifying, co-ordinating and implementing development programmes and projects in the Lake Victoria Basin in Kenya. Lake Victoria Basin is one of the most resource rich regions of Kenya. Improper exploitation of the Basin has and continues to lead to deterioration of the environment and the natural resource base.

The Geographic Information Systems (GIS) was identified as one of the most versatile tools which could enhance LBDA's Planning Capacity to support their Land Resource Management tasks and give them an edge for social and economic development of the people of the Lake Victoria region. This was initiated within the framework of a Data Centre. Implementation of this facility involved the installation of hard and software systems, training of four officers in the Netherlands and data collection and data management activities.

Integration of the system into the overall organizational infrastructure was however done haphazardly. Even though the technological issues were well taken care of, a broad range of factors influenced and impacted adversely on the development of the Project.

New tools such as GIS can only be used effectively if they are properly integrated into the whole work process with due cognizance of institutional infrastructure and not tacked on as afterthoughts. Simply purchasing a GIS system and training a few individuals to operate it may never produce results.

31. Planning of Sustainable Land Management: User Needs and Possibilities

S. Adejumo Ogidan

Pearson and Richards (1965) said “As population expands all uses of land and soil become more competitive. Good agricultural land will be under increasing pressure from urban growth and expanding public facilities such as highways and airports. Much of this will be taken from our supply of irreplaceable, highly productive soils because the steep, rough areas are much less desirable for urban and public facility development. Most of the decisions will be irreversible, so the importance of sound land use planning is evident”.

Although there may not be urban competing uses for the rural lands of Nigeria that NALDA will be mostly after, this statement highlights the relevance of land use planning in the agricultural development of any country. In the case of rural land, the need to safeguard valuable agricultural lands is a major focus of land use planning.

Meaning of Land Use Planning
The requisite of land use planning is an inventory of the resources of the land area prerequisit for use, an exercise translating into soil maps and reports. But soil maps are only good enough for use by soil scientists and others who understand the scientific content of soil survey reports.

What the ordinary farmer needs is the interpretation of soil maps, in the form of Land Capability of Land Suitability maps. But in a rural economy like Nigeria, the peasant Nigerian farmer may not even be able to use these maps, because he cannot understand them.

Land capability or suitability refers to the best or most economical use of a piece of land. Land use planning goes beyond this, to recommend the best land use after due economic, sociological and environmental impact considerations. For example, the choice of crop in an agricultural development project must be acceptable to the people. The use recommended must be environment-friendly, e.g. it must be able to sustain the productive capacity of the land and discourage environmental degradation.

In a classical case, land use planning starts with knowing the available soil resources, the potentials of each and every one and identifying and defining relevant land utilization types, (e.g. growth of maize, oil palm, rice or cassava). The plan for the use of the land would take all these into consideration such that the allocation of land to a defined land use would ensure the sustainability of the production and maximum conservation of the soil resources. The ultimate optimisation of economic benefit to the users of the land is assumed to be guaranteed by the plans drawn up, and the maintenance recommended in the plan.

The practice: Performing Land Use Planning
Land Use Planning can be performed for geographical areas varying from a farm, e.g. the size of NALDA’s of 500 to 1000 ha, to much larger areas of the size of a state, or a region or even a country.

In every case, a soil survey of the landmass is done and the physical parameters (climate, vegetation, geologic history, topography) that would determine the suitability of the land for a particular use are described.

A land use plan should relate all the physical parameters of the environment, including the characteristics of the soil, to the land use or land utilization types, identified or defined for the land. Such relationships would produce suitability maps for individual land utilization types.

Land Use Planning for NALDA Farm

a) Soil Resource Inventory

The first requirement of land use planners is a soil survey of the land. For the first tract of land, selected for the NALDA programme, the soil resource inventory was part of a comprehensive feasibility study called the Design and Formulation Study. For subsequent sites only soil survey will be done, and, of course, the soil survey interpretation.

b) Choice of Crops and Suitability of Land

The choice of crops was made on the basis of the following considerations:

- Agro-ecological suitability and comparative advantage
- Traditional acceptability
- Likelihood of sustainable croppability
- Long term economic advantage
- Overall economic benefit to Nigeria and the participant farmers

So there was no waiting for the consultants' recommended land use pronouncement or submission. But the consultants' findings were often a long list of crops found growing and actively cultivated in the project areas.