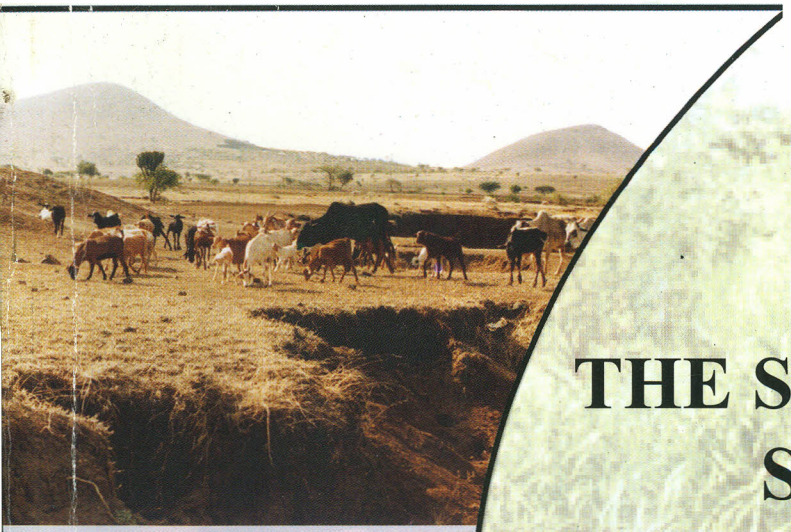

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Capacity Building for Land Resource Management to Meet the Challenges of Food Security in Africa

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LAND RESOURCES INFORMATION AND SERVICES FOR LAND USE PLANNING

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ABSTRACT

My experience in soil science is based on interaction with some of you professionals in the course of duty, interaction with academia in the universities and my own experience as a small-scale farmer. Although I am not a soil scientist, I must say that this resource is a domain of interest to every citizen in the region because it literally ties itself to all sectors of the economy.

This conference is unique and timely in many respects. First, it is organised to address issues related to "***Capacity Building for Land Resource Management to meet the Challenges of Food Security in Africa***". Land cannot be divorce as a resource from agriculture. This brings us to the important role agriculture plays in the economies of our various countries. It is with this in mind that the then Organisation of African Unity (OAU) member states adopted the "Lagos Plan of Action", where agriculture was taken as a top priority sector for economic development. Secondly, the conference is being held at a time when Kenya has just set out an agenda aimed at making the country attain the Newly Industrialised Country (NIC) status by the year 2020. Experiences from other NICs show that the path to industrialization was mainly adding value to agricultural products through developing agro-based industries such as food processing, textiles and clothing, leather products, and beverages manufacture. It is therefore no secret that if Kenya is to attain NIC status as proposed, then we have to vigorously develop the agro-based sub-sectors. The theme of this conference could not have been any more appropriate in that we have to plan now and target to achieve the NIC status in two decades from now. I can assure you that this is not too far as some of us will still be very young and strong to see it come to pass.

Having underscored the importance of this conference, I would now like to focus on the sub-theme "***Land Resources Information and Services for Land Use Planning***".

INTRODUCTION

The human element is very important in Resource Management Information Systems (RMIS). Thus, pertinent key questions emerge: Who makes decisions and how are they made? What type of information do land use planners require and how must it be presented? How are the decisions best conveyed to those who should implement them, and what role does information system play in conveying the decisions, and relevant supporting information, to the working staff? In short, how should an institution's information base be structured and operated so as to assist that institution achieve its objectives?

A RMIS is defined as a functioning information system, consisting of facilities,

staff and data, designed to support the proper management of physical resources by the provision of appropriate information to decision makers, to facilitate their understanding of the conditions relevant to making decisions. This definition does not restrict a RMIS to spatially extensive data such as images and maps, but it does envisage that these data types will be an important component of such systems because of the importance of spatial information in the management of physical and environmental resources. The "information system" consists of the technical facilities, data and staff necessary to implement and operate it. As a system it will consist of an integrated set of components that must include:

- the acquisition of data and its conversion into information;
- the storage, maintenance and ongoing management of the information base, including its auditing, editing and updating, verification and assessment provision of backup and documentation (both technical and non-technical) on the systems and its functions;
- the analysis and presentation of derived information as statistics and maps, to resource managers;
- the facilities necessary to conduct these tasks;
- training and user support as is necessary to ensure that the information is properly and efficiently used;
- integration of the information system into the resource management structure by its adaptation where the implementation and use of its system will also influence the way management decisions are made, i.e. the management style will adapt to this new information source; and
- system management to ensure the effective and efficient management of the whole information system – staff, facilities, information flow and utilization.

Fundamental to the design of a RMIS is an understanding of how managers make decisions. It is a crucial component in ensuring that RMIS provide the optimum information set, in the right form, at the right time, to the appropriate resource manager concerned with particular resource management decision.

Current Resources Information Management methods

The goals of resources managers

The goals of most resource management decisions are concerned with resolving the two issues of the short-term and long term management of resources so as to maintain or improve productivity. The importance of both of these issues will often be stated quite explicitly in the goals or objectives of most users concerned with the management of resources. Many private corporations, including farmers and other land-users, also accept the importance of both issues, and would strive to achieve both objectives in the use of rural resources, even though the relative importance of each issue will vary from person to person and from situation to situation.

There is also considerable knowledge and understanding of the process that cause resource degradation in our society. Most people can describe, in general terms, the processes that cause soil erosion and most other expressions of land degradation. Most land managers have an understanding of the process of land degradation, including those forms of degradation that they are instrumental in causing in their day-to-day management. Despite the recognised importance of maintaining resources and general knowledge of the processes that

lead to resource degradation, there is clear evidence of extensive, serious and on-going resource degradation in most countries. For example, an analysis of environmental degradation in Eastern Africa can be located squarely in the primary production process (Stahl, 1993; Blaike and Brookfield, 1987). The human presence is felt in all ecosystems and landforms in Eastern Africa. Crop and animal husbandry have spread virtually everywhere in the last half a century. Mountain forests, wetlands and dry savannas are the last frontiers where human exploitation is advancing. Forests are being logged and cleared for cultivation, wetlands are drained. In the semi-arid areas the woodlands are cut and burned for charcoal after which livestock are introduced and maize planted. All these activities represent attempts by the poor rural households to earn a living, mainly at subsistence level, from extraction and exploitation of the natural resources to which access is available.

Thus, deforestation, erosion, disappearance of springs, destruction of habitats and species extinction, i.e. all the processes which are known as environmental degradation, are related to primary production and basic household chores; reaping annual crops, raising livestock, collecting wood for household energy and building construction. In the Eastern African context today, these production processes are destructive - earning a daily livelihood takes place at the cost of environmental degradation. Viewed in this context, environmental degradation as well as programmes to develop technologies for environmental rehabilitation are important social issues.

Food security in Eastern Africa is precarious. The region has ceased to be an exporter of food. Rainfall irregularities cause crop failures leading to food deficits. Emergency food shipments are becoming regular ingredients in both multi- and bilateral aid agreements with countries in Eastern Africa. The link between environmental degradation and food security is evident as food production relies on direct exploitation of the environment by primary producers. Further degradation means further vulnerability to food deficits, which may reach massive proportions in drought years.

Resource degradation costs can be very high indeed; in the end the degradation results in the collapse of the rural industries that depend on land, causing poor performance of local economies that depend on the land resource as a major source of income. Problems arise as the land is used beyond its long-term potential – losses in soil fertility and increasing weed infestations are notable examples. A common response in our research effort is to find ways of managing the degradation after it has occurred, incurring costs that raise the overall costs of production. The nature of resource degradation and depletion, despite our knowledge and community support for resource maintenance, suggests that a major cause of degradation may be due to current management practices rather than the intentions of specific sectional groups in the community.

THE NATURE OF CURRENT RESOURCE MANAGEMENT PRACTICES

Current practices are discipline-based such that the potential impacts of decisions on the other aspects of the environment are largely ignored. This means that serious resource degradation will always occur before adequate remedies will be socially and politically acceptable and then instituted.

Characteristics of management systems suitable for addressing both goals of resource managers

Adequate quantitative databases are needed to identify trends and assess relative impacts so as to set priorities. To do this requires databases of the relatively stable resources such as geology, topography and soils as well as information on key dynamic parameters of the vegetation, water, moisture and climate from monitoring of these resources. Development and use of predictive models are needed because resource management systems that include resource inventory and monitoring information are not adequate in themselves as the data used in those systems is after the event in contrast to future-oriented decisions. Resource managers require information systems that assist them assess the potential impact of proposed decisions; they require predictive models as part of the information system.

Predictive models require good resource information to derive and subsequently drive them; resource inventory and monitoring information is a prerequisite to their use. The better the information base, the better the models are likely to be in estimating potential future conditions. However, predictive models cannot predict future conditions *per se*, but can only predict conditions that might exist if the assumptions on which the model are based apply in the future.

Mechanisms to resolve conflicts that arise due to competing demands on resources are required. This will become very important as the actions at one place can have effects at other places and times; the beneficiary of the initial action will often be quite different to those who suffer degradation at other places or other times.

CONSIDERATIONS IN THE DESIGN OF RESOURCE INFORMATION SYSTEMS

The long-term management of resource must take into account, as much as possible the many and varied environmenta interactions that may occur and affect th resource. There are three mai consequences of this process on the desig and use of predictive models.

1. Predictive models are indicators of probable future conditions. They will strive initially to produce short- and medium-term predictions of first- and second order effects. They will subsequently undergo extensive refinement designed primarily to improv the accuracy and reliability of these predictions rather than providing longe term predictions, because of the implications of the butterfly effect on th longer-term predictions.
2. It will often be necessary to monitor both the interactive process and their impacts if the environment is to be understood properly and managed, even at the primary and secondary level
3. The trade-off between increasing marginal costs of prediction and decreasing marginal benefits is likely t see development of different types of models for different managers. Strategic predictions will be relatively coarse, have long-term perspective, but be relatively low cost. Resource management models are likely to have short- to medium-term perspective, but be highly accurate, reliable and hig cost models.

The RMISs are likely to include:

- A method of monitoring key environmental parameters to provide a permanent, quantifiable, objective and geo-referenced temporal record of thes key parameters;

- A method of analyzing data to identify trends and to analyse correlations;
- Modeling of processes to assist in identifying causal processes, predicting the effects of proposed actions and assessing the relative costs and effects of various actions; and
- Integration of the RMIS into the management structure of the organization.

These specifications do not indicate how the information is to be used, by whom and hence the resolution, accuracy, reliability and timeliness requirements. To set these specifications, it is necessary to understand information theory and its role in decision-making.

The nature of information

We use information continuously in our daily lives, in assessing conditions and making decisions, yet most people would have difficulty in defining precisely what is meant by the term information, or describing how it is used. There are many reasons for this, i.e. information is not a tangible, or 'hard' asset. Many components of information are subjective, involving heuristics, trial and error learning, intuition and common sense. The way the information is used depends on the user, the environment and the decision itself, the characteristics of other available information sets and other factors. In consequence, most people, when asked what information was necessary in making a specific decision, cannot specify the full set of information that was used, nor the importance of, or weight given to, the information used in making the decision.

Here, information is defined to be part of a progression that starts with data, which is transformed into information, leading to better knowledge or understanding of the conditions surrounding the issue that requires a decision.

Data

Data are defined as the raw observations made about an object or surface, and can be of four types:

1. nominal data are classes of data which do not abide by the normal numerical rules of mathematics, being usually descriptive titles for objects, such as soil names;
2. ordinal data, where the classes are ranked into an order, but the relativities in that order are not known – soils that are given codes for their characteristics can fall into this category, e.g. the soil colour may be categorized using the normal Munsell soil colour charts, so that the soils can be ranked by their Munsell classification;
3. interval data which ranks objects and assigns relative ranking values, so that the rules of numerical mathematics can be applied, but there is no datum or reference start point for the data, i.e. the data are relative to the other ranked values. If the Munsell soil colour chart values are quantified as to the degree of yellowness of each Munsell value then the resulting data will be interval data, as well as the observations taken by a field spectrometer and satellite data before they have been calibrated; and
4. ratio data which ranks, scales and calibrates the data to a base value, e.g. reflectance data.

Data can sometimes be used directly as information, but it is more usual for the data to be processed to create information. Information can be defined as that collection of facts and opinions that improves the knowledge levels of the recipient in such a way that he or she is in a better position to

be able to undertake a focused activity or make a particular resource management decision. Resource managers will only pay for information systems that facilitate their ability to make decisions, or provide some other benefit to their activities.

LAND USE PLANNING – A TOOL TO ACHIEVE SUSTAINABLE LAND USE

Many definitions have been prescribed for "sustainable land use", but the one suitable in our contest is by Prof. Anthony Young, a renown soil scientist who has done a lot of reputable research in natural resources management. He defines sustainable land use as the system, which achieves production combined with conservation of the resources on which that production depends, thereby permitting the maintenance of productivity. In agricultural terms therefore, a sustainable agricultural system is one, which generates harvests consistently over long period of time without consuming or depleting the basic stocks of the natural resource (Young, 1989).

Influences of the natural environment and society on the land use system are never constant but they change over time and can also be influenced by human impact (positive and negative). Models of sustainable land use claiming to be close to reality are therefore always complex. As a consequence, theories and models to promote sustainable land use would be inevitably incomplete. Recommendations deduced from these models should therefore not be implemented categorically or follow predetermined procedures. They should only be taken as assistance for a gradual learning process.

This also means that strategies have to be multi-sectoral and interdisciplinary and have to be constantly negotiated. The elaboration of these strategies is in many cases supported by bilateral, international or non-governmental organisation (NGO) cooperation worldwide. With the tasks, which can be derived from the sustainable Land Use Triangle in mind, we have to elaborate new means of land use planning to meet the following objectives for different geographic areas.

Ecological targets in land use planning g under the aspect of rising population density can be described as follows:

Land use objectives in peripheral areas (global land use and non-use of ecosystems) are:

i) large scale preservation of material cycles and energy fluxes in the environment and of biological diversity which restricts human intervention and allows for the evolution of soil organisms and wild flora and fauna.
ii) protection of sufficiently large areas in which anthropogenic substance inputs and other interventions are only slightly or not in the least detrimental to dynamic equilibria and habitats are not fragmented.

Land use objectives in rural areas are:

i) preservation of soil quality for biomass production appropriate to the site.
ii) preservation of water infiltration and retention capacity as well as biological diversity and activity of soils.
iii) enhancement of the sequestration of carbon in soils and vegetation and the prevention of greenhouse gases.
iv) preservation of habitats for wild plants and animals and of soils for production of foodstuffs in rural and urban areas.
v) Maintaining of the nutrient balance and regeneration of depleted soils through fertilizing.

vi) Avoidance of accumulation of persistence toxic substances in the soils and in food chains and the eutrophication of areas worthy of nature protection

Land use objectives in urban areas are:

- minimization of sealed land and preservation of the infiltration capacity of rainfall, and the biological activity and the gas exchange of soils.
- preservation of habitats for wild plants, animals and soils for the production of foodstuffs in urban landscapes.
- cycling of nutrient flows and discharge from urban population as far as possible in the same region.
- minimization of depositions of toxic substances in soils, bodies of water and the air and avoidance of enrichment of persistent substances in soils and sediments.

The inadequate utilization of natural resources in developing countries is usually a consequence of the rural population's lack of access to land, capital, means of production, information, education, markets and political power, a situation aggravated by the high rate of population growth. The fundamental political development objectives are therefore: poverty orientation, sustainability, target group orientation, participation, multi-sectoral approach and regional orientation.

'Poverty Orientation" is an attempt to combat mass poverty through directly addressing development measures to the poor rural population to enable them to satisfy their basic needs. The objective of 'Sustainability' tries to secure the livelihood of the affected population groups so that the benefits of the project work continue, at least in the medium term, once the external support has been withdrawn. It is therefore important to enable the people to develop their ability to secure their own livelihoods through a continuous process of adjustment. Sustainability, in this context, also includes conserving the natural environment. 'Target Group Orientation' means to take the needs of different population groups into account using target group analysis for specific development measures. 'Participation' stands for the involvement of local groups in the project work in the form of a dialogue instead of undermining their ability to solve problems for themselves. The 'Multi-sectoral Approach' is beyond sectoral boundaries and tries to solve problems caused by a wide range of determining factors, which arise in several interrelated fields/sectors. 'Regional Orientation' combines spatial units in order to improve the living standard within a broad area with common natural and economic characteristics and shared socio-cultural conditions. One of the main objectives of development cooperation is to identify locally compatible solutions. The role of rural development projects is also to develop and disseminate these innovations (GTZ, 1993; Reiche and Carls, 1996).

Other important strategy elements for sustainable land use projects that have been developed during the past decade are:

- orientation on participative action,
- promotion of motivation to participate and self-help potential,
- process orientation,
- combination of effective short and medium term potential,
- development of local organisations and institutions as well as
- orientation on negotiation and conflict management.

The task/purpose of land use planning is "not (to) be a sectoral effort, executed unilaterally by government institutions, but instead it should develop into a multidisciplinary,

holistic approach that gives attention to all functions of the land and that actively involves all stakeholders through participatory process of negotiation platforms, be it at national, provincial or village level. The aim of land use planning is to create the preconditions to achieve sustainable environmentally sound, socially desirable, and economically appropriate form of land use. Such preconditions are best met by a decentralized approach" (Sombroek and Eger, 1996).

Instruments and methods to achieve sustainable land use include:

- Participative Land Use Planning,
- Conflict Management,
- Participatory Rural Appraisal (PRA),
- Remote Sensing (interpretation of area photographs and satellite images),
- Regional Oriented Rural Planning,
- Geographical Information Systems and
- Participatory Development of Sound Soil Management.

Partnership – the key for cooperation at all levels

From now on scientists will have to work closer together at an international level and take an interdisciplinary approach if the complex ecological, economic and social problems are to be solved as a progress towards more sustainable land use is made. It will be necessary for scientists in collaboration with experienced experts in practical professions to identify the structures of the problems to be solved in the next two decades. Governments and international institutions will have to provide the necessary political and financial support. Soil conservation and the setting up of a strategy defining measurable steps towards sustainable land use have to be more firmly fixed in the agenda of international cooperation.

Today we cannot predict how trends and developments traced here will merge into new patterns of land use in the lifetime of the current and future generation. We only can hope that the present stakeholders in this process will be more and more conscious and find ways to sustainable land use in the broad sense described and this will be the only way for mankind to survive physically and culturally. What can be done now is to help increase cooperation for responsible action: between people and institutions and insofar as the opportunity exists, between institutions involved in land use planning on a national and international level (Hurni, 1996).

Future strategies and challenges for soil science in East Africa

Soil science still suffers the limitation of lack of specialized expertise especially in soil microbiology, soil biology and land evaluation. There is, therefore, a need to focus on training and manpower development in soil science. In the past, training in East African Universities has been biased towards other agricultural disciplines such as agronomy but this is now changing.

Research on soil resource management has been monolithic with each specific soil science discipline attempting to address resource management problems in isolation. The problems of agricultural development are known to be complex and numerous and they are known to act not in isolation but interact in a complex manner. Thus, future strategies should focus on an integrated approach to resource management for sustainable agricultural development. The large amount of available soil resource data for the East African region is not easily

accessible to be re-interpreted for the rapidly changing land use systems. It is imperative to develop an easily accessible and integrated database using modern computer technology and Geographic Information Systems (GIS). This is currently being done with success at the Kenya Soil Survey.

It has become apparent that the use of soil resource information by planners and land users has been below expectation. This can be considerably improved through development of comprehensive research extension linkages and user-friendly methods of information transfer. GIS can play a key role in the presentation of soil resource information taking into account the farmers' needs and their level of knowledge.

Research development will also have to catch up with the research and technology development in the rest of the world and concentrate on the use of modeling approach. This will facilitate holistic and integrated research in soil science, focusing on system analysis, process, simulation and overall predictions for the future.

It is paradoxical that East Africa is known to have experienced the activities of numerous foreign experts, yet there is still inadequate expertise in some key disciplines such as soil physics, land evaluation, water management, etc. This can only be explained by the fact that experts to some extent did not pay adequate attention to training of local scientists in the relevant disciplines. It has been argued that increasing the number of soil and agricultural scientists is not going to solve the problems of agricultural development in most African countries, but that quality and relevance of training are equally important.

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