Agricultural Research Department
The Winand Staring Centre for Integrated Land, Soil and Water Research

Report on a cooperation mission to the Kenya Soil Survey

March 1992

E.M.A. Smaling

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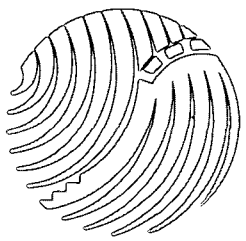

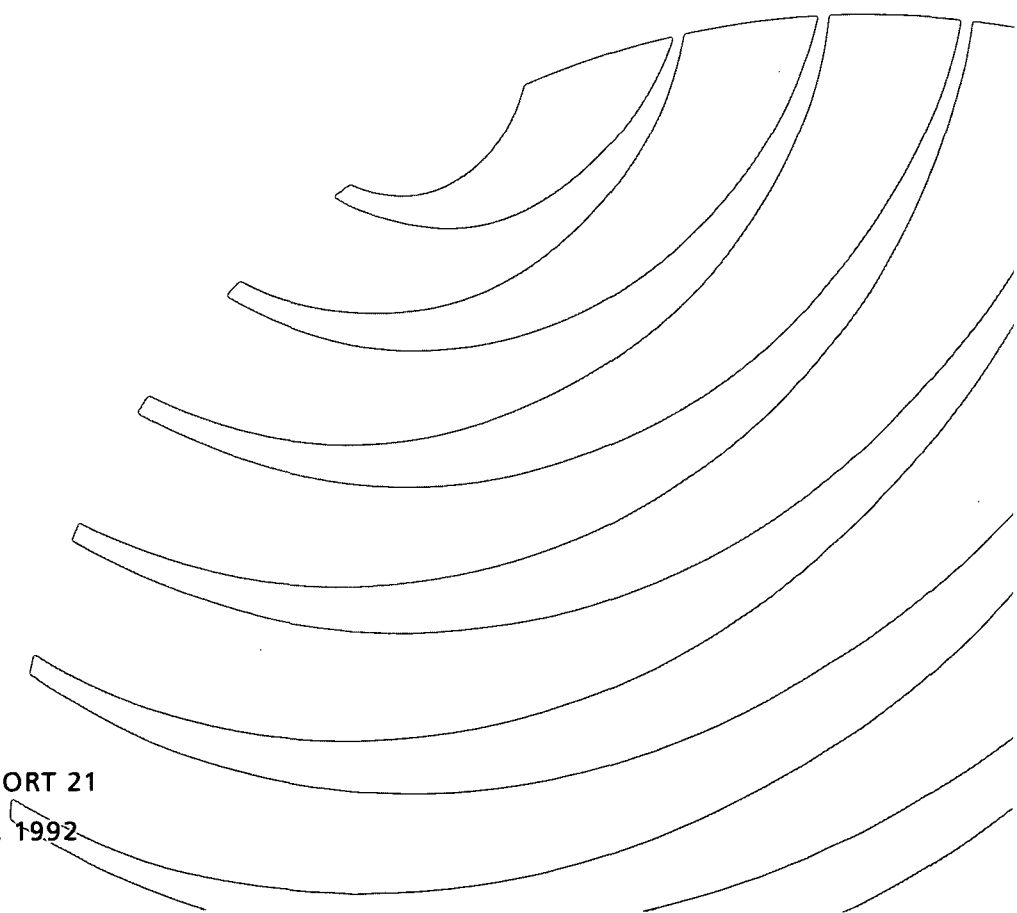

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Report of a cooperation mission to the KENYA SOIL SURVEY

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International Activities Report 21

DLO-The Winand Staring Centre, Wageningen, The Netherlands, 1992

DLO The Winand Staring Centre is continuing the research of:
Institute for Land and Water Management Research (ICW), Institute for Pesticide Research, Environment Division (IOB), Dorschkamp Research Institute for Forestry and Landscape Planning, Division of Landscape Planning (LB), and Soil Survey Institute (STIBOKA).

Project 8559 [045cis/03.92]

CONTENTS

SUMMARY

1 KARI organized a review meeting between the different Netherlands-supported programmes and the RNE. The Acting Head KSS prepared a document which gives the present state of affairs at KSS. The document, 'The Netherlands support to the national agricultural research project: programme review Kenya Soil Survey', can be of help to the mid-term evaluation mission, which will be mounted by April 1992.

2 Two meetings were held on the present status of the different laboratories at NARL, and possible ways to enhance efficiency and complementarity. The output of the laboratories is below capacity, and quality control is poor. An expert on soil laboratory management may investigate and recommend on the specific tasks and equipment in the different laboratories. The need to enhance efficiency is obvious, but should take into account that KARI is at the moment not in a position to recruit large numbers of new staff.

3 The proposed Netherlands component of the KSS budget 1992 is Dfl. 856,000.-. The 1993 budget will also include the anticipated revenues from commissioned surveys, GIS services and sales of publications. Because of 'structural adjustment' programmes, the recurrent GoK budget remains modest, although the expected contribution for 1994/'95 is considerably higher than for 1992/'93.

4 The need for KSS to perform quantitative land evaluation was identified during the 1991 workshop on land evaluation. It has now been given a follow-up in the form of collection of acquisition and synthesis of yield data at the research stations in Kenya. When those yields can be linked with both input data (labour, fertilizers, tillage operations) and environmental data (climate, soils), a basis for quantitative land evaluation has been established.

5 During the past year, the GIS staff has gained a lot of experience, however, still coming across several problems which required further training and discussion. As a consequence, Peter Lentjes, the ARC/INFO specialist from the Winand Staring Centre, spent two weeks at KSS for in-service assistance to the GIS group. His recommendations include major improvements in database management and GIS analysis, and suggestions as to organization and hardware and software.

6 On March 5 and 6, 1992, KARI/KSS organized a symposium on 'Applications of Geographic Information Systems in Kenya'. The meeting, with some 200 participants, was opened by the Minister for Research, Science and Technology and the Chef de Poste of the Royal Netherlands Embassy. Next to a series of presentations and demonstrations, three groups discussed the role of GIS in (1) Land Resources Assessment, Agriculture and Forestry, (2) Range and Wildlife Management, and Pest Control and (3) GIS capabilities in international and national institutes in Kenya and its impact on development. The conclusions included: a strong need for networking, free interchange of GIS products within Kenya, as long as the purpose of its use is geared towards development, and training in GIS at different levels of intensity.

7 KSS intends to hold a seminar in Kwale (September 1992), explaining to provincial and district agricultural staff what KSS can bring in at that level, in terms of land resources inventory and evaluation. During the seminar, the agricultural staff on the

spot will inform KSS on the kind of information required and how it should be presented to make it 'digestable' to non-soil scientists.

1 INTRODUCTION

Between February 18 and March 10, 1992, Ir E.M.A. Smaling of the Winand Staring Centre for Integrated Land, Soil and Water Research (WSC), Wageningen, The Netherlands, paid a working visit to the Kenya Soil Survey (KSS), Nairobi, Kenya. KSS is a section of the National Agricultural Research Laboratories (NARL), which belongs to the group of 15 national research centres in the Kenya Agricultural Research Institute (KARI) in the Ministry of Research, Science and Technology.
Since 1972, KSS is supported through a bilateral agreement between the Netherlands Directorate for International Cooperation in the Ministry of Foreign Affairs (DGIS), and the Kenyan Government. The cooperation between KSS and WSC is laid down in a Twinning Agreement and an Inception Report and supported in The Netherlands by a Project Liaison Unit (PLU). Reports of previous missions (March and September 1991) are available at KSS and at WSC, Department of International Cooperation.

2 KARI/NARL - DONOR REVIEWS AND EVALUATION

By mid-February, KARI organized a review meeting between the different Netherlands-supported programmes and the RNE. The Acting Head KSS prepared a document which gives the present state of affairs at KSS. The document, 'The Netherlands support to the national agricultural research project: programme review Kenya Soil Survey', can be of help to the mid-term evaluation mission, which will be mounted by April 1992. The NARL Annual Report 1991 was completed by February 1992, a remarkable achievement. It implies that the KSS Report for this year is also expected soon, as the bulk of the information is already in the NARL version.

The WSC liaison officer attended a NARL donor meeting (20.2.1992), chaired by NARL Director Dr F.N. Muchena. All sections of NARL (IDR, Agro-Chemistry, FURP, KSS, Crop Protection) were represented, and delegates from RNE, ODA and EEC were also present to discuss matters pertaining to the progress of work in the Soil and Water Management and the Soil Fertility and Plant Nutrition Programmes of KARI.

3 INCREASED EFFICIENCY OF NARL ROUTINE AND RESEARCH LABORATORIES

Many clients of NARL are individuals or organizations who want chemical or physical analysis performed on their samples. Now that different sections of NARL have official tariff systems, it has become necessary to stick to deadlines, previously agreed on by NARL and its clients. Two meetings were held, chaired by Dr F.N. Muchena, Director NARL, on the present status of the different laboratories at NARL, and possible ways to enhance efficiency and complementarity. This issue was also discussed in the November 1991 meeting of the KSS Project Liaison Unit. The meetings were further attended by staff members of the Agro-Chemistry section (Qureshi, Oduor, Ayaga), FURP (Schnir), IDR (Sijali), and KSS (Aore, Ekirapa, Kariithi, Ochieng, Gachini).

Agro-Chemistry
This section does routine analyses for soil fertility evaluation (primary, secondary and trace elements) for farmers, research institutions, projects and consultants, and for KSS. It also does plant tissue analyses for research and advisory purposes, soil mineralogy and analyses on agricultural inputs (fertilizers, waters, manures), animal feeds and foodstuffs for quality control.

Fertilizer Use Recommendation Project
The refurbishment of the former Leaf Analysis laboratory is near completion. Once operational, the laboratory is responsible for analyzing all plant samples from farmers, FURP itself, and other research projects. FURP soil samples will also be analyzed here. In the long run, the laboratory will become the main research lab for the Soil Fertility and Plant Nutrition Programme in KARI.
This laboratory has an auto-analyzer (Skalar), an atomic absorption spectrophotometer, and a UV-Vis spectrophotometer. Provided there is no personnel constraint, the auto-analyzer can handle 200 samples a day (N, P, K, Ca, Mg), whereas the spectrophotometers can handle 100 samples a day (P, S, K, Ca, Mg, Zn, Cu, Mn, Fe).

Irrigation and Drainage Research
This section does all routine soil physical analysis, i.e. mainly texture (both hydrometer and pipette method), bulk density and moisture retention. The laboratory is not able to cope with the demand, due to lack of staff and equipment. At this time, approximately 100 texture samples and 30-60 pF samples can be handled per week.

Kenya Soil Survey
Three laboratory units are being operated, i.e. soil chemistry and fertility, soil physics, and soil micromorphology. They are in principle used for research purposes, but due to long delays in the other sections, the KSS labs do part of the analyses on their own survey samples.
The chemistry laboratory performs CEC at pH 7.0, CEC-clay, gypsum and calcium carbonate, total iron and aluminium, and electrical conductivity.
The soil physics unit can analyse texture, bulk density and moisture retention at low

and high pF, infiltration rates and hydraulic conductivity.
The micromorphology unit can prepare and analyze thin sections, but is currently out of operation, as all staff is abroad on training (Kiome, Kinyanjui, Onyono).
At present, stocks are taken and a complete picture of the available laboratory instruments and their state can be published soon.

The participants in the meetings agreed that the output of the laboratories is below par, both in quantity and in quality. This is largely a result of lack of staff, lack of output of present staff, and lack of coordination between subsections. It may be useful to invite an expert on soil laboratory management to investigate and recommend on the specific tasks and equipment in the different laboratories. The need to enhance efficiency is obvious, but should take into account that KARI is at the moment not in a position to recruit large numbers of new staff. Increased efficiency should be obtained through: higher labour input by the present staff (also the middle and higher cadre), and by some improvements in equipment and the way it is established.

4 BUDGET KSS 1992

The Netherlands component of the KSS budget 1992 is listed in Table 1. It should be noted that by the time of writing, it had not yet been officially approved by the RNE. The 1993 budget will also include the anticipated revenues from commissioned surveys, GIS services and sales of publications. Since the initiation of the tariff system (August 1991), an approximate KSh. 60,000 was realized up to the end of 1991. At present, it is used to pay for part of the running costs of KSS.

Table 2 gives the forward recurrent GoK contribution to KSS up to 1995, excluding personnel emoluments. Because of 'structural adjustment' programmes, this budget remains modest, although the expected contribution for 1994/'95 is considerably higher than for 1992/'93.

Table 1 KARI/KSS project budget 1992 (Netherlands component,in 000 Dfl.)

		via DGIS and WSC	via RNE and KARI
200	PERSONNEL		
211.4	Costs in The Netherlands	33.0	
211 -215	Short missions	40.2	4.0
270	Consultancies	26.0	
	Subtotal	99.2	4.0
400	EQUIPMENT		
421	Survey equipment	10.0	
423	Cartographic equipment	15.0	5.0
424	Laboratory equipment	25.0	5.0
425	Office equipment	15.0	5.0
426	Library	15.0	
430	Vehicles	110.0	
480	Insurance, freight charges	10.0	
	Subtotal	200.0	15.0
500	OPERATIONAL COSTS		
510	Maintenance of station		5.0
520	Maintenance of equipment	4.0	16.0
530	Maintenance of vehicles	10.0	60.0
	Fuel	5.0	15.0
540	Stationery	3.0	12.0
590	Travel and accommodation	8.0	22.0
	Banking costs		
	Subtotal	30.0	130.0
600	TRAINING		
610	Netherlands	110.0	5.0
620	Kenya		
640	Elsewhere	180.0	7.0
690	Short courses, workshops	7.0	3.0
	Research	25.0	
	Subtotal	322.0	15.0
800	CONTINGENCIES	30.0	10.8
	TOTAL	681.2	174.8
	GRAND TOTAL		856.0

Table 2 Forward recurrent budget (GOK Contribution) (in K£) for the period 1992-1995*

		1992/'93	1993/'94	1994/'95
100	Transport and operating Expenses	76,300	86,800	139,300
110	Travel and Accommodation Expenses	83,200	83,200	94,000
120	Postal and Telegram Expenses	2,500	3,000	4,000
121	Telephone Expenses	2,500	3,000	3,500
130	Official Entertainment	250	350	450
140	Electricity, Water and Conservancy	7,500	8,500	10,500
156	Purchase of laboratory stores and Equipment	5,000	11,000	22,500
171	Publishing and Printing	8,500	9,500	16,250
172	Purchase of Uniforms and Clothing	6,000	7,500	9,000
173	Library Expenses	1,500	1,500	5,000
174	Purchase of Stationery	4,500	4,500	20,000
175	Computer Charges	4,000	4,000	5,000
176	Show Expenses	6,000	7,000	8,000
190	Miscellaneous and Other Charges	5,000	6,000	6,000
192	Insurance Cover and Road Tax	10,000	15,000	20,000
194	Training and Seminar Expenses	NIL	NIL	45,000
210	Purchase of Additional Vehicles	NIL	NIL	75,000
220	Purchase of Plant, Machinery and Equipment	NIL	16,000	32,250
250	Maintenance of Plant Machinery and Equipment	4,600	14,500	29,000
260	Maintenance of Buildings and Stations	20,000	20,000	25,000

*K£ ≈ Dfl. 1.30

5 PROGRESS ON SOIL SURVEY AND LAND EVALUATION

5.1 Soil survey

The fieldwork for the reconnaissance survey of Narok District continues according to the time schedule laid down in the 1992 annual workplan for KSS. Termination is foreseen during the second half of 1992. By July/August, a start will be made with a 1 : 100,000 survey of Murang'a District. Survey leaders will be staff members that have recently obtained MSc. degrees, i.e. Waruru, Wanjogu (soil science) and Macharia (vegetation science).

Expected output for 1992 on survey reports:

a **Reconnaissance Soil Surveys**
The following reconnaissance reports have been pending will be finalized and printing during the year:
- Soils of the Busia Area (Rachilo).
- Soils of the Transmara-Kehancha Areas (by Dr Wamicha).
- Soils of the Lodwar Area (Van Bremen-UNESCO Expert, in collaboration with Kenya Soil Survey).
- Soils of the Makueni Area (Aore to assist Dr Muchena - *Note*: only the soils part to be published).

b **Ad hoc Surveys**

i) Ready for printing (to be published by March 30)
- Detailed soil survey of Kimutai's farm, Timboroa Division, Baringo District (Okoth).
- Soils of the proposed Kiambere Irrigation Scheme (Embu District (Kibe and Shitakha).
- Semi-detailed soil survey of the Marimanti catchment area, Meru District (Wokabi).
- A preliminary investigation of the soils of the Transmara-Kehancha area, Narok District (Okoth).
- Semi-detailed soil survey of some poorly drained areas in Uasin Gishu District (Mainaga and Kimotho).
- The Maya's farm, Kilifi District (Ndaraiya).
- Soil conditions of Kigunda's farm, Ntirimiti Settlement Scheme (Rachilo).
- Semi-detailed soil survey of Bukura Institute of Agriculture, Kakamega District (Kibe).

ii)
- Draft reports in the final stages of editing (to be printed by June 30)
- Soil conditions of Machiala farm, Bondo, Siaya District (Kamoni).
- Detailed soil survey of Sigor pilot farm, Sigor Division, West Pokot District (Wanjogu).
- Semi-detailed soil survey of the proposed Marimanti Reseach site, Meru District (Kibe).
- An assessment of the soil conditions of the Magarini settlement scheme, Kilifi District (Ekirapa and Muchena).

Several soil survey reports of the just completed ad hoc surveys are expected to be ready for printingby the end of April. These include:

- Detailed soil survey of Soet farms (2) - in Kitale and Cherangani, Trans-Nzoia District (by Gicheru and Rachilo).
- Soils of the Ungoye Research Station (I.C.I.P.E.), South Nyanza District (by Mare).
- Soil conditions of Moi University Farm, Uasin Gishu District (by Kimotho).
- Soils of the Kibwezi Experimental Station, University of Nairobi (by Ekirapa).
- Soil conditions of the ICRAF experimental site at KARI-Moguga (by Rachilo, Gicheru and Van Bremen).

New surveys to be executed during the year

a **Reconnaissance surveys**

- Resource inventory of Muranga District (1 : 100,000) will commence in May.

b **Ad hoc Surveys**

i) Soil conditions of the KEFRI/ICRAF/KARI Agro-forestry experimental site at Maseno, Kisumu District (Kibe) - KEFRI will meet costs of the survey.

ii) A request to execute ad hoc surveys (six) has been received from the Ministry of Agriculture (Irrigation and Drainage Branch) for the period January to June.

iii) A request to survey the Ngong' Location, Kajiado district has been received from KARI.

Additional requests (maximum of three) can still be executed during the year.

5.2 Land evaluation

The major goal for 1992 will be the publishing of the first draft 'Land Evaluation Manual'. At the time of writing, agro-economist D. Kilambya is participating in the post-graduate International Course on Development-oriented Research in Agriculture (ICRA) in Wageningen. He will return to Kenya in August 1992. A recent recruit is Mrs S. Nyangesi, an MSc. agronomist, who embarked on the acquisition and synthesis of yield data at the research stations in Kenya. When those yields, for various crops, can be linked with both input data (labour, fertilizers, tillage operations) and environmental data (climate, soils), a basis for quantitative land evaluation is there. Knowing the amount of 'grey' literature in the country, Nyangesi's work may prove very useful. Examples of such unknown data are the results obtained in FURP and the often excellent quantitative information in the Annual Reports of KARI Muguga. The information gathered will be used for building the 'Automated Land Evaluation System', which can be used as a planning tool by agricultural departments and can be interfaced with the KSS geographical information system.
Next, N. Achieng, presently on a BSc. agronomy in the US, will return by the end of the year to join this team. D. Wamicha, who has recently obtained a PhD. degree in Germany could possibly be heading this group upon finishing the Transmara

The need for KSS to perform quantitative land evaluation was identified during the 1991 workshop on land evaluation. Too often land is rated 'class 1' or 'class 3', without sufficiently yield ranges or inputs needed to obtain certain yields being specified. A first attempt to show a product of GIS and quantitative land evaluation was presented by Aore, Kamoni and Maingi during the bi-annual FAO soil correlation meeting in Malawi (November, 1991).

6 GIS SUPPORT MISSION (by P.G. Lentjes)

6.1 Introduction

On March 5, 1991, the GIS software ARC/INFO was installed at KSS on 2 PC's. The GIS staff then underwent a 2-weeks training course by Logisterion, the ARC/INFO distributor in the Netherlands. At present, the GIS staff consists of:
- Peter Maingi, cartographer,
- Peter Kimotho, database manager,
- Peter Kamoni, GIS manager.

As a pilot project, the soil map of the Kwale District has been digitized and additional information of land use and suitability for coconut and maize was stored in the database. During the year that has now elapsed the GIS staff has gained a lot of routine, however, still coming across several problems which required further training and discussion. As a consequence, Peter Lentjes, the ARC/INFO specialist from the Winand Staring Centre, spent two weeks at KSS for GIS support and further training.

A prototype of the demo to be presented during the GIS symposium (see Chapter 7) was prepared before the arrival of the consultant. His first activity was to improve the quality of the demo. More analyses were added to the demo and errors in the database were corrected. The work on the demo turned out to be a good training opportunity. Upon completion of the demo, other problems with ARC/INFO were discussed.

6.2 Evaluation and recommendations

Database

* When more than one coverage has the same spatial structure (polygons, arcs and points are identical), the attributes of those coverages should all go to one coverage and the other coverages should be deleted.
* More efforts are needed to check for errors in the attribute information.
* Polygons should have labels.
* When changes are made in the database, the changed tables or even entire coverages should be copied to diskettes or tapes (backup) the same day.

GIS analysis

* Until now the GIS only has been used for simple procedures.
  - Plotting the digitized maps again (e.g. soil map, topography and rainfall maps), actually just reproducing maps that have been digitized.
  - Adding one item with additional information (e.g. suitability for maize) to the attribute file of soil coverage and making maps based on that item.

  With a GIS, however, more complex analyses can be performed, where information of more than one item in several coverages can be combined. For land evaluation,

for instance, information of soil, slope, climate, land use and topography have to be combined using overlay techniques. In future use of GIS these possibilities have to be explored much better.

Organization and personnel

* The database component is below par. Strenghtening this unit is urgently required, with a thorough understanding of dBASE being indispensable.
* The carthographic component was found in order, the officer concerned showing skills that justify further training in more sophisticated analyses and automated mapping.
* The general management needs major improvement, including further development in terms of understanding of the system and its applications, and public relations.

Hardware and software

* With two PC's with ARC/INFO, there is no need for more investment in computer capacity in the near future. Only if there is a strong increase of GIS activities, the situation has to be evaluated again.
* Both computers should have a mouse.
* Both computers use the same plotter and the same printer. T-switch devices can be used for both computers without changing the cables all the time. These switches can also reduce hardware problems.
* High capacity cassette tape units will make it more easy to backup the entire disks of both computers. Backups of a 300 Mb disk to diskettes will take too much time, especially if the disks are almost full.

DAILY NATION, FRIDAY, MARCH 6, 1992

Computer tips for diplomat

The acting director of the Kenya Soil Survey, Mr Wilson Aore, explains how computers are used to collect and store information to, from left, the Counsellor at the Royal Netherlands Embassy, Mr Arend H. Huitzing, Dr Frederick Muchina and a curious participant during a workshop at the Hilton Hotel yesterday. The Minister for Research, Science and Technology, Mr Kirugi M'Mukindia, told research institutions during the workshop to adopt the use of Geographic Information Systems (GIS) in the handling and management of data. He said GIS units were invaluable tools for planning. Mr M'Mukindia opened the two-day GIS workshop, which is organised by the Kenya Agricultural Research Institute (KARI) and is funded by the Netherlands. The workshop draws participants from various research institutions and non-governmental organisations who are deliberating on the theme "the application of GIS for efficient data storage and handling". (Picture by WILLY MWANGI)

KARI-GEOGRAPHIC INFORMATION SYSTEMS CONFERENCE

KARI FIGHTS LAND DEGRADATION

ONLY an approximate 25 per cent of Kenya's land surface has a high or medium suitability for rainfed agriculture. This land is already intensively used and is given little or no time to recover after a period of croping. There are pertinent dangers of erosion, soil acidification and nutrient depletion, salinisation and desertification, requiring judicious land use planning at national, district and farm level.

In the face of this crisis, agricultural scientists, land-use planners and extensionists and of course, the farmers themselves are increasingly asked to find ways of increasing food production in a sustainable manner on shrinking agricultural land. The recent installation of Geographical Information Systems (GIS) in the country can help achieve this delicate goal.

A GIS is a computer based system that can store, manipulate, display, and produce geographical data, that is, spatial information, integrated with tabular and textual data.

In this article, the development of GIS at the Kenya Agricultural Research Institute (KARI) is highlighted, in anticipation of a symposium on this topic on March 5 and 6 at Nairobi's Hilton Hotel.

Kenya Soil Survey

It is with the mandate of the Kenya Agricultural Research Institute to analyse and tackle the problem of land degradation in relation to its use. This pertains, amongst others, to KARI's Nairobi-based National Agricultural Research Laboratories, and in particular its section known as Kenya Soil Survey (KSS).

After 20 years of surveys at different scales, KSS has collected a considerable amount of data on landforms, soils, climate, vegetation and land use. Its output in terms of reports and maps comprises the Exploratory Soil and Agro-climatic Zones Maps of the country on a scale of 1: 1,000,000, 13 reconnaissance maps and reports of the Lake Basin Districts and large parts of Narok and Kajiado districts, and Coast and Eastern provinces on a scale of 1: 100,000 to 1: 250,000, and 160 commissoned surveys.

With such a data set, KSS should be able to play a role in land use planning issues of urgency, providing data on both the productivity as well as the vulnerability of soils in the different agro-ecological zones of Kenya. A current example is the involvement in a soil and land use survey of the Narok District, where the Maasai community as well as the the maginificent game parks are threatened by he increasing occupation of land by farmers and companies.

In order to try to keep the ecological balance right, KSS should provide biophysical reasons why certain areas can be explored, leaving other areas as they are. The services KSS can render in this respect can be greatly improved with the recently acquired Geographical Information System.

Geographical Information Systems

A GIS is a computer based system that can store, manipulate, display, and produce geographical data, that is, spatial information, integrated with tabular and textual data. It contains:

- Spatial elements or map features, i.e. points, lines and areas (for example, villages, roads, and soil mapping unites).
- thematic elements that are the attributes to the spatial elements (soil components of mapping units, for instance), and
- time elements that apply to thematic elements exposed to changes over time (changes in land use/cover, for example).

Data entered into a GIS are stored in digitised format. Thematic elements are entered using traditional input media, such as computer keyboards. Spatial elements are entered into a GIS either manually through digitisation or automatically using scanning techniques.

Data entered in the GIS are stored in a data base where they can be processed and retrieved. The management of the data in the data base is performed by a Data-Base Management System (DBMS), which organises the data in appropriate structures for efficient processing and retrieval.

The most commonly used system in GIS is the so-called relational data-base system since one main objective of the processing is to establish relationships between thematic elements from the attribute data base and spatial elements from the map or image data base.

Information display is used for presentation of the different forms of products created by the GIS. It may consist of one or several devices for the production of maps, graphics, text information and attribute tables. Hence, GIS makes it possible for the resource planner to rapidly produce a combination of maps and tables that answers the questions "where" (location of resources), "what" (kind of resources) and "how much" (quantity/limitation of resources) simultaneously.

Applications in Kenya

The major applications of GIS are in identification of resources potentials and limitations, in land-use planning, and in land-resource monitoring in space and time.

Some examples relating to the work of KSS are: staff of an intended agro-forestry project in Kisii requires insight into the distribution of land with slopes above 8 per cent soils deeper than 120cm, and an average annual rainfall exceeding 1,800mm.

With the Geographical Information System, KSS can indicate where these areas are to be found, by overlaying rainfall, slope and soil depth files from the database, in combination with the specified boundary conditions. Similarly, an area around Taveta may be earmarked for irrigated cotton.

The implementing agency requires information on the present level of salinity in the topsoil, the drainability of the subsoil, and the expected efficiency of fertilizer use. KSS is able to collect the necessary information, that is, electrical conductivity of the topsoil and the irrigation water, texture and hydraulic conductivity of the subsoil, and nutrient availability and retention capacity of the whole profile. When overlaying the results, the client can judge whether implementation is feasible.

During and after implementation, monitoring may be carried out to check if any correction measures are needed. The entire Kwale District (see maps) was surveyed on a scale that is suitable for land-use planning (1: 100,000). The information on the hard-copy soil map (upper map) is too aggregated and too little problem specific for many agriculturalists. With the GIS, the separate characteristics of the soils of the district are entered in files.

With the help of a so-called land evaluation system, the suitability for maize and coconut are derived (lower maps). In case prices change and farmers may have an increasing interest in any of the commodities, the GIS allows easy adjusting and updating of these maps.

In the field of GIS, both national and international linkages are needed to avoid duplication of efforts and enhance efficiency. Examples are the Department of Resource Surveys and Remote Sensing in the Ministry of Planning and National Development, the Regional Centre for Services in survey, Mapping and Remote Sensing and the United Nations Environmental Programme.

Becasue of these anticipated linkages, the choice of hardware and software at Kenya Soil Survey was largely governed by the need for compatibility to similar GIS configurations in the country. Attached to the GIS were a general manager and two data-entry officers, i.e. one for the graphical and one for the attribute component, who have received thorough training on the subject.

Since 1972, Kenya Soil Survey has received technical support from the Government of The Netherlands through a bilateral co-operation programme.

7 SYMPOSIUM 'APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS IN KENYA'

7.1 General

On March 5 and 6, 1992, a symposium took place in the Nairobi Hilton Hotel on 'Applications of Geographic Information Systems in Kenya'. The meeting was opened by the Minister for Research, Science and Technology (Hon. K. M'Mukindia) and the Chef de Poste of the Royal Netherlands Embassy (Arend Huitzing). Almost 200 participants from different international organizations (UNEP, FAO, ILRAD, ICIPE, ICRAF, RCSSMRS), ministries (MoRST, MoWD, MoPND, MoENR), national research institutes (KWS, NERS, other KARI Centres, SoK) universities (Nairobi, Kenyatta, Moi) and parastatal organizations (LBDA, TARDA) were present.
The initiative for the symposium was taken by the Director KARI, Dr C.G. Ndiritu, as a result of the recent installation of a GIS in the Kenya Soil Survey. KSS's Peter F. Okoth invested much time in (perfectly) organizing this symposium. The symposium received excellent news coverage (KBC television and newspapers).
The programme is given in Annex 1. Several presentations were followed by computer demonstrations by ILRAD and Kenya Soil Survey. ICIPE, the National Environmental Secretariat and the Winand Staring Centre presented posters. There was ample time for informal contacts during lunches and a reception at the end of the second day.
An important component of the symposium were the group discussions. Three groups discussed the following subjects:

GROUP I: Land Resources Assessment, Agriculture and Forestry (LRA-A-F)

1 National and district-level data sets presently available in Kenya on LRA-A-F.
2 To what extent is GIS presently used to store, manipulate and present these data to different users.
3 Role of GIS in the integration of LRA-A-F disciplines on an agro-ecological basis: matching land resources with present or potential agricultural or forest land use.
4 Priorities for GIS-related research in Kenya in the fields of LRA-A-F; role of universities.

GROUP II: Range and Wildlife Management, and Pest Control (RWM-PC)

1 National and district-level data sets presently available in Kenya on RWM-PC
2 To what extent is GIS presently used to store, manipulate and present these data to different users.
3 Role of GIS in integration of RWM-PC disciplines on an agro-ecological basis: matching carrying capacity of land resources with sedentary and pastoral livestock systems, wildlife management and incidence of pests.
4 Priorities for GIS-related research in Kenya in the fields of RWM-PC; role of universities.

GROUP III: GIS capabilities in international and national institutes in Kenya; impact on development

1 Present capabilities in international institutes (UNEP, FAO, ILRAD, ICIPE, ICRAF, etc.).
2 Present capabilities in national institutes (KARI, DRSRS, KWS, etc.).
3 Horizontal lines: organizations often work on one scale: who is their end-user?
   a (supra)national (e.g. UNEP);
   b national (e.g.KARI);
   c district (ASAL programmes, DDC's, NGO's);
4 Vertical lines: scaling up and down.
   a exchange of GIS expertise and data between international and national institutes
   b impact of GIS in (inter)national institutes in district development and land-use planning;
   c. networking, training, 'empire-building' in GIS capabilities: recommendations.

The following conclusions were arrived at:
1 There is a strong need for networking. A GIS coordination group was established, tentatively chaired by W.W. Aore, Ag. Head KSS. Some institutes already had overlapping activities. A 6-monthly newsletter could be instumental in keeping GIS users up-to-date on latest developments elsewhere in the country, case studies, and new linkages abroad.
2 The vast majority of GIS users work with Arc/Info. Second is ILWIS, developed at ITC. The common database package attached is DBase III+ or IV. Unfortunately, an important organization like Survey of Kenya, from which many other participants draw their basemaps, uses DEMETER/ORACLE.
3 There should be free interchange of GIS products within Kenya, as long as the purpose of its use is geared towards development.
4 Admitting that their mandate is supra-national, the international organizations such as UNEP, FAO and ILRAD, with all their expertise and resources, should play a more prominent role in extending GIS knowledge and software to national organizations.
5 National organizations should attempt to really make their GIS products reach the end-user, who may well be working on a district level.
6 Training in GIS is needed at different levels of intensity. The universities were asked to take this into consideration when writing up their curricula. All three universities present have embarked on GIS activities, but sofar with too little coordination.

Proceedings of the symposium, including all papers and a summary of the group discussions and recommendations, will be out within a few months. All participants and KSS Project Liaison Unit members will receive copies.

7.2 Contributions KSS/WSC

All organizational matters during the workshop were handled by KSS and WSC. Next, Kenya Soil Survey contributed to the symposium with a demonstration on two PC's, showing the Kwale District land inventory and a simple land evaluation for maize and coconut, using the Automated Land Evaluation System. The Winand Staring Centre had a poster demonstration on agricultural significance and environmental risks of injecting liquid manure (P. Lentjes).

7.3 Follow-up: Kwale District seminar

Though invited, there were few representatives from the districts, i.e. District Agricultural and District Development Officers. Yet, a lot of the information gathered by KSS can be converted into useful thematic information to be used at a provincial, district or even divisional planning level. Interlinkages between the international, national and district level were discussed during the symposium and were found of paramount importance. It is therefore the intention of KSS to hold a seminar in Kwale (September 1992), explaining to provincial and district agricultural staff what KSS can bring in, in terms of land resources inventory and evaluation. Kwale was chosen because of the pilot GIS study of KSS on this district. During the seminar, the agricultural staff on the spot will inform KSS on the kind of information required and how it should be presented to make it 'digestable' to non-soil scientists. Invited for this seminar will be: PDA Mombasa and some of his staff, DC and DAO Kwale and staff members, and staff of the KARI Regional Research Centre in Mtwapa and Matuga. Next, existing projects in Kwale District may have an interest to participate.

8 RESEARCH PROJECTS

8.1 PhD projects KSS staff

D. Wamicha obtained his PhD. on soil genesis aspects of Greyzems in the Transmara area in 1991 (University of Giessen, Germany). He has resumed his duties at KSS and is now completing the Transmara-Kehancha reconnaissance soil report.

R. Kiome is in the final stages of his PhD. research at East Anglia University, Norwich, UK. His topic is 'The effect of soil and moisture conservation measures on soil moisture and crop production. A case study in the semi-arid areas of Embu and Meru Districts'. Fieldwork was completed in August 1991, and the text is anticipated to be ready for judgment by September 1992. The defense could then take place around January/February 1993. Kiome visited WSC and other Wageningen institutes in the period 16-20 March, 1992.

S. Wokabi completed all preparations for trial research during the 1992 long rainy season. For him, 1992 will be fully devoted to data collection at his sites in Kavutiri, Embu Research Centre and Gachoka. The focus will be on quantifying differences in maize yield under researcher and farmers management respectively. His sites lie in three adjacent agro-ecological zones on the slopes of Mount Kenya. Studies will also be done on soil micromorphology and geostatistics. Between May and August 1992, a working visit will be paid to ITC (Prof. Zinck) and to the University of Gent (Prof. Van Ranst).

8.2 Salinity monitoring at the Taveta irrigation scheme

To sustain irrigated agriculture, periodic information on soil salinity is required. Detailed inventories on salt-affected soils are scarce in most tropical countries, and there are few monitoring programmes that document the status and dynamics of salinity in soils and waters, assessing the adequacy of irrigation and draininge systems. In order to establish long-term monitoring programmes, the need for simple, practical and rapid methods for monitoring soil salinity is obvious. One such method, previously tested in The Netherlands and Pakistan, is electromagnetic induction. In October 1991, a study was done to test an electromagnetic device (EM 38) on its suitability to rapidly monitor salinity levels in a partly abandoned irrigation scheme in Taveta, Coast Province. Also, the spatial variability of salinization was monitored. Scientists from the KSS (P. Okoth), IDR (V. Sijali), and WSC (W. van Dooremolen), monitored soil salinity according to different sampling grids, and the outcome was checked against conventional ECe-measurements. A preliminary report on the study was published, 'Monitoring soil salinity using electromagnetic conductivity measurements and geostatistical processing'. The conclusions so far are that the EC-recordings obtained with the EM 38 alone, though positively correlated with the conventionally determined ECe, are not suited for accurate salinity mapping, as soil

moisture and clay content interfered to some extent. Next, the EC and EM measurements displayed a strong spatial dependance over short distances. On monitoring salinity development, information on short-distance variability should be taken into account by adding random points or clusters.
The report will be turned into a combined WSC/NARL publication.

8.3 Athi-Sabaki-Galana project

On March 7 and 8, a visit was paid to Moi Univeristy in Eldoret to draft a research proposal for the EEC's so-called STD-III programme (Life Sciences and Technologies for Developing Countries). An outline of the project is given below. It will be submitted to Brussels by July/August 1992.

Title : **Environmental degradation along the Athi-Galana-Sabaki river basin and its impact on food production.**

Keywords : land-use systems, land degradation, water pollution, small-scale fisheries, natural resource policies.

Objectives : To analyse the impact of agricultural and other land-use policies and practices on the productivity of land/water resources in the Athi-Galana-Sabaki basin.

a to study the impact of cropping and livestock systems on the soil nutrient status and erosion;
b to study the impact of sediment and chemical pollution on the downstream aquatic ecology and fisheries economy;
c to assess the impact of policies and development interventions on land management practices in the basin;
d to propose supplemental policy recommendations to alleviate land/water degradation in the basin;
e to develop integrated research methodology adaptable to other developing countries.

Participants: University of Amsterdam: Dr A. Dietz (social geographer) and M. Vink (foreign office); Moi University: Prof. C. Okidi, Prof. M. Tole, Dr R. Cline, Dr K. Shrivastava; Kenya Soil Survey: W. Aore, P. Okoth; Kenya Marine and Fisheries Res. Inst.: F. Kairu; Winand Staring Centre: E. Smaling; East-Anglia University: absent (proposed: Prof. Blaikie).

8.4 Natural resources and needs assessment for land use planning and sustainable rural development in the Narok and Kajiado Districts

This project proposes to implement a methodology for natural resources and needs assessment for land use planning, which can be replicated in other districts; to develop and strengthen the capacity for land use planning for the selected districts; to strengthen the capacity for data collection and analysis needed for sustainable rural

development; and to strengthen the capacity for dissemination of natural resources and planning information.
The initiative was taken by the RNE, wanting to try and integrate experiences from different projects (WRAP, KSS, DIC Kakamega). A fact-finding meeting on this possible project will be held in The Hague (DGIS) by March 30, 1992. Other participants are TNO, who implemented WRAP, and RUU who guided the establishment of the DIC Kakamega.

8.5 FAO/AEZ, SOTER

Dr R. Brinkman (FAO/AGL) visited KSS to hand over the long-awaited 'Agro-ecological land resources assessment for agricultural development planning - a case study of Kenya'. A set of reports and software is now ready to be used for national planning of food, livestock and fuelwood production. The KSS Exploratory Soil Map was used to enter soils information, and Jaetzold and Schmidt's Farm Management Handbooks to enter climatic data. Linear programming was applied to come to production estimates under different agro-ecological and socio-economic conditions.
Dr R. Oldeman (ISRIC) visited NARL to discuss the Soils and Terrain Digital Database project, which has been submitted to RNE for funding. Kenya Soil Survey as well as the National Soil Service, Tanga, Tanzania, which is also under the auspices of WSC, have been approached to collaborate on this project. It requires a considerable input from these African institutes. As far as KSS, and in particular its GIS unit is concerned, there is a definite need to plan such comprehensive activities far in advance, avail personnel when the time is right, and claim a substantial share in terms of funds, acknowledgement and publication.

9 MID-YEAR WORKSHOP: SOIL AND WATER CONSERVATION

Workshops on various topics of interest to KSS staff are held once every year at the KSS premises. The mid-year workshop for 1992 will be on 'Soil and Water Conservation', intended to strengthen and provide more guidance to the KSS staff at large, and more in particular to officers of the Soil and Water Management section, and the NARL section IDR. By the time of writing this report, no progress had been made on organization as yet. The 2-weeks workshop should also include presentations by KSS staff members who returned from training in the past two years, and who did thesis subjects related to land conservation, i.e. Wamicha, Gicheru, Wanjogu, Macharia, Waruru.

In September 1991, four staff members of the Soil and Water Management section underwent a 4-weeks intensive training on 'Soil Physical Measurement Techniques'. Relevant equipment will be procured during 1992, in the interest of improving the contribution of the section to survey and research work.

10 EQUIPMENT

10.1 Stock-taking

At the request of the WSC and in the interest of the forthcoming evaluation mission, KSS started taking stock so as to better judge the value of goods supplied through the project. During the visit of the WSC liaison officer, the shipment of goods ordered in 1991 was cleared and unpacked at KSS. They included a new printing press, a voltage stabilizer for the GIS unit, and a single beam spectrophotometer.

10.2 Requirements in 1992

Requirements for 1992 will be handed in to the WSC liaison officer by June 1992 latest. Funds are rather limited; hence, no major procurements will be made on survey, office, laboratory and cartographic equipment.
Two diesel landrovers have been ordered at CMC in Nairobi, and were in an advanced stage by mid-March.

11 STAFF REQUIREMENTS AND TRAINING PROGRAMME 1992

The present staff requirements were listed in a review document by the Ag. Head KSS. The details are given in Table 3.
The KSS training programme for 1992 is in Table 4.

Table 3. KENYA SOIL SURVEY STAFF REQUIREMENTS

NATURE OF STAFF	PRESENT	TOTAL REQUIREMENT AS PER APPROVED ESTIMATE	DEFICITS	JUSTIFICATION	QUALIFICATION REQUIREMENTS
1. Soil Surveyors	9	12	3	To replace C.K.K Gachene who joined the University of Nairobi	BSC in Geology/Chemistry/Physics/ BSC in AGric. or MSC in Soil Science
2. Land Evaluation Specialist	0	3	3	To fill vacant posts as per the establishment (M.M.Gatahi left for JKUCAT in Nov.,1990)	MSC in Soil Science (Land Evaluation Option)
3. Soil Chemists	2	4	2	To replace Messrs. Wanjohi, Ngaruiya and Kithome	BSC in Chemistry or MSC in Soil Chemistry
4. Climatologist	1	2	1	To replace Mr.D.N. Mungai	BSC or MSC in Meteorology
5. Soil Physists	1	2	1	To fill vacant post	BSC or MSC in Soil Physics
6. Range Ecologists	1	2	1	To replace Mr. Situma who for the Ministry on 01/11/90.	MSC in Range Ecology or Range Management
7. Technical Officers	5	9	4	To replace Messrs. Kanake and Muigai	Diploma in Agriculture
8. Technical Assistants	5	13	8	To replace Messrs. Mainga, Wachira, Kimotho, Koech, Mwangi, Wachira, Kimani and Ochung'	General Certificate in Agriculture General Certificate in Range Management (2posts)
9. Laboratory Technologists	2	4	2	To replace Mwaura and fill vacant post as per establishment	Diploma in Analytical Chemistry and Diploma in Soil Science
10. Laboratory Technicians	0	3	3	To replace Messrs. Kihonge and Kariithi	Laboratory Technician Certificate
11. Cartographers	3	7	4	To replace Messrs. Olulo, Mukiira and to fill vacant posts as per establishment	Diploma in Cartography or Occupational Certificate Grade III, II, I.
12. Draughtsmen	0	1	1	To fill vacant posts as per establishment	Survey of Kenya Occupational Test Grade III
13. Photo-Lithographers	0	3	3	To fill vacant posts as per establishment	Diploma or Certificate in Photo-Lithography
14. Shorthand Typists	0	2	2	To replace Ms. Mbogo and Mrs. Kuria	Shorthand 80 wpm. Typing Stage II Kenya National Examination Council
15. Copy Typists	1	3	2	To replace Mrs. Odero, Ms.Gachanja and Mrs. Okumu	Copy Typist 50 wpm. Typing Stage II
16. Drivers	9	14	5	To replace Messrs. K. Mwaura, F. Mwaura, M. Kubai, J.Gathirua and P.Kibue	Competent drivers with Grade Test Certificate from Ministry of Transport and Communications
17. Artisan	0	1	1	To replace Mr.Joseph Wainaina	Artisan Grade Test from ministry Labour.
18. Supplies Assistants	1	2	1	To replace Mr. Njogu	-
19. Sub-Staff	10	15	5	To cope up with work load in the section	

* At the moment four casuals are required (two in the Chemistry and Physics Laboratories who assist in soil analyses). One Casual cleans the KSS stores and its arrangements while the second casual does general cleaning of the soil physics and Micromorphology laboratories.

Table 4 Training Programme KSS, 1992

a	**Starting**	
	J.R. Rachilo	- MSc in Eremology (University of Ghent, Belgium - 2 years).
	J.M. Kibe	- BSc in Agiculture (West Virginia University, USA - 2 years).
	F.M. Shitakha	- BSc in Agriculture (West Virginia University, USA - 2 years).
	D.W. Kilambya	- Postgraduate course on Development Oriented Research in Agriculture-ICRA (Wageningen, the Netherlands - 7 months).
b	**Continuing**	
	S.M. Wokabi	- PhD Land Evaluation (ITC, Enschede, the Netherlands).
	H.C.K. Kinyanjui	- BSc in Agricultural Economics (West Virginia University, USA).
	N.M. Achieng'	- BSc in Agriculture (West Virginia University, USA).
c	**Returning**	
	K.L.M. Kiome	- PhD in soil Conservation (University of East Anglia).
	B.K. Waruru	- MSc in Eremology (University of Ghent, Belgium).
	S.N. Wanjogu	- MSc in Soil Science (University of Nairobi).
	P.N. Macharia	- MSc in Range Management (University of Nairobi).
	C.R.K. Njoroge	- BSc in Agriculture (University of West Virginia, USA).
	H.N. Onyono	- Diploma in Soil Survey (ITC, Enschede, the Netherlands).
	H.L. Mikisi	- Diploma in Cartography (Horsen Polytechnic, Denmark).

ACRONYMS

AEZ	Agro-ecological zones
AGL	FAO Land and Water Development Division
ALES	Automated Land Evaluation System
ASAL	Arid and Semi-arid Lands
DAO	District Agricultural Officer
DC	District Commissioner
DDC	District Development Committee
DGIS	Directorate General for International Cooperation, The Hague
DIC	District Information Centre
DRSRS	Department of Resource Surveys and Remote Sensing
EEC	European Communities
FAO	United Nations Food and Agriculture Organization
FURP	Fertilizer Use Recommendation Project (section in NARL)
GIS	Geographical Information System
IAC	International Agricultural Centre
ICIPE	International Centre for Insect Physiology and Entomology
ICRA	International Course on Development-oriented Research in Agriculture
ICRAF	International Centre for Research in Agro-Forestry
IDR	Irrigation and Drainage Research (section in NARL)
ILRAD	International Laboratory for Research on Animal Diseases
ILWIS	Integrated Land and Water Management Information System
ISRIC	International Soil Reference and Information Centre
ITC	International Institute for Aerospace Surveys and Earth Sciences
KARI	Kenya Agricultural Research Institute
KSS	Kenya Soil Survey (section of NARL)
KWS	Kenya Wildlife Service
LBDA	Lake Basin Development Authority
MoENR	Ministry of Environment and Natural Resources
MoPND	Ministry of Planning and National Development
MoRST	Ministry of Research, Science and Technology
MoWD	Ministry of Water Development
NARL	National Agricultural Research Laboratories
NERS	National Environmental Research Secretariat
NGO	Non-governmental organization
ODA	Overseas Development Agency
PDA	Provincial Director of Agriculture
PLU	Project Liaison Unit
RCSSMRS	Regional Centre for Services in Survey, Mapping and Remote Sensing
RNE	Royal Netherlands Embassy
RUU	State University of Utrecht
SoK	Survey of Kenya
SOTER	Soils and Terrain Digital Database
STD	Science and Technology for Development Programme (EEC)
TARDA	Tana and Athi River Development Authority

TNO	Institute of Applied Geoscience
UNEP	United Nations Environmental Programme
WRAP	Water Resources Assessment Project
WSC	Winand Staring Centre for Integrated Land, Soil and Water Research

ITINERARY

17.2	23.20h	Departure Amsterdam
18.2	09.30h	Arrival Nairobi
	14.00h	Meeting with W. Aore, Ag. Head KSS
19.2	morning	Meeting with W. Aore
	afternoon	Meeting with Dr F. Muchena, Director NARL, and P. Okoth (KSS), in charge of GIS symposium
20.2	morning	NARL donor meeting (NARL staff, EEC, ODA, RNE); Preparations GIS symposium at Hilton Hotel
	afternoon	Meeting with Dr C. Ndiritu, Director KARI; KSS staff (S. Wokabi, Head KSS; M. Aguno, KSS Library)
21.2	morning	NARL meeting on efficiency of chemical and physical laboratories; Meeting with Dr F. Schnir (FURP)
	afternoon	Meeting with Dr B. Ngundo, Ass. Director Soils, Water and Other Resources, KARI; Meeting W. Aore
22.2		Preparation of paper for GIS symposium; meeting S. Nandwa (FURP)
23.2		Meeting with Drs. R. van de Weg, Director IAC
24.2	morning	KSS Cartography Section FURP: Mr J. Owuor, Deputy Project Coordinator Other KSS staff
	afternoon	Meeting with S. Wokabi on Ph.D. research
25.2	morning	Arrival P. Lentjes (Winand Staring Centre)
	afternoon	Royal Neth. Embassy: Dr R. Bos (first secretary)
26.2	morning	Discussions with Aore and Dr R. Brinkman (FAO.AGL) on AEZ study Kenya
	afternoon	KSS staff
27.2	morning	KSS Laboratories
	afternoon	Reporting; GIS section
	evening	Dinner hosted by Dr R. Bos and Drs. M. Schomaker (UNEP)
28.2	morning	KSS staff
	afternoon	RNE: meeting with Dr R. Bos (RNE)
	evening	Meeting Ir P. Kiepe (ICRAF); report write-up
29.2		Report write-up
02.3	morning	NARL meeting on efficiency of laboratories, chaired by Dr Muchena
	afternoon	Preparations GIS article in newspaper Kenya Times
03.3	morning	Meeting Mr A. Kintunkwonka (Kawanda Research Station, Kampala, Uganda)
	afternoon	Round-up with W. Aore
04.3	morning	RNE: Meeting with Mr N. Visser (Agric. Attache), M. Rusch (RNE; project management) and A. Huitzing (RNE, Chef de Poste)
	afternoon	Round-up; preparations GIS symposium; arrival of project goods

05.3		GIS symposium
		Meeting wih Mrs N. Linssen and N. Visser (RNE) and A. Kintunkwonka (Uganda)
06.3		GIS symposium
	evening	Reception symposium participants
07.3		Nairobi-Eldoret (with W. Aore and P. Okoth)
08+09.3		Eldoret: project proposal write-up
10.3	morning	Return Eldoret-Nairobi
	afternoon	Debriefing Dr Muchena; round-up Aore
	23.00h	Departure Nairobi
11.3	06.00h	Arrival Amsterdam

ANNEX 1 GIS SUPPORT MISSION (TECHNICAL PART; BY P.G. LENTJES)

The following aspects of using GIS have been discussed:

* Accessing attribute files with the TABLES command.
  The attribute information is stored and can thus be accessed in dBASE. Another way of accessing the dBASE files (query, update etc.) is using the TABLES subset of ARC/INFO. Especially when there is not much experience with dBASE, TABLES is a good alternative. Queries in TABLES are similar to queries in other ARC/INFO commands like ARCPLOT and ARCEDIT.

* Writing comments in SML macro.
  It is important that macros are written in the SML source code. The **&REM** command specifies a comment line. In every macro, information on author, date, version and purpose should be included.

* Use of logical connectors.
  With the logical connectors **AND** and **OR**, two or more expressions can be combined into one. A logical expression only results in TRUE or FALSE. With AND a condition will be evaluated as TRUE if the logical expressions on both sides of AND are TRUE. For instance the expression `CODE < 11 AND CODE > 8` results in TRUE for CODE = 9 and for CODE = 10.
  With OR the condition will be evaluated as TRUE if one of the logical expressions is TRUE or if both expressions are TRUE. For instance the expression `CODE < 11 OR CODE > 8` results in TRUE for all values for CODE.
  If logical expressions are used to select records, for instance with **RESELECT** in TABLES, only the records for which the condition is TRUE will be selected.

* The theory of overlaying maps.
  One of the most important capabilities of a GIS is overlaying coverages. When two polygon coverages are overlayed, geometric intersections are computed. All polygons from both coverages will be split at their intersections and preserved in the resulting coverage. The resulting coverage containes the attributes of both coverages. For instance, you create a coverage called SOIL-LANDUSE by overlaying the coverages SOILS and LANDUSE. The coverage SOILS has the attributes SOILS-ID and SOIL-CODE and the coverage LANDUSE has the attributes LANDUSE-ID and LANDUSE-CODE. The coverage SOIL-LANDUSE will have the following attributes: SOIL-LANDUSE-ID, SOILS-ID, SOIL-CODE, LANDUSE-ID and LANDUSE-CODE.
  There are 3 overlay commands in ARC/INFO:
  - UNION. The input coverage and the overlay coverage should both be polygon coverages. The area of the output coverage is the area of both the input coverage and the overlay coverage.

- **INTERSECT**. The input coverage can be a POINT, LINE or POLYGON coverage. The overlay coverage should be a polygon coverage. Only those features in the area common to both coverages will be preserved in the output coverage.
- **IDENTITY**. The input coverage can be a POINT, LINE or POLYGON coverage. The overlay coverage should be a polygon coverage. All features in the input coverage as well as those features of the overlay coverage that overlap the input coverage will be preserved in the output coverage.

* The use of variables in SML.
  Like in any programming language, SML allows the use of variables. Variables are storage areas in the computer memory which contain a value. The value of an SML variable may be either a number or a string. In SML macros you can use up to 50 variables named from 1 to 50. A variable may be assigned explicitly with the **&SETVAR** command. For variables with a numerical value, the variable can be calculated with the **&CALCVAR** command. Below are some examples of these commands:
  `&SETVAR 1 12.3`the variable called 1 is set to the value 12.3
  `&SETVAR 2 "SOIL MAP"`variabel 2 is set to the string "SOIL MAP"
  `&CALCVAR 3 %1 + 0.8`variable 3 is set to the value of variable 1 + 0.8 (12.3 + 0.8 = 13.1)

  Also with the **SHOW** command in ARCPLOT and ARCEDIT variables can be set. With the &CALCVAR the value can be changed. In the example below the size of a map in ARCPLOT is reduced by increasing the mapscale:
  ```
  MAPEX SOILS
  MAPSCALE AUTOMATIC
  SHOW MAPSCALE %1    the mapscale is assigned to variable 1
  &CALC 2 %1 * 1.1
  MAPSCALE %2    the mapscale is set to the new value
  ```

* Labelpoints in polygons.
  Polygon coverages should have one labelpoint per polygon. The polygon coverages at KSS did not have labelpoints. The labelpoints should be digitized together with the arcs. There are several advantages when polygons have labels:
  - It is easy to find polygons that are not closed after CLEANing (with **LABELERRORS** in ARCPLOT).
  - It is much faster to plot labels within polygons (with **LABELTEXT** in ARCPLOT).
  - The label values will automatically be assigned to the polygons-ID's. Hence, on choosing the right label values, there is no need to change the ID's in the PAT file anymore.

* Transformation of map coordinates.
  When a map is digitized, the digitizer coordinates have to be transformed to world coordinates (e.g. UTM). This can be done in two ways. The first method is by defining an existing coverage whose TIC and BND files are copied to the

new coverage to be created with the **DIGITIZE** or **ADS** command. The second method is transforming the coordinates after the coverage has been digitized, using the **TRANSFORM** command. The output coverage should be an existing coverage only containing tic points with the world (e.g. UTM) coordinates. After TRANSFORM the output coverage also containes the transformed coordinates of arcs points and transformed area, perimeter and/or length in the attribute file (PAT or AAT).

When the orientation of the digitized map is not north-south, the transformed map will be rotated. This also happens when the sequence of tics in the input coverage is different from the output coverage, or when there is an error in the tic coordinates of the output coverage. In the latter case the RMS-error will be large and the output coverage should not be used.

* Hardware problems with the pen plotter.
  The CALCOMP plotter sometimes fails to plot the whole map. Only after the plotter has been switched off for half an hour, the problem does not recur. This is probably caused by the hardware and not by the software. The dealer in the Netherlands shall be contacted.

* Use of one coverage for making several maps.
  At KSS there were several coverages with the same polygons but with other information in the PAT-file. There was a coverage for soils, the area under maize and coconut and the suitability of land for these crops. So there were five different coverages with information related to the same polygons. In this case there should only be **one** coverage with the information of soils, area and suitability stored in the PAT file. On doing so, a lot of disk space can be saved and it is possible to find features that meet several criteria.

* Use of look-up tables.
  Thematic information related to items in the PAT or AAT files can be stored in the same PAT or AAT or in so-called lookup tables. For instance suitability classes that are related to soil codes can be stored in a lookup table. This table has an item for the soil code and an item for the suitability class. The item for the soil code should have the same name in the PAT file and in the lookup table (e.g. SOIL-CODE). In ARCPLOT, ARCEDIT and TABLES the two tables can be joined with the **JOIN** command using SOIL-CODE as join item. Using lookup tables saves disk space and saves time when updating the suitability classes; it boils down to only updating 1 record for every soil code instead of all the polygons having that soil code.
  Lookup tables can also be used in ARCPLOT for assigning colors to every soil code. In this case the items in the lookup table should be SOIL-CODE and SYMBOL (if SOIL-CODE is the item name in the PAT table).

* Checking the database.
  On trying to use lookup tables, many errors were found in the database. In the soil coverage of the Kwale District, for example, we found the codes UT1c,

UTlc and UTIc, whereas the code UT1c was the only correct one. The best way to check the codes in the PAT file is to list them in alphabetical order using the **FREQUENCY** command. Codes that should not be in the table can easily be detected now, but not all errors can be traced in this way. Making a map and checking every individual polygon is the only way to find all errors.

* Installing interfaces for printer and video screen.
  On one PC, the driver for the HP laserjet printer was installed. With this driver the OKI laser printer can be used. On the other PC, the driver for the EPSON matrix printer was installed. This was done with the **CON-CGI** command. ARCPLOT output can be sent to the printer by using the command **DISPLAY 2**. The map is sent to the printer after the **QUIT** command is given in ARCPLOT. For one PC the driver for the screen was changed with **CON-CGI**, as some polygons were not drawn on the screen.

* Installing interface for digitizer.
  The digitizer interface was installed on one PC. With the **CON-DIG** command, it was then installed on the other PC as well.

On ARCPLOT:

* Using hardware colors for drawing maps on the screen.
  In the demo prototype, maps made for a penplotter were drawn on the screen. By using hardware shading for polygons the speed of drawing maps can be increased and more colors can be used. However, there is a limitation in the number of points per polygon. Hardware shading can be used with the command **SHADESET COLOR**.

* Choosing the right shade patterns and colors.
  The legend of a suitability map should almost be self-explanatory. High suitability, for example, is green, moderate suitability yellow and low suitability is red. The suitablity maps that had already been made at KSS were difficult to read, because suitability classes that were very simular, had very different colors.

* Changing the position of the map.
  If a map is not wanted at the lower left of the page or the screen, the **MAPPOSSITION** command should be employed. With this command it is also possible to plot several maps on one page or one screen.

* Making maps with the penplotter in more then 4 colors.
  For plots made with the CALCOMP plotter, mostly the PLOTTER shadeset is used. With this shadeset only 4 different pens can be used. If plots are foreseen with more then 4 different colors, there are two options:
  1 Make two or more plotfiles. In the first plotfile, only the lines, polygon shadings and text in the colors black, red, green and blue should be included. In the second plotfile the lines with maximally 4 other colors should be included. If necessary a third plotfile can be made. The default symbol set

(PLOTTER) should be used in this case. In the symbol set PLOTTER only the pen numbers 1, 2, 3 and 4 are used. If a line in color 1 will be plotted, the plotter will use the pen that is situated in position 1 of the penholder. The user should decide what pen-color should be in that position. First the black, red, green and blue pens should be placed in the plotter. After the first plot is made, the pens are changed to, for example, purple, brown, orange and pink. Now the second plotfile can be plotted, without moving the paper.

2 Defining a new symbol set. If only the shade patterns should have more colors, you only have to define a new shade set using the **SHADEEDIT** command. If the markers, lines and text should have more colors too, you also have to define new symbol sets for these elements. It is also possible to copy the PLOTTER symbol set and use dBASE or TABLES to modify the contents of the table(s). The tables with symbol definitions are situated in the directory \ARCEXE\SYMBOLS\. The new symbol set can be used in arcplot with the **SYMBOLSET** command. If you only want to use the shade set then the **SHADESET** command can be used.

* Placing of several text blocks on a map.
  One or more text blocks can be plotted with the command **TEXTFILE.**

* Scaling maps
  With the **MAPSCALE** command the map scale can be set. Together with the MAPSCALE command, the map units have to be defined with the command **MAPUNITS METERS**, otherwise ARCPLOT assumes the coverage coordinate units are inches and the map will be much too small.

* Zooming in in ARCPLOT.
  With the **MAPEXTENT BOX *** command, one can zoom in in ARCPLOT. After this command you should clear the screen and draw the features again using the commands **ARCS, POLYS** etc.

ANNEX 2

APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS IN KENYA

SYMPOSIUM ORGANIZED BY THE KENYA AGRICULTURAL RESEARCH INSTITUTE MARCH, 5-6, 1992, HILTON HOTEL NAIROBI.

P R O G R A M M E

Thursday, 5th March

8.00 - 9.00	Registration of participants
Session I	Chairman: Dr. F.N. Muchena Rapporteurs: Mr. P. T. Kamoni Miss Grace Njogu
9.00 - 9.30	General Information by the Organizers
9.30 - 9.35	Director KARI to Introduce Hon. Minister for Research, Science and Technology
9.35 - 9.45	Opening Speech by Minister for Research Science and Technology Hon. Kirugi M'Mukindia
9.45 - 10.00	An Address by His Excellency the Ambassador of the Kingdom of the Netherlands
10.00 - 10.30	C O F F E E / T E A B R E A K
10.30 - 11.00	"UNEP/GRID GIS Programme" Dr. Roberto Fernandez United Nations Environmental Programme, Gigiri, Nairobi.
11.00 - 11.30	"Using GIS in the Management of Wildlife Resource" Mr. Apollo Kariuki Kenya Wildlife Service, Nairobi.
11.30 - 12.00	"Use of GIS in Quelea Management" Mr. Christoph Dreichsler FAO/RAF/88/033 Project, Nairobi.
12.00 - 12.30	"Economics of GIS" Mr. Silas Yimbo Aerospace Surveys Kenya Ltd.
12.30 - 14.00	L U N C H B R E A K
14.00 - 14.30	"The Use of GIS in Early Warning Systems for Food Security" Mr. Barry L. Henricksen FAO/IGADD Project for Drought Monitoring. Regional Centre for Services in Surveying Mapping and Remote Sensing, Nairobi.

14.30 - 15.00 "GIS Education in Kenya"

Mr. G.C. Mulaku
University of Nairobi, Survey and Photogrammetry Department.

15.00 - 15.30 C O F F E E / T E A B R E A K

Session II Open session (Participants are free to move freely through the demonstrations)

15.30 - 17.00 "Computer Demonstrations and Poster Presentations"

Computer Demonstrations:

1) "The Applications of GIS in Soil Survey and Land Evaluation"

Mr. P.T. Kamoni / Mr. W.W. Aore
KARI/Kenya Soil Survey

2) "The Applications of GIS in Animal Diseases Research"

Dr. Russell Kruska
ILRAD

Poster Presentations:

1) "The Applications of GIS in Insect Research"

Mr. Henry Mena
ICIPE

2) "Producing Thematic Maps using GIS"

Mr. Peter Lentjes and Mr. Peter Maingi
Winand Staring Centre/ KARI-KSS

Friday, 6th March

Session III Chairman: Dr. Roberto Fenandez
Rapporteurs: Dr. W.N. Wamicha
Mr. Henry Mena

9.00 - 9.30 "Resources Survey, GIS and Instant Data Communication in Migratory Pest Control"

Prof. Dr. Frithjof Voss
Institute fur Geographie, Berlin.

9.30 - 10.00 "GEMS/UNITAR Africa Programme"

Mr. Robert Kakuyo
United Nations Environmental Programme, Gigiri, Nairobi.

10.00 - 10.30 C O F F E E / T E A B R E A K

10.30 - 11.00 "Applications of GIS in Desertification Assessment"

Mr. Wilbur Otichillo

11.00 - 11.30	"Application of GIS in Conservation and Development" Mr. Wycliffe Mutero National Environment Secretariat, Ministry of Environment and Natural Resources, Nairobi.
11.30 - 12.00	"Applications of GIS in the Department of Resource Surveys and Remote Sensing" Mr. R.K. Sinange DRSRS/ Ministry of Planning and National Development.
12.30 - 13.30	L U N C H B R E A K
13.30 - 15.30	Group Discussions **Group I** GIS Applications in Land Resources and Agriculture. Chairman: Mr. G.N. Kibata **Group II** GIS Applications in Livestock and Range Management. Chairman: Dr. Russell Kruska **Group III** The Use of GIS by the International Institutions in Kenya and the impact on National Programmes. Chairman: Mr. H.A. Mwendwa / Mr. R.K. Sinange **Group IV** The use of GIS by National Institutions and the impact on National Development Programmes in Kenya. Chairman: Dr. W. K. Ngulo
15.30 - 17.00	P L E N A R Y S E S S I O N 1) Report of the Group Discussions 2) Conclusion and Recommendations
17.00 - 18.00	**S O C I A L F U N C T I O N**

ANNEX 3

OPENING ADDRESS

HON. KIRUGI M' MUKINDIA
Minister for Research Science and Technology

Mr. Chairman, distinguished guests, delegates, ladies and gentlemen. On behalf of the Government and the people of the Republic of Kenya, it gives me great pleasure to welcome especially visitors from outside Kenya to this country and to the city of Nairobi. During your stay in this country, you are most welcome to visit any places of special interest to you.

The subject of this workshop is an important one particularly for the developing countries where most basic information for resource utilization and planning is either lacking or is not yet compiled into a comprehensive and systematic manner.

Geographic Information Systems and its applications, are invaluable tools for planning the development of any country. Information on land use, agricultural statistics, urban changes, pest infestations, rangeland changes and general resource conditions forms the backbone of any planning process. It is for example impossible to plan for the food security in a country if you do not have the basic information on land and human resources, infrastructure and labour to enable you accomplish such an objective. In the past, such information has been kept in archives in different departments and authorities. The information is normally either held in scientific reports or stored in maps which in most cases are cumbersome to handle or too voluminous for most decision makers to read. It is a relief, therefore, to learn that technology has advanced to such an extent that such information can now be stored in a single DATABASE in a computer and accessed at will by anybody interested in using the information. I am informed that several layers of information can be stored together in a single DATABASE and analysed together to give the results desired by the user. A GIS is therefore, not only restricted to the field of research, but can be utilized by other disciplines as well. I believe that most of you assembled here today are interested in different applications of the system.

Reasons associated with lack of use of GIS in Kenya in the

past can be summarized as:-

1) Lack of awareness of the existence of the technology in Kenya.

2) Lack of expertise in Kenya and

3) Lack of funds to put up such units in most Government institutions.

Other problems associated with the use of GIS in Kenya revolve around the DATABASE formats adapted by the different institutions with such units in place. I am informed that information exchange between such institutions can only take place if the DATA FORMATS are compartible with each other. This issue should form one of the basic parameter to be agreed upon and standardized for National information transfer and exchange. I have noted that in this symposium there are members of the diplomatic corps, members of the donor cummunity, representatives of different Government departments and eminent scientists who are going to deliberate together in trying to find solutions to some of the mentioned problems.

The first GIS unit in Kenya was put in place in 1985 at UNEP headquarters in Gigiri. Since then other institutions have put up GIS units in place. These institutions include: Department of Resource Surveys and Remote Sensing (formally KREMU), Regional Centre for Services in Surveying, Mapping and Remote sensing, The Kenya Wildlife Services, The International Laboratory for Research on Animal Diseases (ILRAD) and the Kenya Agricultural Research Institute (KARI) in the Kenya Soil Survey section.

This is a positive development which requires encouragement. It is my hope that after this meeting more institutions shall see the benefits of using a Geographic Information System in their daily data handling and management. It is also my sincere hope that a strong linkage is going to develop between the institutions and the data users in all spheres of National development.

Mr. Chairman, without taking too much of your time, I would like to wish the participants success in this symposium. I look forward to your advice and recommendations as to how Kenya can

benefit further by strengthening sound data storage and handling techniques. However, let me reiterate once again my pleasure at being invited to participate in this ceremony.

It is now my duty and pleasure to declare this symposium on the applications of Geographic Information Systems for efficient data storage and handling officially open.

ANNEX 4 TWENTY YEARS OF NETHERLANDS ASSISTANCE TO THE KENYA SOIL SURVEY[1]

Ladies and Gentlemen, only an approximate 25% of Kenya's land surface has a high or medium suitability for rainfed agriculture. This land is already intensively used and is given little or no time to recover after a period of cropping. The dangers of erosion, nutrient depletion, salinization and desertification are pertinent and require judicious landuse planning at national, district and farm level. The Kenya Agricultural Research Institute, organizer of the present symposium, investigates and attempts to tackle the problem of land degradation. The Government of The Netherlands cooperates with several KARI research centres, one of them being the National Agricultural Research Laboratories, and in particular its section known as Kenya Soil Survey. Since 1972, Kenya Soil Survey received technical support from the Government of The Netherlands through a bilateral cooperation programme. Expatriate support was initially high, with 7 experts in 1975, but was gradually diminished to 2 experts in 1985. During the 70's, the expatriate staff was mainly involved in soil survey, land evaluation and on-the-job training. During the 80's, Kenyan staff took over most managerial responsibilities and the Dutch staff had an advisory rather than an executive task. In 1988, permanent institutional support came to an end, and donor support continued on a lower profile. On behalf of the Netherlands Government, the Winand Staring Centre for Integrated Land, Soil and Water Research, based in Wageningen, strengthened its already existing ties with Kenya Soil Survey through a so-called Twinning Arrangement. By 1992, national staff included 17 research officers with academic degrees, and 15 technical officers with diplomas in Soil Survey.

After 20 years of surveys at different scales, the Kenya Soil Survey has collected a considerable amount of data on landforms, soils, climate, vegetation and land use. The output of Kenya Soil Survey in terms of reports and maps comprises (i) the Exploratory Soil and Agro-climatic Zones Maps on a scale of 1 : 1,000,000, (ii) 12 reconnaissance maps and reports of the Lake Basin Districts and large parts of Narok and Kajiado District, and Coast and Eastern Province on a scale of 1: 100,000 to 1 : 250,000, (iii) 160 mainly commissioned, detailed surveys and site evaluations, and (iv) numerous miscellaneous reports, internal communications and conference papers.

With such a data set, Kenya Soil Survey should be able to play a role in land use planning issues of urgency, providing data on both the productivity as well as the vulnerability of soils in the different agro-ecological zones of Kenya. A current example is the involvement in a soil and landuse survey of the Narok District,

[1] Speech delivered on behalf of His Excellency the Ambassador of the Kingdom of the Netherlands, on the occasion of the symposium on 'Application of Geographical Information Systems in Kenya', Nairobi, 5-6 March, 1992

originally home to the nomadic Masai, whose livestock shares the extensive grazing grounds with Kenya's game. Increasing land pressure in surrounding districts such as Kisii, Kiambu and Nakuru has caused rapid changes in the Narok District's present-day appearance. The land, which has a moderate to high potential for crops like wheat, barley, potatoes and maize, is rented or bought by agriculturalists and increasingly put to crops. To feed its growing population, Kenya needs to cultivate these areas badly. Meanwhile, however, both the Masai community as well as the magnificent game parks are threatened severely by the increasing occupation of land by farmers and companies. In order to try to keep the ecological balance right, Kenya Soil Survey is in a position to indicate, from a biophysical perspective, which areas could be explored and which areas should be left untouched. Land use planners will then be better able to indicate areas to be used for agriculture, grazing, game parks, and other purposes.

The dissemination of land information to the different users in the field of agriculture is of primary importance. Until lately, much of the information gathered by Kenya Soil Survey has been underutilized as too few people know where to find it, or how to interpret it. Fellow soil scientists can easily master the information provided on maps and in reports, but this is often not the case for users in related fields, such as landuse planners, district and divisional officers, and KARI colleagues at national and regional research centres. Their specific though soil-related questions require 'digestable' answers from soil scientists. When confronted with aggregated information that is commonly presented on soil maps, these users may not be able to identify and interpret the relevant constituents. In addition, part of the data set may have become obsolete, 10-20 years after collection. Hard-copy maps and reports, however, do not allow easy updating.

The services Kenya Soil Survey can render in this respect can be greatly improved with the recently acquired Geographical Information System, allowing easy retrieval, manipulation and presentation of land data. We may think of an intended agro-forestry project in the Kisii District, which requires land with slopes above 8%, soils deeper than 120 cm, and an average annual rainfall exceeding 1800 mm. With the Geographical Information System, Kenya Soil Survey can indicate where these areas are to be found, by overlaying rainfall, slope and soil depth files from the database, in combination with the specified boundary conditions. Similarly, an area around Taveta may be earmarked for irrigated cotton. The implementing agency requires information on the present level of salinity in the topsoil, the drainability of the subsoil, and the expected efficiency of fertilizer use. Kenya Soil Survey is able to collect the necessary information, that is, electrical conductivity of the topsoil and the irrigation water, texture and hydraulic conductivity of the subsoil, and nutrient availability and retention capacity of the whole profile. When overlaying the results, the client can judge whether implementation is feasible. In the field of GIS, both national and international linkages are needed to avoid duplication of efforts and enhance efficiency. Examples are the Department of Resource Surveys and Remote Sensing in the Ministry of Planning and National Development, the Regional Centre for Services in Survey, Mapping and Remote

Sensing and the United Nations Environmental Programme. Because of these anticipated linkages, the choice of hardware and software at Kenya Soil Survey was largely governed by the need for compatibility to similar GIS configurations in the country. Attached to the GIS were a general manager, a database officer and a cartographer, who received thorough training on the subject.

It is my view that donor agencies are all too eager in 'dumping' GIS configurations into African countries without paying sufficient attention to staff training and management. The system often ends up catching dust, remaining grossly underutilized and not meeting a fraction of the intended goals. With this possibly provoking statement, Mr Chairman, I would like to conclude my contribution, wishing you a very successful symposium.