PN-AAV-107

REGIONAL REMOTE SENSING FACILITY

P O Box 18332
Nairobi Kenya

Tel: Nairobi 556400
Cable Landsat Nairobi

1m-45389

To: All participants in the Forest, Energy and Environment Workshop Nairobi 7 - 11 November, 1981.

Subject: Regional Remote Sensing Facility

Date: December 7, 1981

The past four years have seen the development of the Regional Remote Sensing Facility as an effective instrument for resource technology transfer. This is an AID project which, under REDSO/EA brings remote sensing training, user assistance and services to the East and Southern Africa region. The Facility, described more fully on the following pages, is now operational and its services are available to missions as well as government agencies. The Facility's considerable data holdings provide information on natural resources on a regional basis. This can be an effective source of data for projects in the region which are concerned with forestry or other vegetation cover, with energy (water for hydropower, fossil fuel exploration), or with other natural resources (rangeland, wildlife habitat) that would benefit from the inclusions of appropriate remote sensing data in the planning, implementation and monitoring stages.

The presentation of some examples during the Tuesday session by Dr. Falconer and additional material on display panels will give some idea of the applications of satellite remote sensing to resource development projects. The full range of possibilities only becomes apparent when you visit our laboratories and data holdings at the Facility. This you are cordially invited to do during the open house on Friday afternoon or at any other time by special arrangement. Either I or my staff will be pleased to answer questions and discuss particular requirements during your visit.

I look forward to having you with us.

Sincerely

Merrill Comitz
Director

Best Available Document

a joint project of REGIONAL CENTRE FOR SERVICES IN SURVEYING AND MAPPING
and UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

REGIONAL REMOTE SENSING FACILITY

P O Box 18332
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PROJECT SUMMARY

Background

The Regional Remote Sensing Facility was conceived and designed by AID to support the transfer of those aerospace technologies applicable to resource analysis, monitoring and mapping. The U.S. Government has led the world in the development of space related technologies which make such monitoring and analysis possible on a continental regional scale. This project is one that is specifically designed to make the benefits of these technological innovations available to East African countries. The Facility can also support and partially execute development projects for AID and other donors.

Host Organization Structure and Support:

The Regional Centre for Services in Surveying and Mapping is an African Regional organization sponsored by UNECA but financially supported by Kenya, Tanzania, Uganda, Somalia, Malawi, Comoro, Zambia, Lesotho and Swaziland. It provides building accommodation and administrative staff support, shares technical equipment and has recently begun paying the salaries of locally hired staff of the Facility. Through an arrangement with the Survey of Kenya it also gives the Facility access to the surveying and map printing capabilities of that organization. Active divisions of the Centre are administration, library, calibration and maintenance, printing and cartography, and geodesy. The Remote Sensing Facility functions as a semi-autonomous division of the Centre.

Training and Services Provided:

As of November 1981 the Remote Sensing Facility has sponsored 13 three-week specialized short courses with a total of nearly 300 participants from 14 countries in East and Southern Africa. In addition four information seminars have been held in the participating countries with a total of over 200 attendees. Individualized training is regulary carried on at the Facility.

Over 100 projects in the region have been assisted with Satellite imagery, aerial photography and/or technical assistance in the form of image interpretation, specification writing etc. Approximately 10,000 photographic images have been produced in the Facility's photo laboratory. The majority of these are reproductions for the Facility's reference files but many specialized products have been distributed to users in the region. Numerous experimental maps, brochures, training illustrations and information bulletings have also been produced.

Physical Facilities:

--Modern classroom, briefing room and seminar room equipped with all necessary audio visual aids.

--Satellite image and air photo analysis capability supported by extensive reference files, multispectral viewers, scale change equipment and various items of photo interpretation and drafting equipment.

--Modern photo laboratory capable of producing black and white or color enlargements, color composites, mosaics and other specialized reproductions.

--Project support capabilities include aerial cameras for pilot and sample surveys, geodetic satellite positioning equipment, and equipment for various ground surveys sampling and testing.

--Capability to provide staff consultants for resource surveys in forestry, agriculture, land use, rangeland monitoring, geology, hydrology and others with the required thematic and image mapping capability. Staff also available for project design and monitoring.

Staff:

--Remote Sensing Facility staff includes nine professional /technical positions representing various disciplines and four administrative and support staff.

--The host organization provides technical support in cartography, geodesy, printing and electronic/optical equipment maintenance.

Future Plans and Prospects:

As the ministries in East and Southern Africa that are concerned with renewable resources become aware of the technologies available for monitoring these resources, there is an increasing demand for training and technical assistance in remote sensing. The Facility plans to continue its training and technical assistance program at an expanded level. Specialized training in agriculture, land use monitoring, range management, water resources and others will continue. Anticipated changes in the training program include a gradual shifting of financial responsibility from the Facility to the participants or their sponsoring agencies and the introduction of extended training courses. Beginning in CY 1982, the participants or their sponsors will assume responsibility for travel to and from Nairobi. Later there may be a gradual assumption of per diem and training costs. The first extended training course is planned for March through August 1982 and will feature the monitoring of renewable resources. It will be a project oriented course designed to train participants in association with ongoing projects in their home countries after a period of orientation in Nairobi

Another change in Facility activities in the near future will be an increase in project activities. The Regional Remote Sensing Facility presently holds the largest collection of Landsat imagery in Africa. This is supported by an extensive collection of maps, air photos and other reference material. The Facility's multidisciplinary staff has expertise in many resource application areas and has access to consultants in other areas as needed. It is hoped that this expertise along with the reference material and analysis equipment of the Facility will be utilized in the implementation of resource development projects of AID and other donors.

THE REGIONAL REMOTE SENSING FACILITY

PROVIDES THE FOLLOWING SERVICES:

- ☐ **TRAINING**
  - ☐ Information seminars
  - ☐ Short courses
  - ☐ Courses in U.S.A.
- ☐ **USER SERVICES**
  - ☐ Landsat data browse file
  - ☐ Ordering assistance
  - ☐ Analytical equipment use and instruction
  - ☐ Data products
  - ☐ Newsletter
- ☐ **PROJECT WORK**
  - ☐ Demonstration projects
  - ☐ Project design assistance
  - ☐ Landsat image products

The Photographic Laboratory supports these services with

- ☐ Training materials
- ☐ Precision-scaled enlargements
- ☐ Custom enhancements of Landsat data

TRAINING

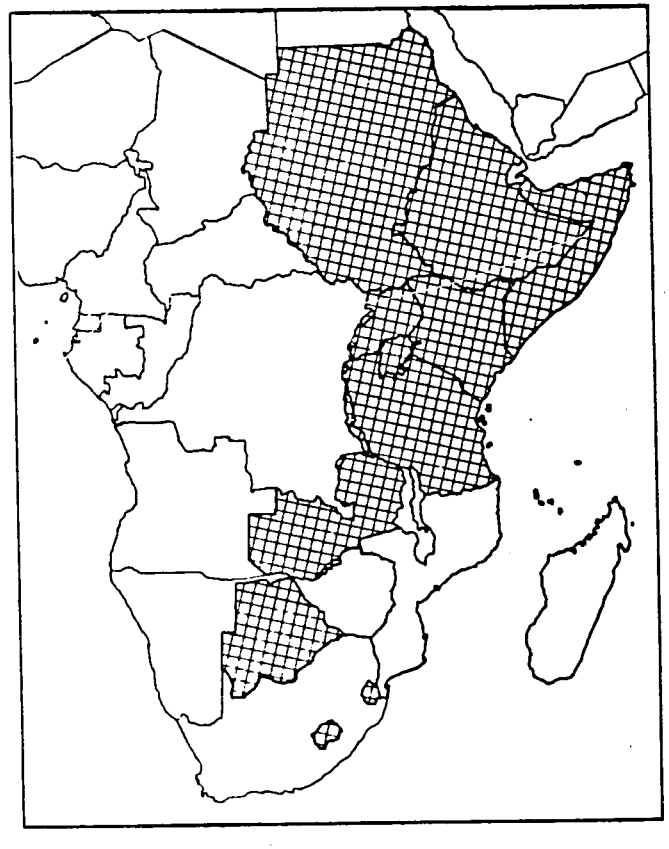
to September 1980

☐ Short courses	9
☐ Information seminars	4
☐ Graduate student now in U.S.A.	1

193 short course participants have come from 12 countries in the region

Courses given:

☐ Agriculture (2)	45
☐ Cartography	25
☐ Forest/range	22
☐ Hydrology	17
☐ Regional planning	32
☐ Teaching (2)	35
☐ Vegetation/soils	17



REGIONAL REMOTE SENSING FACILITY, NAIROBI, KENYA, SHORT COURSE PARTICIPATION
BY DISCIPLINE AND COUNTRY OF ORIGIN
MARCH, 1979 - DECEMBER 1981
(NUMBER OF PARTICIPANTS)

	Agriculture /Land Use a/	Forestry /Range	Geology	Hydrology	Cartography	Transport Engineering	Teaching with Remote Sensing Data	Totals
Botswana	20	1			1		1	23
Burundi	1				1			2
Ethiopia	2		1	1	2	2		8
Kenya	39	11	5	7	14	4	6	86
Lesotho	1			3				4
Liberia						2		2
Malawi						2		2
Mozambique				2	2			4
Rwanda		1						1
Somalia		1						1
Sudan	4	3	1	2	6		5	21
Swaziland		1		1	6			8
Tanzania	14	3	1	3	9	5	17	52
Tunisia			1					1
Uganda	2	1			4	3	6	16
Zambia					5			5
Zimbabwe	5					1		6
	88	22	11	17	50	19	35	242

NOTES: a/ Agriculture and Land Use category includes four courses, one of which was held in Gaborone, Botswana. Cartography category includes two courses. All others represent single course attendance.

b/ Remote Sensing information seminars lasting three to five days have been held in Kenya, Tanzania, Swaziland and Uganda to groups numbering approximately 50 each.

1982 TRAINING PROGRAMME

Missions are requested to bring these opportunities for training in remote sensing to the attention of relevant government departments.

1. Remote Sensing for Geology February 1 - 19, 1982 Nairobi.

This course will be of three weeks duration and will include two field excursions. The emphasis will be on geological mapping and exploration. Participants are encouraged to bring to Nairobi maps and reports relating to a particular area of their home country. They can then make their project work of direct relevance to their field area.

Participants must arrange their own travel to and from Nairobi, including all visas and taxes. The Remote Sensing Facility will provide travel from the airport, to and from the hotel to the classrooms, tuition, field travel and accommodation (bed and breakfast). A small daily allowance (150 Kenya Shillings) is also paid to cover meals and incidentals. The Facility accepts no responsibility for medical insurance and is not liable forcosts or damages arising from accidental death or injury. Applications for places on this course should be forwarded immediately to the Training Programme Manager, Remote Sensing Facility. P.O. Box 18332 Nairobi, Kenya. Applicants should normally hold a degree or diploma in geology and have five years or more post graduate experience.

2. Natural Resources Extended Training-
Nairobi March 15 - 27, August 8 - 12, 1982.

This course will begin in Nairobi on 15th March and there will be two weeks of classroom sessions. Participants will then return to their own countries to undertake project work. The project work should emphasize resource monitoring, particularly vegetation monitoring. Participants will be selected by arrangement between the Facility and participating agencies rather than directly with individual participants. Project work undertaken in the participants own countries will be chosen in consultation with the sponsoring agency which must agree to support the work with all in-country requirements and not transfer the participant until the course is completed. Topics will be in the area of natural resources.

At the conclusion of the project work there will be a final session in Nairobi. All arrangements in Nairobi will be as stated for the geology course above. The participating agency is expected to furnish in-country support for the participants and for the supervision and consultation provided by the Remote Sensing Facility.

3. Teaching with Remote Sensing Data - August 23-September 3, 1982 Nairobi.

This course is intended as a follow on from the course given in 1980. Participants will be given the opportunity to create materials for use in teaching in the context of their accumulated experience with remote sensing courses. Preference will be given to participants from the previous course but places will be available for other teachers using remote sensing data at the college or university level.

Arrangements for this two week course will be as stated for the geology course above.

4. Remote Sensing in Hydrology Extended Training Nairobi October 25 - November 5, 1982 and January/February 1983.

This course will begin with two weeks of classroom instruction in Nairobi followed by project work in the participants' home country. It will feature groundwater exploration and the monitoring of surface water by remote sensing methods. During the field work some supervision and consultation will be provided by the Remote Sensing Facility. There will be a concluding session in Nairobi. Applicants from appropriate agencies will be selected in the same manner as for the natural resources course above.

General Notes:

(A) Background: All training courses are intended to provide insight into the application of remote sensing in specialized professional areas. Participants are expected to have a college degree in the appropriate application area and several years of practical experience. Short Course participants may be at the operational or managerial level. Extended course participants are expected to be assigned to specific projects with data collection or supervisory duties.

(B) Financial Arrangements: Training costs, training materials, hotel accommodation and subsistence for the participants are provided by AID through the Remote Sensing Facility. Beginning in CY 1982 all travel to and from Nairobi by the participants will be paid for by the participants or their sponsoring agencies. Travel and per diem for Facility staff in connection with the extended training courses will be paid by the Facility but any local transport and other logistic support for staff or participants is the responsibility of the participating agencies.

(C) Applications: Persons interested in applying for the geology or teaching materials course should submit their applications to the Training Program Manager of the Facility including present occupation and responsibilities, other Bio data and certification by the employer that such training is sanctioned and travel to Nairobi is approved. Details of application for extended courses contained in (~~septels and~~) the Facility Newsletter.

CARTOGRAPHY SHORT COURSE

Nairobi, May 1979

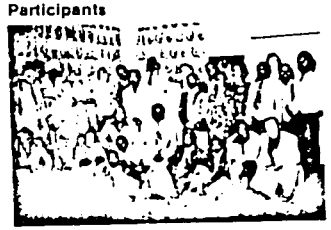
2 CONSULTANTS

Dr. A. Colvocoresses — U.S. Geological Survey
Alden Warren — U.S. Geological Survey

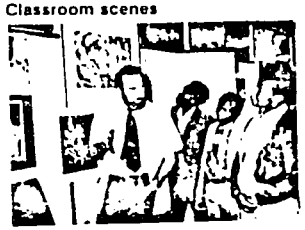
25 PARTICIPANTS

1 Botswana
1 Burundi
1 Ethiopia
9 Kenya
3 Sudan
4 Swaziland
3 Tanzania
3 Zambia

Participants



Classroom scenes



Experimental map product 1:1,000,000

HYDROLOGY SHORT COURSE

Nairobi, May 1979

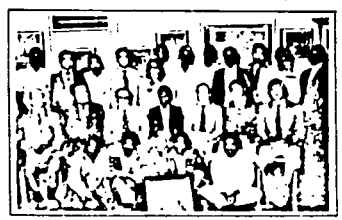
4 CONSULTANTS

Dr. P. Bock	University of Connecticut
Morris Deutsch	U.S. Geological Survey
Dr. B. Haack	Ball State University
William Smith	Spectral Data Corporation

17 PARTICIPANTS

1 Ethiopia
7 Kenya
3 Lesotho
2 Sudan
1 Swaziland
3 Tanzania

Participants



Fieldwork

Landsat Image 1:500,000

FOREST/RANGELAND SHORT COURSE

Nairobi, Nov. 1979

Co-sponsored by KENYA RANGELAND ECOLOGICAL MONITORING UNIT

4 CONSULTANTS

Dr. D. Carneggie	U.S. Geological Survey
Dr. H. Epp	KREMU
Dr. M. Gwynne	UNEP
Dr. J. Ulliman	University of Idaho

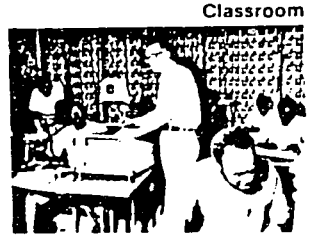
22 PARTICIPANTS

1 Botswana
11 Kenya
1 Rwanda
1 Somalia
3 Sudan
1 Swaziland
3 Tanzania
1 Uganda

Participants

Classroom

Classroom

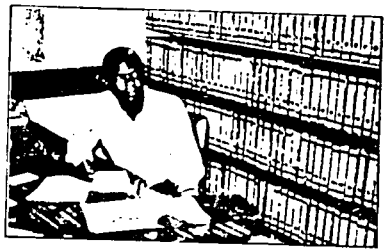


Mount Kenya 1:250,000

USER SERVICES
REGIONAL DATA RESOURCES

August 1980

LANDSAT IMAGERY
555 Scene locations
4000 Reference prints
6000 Analytical images

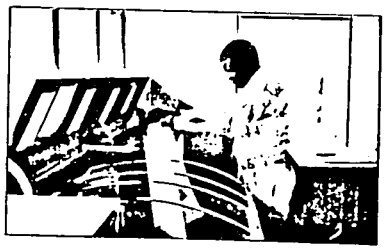


SKYLAB & AIRPHOTOS
400 Frames for training
and project work

MAP COVERAGE
National map collections
Aeronautical charts
Hydrographic charts
Small scale regional series

FUTURE DEVELOPMENT
Quarterly update of imagery
Map acquisition
Additional color imagery
Computer enhancement collection

DATA USAGE
500 Enquiries processed
100 Orders placed



REGIONAL REMOTE SENSING FACILITY, NAIROBI, KENYA, LANDSAT IMAGE REPRODUCIBLES

HOLDINGS AS OF DECEMBER, 1981

Country	Number of Scene Locations	Colour Transparencies	B+W 4-band Positive sets	B+W Multiband Negative	Browse file units (single band negative & print)	Total per country
Botswana	39	121	75	1	587	784
Burundi	4	13	15	4	11	43
Ethiopia	67	154	60	23	769	1006
Kenya	35	153	314	78	363	908
Lesotho	4	24	8	1	81	114
Malagasy	41	68	-	1	198	267
Malawi	12	27	85	1	63	176
Mozambique	52	76	79	5	363	523
Rwanda	4	12	21	2	14	49
Somalia	44	62	32	37	433	564
Sudan	125	179	63	36	3107	3385
Swaziland	4	4	6	2	40	52
Tanzania	49	151	220	43	463	877
Uganda	14	47	85	12	55	199
Zambia	46	67	47	2	284	400
Zimbabwe	27	39	154	35	135	363
Indian Ocean Islands	73	6	12	1	57	76
	555	1203	1276	284	7023	9786

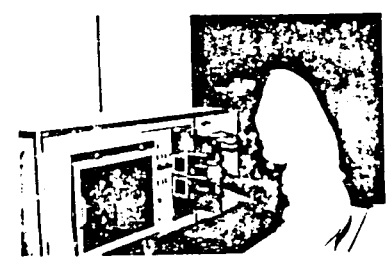
In addition to reproducible holdings well over 2000 Landsat prints are on file in every day use.

EXPERIMENTAL SATELLITE IMAGE MAP OF SWAZILAND

ANALYTICAL EQUIPMENT

includes:

Zoom transferscope
Multispectral color additive viewers
Densitometers
Parabolic (map-correcting) projector
Scale change equipment
Stereoscopic miscoscope
Planimeters
Full range of photographic equipment



EQUIPMENT USED BY OVER 250 PERSONS

SUPPORT TO OVER 75 PROJECTS IN THE REGION

through August 1980

RENEWABLE RESOURCES

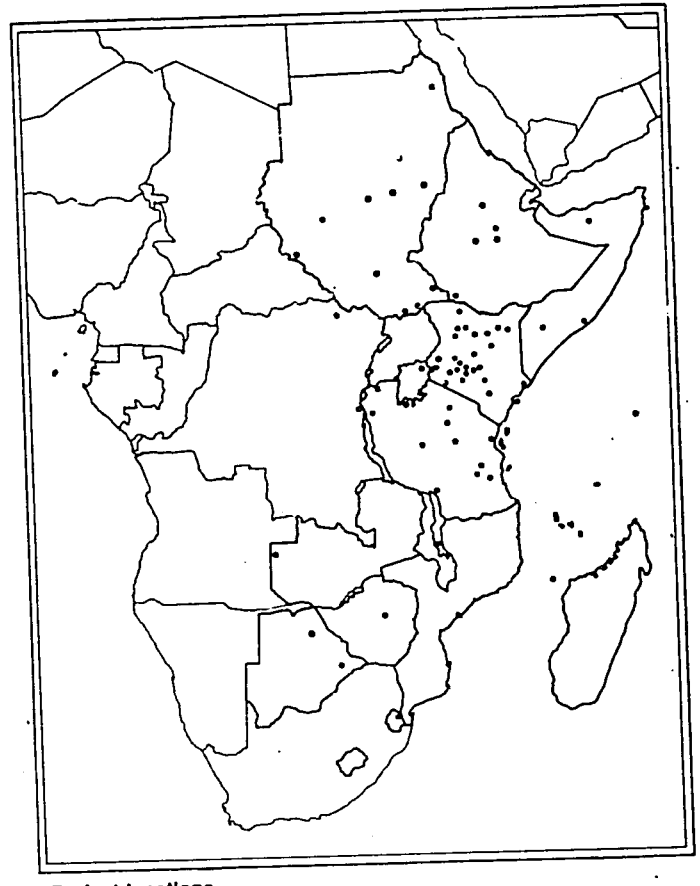
- ☐ Vegetation/habitat mapping 15
- ☐ Agricultural development 9
- ☐ Surface water resources 7
- ☐ Desertification 8

GEOLOGY

- ☐ Geological mapping 6
- ☐ Soil and land potential surveys 11
- ☐ Ground water exploration 4

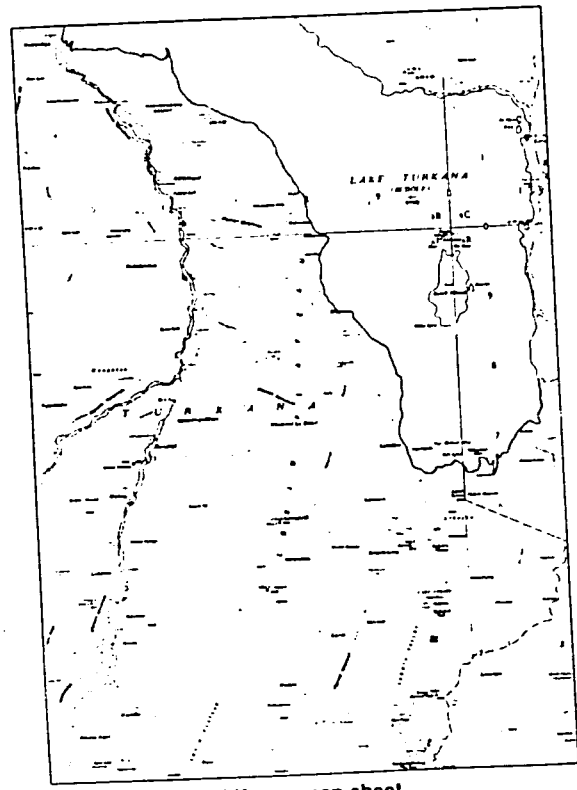
ENGINEERING

- ☐ Highway planning 5
- ☐ Photo-based map production 11

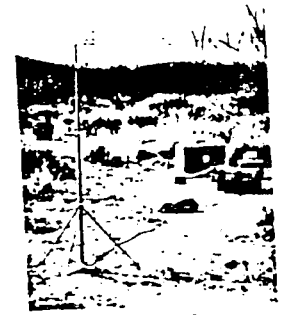


Project locations

PROJECT WORK
EXPERIMENTAL PHOTO-MAP PROJECT

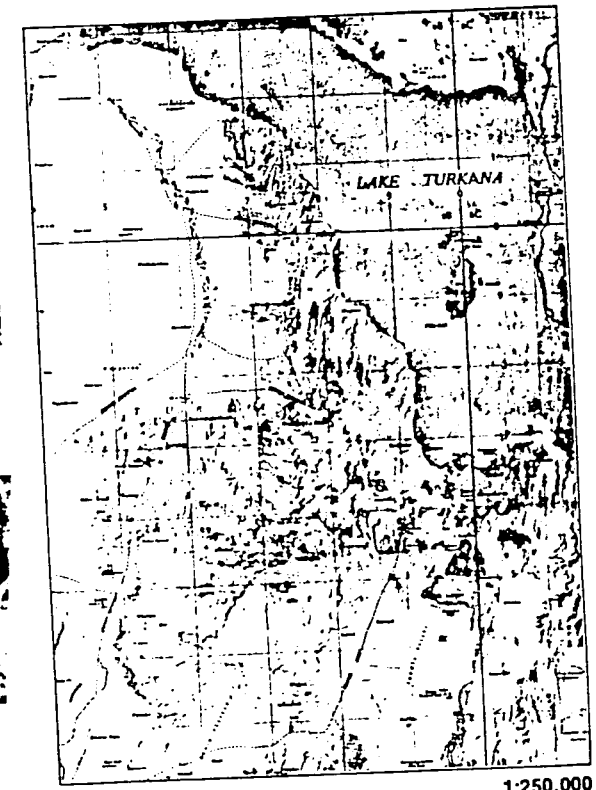


Existing Survey of Kenya map sheet



Field instrument

Landsat image



New map

1:250,000

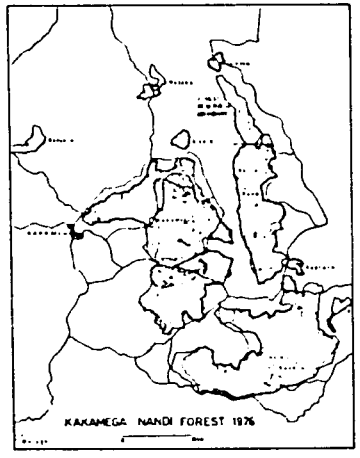
KENYA FORESTRY PROJECT

Conducted by the University of Nairobi, Kenya Forest Department, Kenya Rangeland Ecological Monitoring Unit and RRSF

Landsat provided the data for the Nandi-Kakamega Forest area

Air photo showing change within the North Nandi-forest

With multidate Landsat coverage, changes in forest boundaries are often discernable



SELECTED LIST OF USERS ASSISTED BY AND/OR RECIPIENTS OF IMAGERY FROM THE FACILITY.

USER	PROJECT
UNESCO	Hydro-geological Mapping Dodoma, Tanzania
Rwanda Government	Kagera River Swamps Mapping
OXFAM	Water Availability in refugee camps in the Horn of Africa
Department of Geology University of Nairobi	Ground Water Resources Survey in Central Ethiopia
Ecosystems Ltd, Nairobi	Soil Erosion Mapping Shinyanga, Tanzania
East African Power & Lighting Company	Geothermal Energy Exploration Rift Valley, Kenya.
British High Commission and Government of Mozambique	Geological Survey Cabora Basa Dam area, Mozambique.
Norwegian Church Aid	South Sudan Water drilling project
City Services Corporation	Petroleum Exploration Kenya Coast
USAID - REDSO	Zambezi middle dam environmental impact.
Clark University, USA.	Nyeri District, Kenya development planning
H.P. Gauff Consulting Engineers	Garissa -Garsen Road Alignment Kenya
Sudan Wildlife Conservation Program	Boma Park Planning, Sudan.
Department of Geology University of Dar es Salaam	Geologic Mapping, Dar es Salaam District
Ministry of Works, Power and Communications - Swaziland	Monitoring irrigated lands
Department of Conservation and Extension, Zimbabwe	Land use and land pressure index mapping
Tana River Development Authority, Kenya	Tana River integrated land resources survey.
International Laboratory for Research on Animal Diseases	Insect Distribution survey Kenya Coast.

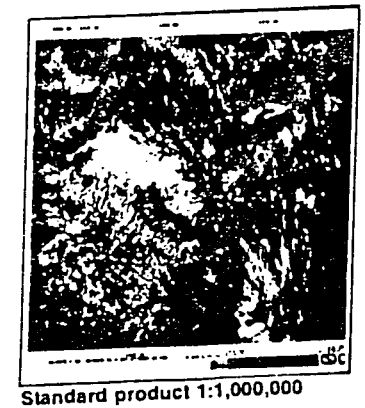
USER	PROJECT
World Bank	Agriculture project planning, Western Somalia
International Livestock Commission for Africa	Ecological mapping, South Ethiopia
UNEP-GEMS	Malagasy Forest Study
Desert Locust Control Organization	Ecological Mapping
Makerere University Uganda	Wetland mapping for Rice Projects
Ministry of Environment & Natural Resources, Kenya.	Baringo Afforestation site planning
New York Zoological Society.	Flood mapping in the Sudd, Sudan.
Western Sudan Agricultural Research Project	Soil and vegetation mapping
Ministry of Agriculture Botswana	Reconnaissance soil survey.
Surveyor General of Swaziland	Photomapping project
Forestry Commission, Zimbabwe	Forest Surveys
Government of Malawi	Flood Mapping
Surveyor General Office, Zambia.	Cartographic Work

THE PHOTOGRAPHIC LABORATORY

provides:

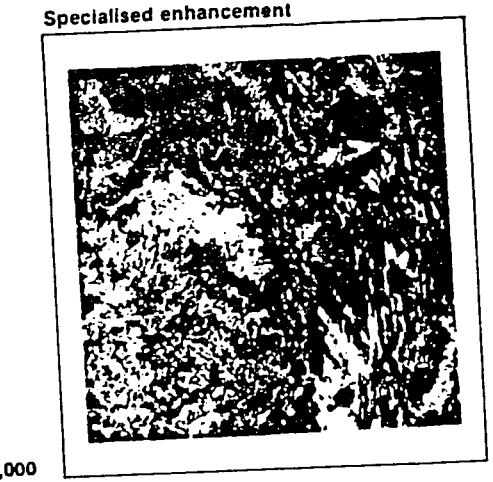
Image reproduction services
Mosaic construction
Specialised enhancements and enlargements
Support for training courses and technical assistance
On-the-job training

Enlargement 1:250,000



Standard product 1:1,000,000

Specialised enhancement



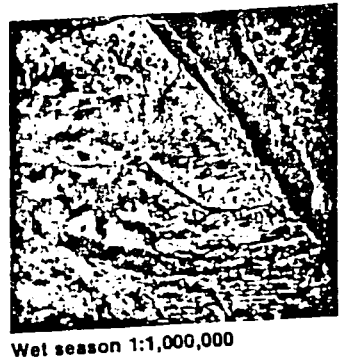
12

LANDSAT DATA CAN BE PROCESSED FOR SPECIAL PURPOSES

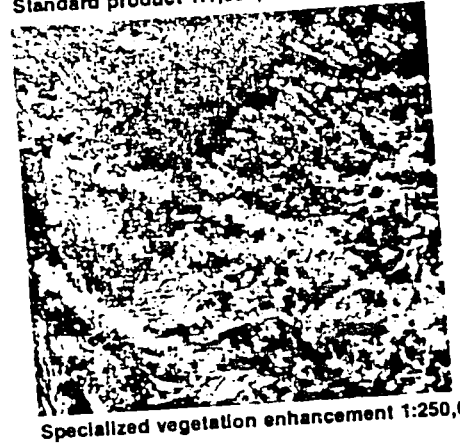
Dry season 1:1,000,000

Standard product 1:1,000,000

Standard product 1:1,000,000



Wet season 1:1,000,000



Specialized vegetation enhancement 1:250,000

Water detail 1:500,000

MAPPING WITH LANDSAT DATA.

Because the Landsat satellite is in orbit at 930 km above the earth it provides a view of the earth which is approximately equivalent to that of an oblique mercator map projection. There are several detailed analyses of this but, in general the Landsat data can be thought of as useful picture maps. Computer processing of the data can make a picture map fit any given map projection and at scales of 1:100,000 or smaller the fit is very good.

Experimental work done by the U.S. Geological Survey with satellite data has provided excellent photo-maps of large areas such as the State of Florida, the Yemen Arab Republic and others. The U.K. Directorate of Overseas Surveys has published maps of Antarctica based on Landsat data and in co-operation with the Regional Centre for Services in Surveying and Mapping and the Regional Remote Sensing Facility has recently produced an experimental 1:1000000 scale map for the Tabora sheet (Tanzania) of the International Map of the World.

In the Eastern African region the demand for maps for use in development project work is considerable. Many users of the Regional Remote Sensing Facility find that the Landsat data are sufficient to meet their maps needs and often Landsat data provide additional information about geology, vegetation or other natural resources.

The Remote Sensing Facility has undertaken a series of experiments with Landsat data used in photo-mapping work. In addition to the 1:1000000 scale map prepared in collaboration with the Directorate of Overseas Surveys, the Facility has prepared a 1:250,000 experimental sheet of South Horr. This was done in association with the Survey of Kenya. The Mapping Centre is embarking on a program of photo-map work supported by the newly acquired doppler positioning equipment and in association with this the Facility is involved in producing map corrected Landsat data.

This correction is done by the Environmental Research Institute of Michigan which also produced a colour mosaic of Landsat data for the Kingdom of Swaziland. The Swaziland mosaic has been matched to existing Survey of Swaziland data and experimental maps produced at 1:1,000,000 and 1:250,000 scale. Photographic work at the Facility has produced a simulated natural colour product which seems to find ready acceptance from cartographers.

The accompanying copy of the experimental 1:1,000,000 map of Swaziland (reduced from 1;250,000) gives an overall impression of the value of Landsat data in a photo-map product. At the 1:250,000 scale the map has been considered to be useful for development work, as it illustrates many items more clearly than a topographic map. However, the photo-map does not show height very clearly and does not convey clearly the major place names, communications networks and stream pattern. In the 1:1,000,000 reduction reproduced here, the type is far too small because of the reduction from 1:250,000.

Overall the photomap product based on Landsat data gives a good visual impression of the landforms and the major natural regions of an area. Irrigation projects are particularly visible on the Swaziland map and so too are major differences in land-use. Forestry plantations are also well defined. Such experimental photo-map products appear to offer a useful view of an area and can be used in conjuction with conventional maps to address many questions about the distribution of natural resources.

Continued collaboration between the Regional Centre for Services in Surveying and Mapping, the Surveyor-General of Swaziland and the Directorate of Overseas Surveys is expected to result in the publication of a 1:250,000 scale map of Swaziland in 1982. Other experimental work is proceeding for areas in Uganda, Tanzania and Kenya. The Survey of Kenya is negotiating with the Regional Centre for Services in Surveying and Mapping to establish a programme of Landsat photo-mapping in the North-East of Kenya. Similar Landsat photo-mapping is to be done in the Sudan under an agreement between the Defence Mapping Agency and the Sudanese Government. For many purposes the speed with which Landsat photo-maps can be produced makes them valuable for large area development projects especially in the arid and semi-arid lands.

EXPERIMENTAL SATELLITE IMAGE MAP OF SWAZILAND

PROVISIONAL EDITION

REMOTE SENSING OF NATURAL RESOURCES IN EASTERN AFRICA

GRASS FIRES IN SERENGETI NATIONAL PARK TANZANIA

by
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Serengeti National Park, Tanzania, is the home of perhaps the last truly vast assemblage of wildlife anywhere in the world. Some two million wildebeest, accompanied by a quarter of a million zebra, still make their timeless migration in response to the patterns of rainfall and the seasonal flushes of fresh green grazing.

The lush open grasslands of the Serengeti Plains support the wildebeest, zebra and some millions gazelle all through the rainy season. Once the Plains dry out, the wildebeest and zebra move first to the west and then swing north into Kenya. The gazelle leave the Plains last, trekking slowly westwards into the acacia woodlands in the west of the Serengeti.

In addition to these three million migratory animals are at least half a million residents, animals who occupy the same general area year round and who make much smaller seasonal movements. And it is these residents, rather than the vast migratory herds, that provide the bulk of the food supply for the predators of the Serengeti.

Grass fires play a subtle – but all-pervading – role in the Serengeti ecosystem. On the one hand, grass fires burn off old standing hay so that the next rainfalls are immediately followed by a flush of the tender, green grass favoured by the migratory grazing herds. However, the fires also inhibit the growth of woody vegetation by burning the sensitive young trees and bush back to ground level.

This dual role of fire – beneficial to the grazers, potentially unbalancing to the vegetation dynamics of the ecosystem, and detrimental to the food supply of the browsing animals – has been one of the major management preoccupations of Serengeti National Park for the last decades. The subtle interactions between grazers, browsers, fire and vegetation dynamics are now becoming understood after considerable long-term monitoring.

In the early 1960s, the now dominant wildebeest were at very low numbers, trapped by sporadic outbreaks of rinderpest. Grass fires were widespread and ran wild throughout the park, burning back woody vegetation and converting woodlands to more open grassland habitats. Rinderpest was eradicated in the early sixties by veterinary programmes among the cattle population surrounding the national park. By the mid sixties the wildebeest population (and those of other rinderpest-susceptible species such as buffalo) were erupting. In the decade 1960-1970, wildebeest increased fourfold, from two hundred thousand to eight hundred thousand, and currently number some two million. With this eruption came a greatly increased grazing pressure, to the extent that grass fires effectively vanished from the ecosystem by the mid 1970s – there was inadequate grass left at the end of the growing season to support widespread fires. By the mid seventies the first evidence of an eruption in the populations of browsing species was evident. Woodland regeneration was widespread, and woodlands were once

March – mid wet season

In this Landsat view of the area around the south-western part of Serengeti National Park all vegetation components show a strong response to the wet season rainfall. The deeper red areas are the acacia woodlands, the lighter areas the heavily grazed grasslands of the western Serengeti Plains.

Landsat scene No. 21503-07013
5 March 1979

June – early dry season

This portion of a Landsat scene shows extensive burning in the south-western woodlands of the Maswa Game Reserve, which abuts the Serengeti National Park, an area little utilized by grazing wildlife. Small fires are evident in the central and northern parts of the sub-scene. These are fires lit by the national park staff to create a mosaic of burned and unburned areas, thus preventing the spread of hot, damaging wildfires later in the dry season.

Landsat scene No. 2153-07173
24 June 1975

July – mid dry season

In this view the portion of the Landsat scene shows where extensive fires have swept through the woodlands of the park. The unburned areas to the east and north are the heavily grazed grasslands – there is inadequate grass remaining to support fire. In contrast, the western boundary of the burned areas corresponds exactly to the boundary of the park and the Maswa Game Reserve. West of this boundary the density of small-holder settlement and domestic stock preclude burning.

Landsat scene No. 1373-07233
31 July 1973

more recolonizing their former areas.

The continuous monitoring of the extensiveness and impact of fires on the woodland-grassland dynamics in Serengeti National Park is of fundamental importance to the management of the park – not only to predict the outcome of contemporary trends but also to devise and refine management policies.

Landsat images play a vital role in this long-term monitoring, for they clearly show the seasonal pattern of fires and their extensiveness throughout the park. Furthermore, historical series of Landsat images show the frequency with which the different vegetation components are burned.

The three sub-scenes of the south-western part of Serengeti National Park reproduced to the right show how effective Landsat imagery is in providing this information in a highly cost-effective manner. The three sub-scenes demonstrate the seasonal patterns of grass fires in this part of the Serengeti, even though they have been drawn from different years. Using such information it is possible to produce maps of the extent of fires each year and to note the locations of the forest fires. Such information, apart from providing basic knowledge, also assists in the planning of fieldwork and ground or light-aircraft survey. Because Landsat data provide information on a large area at a specific time they are ideally suited to the management of extensive parks such as the Serengeti.

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REMOTE SENSING OF NATURAL RESOURCES IN EASTERN AFRICA

FORESTRY RESOURCES

by
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LANDSAT DATA FOR FORESTRY

Since the launch of Landsat 1 in July 1972 satellite images have been gathered showing natural resources of the earth's surface. An outline of the satellite programme is given on the back of this leaflet. The satellite images show considerable detail about the location and extent of forest cover in the East African region. The examples described below provide an indication of the direct uses that can be made of the Landsat data for forestry purposes. In the examples below the Kenyan case illustrates the change in forest as a result of increased demands for more agricultural land and forest products. The Tanzanian example shows the progress of a development project utilizing the forest resource and the Swaziland example shows how the satellite images reveal the changes occurring in a managed plantation situation.

Other issues of satellite images for forestry purposes include the mapping of riverine and coastal forests and the delineation of natural forest with some discrimination between major forest types. Thus satellite data are capable of providing information about the extent and nature of forest cover for a resource inventory project as well as showing changes over time.

KENYA

In 1980 KREMU (Kenya Rangeland Ecological Monitoring Unit), a division of the Ministry of Environment and Natural Resources, Government of Kenya, undertook a review of the forested area of the whole country. This nationwide survey was intended to produce a complete inventory of existing forests, to assess the depletion of indigenous forest and to establish base data for monitoring future changes. The results of this study showed that the standing forest was now less than the forested area determined by the previous survey. In some cases individual forest stands had been reduced by more than half. The example opposite shows change in the Kakamega-Nandi Forest as visible on Landsat images. The scene on the left shows the forested area in dark red tones on 1 February 1973 (Landsat scene No. 1193-07232) and the scene on the right shows the same area on 16 May 1979 (Landsat scene No. 21485-06595). Some areas on the 1973 scene had been completely removed by 1979. The scale of the images is 1:500,000 so each image shows an area of approximately 50 x 52 km. The survey based its initial work on the use of satellite images; where cloud cover obscured the scene aircraft data were used. Field checking of areas using light aircraft was also a feature of the survey. The value of the satellite images was that they significantly reduced the time taken to complete the work as well as provided a permanent record of forest areas at given times. The regional scale of the satellite images made them easy to utilize for such large-area inventories, and the detail they contain is sufficient for precise field checking.

The information above was extracted from reports by R. Doute, N. Ochanga and H. Epp of KREMU, which undertook this work in association with the Regional Remote Sensing Facility. Permission to refer to this work, given by Mr. David Andere, manager of the KREMU project, is gratefully acknowledged.

TANZANIA

Changes in vegetation patterns in areas of smaller trees and bushland also show clearly in satellite images. The centre pair of images shows part of a scene with this type of vegetative cover south of Tabora in western Tanzania. The image on the left is from 19 August 1973 (Landsat scene No. 1392-07295) and on the right from 25 June 1975 (scene No. 2154-07190). These images, at a scale of 1:500,000, are approximately 50 kilometres along each side. They document variations in climatic/moisture conditions and also extensive changes in land cover brought about by man's activities.

The August image has a lesser amount of red tones which would occur from green vegetation. This lack of red tones indicates relatively dry conditions. The various dark tones are fire scars in various levels of regeneration. The small scattered light tones south-west of the image centre are probably settlement patterns. There is no evidence in this scene of active land management practices; however, drainage patterns are very evident.

The June image records a time of wetter conditions, indicated by the extensive red tones: green vegetation. Some small burned areas can be seen in the north and east portions of this scene as can the drainage patterns. The small light-toned settlement areas are more visible because of their contrast with the red tones and appear to have expanded. The most obvious change is linear systematic cutting of brush over some 400 square kilometres in the south-west.

The changes in vegetation conditions both due to moisture variations and due to activities removing vegetation are very obvious on these images. The repetitive and large-area views from Landsat can be very useful to planners and administrators in identifying areas for development projects and by providing a permanent record of progress which is also useful for monitoring the impact of the projects.

SWAZILAND

The forest industry of Swaziland serves a major export market. Timber products come from extensive plantations which have been developed since 1950. A total of 120,000 hectares of forest lands including natural forest and plantation areas is devoted to the forest industry (6.9 per cent of the country). In 1979 a questionnaire survey indicated that 99,573 hectares of forest existed in plantations and a 1979 study based on Landsat images alone shows a total of 110,388 hectares of plantation forest. The discrepancy between these figures is of the order of 10 per cent, an acceptable variation between these data sources.

On the facing page the bottom two images show the Pigg's Peak Plantation in north-western Swaziland. Each image is approximately 50 x 52 km. The image on the left was collected on 8 September 1972, the image on the right on 19 June 1979. The changes in this seven-year period are clearly visible. Because the plantations are managed and trees harvested by clear felling of individual stands the cleared areas are easily seen on satellite images. The forests show in red tones and the cleared or newly planted areas in blue-green tones. For pine forest this occurs on a 20-30 year cycle and for eucalyptus forest a 10-20 year cycle. The newly planted trees do not cover much of the ground area and so may appear in blue-green tones on the satellite images. Howe[illegible] growth proceeds the tree cover in[illegible] the areas show change from blue-gre[illegible] to red colours in the images. This change is visible in the pair of images opposite.

The images presented here show that monitoring of plantation programmes can easily be done using satellite data. Estimates of cut area are readily obtained, and in managed plantations where stands are of uniform age, the area may be related directly to volume. Thus productivity of plantations may be estimated. In 1979, 900,000 cubic metres of roundwood were harvested, the pine being used for pulpwood and saw logs, the eucalyptus for mining timbers, pulpwood and poles.

LANDSAT DATA FOR FORESTRY IN EASTERN AFRICA

Recent studies indicate that the world's forests are being depleted at the rate of 20 million hectares each year. Much of this loss is in the tropical region and in Africa projections of current rates of forest cutting indicate that 40 per cent of the present forest cover will disappear by the year 2000. The demand for additional land for food production accounts for a substantial loss of forest each year. This demand is usually regulated and documented in agricultural development projects. However, a growing demand for fuelwood for burning as firewood or for conversion to charcoal is less easy to regulate and monitor.

The costs and the logistical support for monitoring this informal cutting of fuelwood by on-the-ground inspection are prohibitive. However, aerial surveys can produce the necessary information in reliable form. It is frustrating to finance aerial surveys of large areas over which no substantial change has taken place. Thus the use of Landsat data can give a very effective overview of major changes in forest cover. On the basis of such an overview, selected survey flights can be planned to produce the necessary detail for areas of significant change. Supporting light-aircraft observation or ground survey can then be directed to areas of change and the cost effectiveness of such work greatly increased.

For most countries in the Eastern Africa region the need to assess present forest cover can be easily met using Landsat data in a photo-print form. Comparisons between Landsat scenes of different dates reveal information about changes in forest area and about progress of regrowth in plantations. An overall view of the forest resource can be rapidly and cheaply obtained in this way.

Experimental work in various western countries using computer analysis of satellite data is producing interesting results. Such work can indicate age or species differences between certain types of forest cover and can be used to assess forest resources over large areas. This produces statistics that can be more accurate than those derived from the visual inspection of photo prints. For many purposes, it is more cost effective to provide photographic prints to existing staff, who can then relate these to survey photography and ground data. Individual national programmes in Africa are in most cases concerned with small numbers of satellite scenes and at the present time most needs can be met from photographic processing of the satellite data.

Many items of importance to foresters are also visible on satellite images. Such things as geological structures, some soil types and the major terrain units can be rapidly mapped from Landsat images. Thus afforestation projects or rapid mapping of areas for forestry development can be assisted with such information. Using the satellite images as a base for planning soil surveys, terrain mapping and field deployment, including the planning of survey flights, can be a most effective low-cost strategy in development.

In summary, Landsat data provide a picture map of forest resources. This is a low-cost large-area picture which can form the basis of country-wide forest mapping. Such mapping can be achieved rapidly and with acceptable accuracy but is limited by cloud cover, especially in coastal regions. Because the satellite remains in orbit, pictures are taken in a time sequence. Therefore comparison between pictures can show change. In addition the satellite data indicate the vigour of vegetation growth and can be valuable indicators of disease or stress in forest growth. Fire damage can also be easily mapped over large areas.

THE LANDSAT SYSTEM

The satellites in the Landsat series orbit the earth at an altitude of approximately 930 km. From this altitude the satellites view a swath of the earth's surface 185 km wide. Each day the satellite makes 14 orbits of the earth, and on the 18th day the orbit pattern repeats. Therefore, every 18 days Landsat views the entire earth's surface between 81°N and 81°S. The systems on board the satellites do not penetrate clouds. Most places are cloud free on two or more occasions each year and since the launch of the first Landsat satellite in 1972 the whole of the Eastern African region has been viewed by the satellite on at least two cloud-free occasions. The overall average of cloud-free images per area is six.

The images gathered by the satellite are made up of individual measurements of reflected energy for 0.4 hectare areas of the earth's surface. These measurements are gathered row by row in a scanning system and transmitted to earth where they are received at ground stations, recorded and then reassembled to make "pictures" of the earth's surface. A standard Landsat image views approximately 35,000 sq km of the surface of the earth. The measurements collected to make these images are taken in four parts of the electromagnetic spectrum and are measurements of green-yellow light (referred to as band 4), orange-red light (band 5), invisible infra-red energy (band 6), and a further step in infra-red energy (band 7). Precise definition of these bands is as follows:

band 4 500-600 nanometres wavelength
band 5 600-700 nanometres wavelength
band 6 700-800 nanometres wavelength
band 7 800-1100 nanometres wavelength

The measurements in the infra-red are not measurements of heat but are measures of reflected infra-red energy. Healthy vegetation is highly reflective in these infra-red bands so information in bands 6 and 7 indicates vegetation response. If information from bands 4, 5 and 7 is used projecting band 4 in blue, band 5 in green, and band 7 in red, vegetation shows in red tones. This combination of colours is referred to as the standard false-colour composite and is the combination used in the illustrations.

On board the Landsat satellites there are other sensor systems; however, the majority of the available data is of the type described here.

REGIONAL REMOTE SENSING FACILITY

Because of the value of remote sensing data in natural resources studies and the need for such studies in Africa, the Regional Centre for Services in Surveying and Mapping included a remote sensing division in its plans. The Regional Centre, set up under the auspices of the U.N. Economic Commission for Africa, is designed to provide specialized services in surveying and mapping under the motto "mapping for development". The United States Agency for International Development (AID) entered into an agreement with the Regional Centre, which provides support for the remote sensing division.

The Regional Remote Sensing Facility is the remote sensing division of the Mapping Centre. It provides advice, services and support for users in the Eastern Africa region. The Facility produces copies of satellite images from an extensive library of photographic transparencies and can create scaled enlargements, map overlays and photographically enhanced images to meet user requirements. There are charges based on a cost-recovery policy for the photographic products. The Facility also provides a programme of subsidized training courses in remote sensing and a subsidized consultant service for investigators wishing to utilize remote sensing data. A limited amount of work is also done on a co-operative basis with natural resources projects in the region:

For further details write to:

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P.O. Box 18332
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REGIONAL REMOTE SENSING FACILITY NAIROBI KENYA

REMOTE SENSING OF NATURAL RESOURCES IN EASTERN AFRICA

WATER RESOURCES

by
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REMOTE SENSING AND HYDROLOGY

Over large areas of the earth the identification, evaluation and monitoring of water resources are of vital importance. Agricultural development, rangeland management and urban or regional planning are dependent upon the availability of adequate water supplies. In many cases these water supplies are a function of the hydrology of a large area. The data from Landsat, providing views of large areas on a repetitive basis, can be very important in the examination of certain hydrologic features. Major hydrologic applications are ground-water exploration, flood monitoring, surface-water inventory, water quality analysis, irrigation monitoring, the detection and mapping of wetland areas, and the mapping of some coastal features and reefs.

Important in many hydrologic applications is Landsat's ability to detect open water. The principles of air photo interpretation can be applied to the Landsat images to delineate open water easily, providing low-cost and rapid mapping of floods, rivers and surface-water bodies. In addition data from Landsat reveal turbidity patterns in larger water bodies as well as floating vegetation and shallow water areas. Where water is in association with vegetation, as in wetlands or swamps, the Landsat data provide some detail of the variation in the vegetation and a ready means of mapping the vegetated area. In other cases, areas of ground-water seepage are revealed by the presence of vegetation, and ground-water movement may be inferred from the patterns of geological structure and rock type evident in the Landsat image.

The examples given here deal with aquatic vegetation, characteristics of surface water in lakes, and flood damage assessment.

MALAWI

LAKE CHILWA

The two portions of Landsat images opposite are of Lake Chilwa in southern Malawi. The image on the left is from 8 October 1973 (scene 1442-07084) and on the right from 11 August 1979 (scene 21662-06523). These images are at a scale of 1:500,000 and are about 50 kilometres on each edge. Lake Chilwa is a shallow lake from which a considerable amount of fish are caught.

The interesting comparison between these two images is the location of chlorophyll-rich green vegetation in and near the lake. Because of the method of this Landsat data collection and processing, such vegetation appears as red or pink. In the 1973 scene, much of the lake has the red colouration indicative of green vegetation which is probably an algae bloom. In the 1979 scene, there is no evidence of vegetation in the main portion of the lake but considerable evidence along the shoreline.

Interpretation of these vegetation patterns for Lake Chilwa requires an understanding of the lake's ecology and some fieldwork. The images are presented here as examples of information obtainable with the synoptic view and repetitive coverage of Landsat. In these images, the vegetation patterns are recorded for the entire lake. Repetitive Landsat scenes, which can be gathered at 18-day and possibly 9-day intervals (except for cloud cover and receiving station availability) would document the changing patterns of vegetation in the lake. An examination of seasonal imagery over years would indicate the frequency and conditions of large algae blooms such as the one apparent in the 1973 scene. Such information assists an ecologist in developing plans for control or exploration of the lake's resources.

TANZANIA

LAKE EYASI

The three images opposite illustrate differing water levels and conditions as seen from Landsat of the northern portion of Lake Eyasi in Tanzania. These images also include some clouds, Mount Lemagent in the north-east, and the Serengeti Plains in the northern portion of the scenes. Drainage patterns into the lake and an escarpment to the west of the lake are also quite apparent. These images are from 31 January 1973 (scene 1192-07183), 23 June 1975 (scene 2152-07064), and 29 June 1979 (scene 30481-07061). Each scene is a portion of a Landsat scene, at a scale of 1:500,000, and covers approximately 35 by 50 kilometres of the earth's surface.

Lake Eyasi is an alkaline lake which is frequently dry. These three images show very different water conditions within the lake. In 1973, the lake is full of water, the water is quite clear, and in many places reflectance from the lake bottom can be seen. There is also some aquatic vegetation (red tones). The extensive green vegetation (red tones) north of the lake indicates wet climatic conditions. The 1975 scene is very dry with no surface water and little vegetation north of the lake except at higher elevations. The salt flats reflect very bright tones. In the 1979 scene the lake is again full of water but the water is quite turbid and no bottom details are evident nor is any aquatic vegetation visible. The water current patterns can be identified. The amount of green vegetation on the land falls between the amounts shown in the other two images.

The variations in Lake Eyasi evident in these Landsat scenes may be useful in developing a programme for extracting salt, evaluating animal and particularly waterfowl habitat, or perhaps examining alternatives for utilization of the surface water.

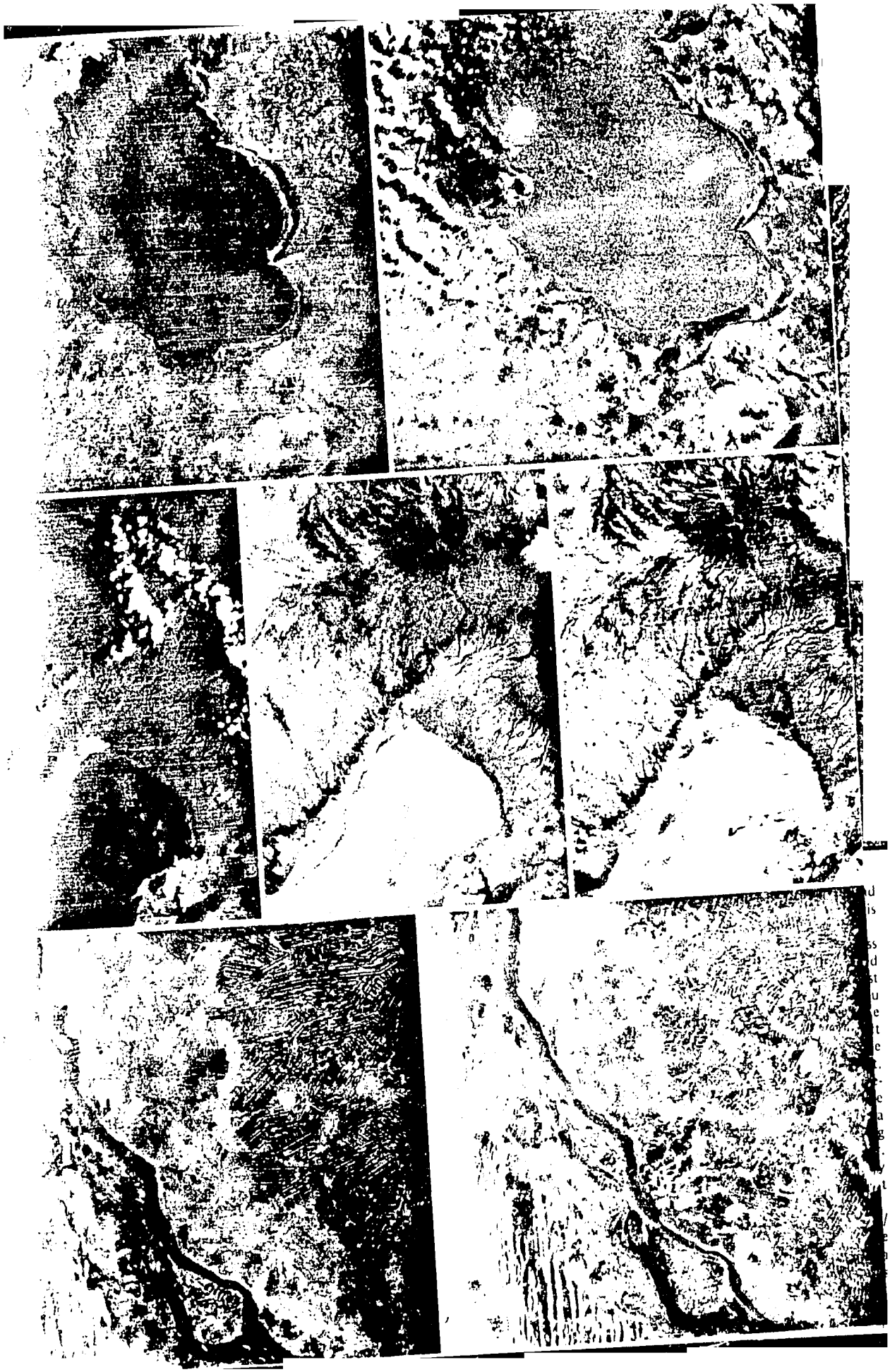
SUDAN

WHITE NILE RIVER FLOOD

These images illustrate the utility of Landsat for flood disaster assessment and planning. The image on the left is from 7 November 1972 (scene 1107-07421) and on the right from 14 August 1978 (scene 30162-07305). These portions of full Landsat scenes, at a scale of 1:1,000,000, extend about 100 kilometres on a side. The area covered in this scene is in the Sudan along the White Nile south of Khartoum. Principal features in these images besides the White Nile include the light-toned desert area in the west with some extensive north-south trending dunes south of the river, riparian and agricultural vegetation along the river, and the irrigated fields of the Gezira agricultural scheme along the eastern portion of the scenes. This is an extensive area of irrigated cotton.

During July 1978, the area received 370 mm of rain in two days, over twice its 150 mm average annual precipitation. The flat terrain and low permeability of the heavy clay soil, together with the irrigation water already brought to the fields just before the rains, created an environment very prone to the flooding evident in the 1978 image. The entire Gezira area was inaccessible for several weeks after the flood, making damage assessment and relief activities difficult.

Images of previous floods, such as the 1978 scene, can be very valuable in preparing for future floods by identifying those areas most likely to be flooded, weak points in canals or embankments, and the best transport routes for relief. The flooded areas that still have ponded water are quite evident in the August image, particularly in and near the sand dunes to the South. In the irrigated areas, much of the flood was water that flowed through breaches in the irrigation canals. Areas without ponded water but with saturated clay soils due to the flood appear as dark blue tones.



LANDSAT DATA FOR HYDROLOGY IN EASTERN AFRICA

In the Eastern Africa region Landsat data provide an important source of information about water resources. The repetitive coverage of Landsat is ideally suited to provide seasonal images of surface waters such as Lakes Chilwa and Eyasi from which changes in the areal extent, presence of vegetation, and degree of turbidity may be correlated with contemporary or previous field studies of actual conditions. Data derived from the analyses of such images can provide a rational basis for planning the economic utilization (salt or water extraction and agriculture) and engineering development (roads and airfields) of these hydrologic features.

Simple location of surface water can be done very effectively with Landsat. Surface areas greater than five hectares can be identified with 99 per cent accuracy. Mapping of floods and water courses or water body changes for map updates can also be done very effectively.

Repetitive coverage of Landsat may determine if a stream is in continuous or intermittent flow. Landsat has proved effective in providing data on stream networks for drainage maps in Lesotho.

It has provided reconnaissaince-level data needed for the development and operation of large irrigation projects as in Swaziland. Such data may also be used for the design of major impoundment structures and their impact can be Landsat monitored. Landsat data have in some situations provided input to water-demand and ground-water-flow models for irrigation projects.

Landsat data are used to assess major watershed characteristics that affect runoff. It is possible in the semi-arid and arid watersheds of East Africa to develop information on runoff prediction based on data from Landsat and available meterological satellites.

Meterological satellites also provide information on cloud cover, cloud type, and cloud persistence, and information on moisture which may be useful for agricultural crop yield prediction.

Interpretation of a photographic print of Landsat data also reveals features associated with ground-water occurrence such as landforms and landform patterns, drainage characteristics, vegetation types and associations, outcrop patterns, soil tones, lake patterns, and land-use or land-cover characteristics. Some detected features directly imply the presence of shallow sands and gravels; other features indicate rock types or the presence of folds and fractures. There is often a good correlation between lineaments detected on aerial photographs or satellite images and the occurrence of ground water in dense, fractured limestones. There is good reason to believe that many lineaments are related to ground-water occurrence in other types of dense, fractured rocks. Another application of Landsat can be the delineation of zones of potential recharge for ground-water supplies. Delineation of such recharge zones could aid in more efficient management of water quantity and quality.

In one area of the Sahel, no surface drainage ways of any substance were found on Landsat, indicating very porous soils for that region. The absence of surface drainage ways may suggest the presence of shallow aquifers which could be developed for livestock watering points for nomadic herds. The regional distribution of existing watering points may also be associated with regional patterns of geology revealed by the Landsat data. Thus for the development of regional hydrology plans Landsat data can play a useful role, as in Tanzania where satellite data have been used by the Bureau for Resource Assessment and Land Use Planning (BRALUP) in compiling data for regional planning purposes. International agencies and engineering consultants are using Landsat data for regional planning, especially in relation to water development.

THE LANDSAT SYSTEM

The satellites in the Landsat series orbit the earth at an altitude of approximately 930 km. From this altitude the satellites view a swath of the earth's surface 185 km wide. Each day the satellite makes 14 orbits of the earth, and on the 18th day the orbit pattern repeats. Therefore every 18 days Landsat views the entire earth's surface between 81°N and 81°S. The sensing systems on board the satellites do not penetrate clouds. Most places are cloud free on two or more occasions each year, and since the launch of the first Landsat satellite in 1972 the whole of the Eastern African region has been viewed by the satellite on two or more cloud-free occasions. Overall there is an average of six cloud-free images for each area.

The images gathered by the satellite are made up of individual measurements of reflected energy for 0.4 hectare areas of the earth's surface. These measurements are gathered row by row in a scanning system and transmitted to earth where they are received at ground stations, recorded and reassembled to make "pictures" of the earth's surface. Each of these pictures is referred to as a Landsat image and each standard image is made up of 7,581,600 pixels (or picture elements), each 57 x 79 m. Each standard image covers 34,225 sq km of the earth's surface. The measurements for each pixel are taken in each of four parts of the electromagnetic spectrum. These are:

band 4 500-600 nanometres wavelength green-yellow light

band 5 600-700 nanometres wavelength orange-red light

band 6 700-800 nanometres wavelength mostly invisible infra-red energy

band 7 800-1100 nanometres wavelength invisible infra-red energy

The measurements in the infra-red are not measurements of heat but are measures of reflected infra-red energy. Healthy vegetation reflects both band 6 and band 7 wavelengths. Water does not reflect band 7 wavelengths. Therefore definition of open water features is easily achieved using band 7. Data from three of the four bands can be used together to create full colour images. The standard false-colour composite shows band 4 in blue, band 5 in green, and band 7 in red, which gives full colour pictures that show vegetation in red, clear water in dark blue to black, and turbid water or very shallow water in light blue-green colours. It is this standard composite that is used in all the examples given.

On board the Landsat satellites there are other sensor systems; however, the majority of the available data is of the type described here.

REGIONAL REMOTE SENSING FACILITY

Because of the value of remote sensing data in natural resources studies and the need for such studies in Africa, the Regional Centre for Services in Surveying and Mapping included a remote sensing division in its plans. The Regional Centre, set up under the auspices of the U.N. Economic Commission for Africa, is designed to provide specialized services in surveying and mapping under the motto "mapping for development". The United States Agency for International Development (AID) entered into an agreement with the Regional Centre, which provides support for the remote sensing division.

The Regional Remote Sensing Facility is the remote sensing division of the Mapping Centre. It provides advice, services and support for users in the Eastern Africa region. The Facility produces copies of satellite images from an extensive library of photographic transparencies and can create scaled enlargements, map overlays and photographically enhanced images to meet user requirements. There are charges based on a cost-recovery policy for the photographic products. The Facility also provides a programme of subsidized training courses in remote sensing and a subsidized consultant service for investigators wishing to utilize remote sensing data. Work is also done on a co-operative basis with natural resources projects in the region.

REGIONAL REMOTE SENSING FACILITY NAIROBI KENYA

GEOLOGICAL INTERPRETATION OF THE SOUTHERN KERIO VALLEY KENYA

by
Jean-Claude Rivereau
Ministry of Environment and Natural Resources
for

UNESCO Regional Field Training
Course in Mining Geology

Nairobi
September - November 1981

REGIONAL REMOTE SENSING FACILITY
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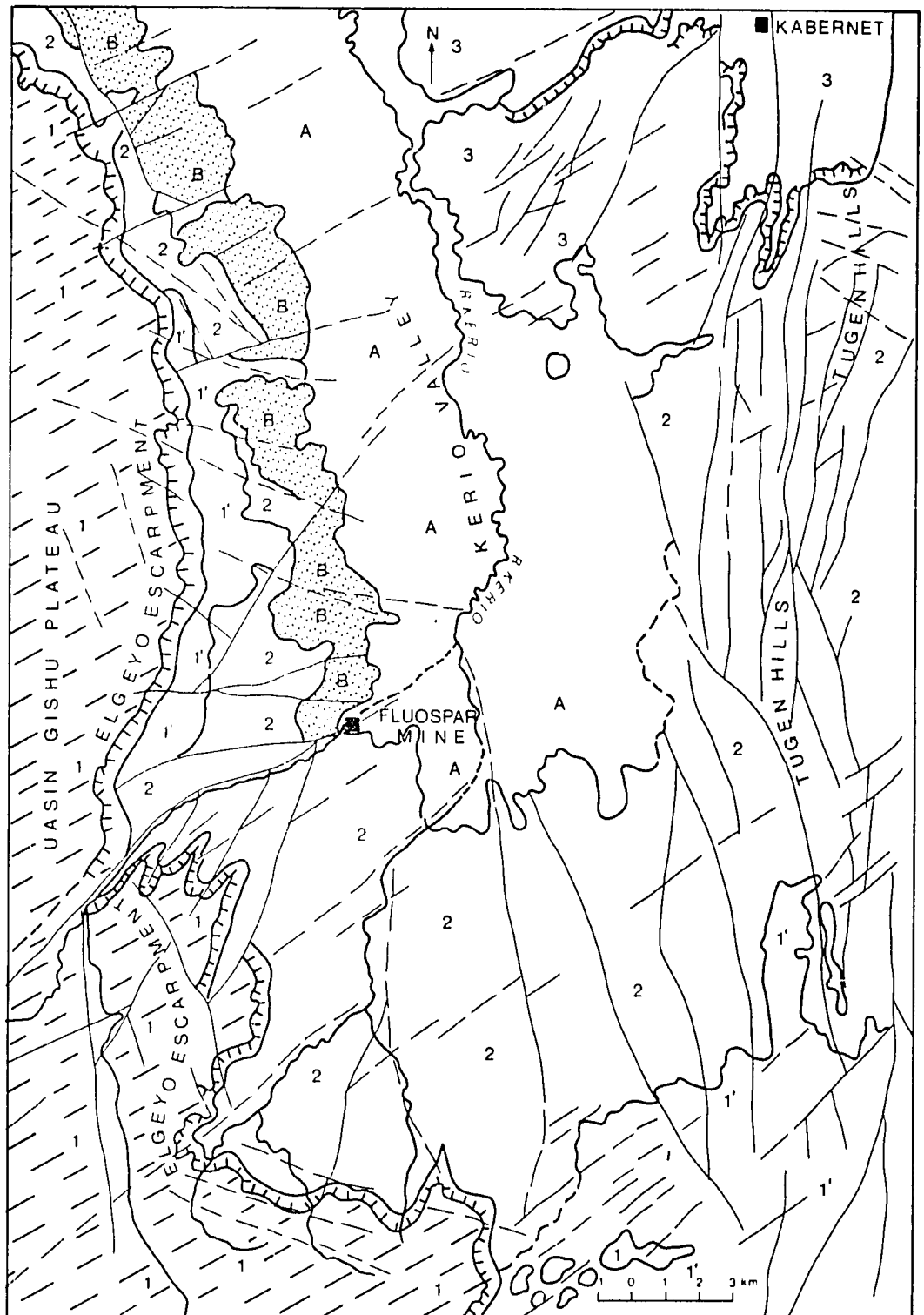

GEOLOGICAL SKETCH MAP OF
KERIO VALLEY FROM LANDSAT DATA

KEY:

- Fault, linearment
- Geological boundary
- River
- Escarpment
- A Alluvium
- 3 Kabernet trachytes
- 1 Tinderet volcanics (phonolites)
- 1·2 Uasin Gishu series (phonolites, tuffs, basalts)
- B Basement system

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GEOLOGICAL INTERPRETATION OF THE SOUTHERN KERIO VALLEY KENYA

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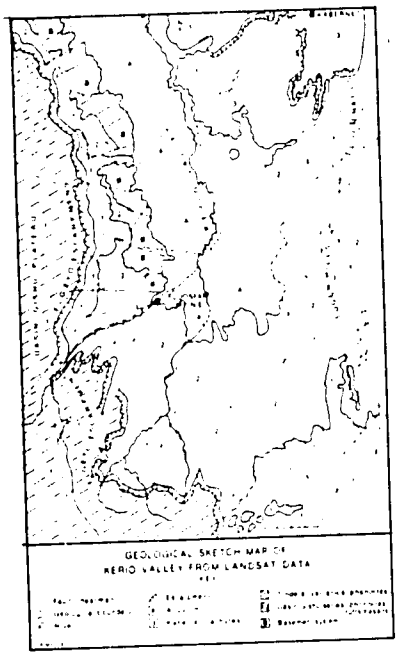

This false colour print is an enlargement of part of Landsat Scene 181/60 of 25 January 1976 over the southern portion of the Kerio Valley in Rift Valley Province of Kenya. It is at a scale of 1:125,000.

PHYSIOGRAPHY

The area can be divided into four physiographic units, from west to east:

1 The eastern edge of the Uasin Gishu Plateau and its extension to the south standing at an altitude between 2,400 and 2,700 metres. This is a region of large farms and plantations (cereals) with some forest reserves such as the Kaptagat and Metkei forests which appear in a continuous deep red tone on the picture.

2 The Elgeyo Escarpment face, a steep slope to the Kerio Valley, which lies below 1,200 metres. The escarpment is an area of mixed agricultural and remnants of indigenous forests.

3 The Kerio Valley proper, a subarid area with poor thorn scrub utilized for cattle grazing.

4 The Kamasian-Tugen Hills unit. Agriculture here is primarily maize production in small farms with remnants of indigenous forests on the slopes.

GEOLOGY

The Kerio Valley is an arm of the Kenya Rift Valley system, separated from the main valley by the Kamasian/Tugen Hills horst. It is characterized by a major fault running along its western flank which is responsible for the Elgeyo Escarpment (1,500 m) with a geological downthrow that may exceed 1,000 metres (see below). One geological peculiarity of the Kerio Valley is that this major fault suddenly dies out only about 10 kilometres to the south where the Metkei Plateau joins the Uasin Gishu Plateau.

Lithology – the main formations encountered are:

- The basement system, which consists of metamorphosed sediments (hornblende and quarto-felspathic gneisses and crystalline limestones) and is exposed at the foot of the Elgeyo Escarpment.
- A series of volcanic or volcano-sedimentary formations, which extend from Miocene to Pleistocene in age and include basalts (Samburu, Elgeyo), phonolites (Uasin Gishu, Tinderet), trachytes (Kabarnet), and intercalations of tuffs, silts and diatomites.
- Quaternary deposits, alluvium and red soils, which form the floor of the valley.

Tectonics – the area is controlled by roughly north-south normal faulting facing east on the western side and west on the eastern side of the valley. There is a controversy about the magnitude of the Elgeyo Escarpment fault system which exceeds 1,000 metres if it assumed that the Samburu basalts, which occur at 1,200 metres in the Kerio Valley, were laid down on a plane surface of gneiss. The basalts are presently at an altitude of 2,300 metres in the escarpment. Other evidence suggests that the basaltic series was progressively deposited when the downwarping and faulting process was already taking place, thus indicating that the magnitude of the fault may be of lesser extent.

To the south and to the east, the area is characterized by an uplift and downthrow system of faults arranged "en echelon"

Two 1:125,000 scale geological sheets are available in this area, published by the Mines and Geology Department of the Ministry of Environment and Natural Resources. One is by J. Walsh in 1960 and the other by P.H. Truckle in 1978. There are considerable differences between the two sheets in both stratigraphy and tectonics, which illustrate the difficulty of mapping in volcanic areas.

LANDSAT INTERPRETATION

The Landsat interpretation was carried out on scene 181/60 of 25 January 1976 along with scene 182/60 of 16 May 1979 of the adjacent orbit. Together these images permit a stereoscopic view of the area because it is in the area where the orbits overlap. Through texture and tone analysis, the main physiographic and related geologic units can be delineated. This is the case for the Uasin-Gishu volcanic plateau and the Elgeyo Escarpment where the basement rocks clearly stand out with a peculiar light-coloured rough surface. The Quaternary sediments composing the floor of the valley are also easily recognized, appearing as a light- to blueish-toned smooth surface. The mottled pattern developed over the Tugen Hills can also be identified and discriminated from the rest of the picture.

However, one could not expect to differentiate in detail between the various volcanic units because there is very little lithologic difference between basalt and phonolite and also because stratigraphy in volcanic areas is usually very complicated.

The various units interpreted from the Landsat image are in reasonably good agreement with the geological maps, although some discrepancy may occur on the delineation of these units.

Unit A corresponds to the Quaternary and Recent deposits of the Kerio Valley.

Unit B is the basement metamorphosed series

Unit 1 corresponds to the Tinderet volcanics

Unit 1' and 2 are related to the Uasin-Gishu series which consists of phonolites, tuffs and basalts.

Unit 3 corresponds to the Kabarnet trachytes. This unit has a peculiar light-toned and flat surface aspect, which might be confused in places with the Quaternary deposits.

From the structural and tectonics standpoint, the Landsat image provides excellent data. The roughly north-south network of normal faults can be readily and accurately analysed, especially in the southern and eastern part of the image. The interpretation gives a clearer definition of the fault pattern than is shown in previous geological works. In particular two new structural trends, north-east and north-west in direction, clearly appear. The north-east trend of faulting is particularly well expressed to the south of the image (fluorspar mine valley and south) with both vertical and horizontal offset. It appears that it is along these faults the rifting process dies out to the south.

In this small proportion of Landsat data for the Kerio Valley the large fault bordering the western wall of the valley is not seen because it lies under the Quaternary sediments. When the full Landsat frame is examined the fault is well expressed by the wall of the escarpment, which extends for more than one hundred kilometres.

REGIONAL REMOTE SENSING FACILITY NAIROBI KENYA
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SATELLITE IMAGE OF

The full colour scene of the Nairobi region was created from data gathered by a scanning system aboard the U.S. satellite Landsat 2. Locational information is provided on the adjacent annotated photo map and more detailed explanations are given in the following notes. Landsat 2 is in orbit at an altitude of 930 kilometres above the surface of the earth. It repeats its orbit pattern every 18 days and adjacent orbit paths are traversed on consecutive days so that the colour scene overleaf is composed of part of Landsat scene 2367-06580 gathered on 24 January 1976 and part of scene 2368-07034 gathered on 25 January 1976. The data were collected at 9.30 a.m. local solar time each day.

The scanning system on board the satellite gathers information which our eyes would see as green light and it gathers information which our eyes would see as red light. Information which our eyes cannot see, from the reflected solar infra-red portion of the spectrum, is also gathered. This is *not* heat information but is solar infra-red radiation which is reflected by healthy chlorophyll-rich vegetation. In the printed picture overleaf the infra-red energy (which we cannot see) is measured and printed in red (brighter red indicates higher infra-red reflectance). The other information from the visible part of the spectrum is printed in blue and green (blue for green light and green for red light).

This combination of colours gives red tones for healthy chlorophyll-rich vegetation, especially the tea plantations at 4. White areas with corresponding black areas immediately to their left are clouds with their shadows (7) and black areas are open water such as Lake Naivasha (1). Sandy soils with little or no vegetation are bright areas (e.g. the Loita Plains); they show pink tones where there is chlorophyll-rich vegetation and green/blue tones where the vegetation is dry or has very small leaf area.

The Rift Valley extending N-S across the image is a striking feature bounded by the red tones of the Nyandura Forest to the east and the forest of the Mau Escarpment to the west flanking Lake Naivasha (1). Contained in the Rift Valley are Lake Naivasha (1) and Lake Magadi (13) and the volcanoes Mt. Longonot, Mt. Susua and Mt. Olorgesaillie (south of 12). On the floor of the Rift Valley the patterns of volcanic lava flows and the faulting and fracturing patterns associated with them are clearly shown and the steeper sections represent a feature of 700 m or more in height.

In general the Rift Valley shows green/blue tones because it is drier than the adjacent escarpment areas, and the acacia vegetation has a small leaf area. There is

THE NAIROBI REGION

1 Lake Naivasha – dark tones indicate clear water more than 5 m deep.
2 Forest on the southern slopes of the Aberdares including shadows on west-facing slopes at 9.30 a.m.
3 Small-holder agriculture, each plot having a different mix of cultivated ground, houses, trees, bananas, maize, coffee or other crops and showing different reflectance characteristics giving a mottled pattern.
4 Tea plantations – bright red; the adjacent pink areas to the south are the pastures of dairy farms.
5 Coffee plantations – red colour.
6 Sisal plantations – dull purple tones.
7 Clouds.
8 City of Nairobi – blue tones indicate built-up areas with little vegetation; the industrial area shows brightly because of the concrete and asbestos roofs and large areas of paved factory yards.
9 Jomo Kenyatta Airport – runway can be identified, also terminal buildings and access roads.
10 Vegetated hills around Machakos.
11 Patterns of green/blue in the dry plains area are a function of the red soils and the yellow/green acacia vegetation.
12 Olorgesaillie – old lake beds show bright tones.
13 Lake Magadi – a natural soda lake with reflecting crust of crystalline salts.
14 Open water in Lake Magadi maintained by dredge mining of the crystalline soda.
15 Geological formations clearly visible because of tree cover (red).
16 Wheat and barley fields on the Mau Escarpment – the bright fields have straw or stubble; dark fields indicate the stubble has been burnt or ploughed in.
17 Natural forest.
18 Clearing of forest for small-holder agriculture.
19 Large-scale wheat farming.

The two scenes making up this image are Landsat scenes 2367-06580, 24 January 1976, and 2368-07034, 25 January 1976. The scale of the image overleaf is approximately 1:500,000.

very little infra-red reflectance from this and so very little red colour in the Rift Valley area of the scene. Volcanic cones in the Rift Valley can be identified, especially Longonot and Susua. Lake Naivasha (1) and Lake Magadi (13) are quite different in their reflectance characteristics, Lake Naivasha appearing black because it is clear water which absorbs the infra-red and much of the visible light energy recorded by the satellite. Lake Magadi appears white because it is a soda lake and has a thick alkaline crust which is light in colour and reflects the solar energy giving a white appearance in the image. Where the dredge keeps the crust from forming the dark appearance of open water is present (14).

Small-holder farming gives a mottled appearance on the image because of the many varying types of ground cover on the small holdings. Areas of this at 3 show dark tones where there are more bare fields and trees. The high chlorophyll reflectance from small holdings with young growing crops is visible as brighter red tones at 18. Wheat and barley fields at 16 show a variety of tones, the bright fields being those with straw and stubble, the darker ones those which have been burnt or ploughed.

The city of Nairobi has many features. The industrial area shows the brightest tone because it is composed of highly reflective surfaces–concrete, asbestos roofing, etc., and has very little vegetation. It shows as bright blue. The central city (8) is quite well vegetated and shows as dark purple. The pink tones of Uhuru Park are clearly divided from the city centre by the straight line of Uhuru highway. Jomo Kenyatta Airport runway, terminal buildings (9) and access road can be seen to the east of the city.

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REGIONAL REMOTE SENSING FACILITY NAIROBI KENYA

A division of the Regional Centre for Services in Surveying and Mapping

SATELLITE IMAGE OF

SATELLITE IMAGE OF THE ARUSHA REG

The full colour scene of the Arusha region was created from data gathered by a scanning system aboard the U.S. satellite Landsat 2. Locational information is provided on the annotated photo map above and more detailed explanations are given in the following notes. Landsat 2 is in orbit at an altitude of 930 kilometres above the surface of the earth. It repeats its orbit pattern every 18 days and adjacent orbit paths are traversed on consecutive days so that the colour scene overleaf is composed of part of Landsat scene 2367-06582 gathered on 24 January 1976 and part of scene 2368-07040 gathered on 25 January 1976. The data were collected at 9.30 a.m. local solar time each day.

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This combination of colours gives red tones for healthy chlorophyll rich vegetation, especially the vegetation on the slopes of Kilimanjaro and on the higher hills and mountains of the region. The crops on the large farms south of Moshi show this chlorophyll reflectance (7) as do the marsh lands (3) north of Amboseli National Park (Kenya).

Areas of high reflectance appear white. These include clouds (2) which have black shadows immediately to the West and the snow caps of Kilimanjaro — at Kibo peak (5) and Mawenzi (6). Also showing white are the unvegetated saline areas of Lake Amboseli (4) and the crystalline soda crust of Lake Natron (20). In all these cases the brightness results from the reflection of sunlight by white surfaces. Brightness elsewhere in the image indicates a compact or sandy soil with sparse vegetation cover. Around the shores of Lake Manyara and Lake Magadi in Ngorongoro Crater there is also a component of soda or salt adding to the brightness.

Dark tones in the image indicate open water in Lakes Manyara, and Eyasi and the lake in Embagai Crater.

The southern end of Lake Natron shows the dark appearance of open water and so does the lake created on the Ruvu River (south-east corner of the image). Also appearing dark are the lava plateau and moorlands of the upper slopes of Kilimanjaro and Mt. Meru.

The blue-green/grey tones of the image indicate a lack of active chlorophyll and are in general areas

THE ARUSHA REGION

1 Ol Doinyo Orok, Wooded hills by Namanga border post.
2 Clouds (note shadows to left).
3 Marshland with vigorous vegetation growth shown by the red tones of infra-red reflectance.
4 Lake Amboseli depression with high reflectance from dry lake bed and salt deposits.
5 Kibo — snow-capped main peak of Kilimanjaro 19,340' (5,895 m).
6 Mawenzi — subsidiary peak of Kilimanjaro, small snow cap 16,900' (5,151 m).
7 Moshi town
8 Large-scale agriculture, coffee estates and other plantations
9 Kilimanjaro International Airport.
10 Small-holder agriculture. The individual plots have small amounts of different crops, coffee, bananas, maize, and different areas of houses, other buildings, etc., giving a mottled pattern.
11 Cloud over Mt. Meru
12 Arusha town. Note the clearly defined road at the northern edge of the town.
13 Engaruka Basin, a local drainage area giving bright reflection from the dry lake bed. The lake is seasonal.
14 Mottled pattern of small-holder agriculture, the dark tones being ploughed or burnt fields after crop harvest.
15 Crater Highlands, a volcanic complex with high elevations including craters and with a dense woody vegetation as a consequence of higher rainfall and volcanic soil. This is a product of the Rift Valley volcanic activity, several major craters are clearly visible. Note the pink tones of the grasslands in Ngorongoro Crater.
16 The eastern part of Olduvai George, famous for the excavations by Dr Leakey.
17 Extensive grazing area showing blue-red tones of grassland and the contrast with the red tones of the higher, better-watered lands to the north and south.
18 Ol Doinyo Longai volcano with lava field. Note relative lack of vegetation (blue-grey colours) and recent lava flows (1960s).
19 Hill area extends northwards to Loita Hills of Kenya. Main geologic structures are visible and altitude results in greater rainfall, hence the vegetation vigour and more red colour.
20 Soda crust of Lake Natron with patterns indicating ponding of rainwater on the soda. The green areas are areas of red algae which bloom in these soda-rich waters.

The two scenes used to make this image are Landsat scene 2367-06582, 24 January 1976, and 2368-07040, 25 January 1976. The scale of the image overleaf is approximately 1:630,000. Colour separation, design and printing have been done in Nairobi, Kenya from work done in the photo laboratory of the Regional Remote Sensing Facility using standard products from the EROS Data Center, Sioux Falls, South Dakota, U.S.A.

of acacia vegetation over volcanic soils. The red-brown soils of the basement rocks complex are shown as a yellow-brown tone over the central and northern part of the scene. These areas are generally rangelands and the red tones indicate areas of better plant growth along stream courses or in local drainage basins. Rising above these arid plains are the numerous volcanic peaks. Mt. Kilimanjaro is the most spectacular and the Crater Highlands, a volcanic mass which includes Ngorongoro, Olmoti and Embagai craters, is the largest feature showing bright red tones. The redness results from the vegetation of these hills, which have woody cover thriving on the volcanic soils and watered by the mists and rains resulting from the elevation of these areas. Ngorongoro Crater rim in the east is over 7,000' (2,130 m) in elevation, Embagai more than 9,000' (2,750 m). Less spectacular patterns can be seen for Losiminguri, Kitumbeine Hill, Gelai Peak, Monduli, Longido and Ol Doinyo Orok.

In the north western corner of the image are a series of hills, including Loliondo Hill separated from Ngorongoro by a lower-lying area of grasslands, which are the beginnings of the plains leading to the Serengeti area. Olduvai Gorge is in this area, just visible at 16.

Between Ngorongoro and Lake Manyara the image shows a mottled pattern of dark greens and reds, this is an area of small-holder agriculture. Similar patterns with more red can be seen around Arusha and in the area from the slopes of Mt. Meru to the southern slopes of Kilimanjaro.

The towns of Arusha and Moshi can be distinguished. The road which forms the northern edge of the main built-up areas of Arusha being particularly clear. Kilimanjaro International Airport (9) is visible on the Sanya Plain.

There is no major indication of the Kenya-Tanzania border in the image, but the border, through Namanga, is indicated on the photo map above for reference. Lake Natron to Lake Manyara is a part of the East African Rift Valley, less spectacularly defined here than in the section immediately to the north.

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REGIONAL REMOTE SENSING FACILITY NAIROBI KENYA
A division of the Regional Centre for Services in Surveying and Mapping

EARTH RESOURCES MAPPING in Africa

A NEWSLETTER OF
THE REGIONAL CENTRE FOR SERVICES IN
SURVEYING AND MAPPING AND
THE REGIONAL REMOTE SENSING FACILITY

NAIROBI KENYA
No. 5 March 1981

Prof. Adebayo Adedeji, second from right, addresses the meeting of plenipotentiaries during the Centre's November meeting in Addis Ababa. Also pictured from left to right are Mr. Funso Olujohungbe, Chief of ECA's Cartography and Remote Sensing Unit, Dr. Peter Mwanza, Head of ECA's Natural Resources Division, and Mr. Bernard Sikilo, Director General of the Centre.

ZAMBIA AND COMORO BECOME MEMBERS OF THE MAPPING CENTRE

A series of Mapping Centre meetings was held in Addis Ababa during the week of 24-28 November. These meetings culminated with a meeting of plenipotentiaries on the 28th during which delegates from Comoro and Zambia signed the Centre's charter, making those countries the sixth and seventh contracting parties.

The meeting of plenipotentiaries was preceded by a Technical Advisory Committee (TAC) meeting on the 24th and 25th, a meeting of the Commission for Geodesy in Africa on the 26th and the Governing Council on the 27th.

The TAC meeting was opened by Mr. F.O. Olujohungbe, Chief of the ECA Cartography and Remote Sensing Unit. TAC members then heard a report of the three-man mission, which visited 16 countries of eastern, central and southern Africa during the first half of 1980 to introduce them to cartographic and remote sensing assistance available through the Centre and Facility. TAC also considered various items of business of the Centre including a proposal for the development of its permanent headquarters site. The TAC report was then submitted to the Governing Council and the plenipotentiaries for consideration.

The principal item on the agenda of the Commission for Geodesy in Africa was a resolution naming the Regional Centre for Services in Surveying and Mapping in Nairobi as the principal implementing agency for geodetic projects in Africa. The Commission also received a proposal by Prof. G.K. Sherurah, the Centre's newly appointed geodesy expert, for a unified rectification and adjustment of the horizontal control network in eastern Africa.

The meeting of plenipotentiaries was opened by Professor Adebayo Adedeji, U.N. Under-Secretary General and Executive Secretary of the Economic Commission for Africa. Prof. Adedeji traced the events

continued on page 4

TRAINING PROGRAMME

Since the publication of the previous newsletter the Facility has offered three short courses here, bringing 52 people to the Facility from 11 different countries. These include courses in teaching with remote sensing data, remote sensing for mineral exploration, and remote sensing for transportation engineers.

Beginning in 1981 courses will be based on partial cost recovery and the participant's home agency will bear half the travel costs. To ease adminstration, participants must arrange to travel to Nairobi before the first day of the course. Once participants arrive all further costs including their return journey to their main international airport will be met by the Facility and we will continue our practice of providing hotel accommodation and an allowance to cover the cost of meals.

The course on hydrology and drought monitoring previously scheduled for the period 26 January to 13 February has been postponed.

Discussions are presently under way with the U.S. National Ocenographic and Atmospheric Administration (NOAA) to include their expertise in weather monitoring for this and the agriculture course scheduled for September. As soon as arrangements are finalized, new dates for the course will be announced.

TEACHING WITH REMOTE SENSING DATA

The course in teaching with remote sensing data was attended by 22 participants, 19 of them teachers in African universities. Activities centred around the preparation of materials for teaching and discussions about the balance of materials required in courses using remote sensing data. All participants prepared sets of 35 mm

continued on page 2

TEACHING

continued from page 1

slides explaining the basic principles of remote sensing and illustrating particular features within their own country or within the region at large. There was a one-day field trip and participants were able to take ground photographs to illustrate the content of the Landsat image of the Nairobi area. The participants provided interesting applications of satellite remote sensing to study areas including several examples of geological structures, terrain on different rock types and the geology/geomorphology of the Rift Valley. Other examples included the application of satellite data to ecological studies in the Ruwenzori National Park, to studies of the water in the lakes of eastern Uganda, and to various forestry, rangeland and regional geography studies.

REMOTE SENSING FOR TRANSPORTATION ENGINEERS

Discussions between the UN Economic Commission for Africa (ECA) and the Facility led to the development of a course in remote sensing for highway and railway engineers. Consultants were Dr. Harold Rib of the U.S. Federal Highway Administration and Mr. Peter Beaven and Mr. Clifford Lawrance of the British Transport and Road Research Laboratory (TRRL). The ECA transport advisor, Mr. Shiferaw Bizuneh, provided coordination among ECA, the Facility and TRRL.

The course was opened by Mr. M. Manirakiza, Deputy Executive Secretary of ECA who in his address stressed the need for technology transfer and the advantages to be gained by using satellite data to plan major transportation corridors. A following address by Mr. Shiferaw described the potential value of remote sensing in examining the major transcontinental highway routes planned for Africa including the Lagos-Mombasa corridor and the Cairo-Gaberone corridor.

During the first week of the course Dr. Rib provided lectures, illustrations and laboratory exercises which showed how aircraft remote sensing data could be effectively applied at all stages of highway development, from planning, route selection and design through to contract pricing, acceptance of the finished job and maintenance surveys. The second week included regional data studies with Mr. Lawrance showing the value of terrain of land systems maps for major route corridor selection and providing examples of Landsat data used as a base for such maps, and Mr. Beaven dealing with data processing techniques leading to definition of sources for road-building materials. There were two field excursions, one to the Rift Valley to familiarize participants with the content of the local Landsat images, and the other to the Thika area where road construction is in progress. The final week was devoted to project preparation and report presentations by the participants.

REMOTE SENSING AND MINERAL EXPLORATION

The remote sensing and mineral exploration course was organized by the UNESCO-sponsored International Geological Correlation Programme with Doug Carter and Larry Rowan of the U.S. Geological Survey serving as project co-leaders. The workshop was attended by 12 geologists from African countries. The Magadi Soda Company provided a tour of its factory area and visits to the dredger and the salt production unit, so the participants were able to make a full visit to Kenya's most productive mineral deposit, Lake Magadi. A visit to the gemstone area of the Taita Hills was also arranged in conjunction with staff members of the Kenyan Department of Mines and Geology. Mr. R. Okelo of that department led the trip which was through the area where he had been involved in compiling the most recent geological map. Mr. J.C. Rivereau of the Ministry of Environment and Natural Resources prepared an analysis of the Landsat data for the area.

SENIOR U.S. OFFICIALS VISIT CENTRE

On 26 September the Centre and Facility hosted a delegation of senior U.S. government officials headed by Dr. Frank Press, Science and Technology adviser to the President. Others included in the group were Dr. Richard Frank, Administrator of the National Oceanographic and Atmospheric Administration (NOAA), Dr. Robert Frosch, Administrator of the National Aeronautics and Space Administration (NASA), and Dr. William Menard, Director of the U.S. Geological Survey. The group was accompanied by Mr. William Harrop, U.S. Ambassador to Kenya, Mr. Ray Love, Director of the USAID Regional Economic Development Office for East Africa (REDSO/EA), and Mr. Tom Bebout, also of REDSO/EA.

The group heard a presentation by the Centre and Facility staff on present and planned activities in remote sensing and cartography. This was followed by a discussion of problems and prospects for space technology in Africa.

As a result of this visit, NASA has offered to loan to the Centre a complete set of all data acquisitions of Africa by Landsat 1 and 2. This will give the Centre and the Facility the most comprehensive set of Landsat imagery available anywhere in Africa.

During their Africa trip, Dr. Press and his group also visited Senegal, Nigeria and Zimbabwe. Discussions concerning the application of space and other technologies for Africa with local officials were undertaken at all these stops.

AFRICAN REMOTE SENSING COUNCIL SELECTS BAMAKO HEADQUARTERS

During the Second Meeting of Plenipotentiaries of the African Remote Sensing Council held in Addis Ababa, 11-15 August, the delegates selected Bamako as the permanent site for Council headquarters. The government of Mali had offered to host the headquarters of the secretariat and provide various facilities.

The meeting was attended by representatives of 18 member states of the Economic Commission for Africa (ECA), of which 13 were signatories to the constitution. Representatives of the United Nations specialized agencies, donor countries and African intergovernmental organizations and institutions also attended the meeting.

This meeting was opened by Dr. Adebayo Adedeji, United Nations Under-Secretary General and ECA Executive Secretary. In his opening statement Dr. Adedeji reviewed the progress of the African Remote Sensing Council (ARSC) since its constitution was adopted in September 1978 at a meeting in Ouagadougou. Dr. Adedeji challenged those countries that seem to be adopting a "wait and see" attitude betore giving the Council their full support. He said that if all governments acted in this manner regional programmes such as this would never get off the ground. Dr. Adedeji stressed the fact that technology holds the key to knowledge about African resources and that progress in resource exploration and development is the means of achieving economic independence. He said that at the present time the "industrialized economies and their surrogates, the transnational corporations, know more about our resource situation than our governments do..."To achieve more and effective sovereignty over our natural resources we need to ensure

that the ARS programme is an outstanding success."

In other business, the Council deferred consideration of the appointment of a Secretary General until its third meeting. In the meantime a select committee was appointed to shortlist the applications already received by the ad-interim secretariat of the Council. The Council approved a budget for ARSC for the 1981 financial year of US$231,420. It was agreed that the OAU scale of assessment prior to the Monrovia summit would be adopted for apportioning member states' contributions to the budget of the Council. Two separate accounts will be opened, one for the Council and the other for the centres. Member states will be informed by ECA of the contribution in respect of each account. The Council also adopted a model agreement concerning the housing of headquarters of the regional remote sensing centres based on a draft agreement developed for the Ouagadougou Centre. The third meeting of the Conference of Plenipotentiaries of ARSC will be held in Bamako, Mali, early in 1981.

REGIONAL MANAGEMENT COMMITTEES

The Council meeting also provided an opportunity for the delegates to meet with their respective regional management committees. East African delegates from Kenya, Uganda, Mali and Zambia met with the ECA Secretariat to discuss procedures for forming an East and Southern African Regional Management Committee. It was determined that since the constitution of the Council already provided for the establishment of regional committees, an East and Southern African Committee could be constituted immediately. Kenya, Tanzania and Uganda, being the only signatories to the Council's constitution in this region, were designated as the original committee members. The Director General of the Regional Mapping Centre (host organization to the Nairobi Remote Sensing Facility) was designated rapporteur for the committee. He was instructed, with the cooperation of member delegations, to draft a plan to coordinate the activities of the Remote Sensing Facility and the Mapping Centre under the umbrella of the Management Committee.

The West African Regional Management also convened a meeting on 14 August. The committee heard a report of the ad-interim bureau which outlined its work since the last meeting, reviewed the draft headquarters agreement, which had already been approved by the Council, and received a report on the operation of the Ouagadougou Centre.

USAID DEVELOPS NEW ENERGY PROJECTS

The United States Agency for International Development (USAID) has developed two new projects to help AID-assisted countries improve their capabilities to explore for, develop and produce indigenous supplies of conventional energy resources (primarily oil, natural gas and coal). One is a Conventional Energy Training Project, which will provide energy fellowships for academic training in U.S. institutions, industries and research laboratories. Training will be primarily in science and engineering disciplines related to the exploration, development and production of conventional fuels. It is expected that approximately one hundred applications will be accepted worldwide during 1981 for a training period of up to two years.

The second project, entitled Technical Assistance on Conventional Energy Resource Identification, will provide technical assistance aimed at improving recipient countries' base of information about geological potential for indigenous conventional energy resources and at improving countries' ability to plan and manage programmes for exploration and development of such resources. The technical assistance available will include reviewing available data and human resources, developing comprehensive energy plans, and gathering and analysing new data through magnetic, gravity and remote sensing surveys. Persons interested in participating in either of these projects should contact their local USAID missions for further information.

These two projects will complement AID's existing Energy Management Training Programme for Developing Countries. Since 1978 this project has trained officials of 70 agencies from 40 countries worldwide. Additional applications for the next nine-week course which begins in September 1981 will be accepted through 15 June. Applicants must have a college degree in engineering, resource planning, mathematics, science or a related area and must be working in an energy-related field. The course of instruction will include energy in economic and social development, energy systems analysis, energy information systems, technology assessment and special topics. Further information and application forms may be obtained by writing to: Institute for Energy Research, SUNY, Stony Brook, NY 11794, U.S.A.

Country Notes

BOTSWANA

Uses of remote sensing data in Botswana include the regional soil survey project of the Ministry of Agriculture, based on 1:500,000 and 1:250,000 scale Landsat images for reconnaisance soil mapping. Geological maps of the Kalahari region interpreted from Landsat data have been published by the Geological Survey of Botswana. Both Mr. Godfrey Modukanele and Mr. Jutta Breyer have used remote sensing data from Botswana to complete their graduate degrees from the International Training Centre (ITC) in Holland. Both are now teaching in the Department of Environmental Studies, University College of Botswana. We have also received from the U.S. Geological Survey a mosaic of the entire Okavango Swamp area constructed from Landsat data and a copy has been sent to Botswana.

ETHIOPIA

The Ethiopian Ministry of Agriculture has undertaken a nationwide survey of agricultural potential, using Landsat data and supported by FAO technical personnel. The Ethiopian Road Authority has been using Landsat data for terrain evaluation as part of the route selection process for its highway development programme. A joint Ethiopian-Kenyan project planning for the Omo-Turkana basin development has been using Facility equipment and imagery in its survey work. The increased activity of the Regional Centre for Services in Surveying and Mapping has resulted in greater contact with ECA headquarters, visits from ECA project personnel have become frequent.

KENYA

During the year the Kenya government has completed its post-election reorganization. Remote Sensing is now the responsibility of the Ministry of Environment and Natural Resources.

The Committee on Applications of Satellite and Space Technology, organized by the National Council for Science and Technology, is now chaired by Mr. J. Ndoto, Permanent Secretary in the Ministry. Early in the year this committee received a report

from Dr. C.K. Paul of USAID's Washington office. The report, requested by the Kenya government, reviewed the development of remote sensing in Kenya and the implications of the regional policies suggested by the newly formed African Remote Sensing Council. Dr. Paul recommended a detailed study to determine the feasibility of building a ground receiving station in Kenya for earth resources satellite data.

The Kenya Rangeland Ecological Monitoring Unit (KREMU) staff members have been active users of the Facility during the year and the Facility is currently engaged in producing data products for them. Two French remote sensing experts are attached to the ministry, Mr. R. Douté and Mr. J.C. Rivereau. Mr. Douté has been working with Mr. Nicholas Ochanda of KREMU and the Department of Forestry on the forest mapping project. Mr. Rivereau is conducting training courses and programme reviews within the Department of Mines and Geology, he assisted with the geology workshop held by the Facility in October, and he is compiling a report for the National Council for Science and Technology about possible remote sensing institutions at the national and regional level.

Other Kenya projects include group ranch evaluation in southern Kenya, soils and grazing pressure studies in Marsabit District, and further studies of nomads in northern Kenya. The Facility is also assisting development planning in the Isiolo area. In response to requests we have recently advised the Tana River Development Authority on the acquisition of an extensive library of Landsat imagery for its planning and evaluation studies.

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MAURITIUS

While visiting Mauritius the Director General of the Mapping Centre was asked about the use of remote sensing data to chart shoals and reefs in ocean waters. The Facility was able to produce a demonstration image scaled to an existing chart overlay at 1:121,000 and this was delivered to Mauritius.

TANZANIA

The Remote Sensing Newsletter of Tanzania began publication with the September 1980 issue. Its appearance followed from a resolution at the April meeting of the Tanzanian Remote Sensing Working Party. Implementation of the resolution was by the Bureau for Resource Assessment and Land Use Planning (BRALUP), which is the main agency for remote sensing in Tanzania. In the newsletter is information about the Tanzanian remote sensing programme coverage of Tanzania by air photos and by satellite imagery, a feature on future satellites, details of training courses held in Rome in May/June 1980 and courses to be offered by various agencies around the world up to November 1981.

UGANDA

Demand for data from Uganda reached a significant level during the year. This followed in part from the information seminar given in Kampala by Facility staff in March. A collection of data covering the whole of Uganda in black and white band 5 has been sent to Kampala. We are also providing data in support of studies of the Ruwenzori National Park, water weeds in the Kyoga system, and geological mapping in the Gulu area. Makerere University staff have several projects for teaching or research purposes and we are providing data to them.

ZAMBIA

The Surveyor of Zambia has accompanied the Director of the Mapping Centre on a series of visits to East African countries and has expressed interest in Landsat data for mapping projects in western Zambia. We are pleased to note that Zambia has signed the Mapping Centre charter at the November meeting in Addis Ababa and is now a full participating member of this regional organization. We look forward to working more closely with Zambia in the coming year.

ZIMBABWE

The Facility Director visited Zimbabwe in mid-September to familiarize government officials with the Landsat programme and Centre and Facility activities prior to the visit of Dr. Frank Press and his group later that month. Subsequent activity has included the preparation of detailed enlargements of the Salisbury region and a mosaic of the region to the south and west of Salisbury in response to requests from government agencies. These requests followed from a visit in November by Mr. Ray Love, the director of USAID's regional office, who took some Landsat images to Zimbabwe. Various government officers evaluated the images and immediately requested additional materials for use in their projects.

ZAMBIA AND COMORO

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leading toward the development of joint centres for specialized services in surveying and mapping from the first U.N. Regional Cartographic Conference for Africa in 1963. He emphasized the need for African countries to pool their resources in order to receive access to the latest mapping technology. This technology, he noted, is essential for the development of the continent.

The highlight of the meeting of plenipotentiaries was the signing of the Centre's documents by delegates from Comoro and Zambia. The Swaziland delegate announced that his country had agreed in principle to become a contracting party and that detailed arrangements would be worked out later. This meeting concluded with a slide presentation by Mr. Merrill Conitz, Director of the Regional Remote Sensing Facility, on remote sensing applications for Africa

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