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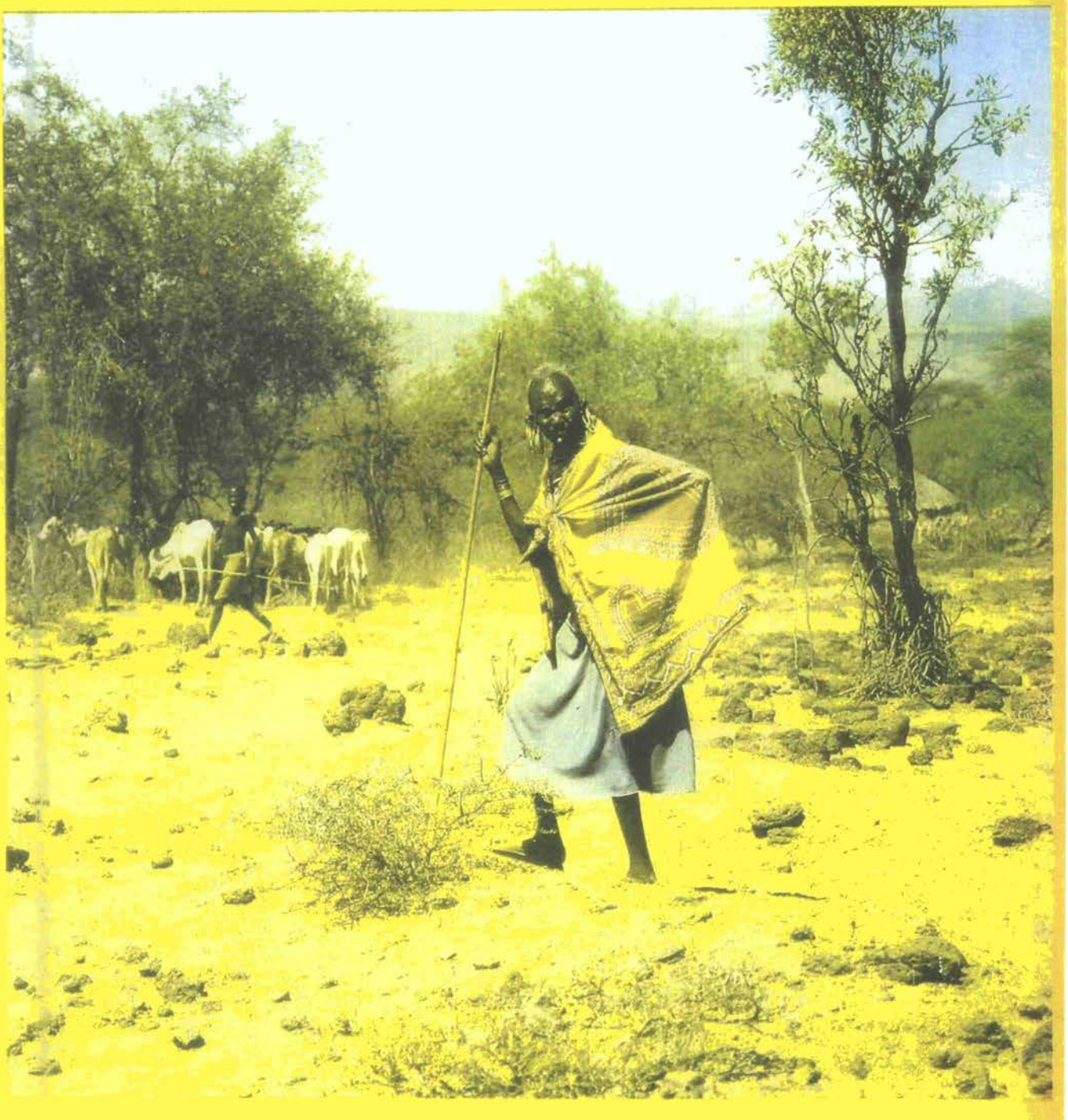
Desertification Control Bulletin

A Bulletin of World Events in the Control of Deserts, Restoration of Degraded Lands and Reforestation

Number 17, 1988



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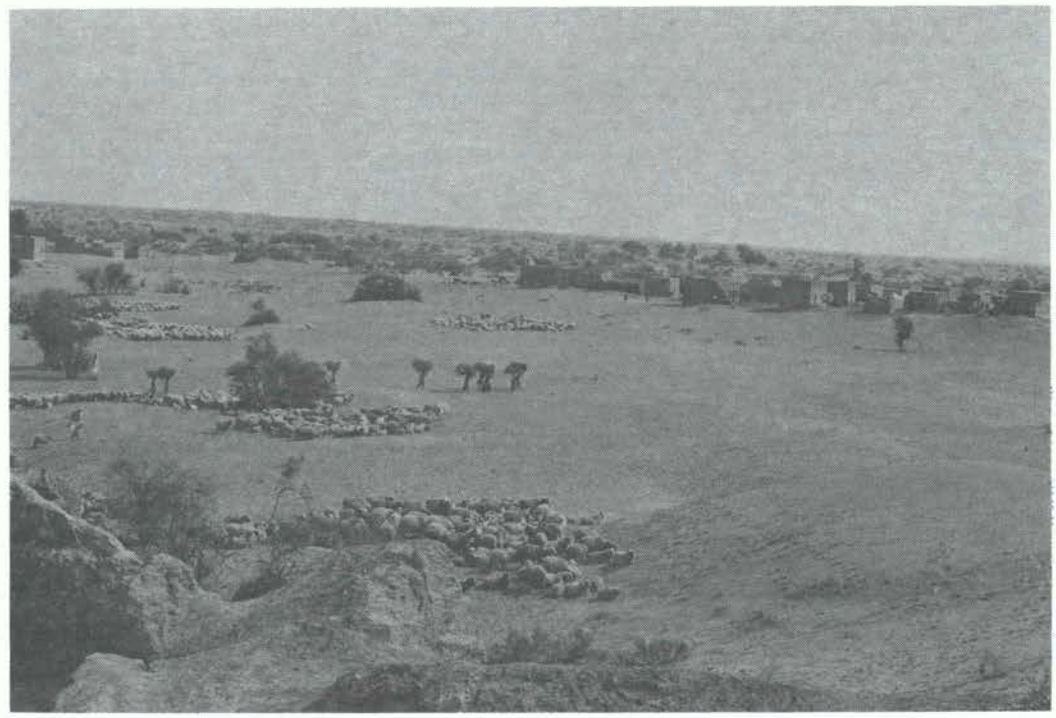

Cholistan Desert, see page 50 (Mohammed Arshad)

Number 17, 1988

Cover: Arid land bush has traditionally been left to pastoralists. There might also be great potential in the products from its trees and shrubs. See article on page 18 (photo: UNEP/Daniel Stiles)

The United Nations Conference on Desertification (UNCOD) was held in Nairobi from 29 August to 9 September 1977.

This was the first worldwide effort ever initiated to consider the global problem and responsibilities posed by the spreading deserts.

95 States, 50 United Nations offices and bodies, 8 intergovernmental organisations and 65 non-governmental organisations participated.

The United Nations Conference on Desertification prepared and adopted a worldwide Plan of Action to Combat Desertification (PACD) with 28 specific recommendations.

The Plan of Action was approved by the United Nations General Assembly at its 27th session on 19 December 1977.

Recommendation 23 of the Plan of Action invited all relevant United Nations Bodies to support, in their respective fields, international action to combat desertification and to make appropriate provisions and allocations in their programmes.

Recommendation 27 gave the responsibility for following up and co-ordinating the implementation of the Plan of Action to the United Nations Environment Programme (UNEP) with its Governing Council (GC) and Administrative Committee on Co-ordination (ACC).

Immediately after approval of the Plan of Action, the Desertification Unit was established within the UNEP Office of the Environment Programme to assist the Executive Director and ACC in carrying out their tasks in the implementation of the Plan of Action.

One of the main functions required by the Plan of Action from the Desertification Unit was to prepare, compile, edit and publish at six-monthly intervals a newsletter giving information on programmes, results and problems related to the combat against desertification around the world.

In 1985 the Desertification Control Programme Activity Centre was created by UNEP's Executive Director with approval from the Governing Council. DC/PAC is a semi-autonomous office with increased flexibility to respond to the demands of following up and implementing the PACD.

Desertification Control Bulletin is an international bulletin published at six monthly intervals by the United Nations Environment Programme (UNEP) to disseminate information and knowledge on desertification problems and to present news on the programmes, activities and achievements in the implementation of the Plan of Action to Combat Desertification around the world. Articles published in *Desertification Control Bulletin* do not imply expression of any opinion on the part of UNEP concerning the legal status of any country, territory, city or area, or its authorities, or concerning the delimitation of its frontiers or boundaries.

Desertification Control Bulletin is published in English. Enquiries should be addressed to:

The Editor
Desertification Control Bulletin
UNEP
P.O. Box 30552
Nairobi, Kenya.

Cover Photographs

The Editor of *Desertification Control Bulletin* is seeking photographs for consideration as bulletin covers. All submissions should be addressed to:

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Nairobi, Kenya

Technical requirements
Photographs must be colour transparencies of subjects related directly to desertification, land, animals, human beings, structures affected by desertification, control of desertification, reclamation of desertified lands, etc. Submissions must be of high quality to be enlarged to accommodate a square.

Captions
A brief caption must accompany each photograph giving a description of the subject, place and country, date of photograph and name and address of photographer.

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Articles

Desertification Control Bulletin invites articles from the world's scientists and specialists interested in the problems arising from or associated with the spread of desertification.

Audience
The bulletin addresses a large audience which includes decision makers, planners, administrators, specialists and technicians of countries facing desertification problems, as well as all others interested in arresting the spread of desertification.

Language
The bulletin is published in English. All manuscripts for publication must be in English.

Manuscript preparation
Manuscripts should be clearly typewritten with double spacing and wide margins, on one side of the page only. The title of the manuscript, with the author's name and address, should be given in the upper half of the first page, and the number of words in the main text should appear in the upper right corner. Subsequent pages should have only the author's name in the upper right hand corner.

Metric system
All measurements should be in the metric system.

Tables
Each table should be typed on a separate page, should have a title and should be numbered to correspond to its point in the text. Only essential tables should be included and all should be identified as to source.

Illustrations
Line drawings of any kind should each be on a separate page, drawn in black china ink and double or larger than the size to appear in the bulletin. They should never be pasted in the text. They should be as clear and as simple as possible.

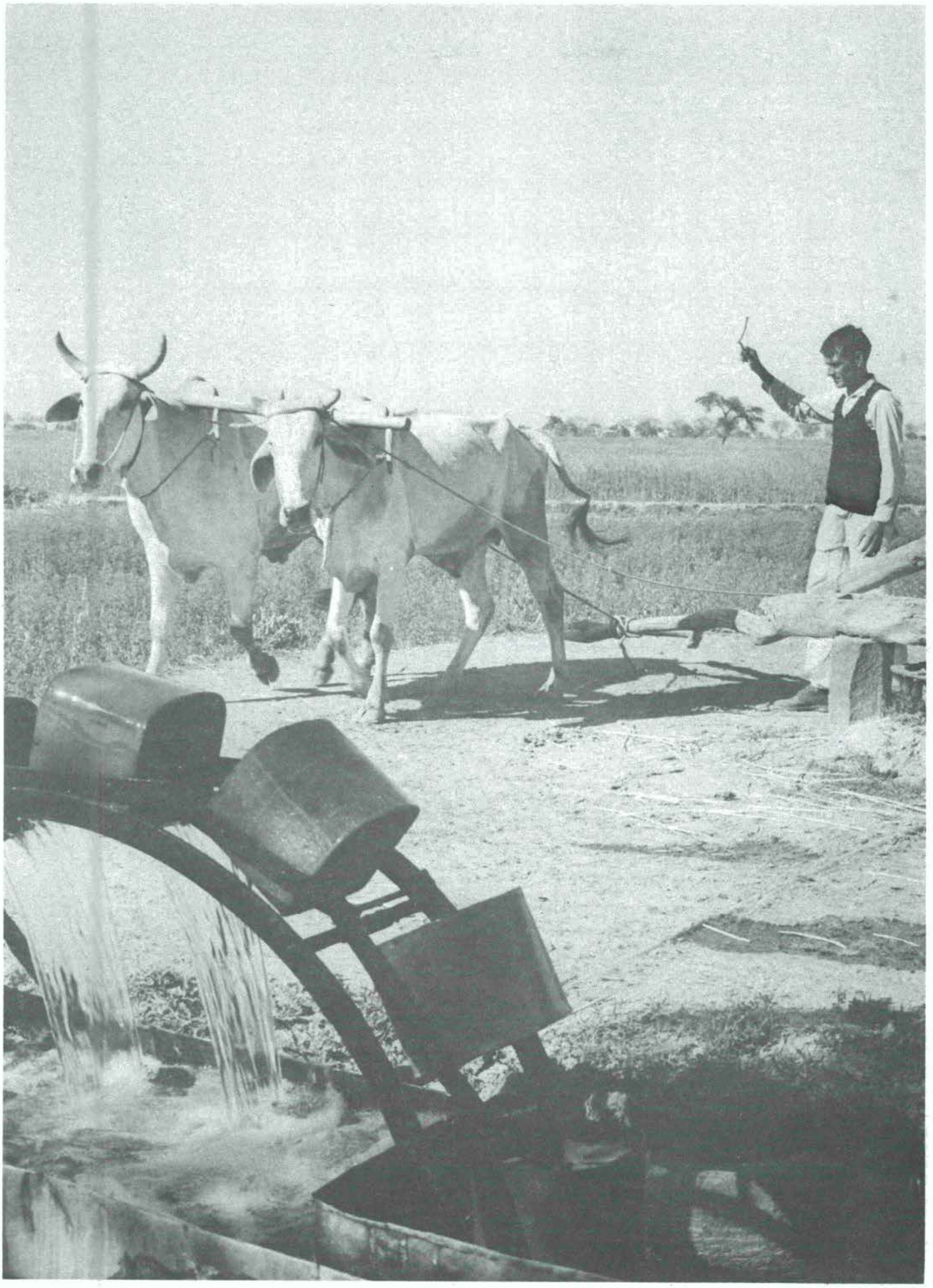
Photographs in the bulletin are printed black-and-white. For satisfactory results, high quality black-and-white prints 18 x 24 cm (8 x 10 in) on glossy paper are essential. Diapositive slides of high quality may be accepted; however, their quality when printed black-and-white in the bulletin cannot be guaranteed.

All line drawings and photographs should be numbered in one sequence to correspond to their point of reference in the text, and their descriptions should be listed on a separate page.

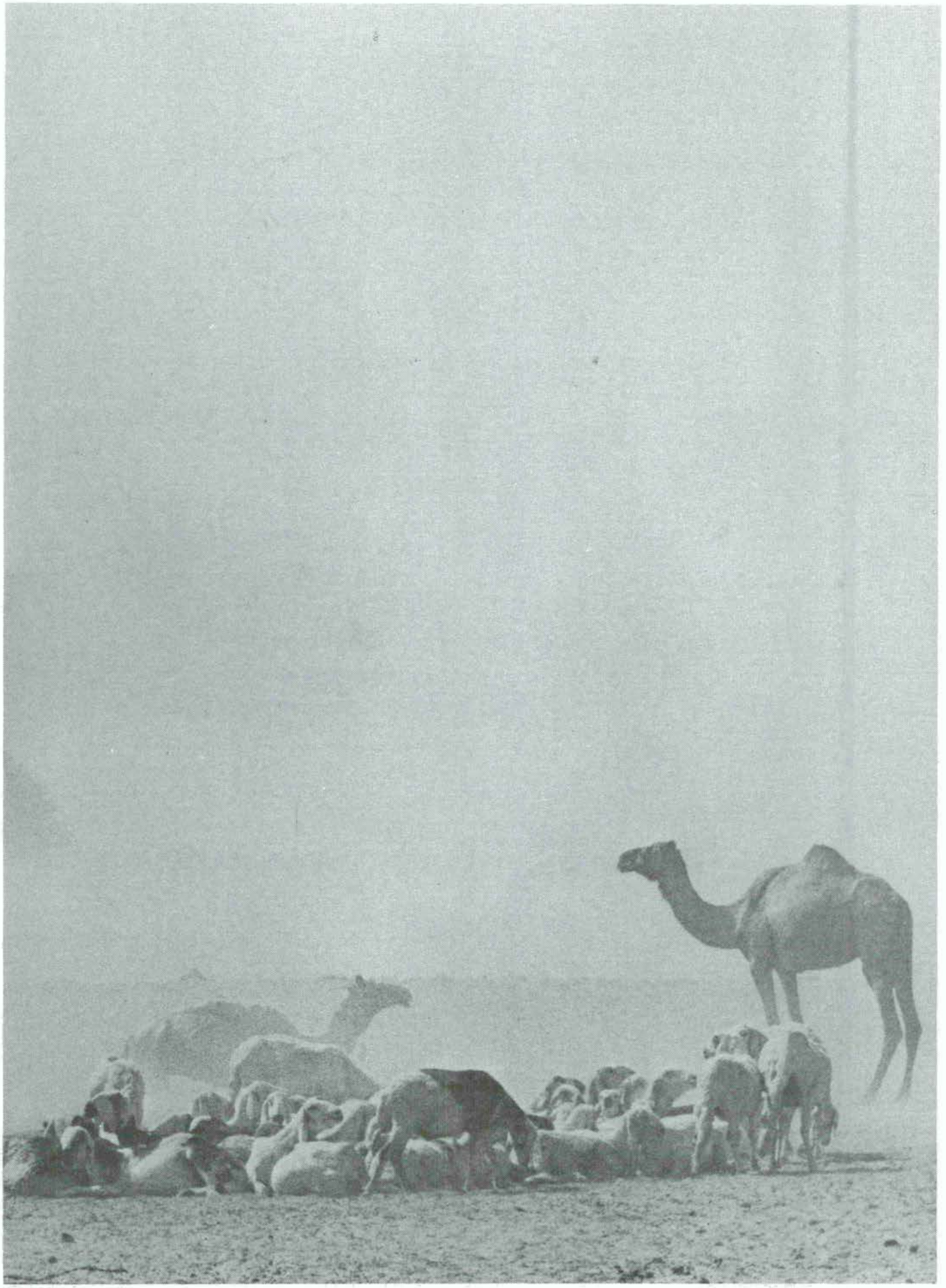
Footnotes and references
Footnotes and references should be listed on separate pages at the end of the manuscript. Footnotes should be kept to an absolute minimum. References should be strictly relevant to the article and should also be kept to a minimum. The style of references should follow the format common for scientific and technical publications: the last name(s) of the author(s) (each) followed by his initials, year of publication, title, publisher (or journal), serial number and number of pages.

Other requirements
Desertification Control Bulletin publishes original articles which have not appeared in other publications. However, reprints providing the possibility of exchange of views and developments of basic importance in desertification control among the developing regions of the world or translations from languages of limited audiences are not ruled out. Short reviews introducing recently published books in the subjects relevant to desertification and of interest to the readers of the bulletin are also accepted. Medium length articles of about 3,000 words are preferred, while articles longer than 4,500 words are not accepted.

A nominal fee is paid for articles accepted for publication, and 25 reprints are provided to the authors.



Traditional animal powered water pump in India, see page 47 for a new prototype being developed (UNEP)



Nomad herds of livestock are a major factor in the initiation of desertification.
The Saharan fringes, Kordofan province, Sudan, February 1977. (Earthscan/Mark Edwards)

Report on the Desert Encroachment Reconnaissance in Northan Sudan:
21 October to 10 November 1975

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(Presently East and Central Africa Regional Representative of WWF, Nairobi, Kenya)

The following article was written as a report in 1975 based on the air and car field survey described in the report. It has never been published, yet it has become one of the most widely cited references in the world as a source of the rate of spread of the Sahara Desert south. The figures cited in the report have been questioned by various workers, in particular a team of geographers using remote sensing techniques from the University of Lund, Sweden, led by Dr. Ulf Hellén. Following the unedited report of Dr. Hugh Lamprey on his Kordofan survey, we publish an edited version of a paper contesting Dr. Lamprey's findings by Ulf Hellén, with kind permission of the author.

The purpose of publishing these two pieces is to bring together and into the public domain a controversy which is of the utmost importance to UNEP and others who are working to control desertification. Is desertification actually occuring? These two articles do not answer the question, but they are good examples of the basis from which we must start. — Ed.

Introduction

Desert encroachment is recognised as the most serious environmental problem affecting northern Sudan. It was the subject of the Report by the National Council for Research and the Ministry of Agriculture, Food and Natural Resources in Sudan, issued in May 1974 and sent to UNEP as the basis for an important project proposal entitled "Desert Encroachment Control". The report included a proposal for a reconnaissance survey of the arid zone to make an up-to-date assessment of the status of desert encroachment and ecological degradation as a preliminary step towards a full integrated research and development project. The Ministry and the National Council for Research requested the assistance of UNEP to carry out this reconnaissance. Subsequently, a meeting was held in Khartoum on 17 September 1975, chaired by Dr Mohamed Obeid Moubarak and attended by the Secretary General of the National Research Council, Dr El Samani Yacoub, and the directors and representatives of natural resources departments in the Government and the University of Khartoum, to plan the reconnaissance. Dr H.F. Lamprey attended as the UNESCO-UNEP representative and as a prospective member of the reconnaissance team. A further meeting of the Council was held on 16 October, attended by Dr Baumer and Dr Lamprey, under the Chairmanship of Mr Wadie Habashi, President of the Council, at which the survey and its objectives were discussed. It was agreed that the results of the reconnaissance would be incorporated into a major report to be presented at the forthcoming meeting of potential donors to the main desert encroachment project.

The reconnaissance was planned and executed as a co-operative venture by the National Council for Research and the Ministry of Agriculture, Food and Natural Resources, with the financial assistance of the UN and the IUCN. While the two international organizations funded the cost of the aerial reconnaissance, the Sudan Government provided excellent ground support with several vehicles to carry personnel and supplies, including aircraft fuel.

Objectives

The reconnaissance was intended to provide information on the most recent changes in the desert encroachment situation in northern Sudan, on the present distribution of agriculture, human settlements, animal husbandry and wildlife, in relation to the main degraded areas. It also intended that the reconnaissance should provide the opportunity to identify a series of working areas in northern Kordofan, northern Darfur and the northern Nile Valley where desert encroachment and related ecological problems could be studied and management procedures tested and where biosphere reserves, monitoring areas and possibly national parks could be established.

In the course of a month's reconnaissance it was not possible to make more than a preliminary assessment of the situation but it was hoped that it would be possible to fill in some of the gaps in recent knowledge on the progress of desert encroachment and its causes.

It was requested by The National Council for Research that the reconnaissance should prepare a report to supplement the documents to be presented to the potential donors' meeting to be held in March 1976. The present report is one of several to be prepared by the members of the reconnaissance team under their respective specialized headings.

Reconnaissance Transport and Routes Northern Kordofan and Northern Darfur 21 October — 3 November

The reconnaissance team travelled in several vehicles and a 4-seater light aircraft, supported by a heavy truck which carried fuel, supplies and camp equipment. The vehicles followed an approximately central route through the arid zone and the aircraft was used to make reconnaissance flights mainly to the north of this route. Vehicle and aircraft routes are shown on the map (Figure 1). Those of the aircraft were intended to make several crossings of the eco-climatic boundaries between the latitudes of 13 and 19 degrees North, the most northernly point being reached approximately 50 km NW of the Nukheila Oasis in the Libyan Desert.

The Northern Nile Valley 5 — 9 November

The Nile section of the reconnaissance was carried out by the light aircraft only,

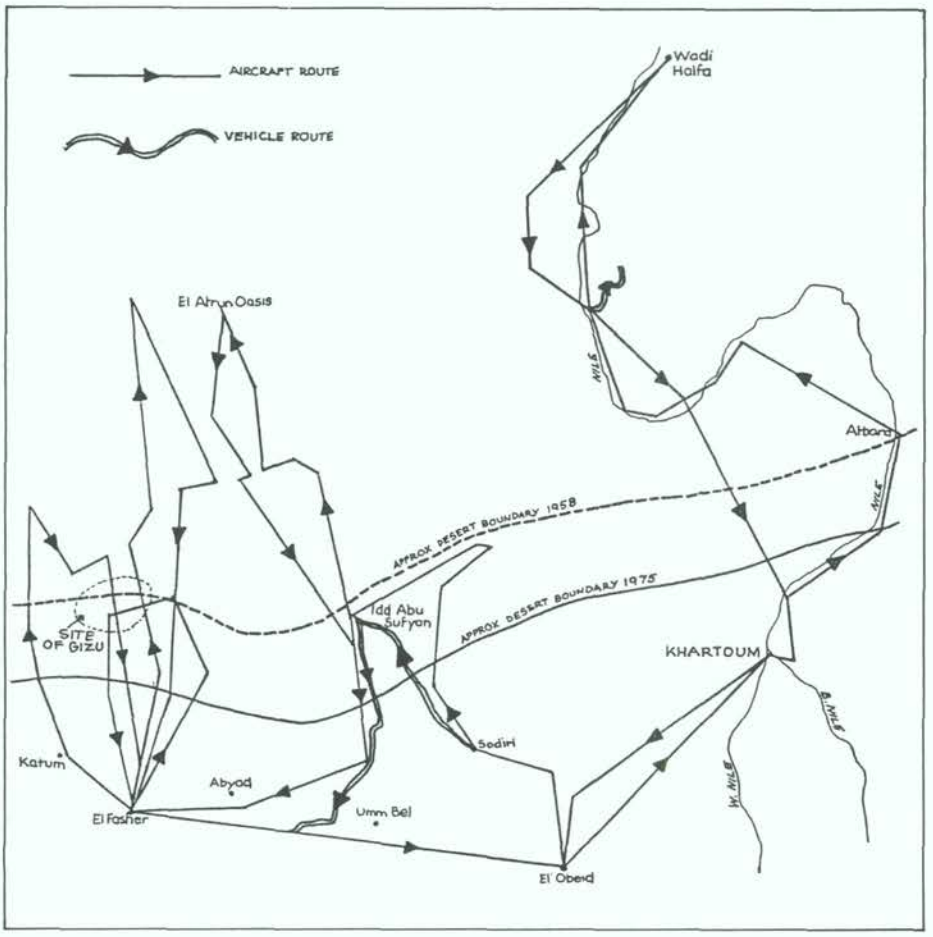


Fig. 1 The survey route taken by aircraft and vehicle in 1975.

following the route Khartoum-Soba-Atbara-Merowe-Dongola-Wadi Halfa-Dongola-Khartoum (see map Figure 1). The only section of the Nile omitted was that between Atbara and the 4th Cataract. In particular, observations were made upon sand encroachment on agricultural land on the banks of the Nile and in adjacent depressions. A road journey was made to the Kerma Depression Land Reclamation Scheme. On the northward and southward journeys diversions were made westward into the desert to search for evidence of wildlife.

Discussions and meetings during the reconnaissance

The reconnaissance teams attended meetings with the Provincial Governors and other administrators of northern Kordofan, northern Darfur and Dongola Provinces. These meetings were useful in helping teams to assess the political and sociological problems related to desert encroachment (discussed later in this report) and to obtain the views of these officers on the importance of the problems in their provinces. A seminar was held at the El Fasher Upper Secondary School where the team addressed 650 school boys and answered questions on desert encroachment in northern Darfur.

Evidence or recent Ecological Decline in Northern Kordofan and Northern Darfur

(a) Southward Shift of Ecological Boundaries

In the course of ten north-south reconnaissance flights (see map Figure 1) the position of the boundary between the sub-desert scrub and grassland and the desert was noted. Although the boundary is diffuse, it was possible to mark it on the map to the nearest 5 km and its approximate position is shown in Figure 1. The map also shows the position of the same ecological boundary as it was mapped in 1958 by M. N. Harrison and J. K. Jackson in their publication "Ecological classification of the vegetation of the Sudan". It is evident that the desert's southern boundary has shifted south by an average of about 90-100 km in the last 17 years. The southward shift can be readily appreciated in the vicinity of the Wadi Milk in northern Kordofan. Harrison and Jackson showed that the boundary between the desert and the *Acacia mellifera — Commiphora* desert scrub occurred where the wadi turned from its northward course to northeast, passing the El Ain escarpment. The reconnaissance noted that the Wadi Milk now passes out of the desert scrub zone into full desert near Bagaria, some 110 km south of El Ain escarpment which now stands in total desert.

A large block of *Acacia mellifera — Commiphora* scrub shown by Harrison and Jackson at between 15 and 16 degrees North, to the northwest of Malna in Darfur, no longer exists except in some small pockets on the top of the Teiga Plateau. Elsewhere it has been replaced by sandy desert.

The "gizu" ephemeral winter vegetation, which occurs in the desert near Wadi Howar at intervals of several years, is much valued by the nomad pastoralists as browse for their camels. It has not been seen since 1964 but was reported to have appeared again in October 1975 following local rain. With the guidance of Hussein Dosa, who had seen and reported the gizu of 1964, three members of the reconnaissance team flew to its former site, some 30 km north of the Wadi Howar near the Chad border (in the latitude belt between 16 degrees 30′ N and 17 degrees 00′ N) but could not find it. However, on the return flight southwards, the gizu was found accidentally on a relatively small area at latitude 15 degrees 40′ N, some 80 km south of its previously reported position. Several thousand camels were already browsing the gizu vegetation. It appears that the ephemeral vegetation belt has shifted southwards concurrently with the general southward trend of ecological boundaries. It may, however, have reached its southern limit since it occurred in 1975 on the most southerly area of the raised sandy plains which are its normal habitat. The present site of the gizu was shown by Harrison and Jackson as sub-desert grassland but it is notable that grass is almost absent from the vegetation now growing there.

(b) Sand Encroachment

Sand from the very extensive Libyan Desert and the Jebel Abyan Plateau is being blown southwards on a broad front by the steady northerly winds. In general the forward edge of the drifting sand

follows the approximate southern edge of the desert as shown by the near absence of vegetation, although locally, such as in the vicinity of the Meidob Hills, the desert is stony and free from drifting sand. However, in several areas, particularly in northern Kordofan in the Hamrat El Wuz and Kheiran areas, sand encroachment has moved rapidly ahead of the southern boundary of the desert and loose sand is accumulating over the formerly consolidated sandy (and locally clay) soils. In the Hamrat El Wuz area, a depth of approximately 10 cm of loose sand covers the terrain except where it has drifted up against obstacles. The northern perimeter wall of the large hospital at Hamrat El Wuz collapsed under the weight of a sand dune on its northern side. Shallow sand encroachment appears to have killed nearly all vegetation except *Acacia tortilis* and *Balanites aegyptiaca* and a small number of dune-adapted shrubs as far south as 15 degrees N in the Hamrat El Wuz area. Immediately south of this area mobile dunes are moving southwards with the prevailing wind and are becoming an increasingly serious threat to the agricultural land and several villages in the Bashiri and Bara areas of the Kheiran region. The sand dunes are being augumented by the very large area of drifting sand further north near Hamrat El Wuz.

A striking piece of evidence of the southward drift of sand on a large scale is the covering of the bed of the Wadi Howar by loose sand over its whole length. On the reconnaissance flight to the gizu area, Hussein Dosa, who has described the vegetation in his report of 1964, was astonished to find that the area in the immediate vicinity of the Wadi Howar and the Wadi itself had become sandy desert except that many of the old *Acacia tortilis/raddiana* trees were still standing and alive. The Wadi bed had sanded up and there was no sign of the former herb and tufted grass vegetation which was an important habitat of the abundant gazelles and scimitar-horned oryx which he had seen there in 1964. Further to the east, the reconnaissance team saw where the same sanding-up process was overtaking the Wadi Milk. Along the whole length of the Wadi Howar and Wadi Milk covered by the reconnaissance flights no oryx were seen near the northwestern bend of the Wadi Milk. The subject of wildlife is discussed later in the report.

(c) Mortality of Gum-Producing Acacia Senegal Woodlands

A very extensive die-off has taken place in the *Acacia senegal* woodlands along the 14th parallel, particularly in the vicinity of Mazrub. The northern limit of growth of this species appears to be shifting south. Over wide areas *Acacia senegal* is being replaced by the xerophytic shrub *Leptadenia,* particularly on areas of relatively loose sand soil.

In many areas of the Sudan sand dunes are encroaching on fields and villages. (UNEP/ Sarah Errington)

(d) Failing Agriculture

Marginal agriculture is still practised on sandy soils as far north as 14 degrees N near Mazrub and on clay soils as far north as 15 degrees N. However, there are signs of progressive abandonment of agriculture in these areas, particularly where sand encroachment has taken place.

Desert Encroachment in the Northern Nile Valley

From about 50 km north of Khartoum the Nile flows through the arid zone and is surrounded by almost total desert. A discontinuous narrow bank of irrigated alluvial soil along the Nile is cultivated and is very productive. This alluvial area includes the Kerma Depression, a former course of the River, lying to the north of Dongola and to the east of the Nile. The surrounding desert areas are beyond all reasonable hope of rehabilitation because of the climate and the loss of topsoil. The alluvial strip along the River and in the nearby depressions is being steadily reduced by the encroachment of the drifting sand from the north and the east. Settlement and agriculture are limited by the extent of the alluvial soil, by the capacity (and authority) to irrigate it from the river, the capacity to irrigate from boreholes and, finally the extent of sand encroachment. The latter limiting factor is becoming increasingly serious.

The reconnaissance team made observations on the sand encroachment situation from the aircraft, flying at between 100 and 500 meters above ground level. It was noted that the whole length of the Nile between Delgo and Karima, that is the greater part of the east-west loop, is subject to serious sand encroachment along the north-facing bank. Over long stretches of the bank, sand dunes have reached the river and have obliterated cultivation and extensive settlement. In other areas moving sand dunes are in the process of covering agricultural land and villages. The reconnaissance team visited the Kerma Depression Land Reclamation Scheme where large areas of agricultural land on alluvial soil have been abandoned due to sand accumulation with an average depth of only 7 cm. Exprimental shelter belts of trees had been planted by the Forest Research Department and are showing signs of becoming established after three years of irrigation. Tree planting is referred to later in this report.

It was evident to the team that unless very extensive control measures are introduced in the near future, the whole of the north and northeast-facing banks of the Nile will be covered by sand within one or two decades.

Contributory Factors in Desert Encroachment and Ecological Degradation in Northern Sudan

It was generally understood by the natural resources specialists on the reconnaissance teams that the ecological degradation taking place in northern Sudan is largely due to past and current land use practises but is accelerated during periods of drought. It must be stated, however, that the sand encroachment problem cannot be attributed only to recent mistakes but is the result of several thousand years of abuse of the fragile ecosystems which formerly existed in the Sahara and Nubian areas.

It was evident to the reconnaissance teams, both from their own observations and from discussions with Provincial Governors and their staffs, that the most fundamental contributory factors in the current crisis are the lack of any natural resource and land use planning policies. From these basic deficiencies stem many other serious omissions: no natural resource legislation and no means of implementing (and enforcing) management policies; no range management procedures; no control of water resources; no control of stocking rates; no agricultural policy or management. It is not surprising, under the present conditions of increasing population pressure, that the land is incapable of withstanding the present levels of exploitation.

It was appreciated by the team that the need for land-use planning and resource management could not be separated from the need to educate the rural population, particularly as many of the problems are due to traditional and hitherto unquestioned practices. Furthermore, it was appreciated that the nomadic pastoralists now enjoy almost complete freedom from interference by the Central Government and would find the introduction of the constraints necessary for land management unpalatable. Some administrators went further than this to say that any form of control over the nomadic pastoralists was virtually unthinkable (although there was much agreement that control of agriculturalists in the arid zone was necessary and feasible). Thus, there lies at the heart of the ecological problem what appears to be an extremely difficult sociological problem. It seems unlikely that any substantial progress can be made towards solving the crisis of ecological degradation in northern Sudan until a considerable measure of control over land-use has been achieved. Without the means to control land-use practices in accordance with ecologically oriented management principles, effort and money directed towards technological solutions will be largely wasted.

A serious obstacle to management aimed at the control of desert encroachment in the arid-zone of northern Sudan is the lack of information on the ecology of the zone. There is an urgent need for comprehensive natural resource surveys to produce maps and baseline data for future management and ecological monitoring.

In his report of 10 November 1975 to the UNDP Resident Representative in Khartoum, Dr. W.J.A. Payne mentions several resource surveys which have taken place or are being carried out in the region, including a land-use survey covering 66,000 km centered on El Obeid in northern Kordofan and completed in 1965 (FAO/SE 32/SUD); two reconnaissance soil surveys in northern Kordofan and northern Darfur which are in progress; a remote sensing project between El Obeid and the Nile and the MSFNR aerial survey of livestock which should be completed in Darfur and Kordofan early in 1976. Although these surveys will make very important contributions to knowledge on the arid zone, they must be regarded as the very beginning of the extensive resource surveys which are now needed in the areas affected by ecological degradation. Integrated land-use planning and its rigorous implementation, which are the only lasting solutions to the ecological decline of northern Sudan, will have to be based on comprehensive resource surveys and thorough appraisals of the socio-economic background. In particular, long term solutions must take into account the ecological limitations of the land. Very urgent answers are needed to the problems of over-exploitation of extremely fragile ecosystems by excessive densities of people and livestock.

Sites for Pilot Projects related to Desert Encroachment

The reconnaissance teams examined several sites in northern Kordofan, northern Darfur and in the Nile Valley as possible locations for research stations and experimental areas. The sites examined including four where forestry and range management investigations are currently taking place on a small scale: Bashiri, Kordofan (dune stabilization); Qoz Ashfar, El Obeid (*Acacia senegal* plantations); Kerma Depression, Dongola Province (shelterbelt trials); and Abu Fas, northwest Kordofan (range management observations). The UNESCO-UNEP consultant's particular assignment was to identify possible sites for various aspects of the Acacia Ecosystems Project. With the help of other members of the team, particularly that of Mr. A.G. Seif El Din, a series of field stations, including an excellent base laboratory, were selected. An important guiding principle in the selection of the working areas was that they should form a series along the eco-climatic gradient from the 400mm isohyet in the south to the 50mm level in the north:

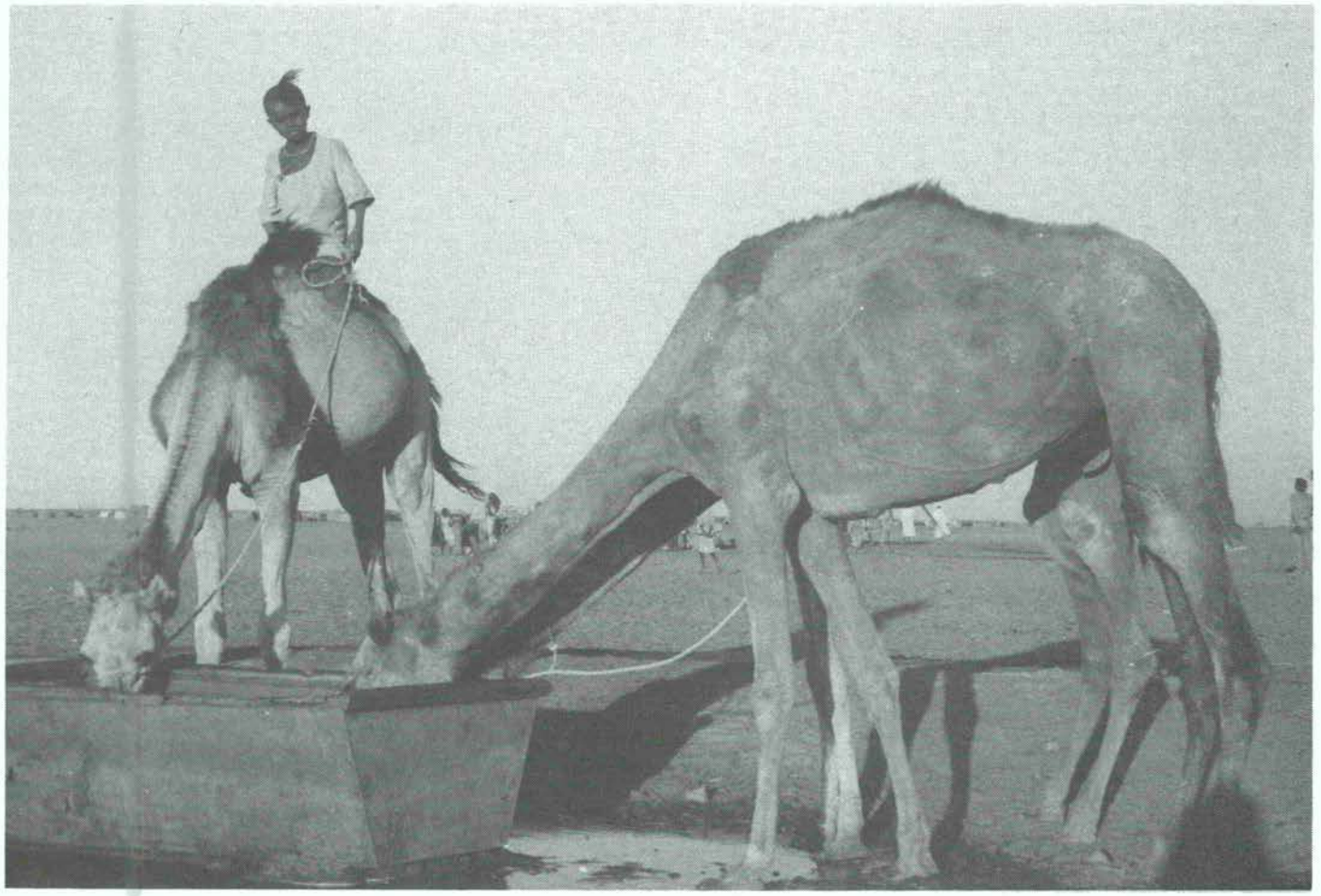
(a) *Bashiri.* Northwest Kordofan. Sand encroachment station in the marginal cultivation zone (Latitude 14 degrees N. 300mm rainfall). Important cultivation and livestock area. Degraded *Acacia senegal* woodland on sand.

(b) *Mazrub.* Northwest Kordofan. Important *Acacia senegal* gum producing area; woodlands suffering high mortality owing to drought and over-exploitation. Also livestock area near the northern limit of cultivation. (Latitude 14 degrees N. 250mm rainfall).

(c) *Abu Fas.* Northwest Kordofan. Established rangeland experimental station since 1959, on sand, "gardud" and clay soils with adjacent stabilized sand dune vegetation (qoz), with local abundant *Acacia tortilis/raddiana* and *A.mellifera* and *Commiphora africana.* Northern limit of cultivation zone. Abundant livestock, mainly cattle. (Latitude 14 degrees 20″N. c. 250mm rainfall).

(d) *Hamrat El Wuz.* Northern Kordofan. Absolute northern limit of cultivation on clay soils but on the point of abandonment, due to sand encroachment, general loss of topsoil and fertility owing to current overstocking and desiccation. Heavy exploitation by livestock; centre for nomadic pastoralists. Vegetation almost wholly comprised of *Acacia tortilis* and *Balanites aegyptiaca.* Serious sand encroachment towards south. Large hospitals with much unused space available for laboratory and base research station. (Latitude 15 degrees N. 150mm rainfall).

(e) *Bagaria and Abu Sufyan.* Northwestern Kordofan. Acacia desert-scrub/desert boundary; also water-course *Acacia nilotica* and *A.seyal* forest in the Wadi Milk near their northern limits.



Numerous livestock, mainly camels, were seen in northwestern Kordofan. (UNEP/Daniel Stiles)

Numerous livestock, mainly camels and goats. Relic dorcas gazelle and dama gazelle populations. (Latitude 15 degrees 20′ N and 15 degrees 30′N. c. 80mm rainfall).

(f) *The Teiga Plateau area* and adjacent sand plains. Northern Darfur. Sub-desert/ desert emphemeral vegetation and its interaction with livestock. (Latitude 15 degrees 40′ N. c. 50mm rainfall).

(g) *The Wadi Hower.* Northern Darfur. Northern limit of extensive *Acacia tortilis/raddiana* woodlands and Acacia desert scrub. Recently degraded by sand encroachment. Numerous camels in the winter. Relict scimitar-horned oryx population on the point of extinction. Relict dorcas gazelle population in need of protection by declaration of game reserve or national park. (Latitude 16 degree 30′N. c. 30mm rainfall).

N.B. The above three areas should, separately or as a single region, be declared Biosphere Reserves since they offer the opportunity for the study and monitoring of desert formation, of desert wildlife and vegetation. The declaration of effective Biosphere Reserves would necessitate the exclusion of people and livestock from limited areas to permit the survival and rehabilitation of desert wildlife and plant life.

(h) *Zalingi.* Western Darfur. *Acacia albida* woodlands in the semi-arid zone. Station for the study of *Acacia albida* as an important resource and in its interaction with livestock. (Latitude 13 degrees N. 450mm rainfall).

(i) *Qoz Ashgar.* Northern Kordofan. Gum Research Institute's *Acacia senegal* experimental plantation, for the study of gum acacia regeneration. (Latitude 13 degrees N. 400mm rainfall).

(j) *Kerma Depression Land Reclamation Project.* Dongola Province, Nile Valley. Forest Research Department shelterbelt trials in area currently being covered by drifting sand. Proposed Acacia shelterbelt trial area using initial irrigation. (Latitude 19 degrees N. 25mm rainfall).

(k) *Khartoum — Soba area* Nile Valley. *Acacia tortilis* wood and proposed range reclamation scheme for grassland improvement. (Latitude 15 degrees 50′N. c. 100mm rainfall).

Each of the above project areas would include fenced exclosures which would permit the monitoring of vegetation succession under protection from domestic animals and people and, where possible, under varying degrees of exploitation and different management regimes. Where appropriate, protection from grass fires would be included in the experimental treatment. In all experimental areas a major objective would be the study of vegetation-livestock interaction. In *Acacia senegal* woodlands the experiments would include variations in gum harvesting intensity and the tree-cultivation rotation.

In addition to the study areas enumerated above, further investigations on desert encroachment could be made in the Mellit and Malha areas of northern Darfur, particularly on the relationship of marginal agriculture and of livestock to desert formation. These studies could be included within the Acacia Ecosystems Project if funds and personnel permit. It is hoped that the Project can become operational in Sudan by later 1976.

In an aerial transect 1500 sq km in area not a single ostrich was seen. (UNEP/Daniel Stiles)

The proposals made by Dr Payne in his report of 10 November for camel and sheep husbandry research stations to be sited in northern Sudan could be integrated with parts of the Acacia Ecosystem Project for the purpose of studying the ecology of these species and their impact on arid-zone vegetation.

The Status of Wildlife in the Arid-Zone of Northern Sudan

During the reconnaissance a non-systematic aerial survey was made of wildlife numbers and distribution. A total of approximately 3000 kms were flown at low level (c. 300 ft. a.g.l.) covering a sample of all eco-climatic zones between the 25 mm and 400 mm isohyets in northern Darfur and northern Kordofan and in the vicinity of the Nile in Northern Province. The open nature of the vegetation (and the near absence of vegetation in the desert) gave excellent visibility over the whole reconnaissance area and the low passage of the aircraft probably frightened any gazelles or other species out of cover within at least 200 meters of the line of flight, so that very few were likely to have been missed. The following species have been reported from the area surveyed and were searched for on the reconnaissance: addax, scimitar-horned oryx, dama (red fronted) gazelle, dorcas gazelle and ostrich.

The observers covered a strip estimated at 250 meters wide on each side of the aircraft but in the desert the width was about 400 meters and it was apparant that large antelopes would have been visible in the open at several times this distance. A transect area of approximately 1500 km sq was observed in which the total sightings of wild animals were: dorcas gazelles, 45; dama gazelles, l; oryx, 0; addax, 0; ostrich, 0. The apparent density of dorcas gazelles over the area observed was about one to 35 km sq. However, the density varied according to the vegetation and distance from human settlement. In the Wadi Howar *Acacia tortilis* woodlands and in the "Acacia desert scrub" between 14 degrees 30′N and 16 degrees 00′ N in Kordofan and Darfur, the density of dorcas was estimated at 1/10 km sq. In the desert it was about 1/200 km sq and the very few gazelle seen were in isolated patches of vegetation. In the *Acacia senegal* woodlands and the cultivated areas and sub-desert grasslands south of 14 degrees 30′N. no wild animals were seen in the arid zone. The most southerly area reported to be inhabited by dorcas gazelle was Abu Fas, near Sodiri (14 degrees 30′N) although a very small number have probably survived somewhat south of this zone. The single sighting of dama gazelle, about 25 km west of the Wadi Milk in desert at 16 degrees N, indicates an extremely low density of this species in the area surveyed. Nomads who were asked about numbers and distribution confirmed the rarity of this species in Kordofan and Darfur.

In order to make the most effective possible search for addax and oryx in the limited time available, flights were made to areas where these species were last reported by nomads who had travelled in the desert. The best source of information was Mr Hussein Dosa who had seen several herds of oryx in numbers of up to 50 in the Wadi Howar in 1964 and others on the "gizu" ephemeral vegetation north of the Wadi Howar. Some small herds of dorcas gazelle were seen but, along the 220 km of the course of the Wadi that were searched, no signs of oryx (nor of addax) were seen. In two flights to the vicinity of the Nukheila and El Atrum Oases and the desert to the west of them, no signs of oryx were seen although it would have been possible to see recent spoor.

The Kababish and Camel Rezeigat nomads who were questioned about

addax and oryx said that the former species had not been seen in the vicinity of the Wadi Howar for about 15 years. The latter were thought to be present there in very small numbers but we found nobody had seen any since 1973. Each year a small number of well-equipped big game hunting parties motor across the desert from Egypt and some from Khartoum to hunt oryx and addax on the Chad border north of the Wadi Howar. They appear to hunt in the Mourdi Depression which lies in Chad but has its eastern end just inside Sudan. In the last three years a very small number of oryx have been shot by three parties on the Chad border (possibly in Chad) and one was reported to have been killed at the western end of the Wadi Howar (in Sudan) in 1973. It seems likely that this oryx was one of the last to frequent the Wadi Howar and that the species is now virtually extinct there. It is remarkable under the circumstances that the Wildlife Administration of Sudan continues to issue oryx and addax licences to big game hunters visiting northern Darfur and that professional hunting firms advertise addax and oryx as available in the area. Any hope of recovery of these species is very remote.

The reconnaissance could not be extended into Chad nor was it possible on this occasion to go as far north as the Jebel Uweinat area on the Egyptian-Libyan border. Very little can be said about the occurance of addax and oryx in that region. There are reports, which we could not confirm, that small numbers of oryx have been seen in recent years near Jebel Uweinat. Since the reconnaissance flights covered a relatively small proportion of the Libyan Desert area of Darfur (albeit the areas formerly most frequented) it is possible that some oryx or addax herds were missed and the negative results of the reconnaissance should not be taken to suggest that the two species are extinct in the area. All that can be said, on the basis of the most recent information and the results of the reconnaissance in the former habitats, is that they are extremely scarce. It is difficult to understand how the hunting of these species and the dama gazelle can be justified and it is to be hoped that full protection will be given to these species immediately.

Several attempts were made by the reconnaissance teams to find out the main causes of the virtual disappearance of the three largest wild ungulate species in the arid zone of Sudan. The view held by the team, and by several government officers with whom the matter was discussed, was that very many of the nomadic pastoralists own modern rifles and hunt without restraint. They are not subject to any form of law enforcement. A second view expressed by Hussein Dosa, Assistant Commissioner, was that there is free movement of people from over the border in Chad into the Wadi Howar area and that these people not only kill the wildlife but destroy the woodlands and the scrub vegetation which constitute their habitats. It was difficult to avoid the conclusion that nobody intended to accept responsibility for the disastrous decline in the wildlife populations and it was observed by the reconnaissance team that the nomads with whom it was discussed were reluctant to talk about it.

It was evident to the reconnaissance team and emphatically affirmed by Hussein Dosa from his personal observations that there had been a great deterioration in the wildlife habitats of the Wadi Howar area in recent years. It appeared likely that the absence of the larger desert ungulates was at least partly due to the loss of their habitats. Surviving individuals could have moved south during the five years of serious drought but would have become more vulnerable to hunting during that period, particularly in view of the shortage of food. With the improvement of conditions that has taken place during 1975, a recovery of the wild ungulate populations in the Wadi Howar region might be expected. It is likely in the case of the dorcas gazelle, but it seems probable that addax, oryx and dama gazelle have gone past the point of recovery. It is significant that no wild ungulates were seen on the gizu vegetation either by the reconnaissance team or by the Rezeigat nomads who were asked, which suggests that there were few within reach of it or that the remaining individuals have learned to avoid the vicinity of the nomads.

There is no shortage of suitable habitat for the desert ungulates in the newly formed desert and sub-desert areas. The country to the south of and including the Wadi Howar would make a good game reserve if it could be given full protection. Under protection addax, oryx and dama gazelle could be reintroduced and dorcas gazelle would undoubtedly increase. Hussein Dosa thought that the conservation of the vegetation and the wildlife of the western Wadi Howar region could have been assured by a body of 20 to 30 camel-mounted armed rangers under his command and he suggested that he would be capable of undertaking such protection now and was anxious to do so. His obvious distress at the deterioration of the Wadi Howar area and its wildlife populations was a convincing demonstration of this man's intense interest in the area. The formation of a conservation force led by Hussein or a leader similarly motivated, may be the only remaining practical safeguard against further depredation and habitat destruction in the Wadi Howar. Even if only the vegetation were to be protected, such a measure would be worthwhile. Given such protection, the creation of a biosphere reserve would be justified and possibly also a national park.

Although no wild ungulates were seen in the vicinity of the Nile Valley in Dongola Province, there are reliable reports of small numbers of dorcas gazelles in the rocky hills some 30 kms to the west of Dongola. We could obtain no confirmation of reports that there is a population of dama gazelles living near the Nile in the Delgo area. The rocky and sandy desert areas around the southern end of Lake Nasser were searched but appeared to be devoid of wildlife. There were reliable reports of flocks of sand grouse coming to drink at the Nile between Arbri and Dongola. The reconnaissance teams both in the aircraft and on the ground noted the almost total absence of game birds throughout the arid-zone in Sudan. The only Arabian bustard *(Ardeotis arabs)* seen by the team was a dead one (apparently shot) at Idd Abu Sufyan in northwestern Khartoum. It was evident that the species is very scarce indeed. However, Praed and Grant described this species in 1952 (in the African Handbook of Birds, Series One) as the common large bustard of the northern Sudan.

To conclude, the state of wildlife in the arid zone of northern Sudan is at a very low ebb and for many formerly numerous bird and mammal species it may be too late to promote their recovery. Nevertheless, it is possible to protect what remains through the declaration of national parks and game reserves, the strengthening of the wildlife administration, the power to enforce the wildlife laws and the strict control of the use of firearms at least in certain conservation areas. Only the dorcas gazelle should be hunted (on licence). The other wild ungulates should be totally protected. A force of camel-mounted armed rangers under the control of a leader familiar with the desert areas and with the support of the Government to enforce the protection of wildlife and wildlife habitats, is probably the best means by which the wildlife populations can be given a chance to survive.

Desertification Monitoring: Is the Desert Encroaching?

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Introduction

This study is one of several carried out within the project "Regional Studies of Desertification and Its Control" initiated during 1981 in co-operation with the University of Khartoum, Sudan and completed in 1985. Its general goal was to develop, test and apply monitoring methods, for the understanding and prediction of desertification (Ref. 1). The Sahelian pre-drought, drought and post-drought period 1961-1979 and the Province Northern Kordofan was the focus of the project.

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Definition of Desertification

—Desertification is the diminution or destruction of the biological potential of the land, and can lead ultimately to desert like conditions (Ref. 2)

—Desertification can also be described as a process of impoverishment of arid, semi-arid and some sub-humid ecosystems by the combined impacts of man's activities and drought (Ref. 3).

—Desertification has also been defined as a process leading to reduced biological productivity, with consequent reduction in plant biomass, in the land's carrying capacity for livestock, in crop yields and human well being leading to the intensification or extension of desert conditions (Ref. 4).

—Desertification (desertization) was defined as the spread of desert-like conditions in arid or semi-arid areas due to man's influence or to climatic change by Ref. 5.

It is implicitly understood that desertification leads to long lasting and possibly irreversible desert like conditions. "Decreasing productivity" is a key process included implicitly or explicitly in all definitions.

Severe Desertification caused by Man

The impact of desertification and its causes in north Kordofan were described in several reports during the 1970's following the 1964-74 Sahelian drought. For example:

"It is evident that the desert southern boundary has shifted south by an average of about 90-100 km in the last 17 years. . . in several areas, particularly in northern Kordofan in the Hamrat El Wuz and Kheiran areas, sand encroachment has moved rapidly ahead of the southern boundary of the desert and loose sand is accumulating over the formerly consolidated sandy (and locally clay) soils . . . Shallow sand encroachment appears to have killed nearly all vegetation except the trees *Acacia tortilis* and *Balanites aegyptica* and a small number of dune adapted shrubs as far south as 15 N in the Hamrat El Wuz area. Immediately south of this area mobile dunes are moving southwards with the prevailing wind and are becoming an increasingly serious threat to the agricultural land and several villages in the Bashiri and Bara areas of the Kheiran region. The sand dunes are being augmented by the very large area of drifting sand further north near Hamrat El Wuz." (Ref. 6, p.4-6). This is a commonly accepted description of desertification in Kordofan reproduced e.g. by Refs. 7-9. It was even stated by Ref. 10 that: "Surveys have shown that the desert had advanced 90-100 km within a 17 years period and is currently advancing at the rate of 5 to 6 km per year".

A severe effect of the described desertification is declining food and meat production. "Food production has declined and continues to decline because of soil deterioration associated with desert encroachment and because of loss of land, especially land buried by sand." (Ref. 11, p.4).

Ref. 12, referring to Ref. 6, stated that the desert is continuing to move southwards at a rate of 5-6 km per year. It was also stated that desertification is spreading like cancer in other areas including the adjacent low rainfall savanna and that it is quite clear that desert encroachment in the Sudan is mainly a man made phenomenon caused by the misuse of land. Cultivation in marginal areas was assumed to be one of the main causes of desertification.

". . . that the desert's edge is gradually shifting southward there is little doubt. The spread of the Sahara has probably been measured most precisely in Sudan. There, as elsewhere, vegetational zones are shifting southward as a result of overgrazing, woodcutting and accelerated soil erosion. Steppe loses ground to the desert, it creeps into the neighbouring savanna which, in turn, creeps into the forest" (Ref. 13).

Overcultivation has been mentioned as a major cause of desertification by Ref. 8. The matter is described in the following way by Ref. 14 (p.31): "Field study has firmly convinced us that transgression over the potential, i.e. climatically controlled border of millet cultivation, is the major factor in the process of desertification in Northern Darfur". It was stated by Ref. 15, (p.247): "Though the impression is created as if the desert was creeping southwards with the north-eastern Trade Winds the sands actually originate from the Qoz-belt itself, mobilized by intensive cultivation". This opinion contradicts the one presented by e.g. Refs. 6, 12, and 13.

Another mechanism of desertification described in the literature includes the expansion of existing vegetation-stripped village and water hole perimeters generated through overgrazing and wood cutting (Refs. 16, 9, 5, 17). When several village "desert patches" coalesce a local or regional desert is created. According to Ref. 18 it could be proved, by the help of satellite photographs, that desert expansion proceeds by way of forming new marginal islands around the villages of the settled cultivators in the Sahelian zone of the Sudan.

However, it was not possible to verify this concept of desertification in north Kordofan in the present project. The following section is condensed from Ref. 19.

Sahara encroachment

A stratification of a transect through N. Kordofan was carried out based on Landsat false colour composites (FCC) (188/49, 51, 52) and one MSS 5 image (188/50) recorded Nov. 9, 1972 and compared with a corresponding stratification based on Landsat imagery (MSS 5 and RBV imagery) recorded Jan. 25, 1979 (Fig.1). All imagery was in the original scale of 1:1 million superimposed on maps of the same scale.

The desert boundary, defined as the border between semi-desert bush/shrub and grassland and with a more or less continuous vegetation cover, and areas with no or very scattered vegetation cover were mapped together with a delineation of other strata. It was not possible to identify any significant shifts in borders between 1972 and 1979. Neither was it possible to find any significant differences in the delineation of the desert margin/semi-desert when the maps were compared to the location of the desert margin as it was presented by Ref. 20, based on Landsat imagery from 1976, or as it was presented by Refs. 21-22. The border coincides roughly with the 100 mm isohyet at latitude 16 degrees North.

The 1975 desert boundary was mapped by Lamprey (Ref. 6) and compared with the one presented on a vegetation map of the Sudan by Ref. 23 in 1958. Lamprey based his map on a combination of reconnaissance flights and ground based surveys from a car. He concluded that the Sahara desert had advanced 90-100 km between 1958 and 1975. The 1975 border fluctuates around latitude 16 degrees N roughly corresponding to the 100 mm isohyet and in rough accordance with the Landsat based results presented above.

It seems, however, that the desert boundary described in the vegetation map of Ref. 23 from 1958 was defined to follow the 75 mm isohyet, located 90-100 km north of the 100 mm isohyet, rather than actually mapped (Ref. 12). It might explain why Lamprey found the 1958 desert boundary to be located 90-100 km north of the boundary defined by himself in 1975. There does not seem to be any evidence for the Lamprey conclusion that the Sahara desert had advanced 90-100 km in the area during the period 1958-1975. The vast Sahara dune complex encroachment mapped by Ref. 6 could not be found (Cf. Fig. 2)

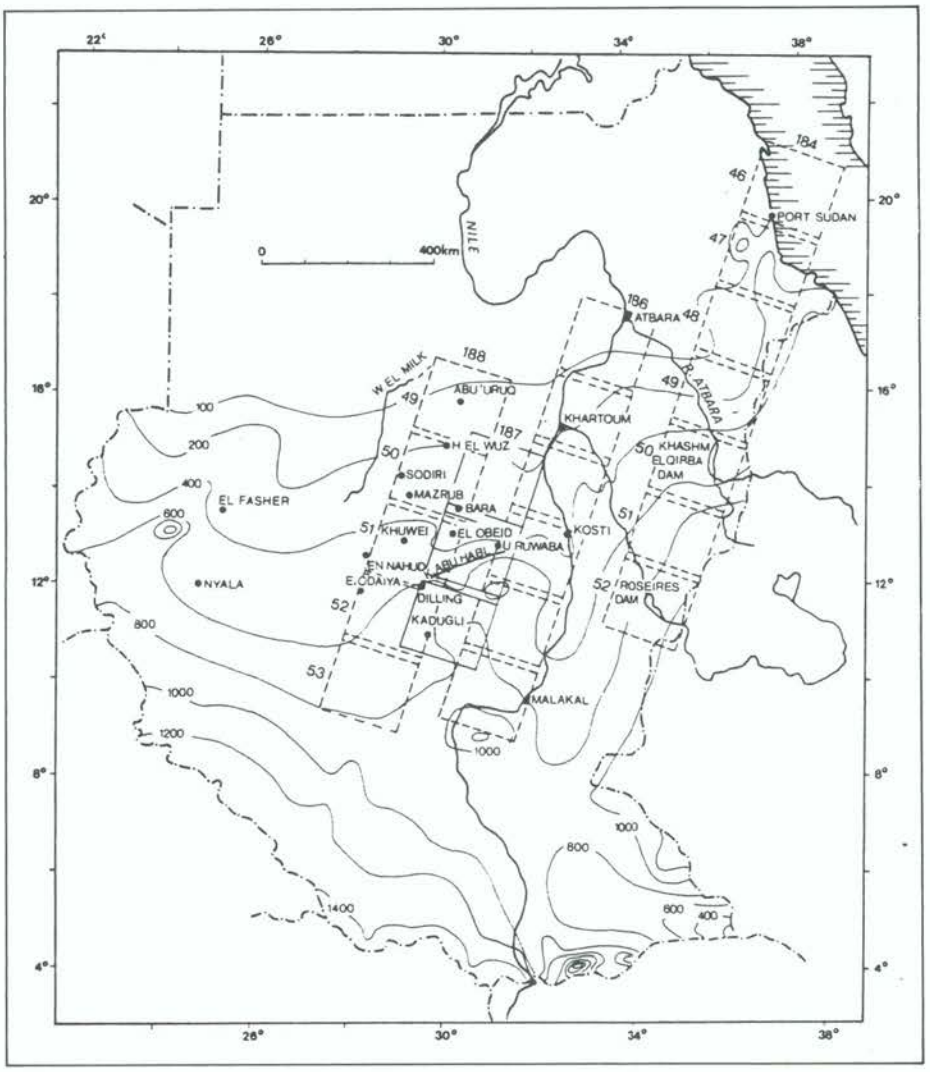


Fig. 1. The area studied is delineated by the Landsat scenes 188/49 — 188/52. The mean annual precipitation (mm) for the period 1921—1950 was obtained from the Sudan Survey Department Topo No. S9 1254.

Land use/cultivation transformation

In the study by the author, the extension of cultivated fields was mapped through interpretation of the 1972 and 1979 Landsat imagery to the scale of 1:1 million. The proportion of the Qoz zone considered to be under cultivation inside the transect was assessed for 1972, 1976 (recalculated from data presented by Ref. 21) and 1979. The proportions are 21%, 14% and 14% respectively. There is a good correspondence between these data and data for Northern Kordofan recalculated from the official agricultural statistics.

A 6,000 sq km area located in the centre of an old core area of cultivation was mapped to the scale of 1:500,000

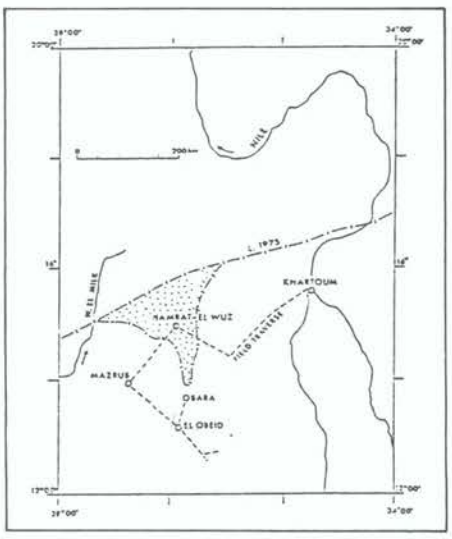
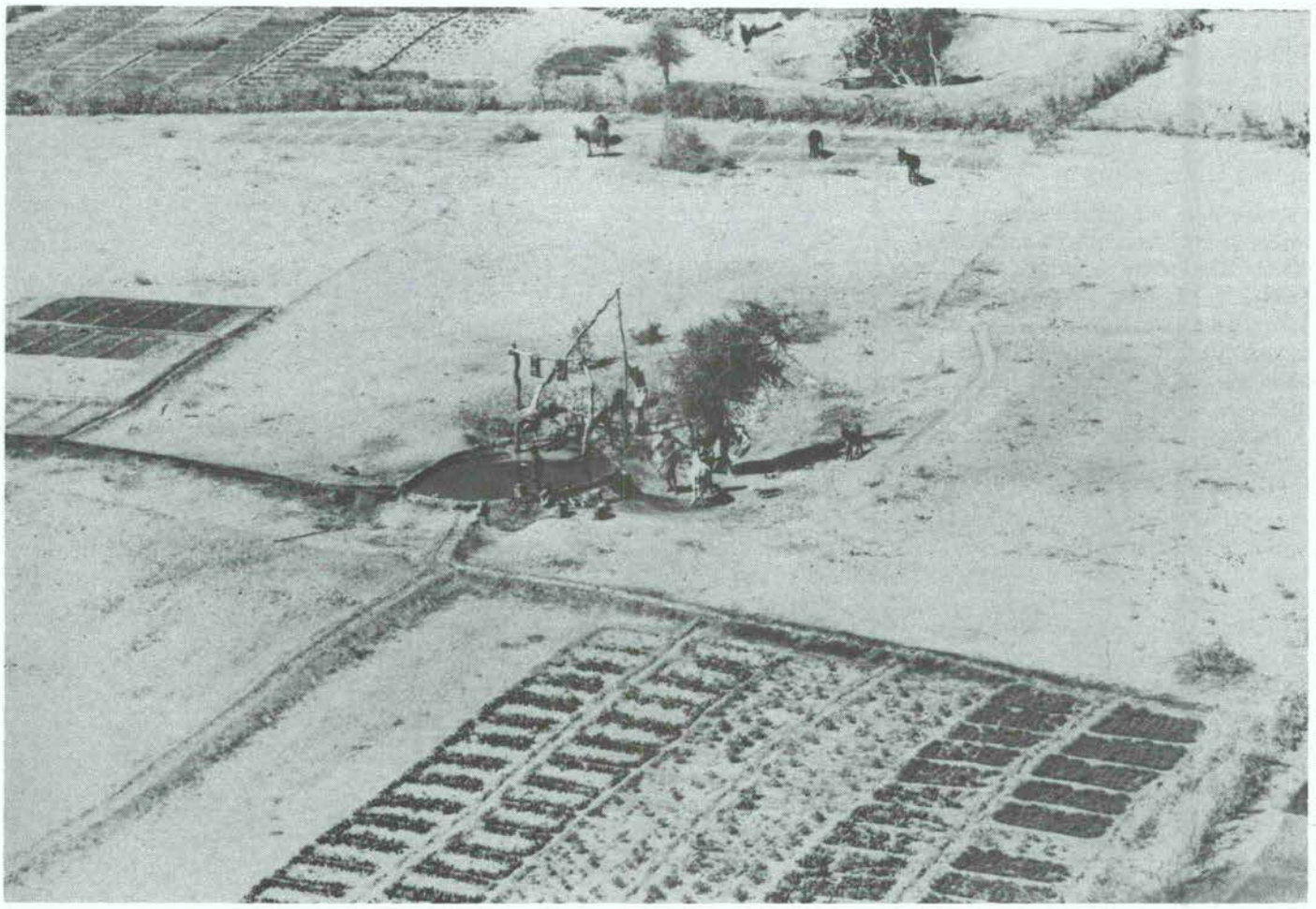


Fig. 2. The Sahara desert boundary and the extension of an area of mobile dunes encroaching southwards in 1975 according to Lamprey (1975). A field data sampling route used by the author in 1977 is outlined.



Some 581 wells were opened by the Sudan Government during the period 1919—1982, over 50% of them in the drought years of 1968-1973. (Earthscan/Mark Edwards)

through interpretation of the Landsat 1972 and 1979 imagery and compared to a map of cultivated fields based on interpretation of air photos (approximate scale 1:48,000) recorded in 1962. The proportion of cultivated land for the years 1962, 1972, 1976 (Ref. 21) and 1979 in the most intensively cultivated zone of the transect was 25%, 22%, 24% and 29% respectively. By adding the 1962, 1972 and 1979 maps to each other it was indicated that 40-50% of the land in this zone was used in the cultivation — fallow rotational process while half the area was never used for cultivation.

Precipitation data (annual and the sum of July-September), proportions of cultivated Qoz land, variation of yield and production for the staple food crops millet and sorghum together with estimates of the areas used to grow these crops for the period 1962-1978 were plotted in graphs. An explosive expansion of the areas cultivated was noted at the end of the 1960's in the middle of the Sahelian drought, followed by a decrease after the drought. The expansion can hardly be explained by a population increase during this short period. The fact that the major part of the Sudan Government water supply programme was implemented during the 1960's can possibly explain some of the increase. Almost 300 wells (bore holes) were opened during 1968-73 which is 51% of all the wells opened during the period 1919-1982 (581 wells), according to Ref. 24. The availability of new water resources might have resulted in the cultivation of areas which could not be reached before because of lack of water for the labour.

It seems that the farmers succeeded in keeping up food production fairly well during the drought in spite of declining yields. It was demonstrated by Ref. 25 that 85% of the variation in millet crop yields in Northern Kordofan could be explained by rainfall parameters during the 1952-1980 period. The very drastic expansion of the areas under cultivation at the end of the 1960's is a possible response by the farmer to declining crop productivity caused by drought. Analysis of the data indicates that the size of the areas under millet production in a specific year can be described as a linear function of the average yield of millet and sorghum for the two preceeding years in the time series 1962-1978. The multiple regression explains 81% of the millet area variation.

No significant northward transgression of the cultivation limit was noted between 1972 and 1979. It was found around latitude 14.5 degrees N on all Landsat data (1972, 1976, 1979). Ref. 26 considered in 1877 that almost all millet grown in Northern Kordofan could be found between latitude 13 degrees N and 14.5 degrees N. He stated that 800-900 seasonal wells were distributed over the area and that every square metre will produce but that probably only 1/5th of the land was planted. The reliability of the area assessment is of course very uncertain. It indicates that the proportion of Qoz land under cultivation, more than 100 years ago, might have been as high or even higher than it was in 1979.

Desertified village perimeters

To follow the development and possible increase of desertified area surrounding

villages and water holes, 77 villages, most of them located within the old core of intensive cultivation, were identified on air photos from 1962 and digital Landsat data from February 1973 and January 1979 and RBV imagery recorded January 1979. The 1973 Landsat MSS data were registered to the 1979 data through a nearest neighbour resampling. The residual error (X and Y) was assessed to less than half a pixel. The maximum width of existing perimeters were measured together with village diameters. The type (fula, well, borehole, hafir, water yard) and number of water sources available in each village were noted and the total water resources available in each village was assessed on a nominal scale. The water resources data were obtained from Refs 27 and 24. Possible relations and trends were studied through multiple correlation and variance analysis.

It was not possible to find any systematic change in the size of the perimeters for the periods studied. Just 7 out of the 77 village perimeters indicated a significant (95%-level) expansion. The size of existing perimeters could not be related to the size of corresponding villages. However, a relationship seems to exist between water resources available in a village and the width of its perimeter. It was indicated that some of the fluctuations in the size of the village perimeters can even be a result of rotational land use.

Encroaching dune systems

Kheiran is the name of a large dune complex elongated in North-South direction about 80 km x 15 km and located west and north-west of Bara forming the southernmost end of the dune front indicated in Fig. 2. "Kheiran" is the plural form of "Khor" meaning depression. The area is made up of transversal dune ridges (E-W) and interdunal depressions. The major part of the area is covered by vegetation. In 1911 Ref. 28 reported the area to be covered by tufts of coarse grass and scattered Marrakh (*Leptadenia spartium/Leptadenia pyrotechnica*) serving to keep the dunes stationary. Vegetation free dunes were reported around El Tawil and El Hamra as early as 1911.

In 1911 Ref. 28 assumed the Kheiran to represent the bed of an ancient stream rising in the Umm Durrag and Abu Hadid hills and losing itself on the level plains round El Obeid. He even suggested that the whole country covered by undulations was once a lake fed by streams from surrounding areas. According to Ref. 28 native tradition said that Kheiran was once a "bahr" (lake).

Ref. 29, 1937, was perhaps the first one to introduce the perception that Kheiran was an active Sahara dune complex lobe pushing the people southwards. He described the southern parts of Kheiran as a deforested and heavily grazed area with many active crescent dunes.

Kheiran has attracted people, at least since the beginning of the 19th century, because the ground water in the interdunal depressions is very close to the surface. According to Ref. 28 there were some 150 interdunal basins with a potential for irrigated cultivation in 1911. About 100 of the 150 were used for irrigated cultivation during the Turkish Government rule 1822-1882. Good access labour in the form of slaves was an important factor in the agricultural development. In winter 1910/1911 only 49 were irrigated. The decrease is explained by Ref. 28 as historical/ political events and not by land degradation. Ref. 16 estimated some 40-45 depressions were under irrigated cultivation in the mid 60's implying that human exploitation pressure was probably higher or at least as high 150 years ago as it was during the Sahelian pre-drought, drought and post-drought period 1961 — 1979.

Air photos from 1962, Landsat MSS data recorded in October 1972, January 1973, January 1979 and October 1979 were used for a study of the barren dune field in the southern part of Kheiran. The dune field is located at the southernmost tip of the large dune complex mapped by Ref. 6 in 1974 and described as the front of active sand encroachment from the Sahara desert (Cf. Fig. 2).

All MSS data were precision corrected through a third order polynomial transform and registered to the October 1979 data using a nearest neighbour resampling algorithm. X and Y residual errors were less than 0.5 pixels.

No southward dune complex encroachment was found. Some new non-vegetated dunes were created in the south through vegetation clearing, followed by cultivation, on fossil dunes especially between 1962 and 1972.

As already mentioned, vegetation free dunes in the southern part of the Kheiran area was reported as early as 1911 (Ref. 28). It was reported that sand dunes around El Tawil seemed to gradually encroach southwards over the basin at the foot of the ridge. The El Tawil basin has been under irrigated cultivation ever since the beginning of the 19th century and is still not buried by sand. The land between Hamrat El Wuz and the barren dunes in southern Kheiran was covered by vegetation in 1972, 1979 according to Landsat data and in 1977, 1980, 1982 and 1983 according to field surveys in the area carried out by the author. There are no signs of an active sand creep connection between the Sahara and the barren dunes in southern Kheiran.

Summary and conclusion

It was *NOT* possible to verify that:
- —desertification takes place through a systematic Sahara desert boundary encroachment
- —any major and systematic sand dune complex encroachment takes place.
- —desertification takes place through a systematic expansion of desertified village/ water hole perimeters.
- —variations in crop yield and food production indicated desertification or that these variations are caused by a systematic expansion of cultivation into marginal and vulnerable lands.
- —there has been significant northward transgression of the cultivation limit during the past 100 years.

There was no creation of long lasting desert-like conditions during the 1962-1979 period in the area corresponding to the magnitude described by many authors. There was however a severe drought impact on crop yield during the Sahelian drought 1964-1974. The drought effects on the natural vegetation productivity was most probably of the same magnitude. The impact of the Sahelian drought was short lasting followed by a fast land productivity recovery.

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Amazing Graze: How the Livestock Industry is Ruining the American West

By Lynn Jacobs
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The new health food store in Tucson, Arizona is by far the largest "natural" foods store in town. Its shelves are well-stocked with edibles and products of every description. There, you can buy everything from non-factory-farmed eggs to "save the whale" soap.

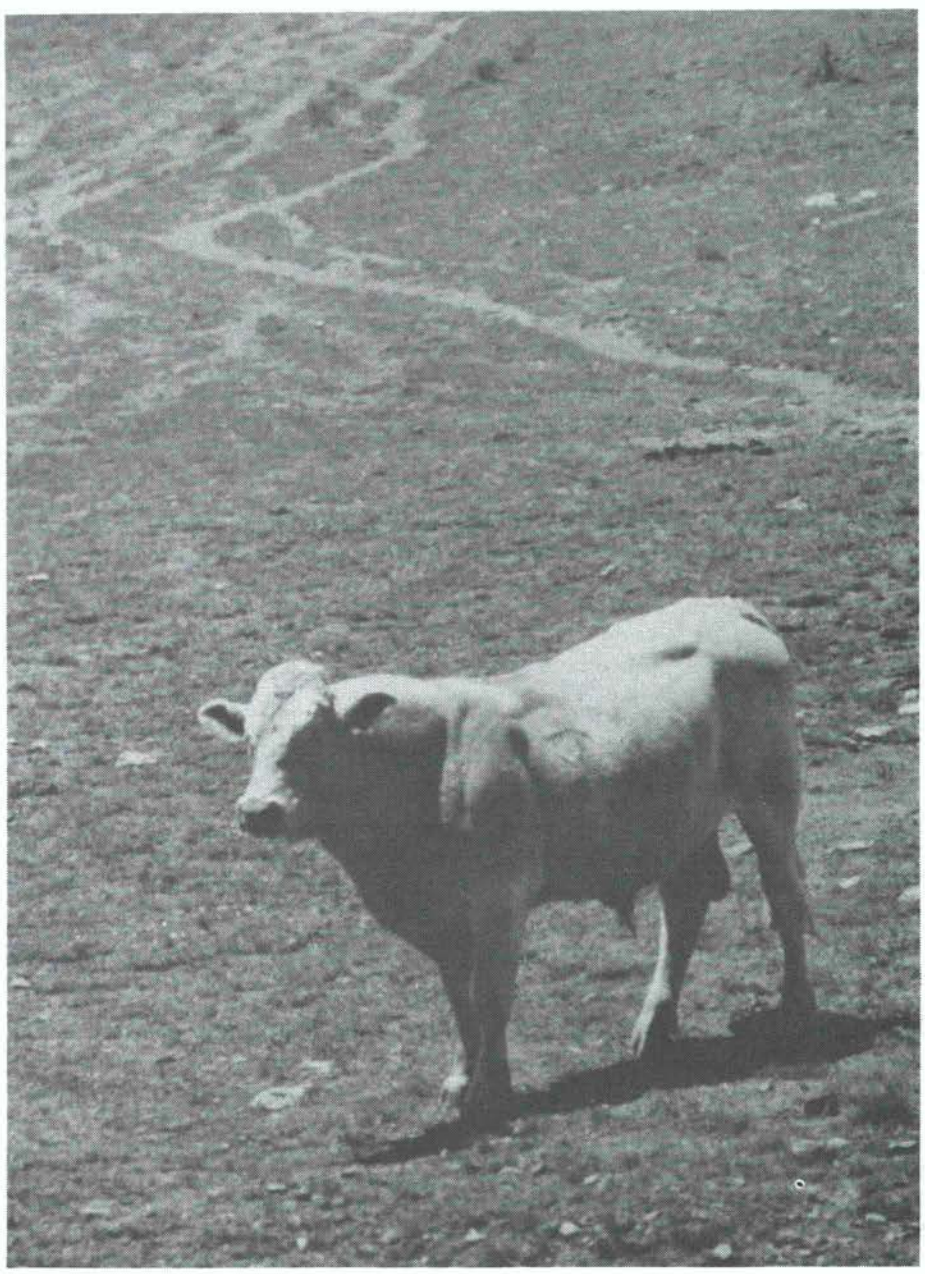
The meat, poultry, and fish section of this "ranch market" is not only a source of professional pride, but a big customer draw. It features as its main attraction "the finest range-fed beef available—100% Rocky Mountain Pure".

A free handout on the meat counter details how these "cattle graze on unfertilized mountain pastures, drink from snow-melt streams, breathe crystal clear mountain air, and are raised in a completely natural environment". On its cover, beautiful, rugged mountains sweep up majestically to meet a deep blue sky. In the foreground is a large meadow scattered with cattle. The meadow is badly trampled and overgrazed.

On the wall behind the meat counter is a collection of old photographs of prize-winning bulls and rangeland roundups. One portrays a vast western landscape—overrun with cattle beaten and stripped of almost all vegetation. If not for the cattle, the scene could easily pass for the aftermath of some warborne holocaust.

Is there something out of kilter here? This "ranch market" promotes the consumption of some of the "purest" and most "naturally" produced beef in the country. Yet scenes portraying cattle-caused environmental devastation are displayed as proudly on the walls and in pamphlets as the meats are in their cases.

The contrast between unadulterated beef and an adulterated environment demonstrates that very few people recognize or understand the environmental problems associated with cattle grazing. Probably the large majority of consumers who purchase "natural range-fed beef" believe they are doing something positive by selecting it as a "clean, healthy alternative" to intensive pasturing and feedlot factory farming. Looking at it from a personal human health vantage point, they are probably right as so-called natural meat *is* generally leaner and more chemical-free than nearly all other beef. But from an environmental perspective, livestock grazing is nothing short of a disaster.



From an environmental perspective, livestock grazing is nothing short of a disaster. (Photo: Lynn Jacobs)

The public lands oligarchy

For decades, ranchers and government agencies in the U.S.A. have been working together in an attempt turn public lands into profitable cattle ranches. The reality is that they are perpetuating a system—often described as "welfare ranching"—which consumes tax dollars as quickly as range livestock consume the environment.

This destruction began in the mid to later 1800s, when the grazing industry took control of most of the West in a flurry of violence and intimidation. During that era, ranchers ruled over most of the West with an iron fist. They ran cattle and sheep across the landscape with litte or no consideration for farmers or other land users. They also had a major hand in formulating the laws that Westerners in the U.S. still live under today.

Now, in the 1980s, things have not really changed much, except that social violence is a much less acceptable tactic. The grazing industry continues to control most of the rural West - socially, politically, and economically. A distinctly high percentage of Western politicians are themselves ranchers or are closely tied to the ranching industry. It is not uncommon for a Westerner's county supervisor, governor, and state and Federal representatives to all be ranchers. Even Ronald Reagan is a rancher. Thus, it is not surprising that needed reforms have not occured.

Today, less than 23,000 ranchers run their cattle and sheep on 323 million acres of public land - 43 percent of the land area of the 11 far Western states. This averages about 11,870 acres of public land for each public rancher. Livestock graze not only on grasslands, but on deserts, forests, brushlands, wetlands, wildlife refuges, military reservations, recreation areas, wilderness areas, and even some national parks and monument grounds — almost any place that has enough forage or browse to keep a cow alive.

The bulk of this public land is administered by the Department of the Interior's Bureau of Land Management (BLM) and the U.S. Forest Service (USFS), which is part of the U.S. Department of Agriculture (USDA). Privileged ranchers hold permits from these agencies which entitle them to lease the forage (not the land itself) for a small fee. This fee is currently $1.54 per month per cow — only about a fifth what is charged for equivalent forage on the private market. Since the government spends much more on grazing programs than it takes in from grazing fees, public forage is essentially given to the "welfare ranchers". The U.S. Treasury grossed only $9.2 million from all grazing fees in 1985, while spending at least $100 million directly on livestock grazing-related programs that year.

Other indirect government subsidies (which, in sum, make that $100 million seem a small amount) include predator control, fire management, soil erosion control, "dirt-cheap" property taxes, open-range laws (which state that a person must fence other people's livestock out, not vice-versa), road networks, and much more. Taken as a whole, these subsidies add up to more than the total annual net worth of the public lands grazing industry itself.

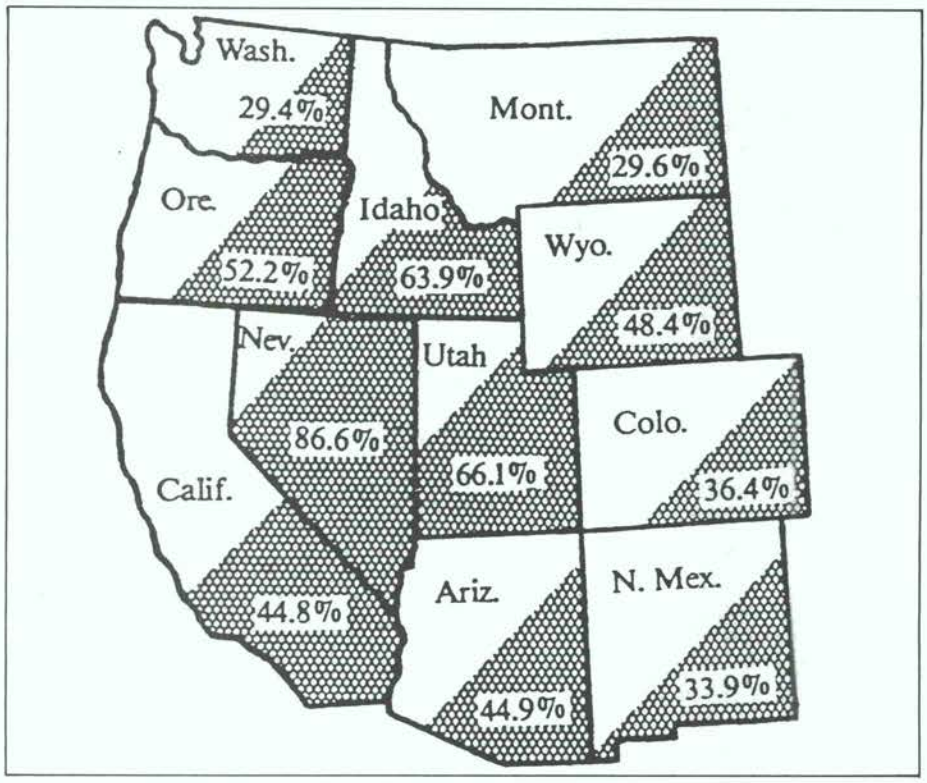


Fig. 1. Proportion of land in 11 western states owned by federal government (does not include state, county, and city lands). 80% of this federal land and 72% of most of the balance — private land — is currently grazed by livestock.

The BLM, with half or more of its total operation geared toward livestock production, is often referred to as the "Bureau of Livestock Management", and the Forest Service makes no secret of the fact that, under its stewardship, logging comes first with livestock grazing a close second. These agencies function as components of the overall grazing establishment. And besides providing material and technical assistance to ranchers, they serve as public relations conduits, trying hard to offer the public a positive image of the grazing industry.

But power abuse could not occur indefinitely if the public did not let it. What keeps the public lands grazing industry in business is the public's lack of knowledge and even apathy towards the issue -both overshadowed by the public's blind love for cowboys and cows, ranchers and ranches, and anything even remotely Western.

To overcome this, we must understand that the livestock grazing industry is a hard-nosed business -not a romantic fantasy. Much more than a loose coalition of harmless, rustic cowpokes, it is a highly organized and heavily financed oligopoly that is despoiling the American West.

The livestock invasion

Trying to explain the many effects of livestock grazing upon the environment is difficult and complicated. The effects are as numerous as the ecological interrelationships they disrupt. Basically, the damage can be divided into two categories — that caused directly by the livestock themselves and that caused by "range management". For over 100 years, these factors have kept Western rangelands in a dynamic state of severe degradation.

The most obvious thing livestock animals do to the land is strip off the vegetation cover. On most rangelands, cattle eat most of the forage (grass and herbage cover) and a fair percentage of the browse (leaves on shrubs and trees). They generally prefer forage, but will eat almost anything, including cactus and tree bark if they get hungry enough. In fact, today, cattle eat a much greater percentage of forage and browse on Western rangelands

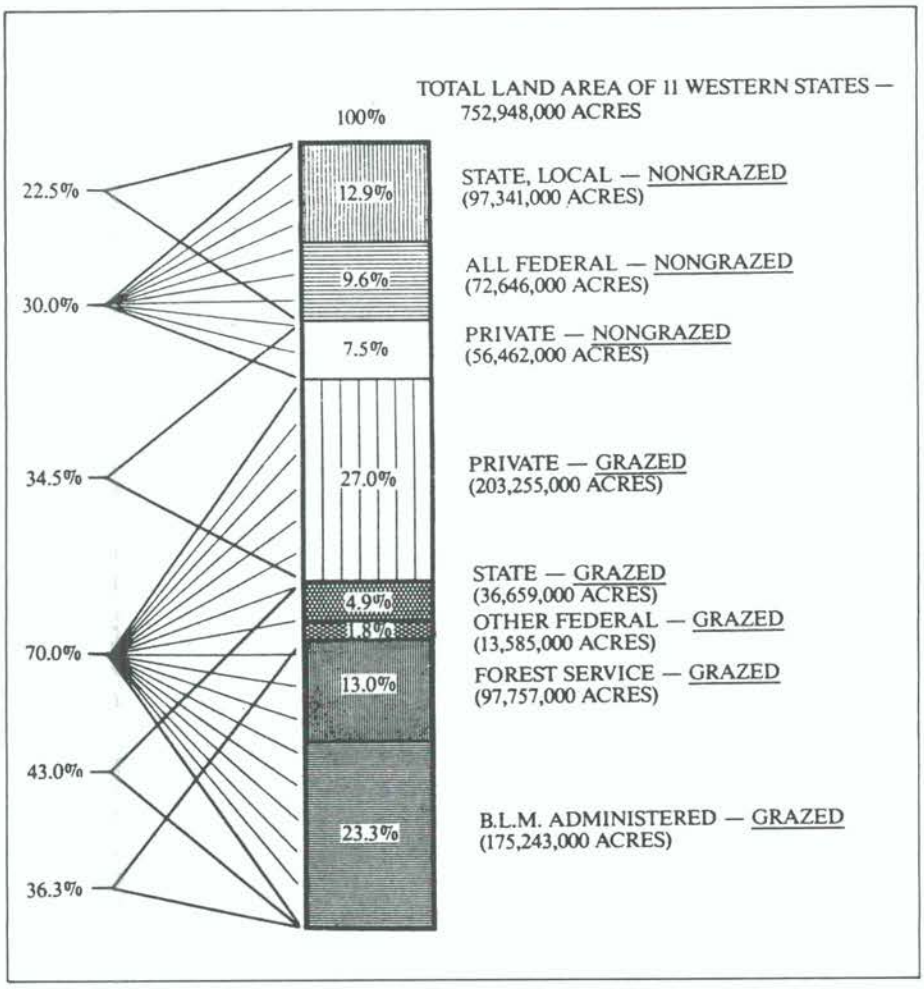


Fig. 2. Grazed and ungrazed lands in the West

than do native wildlife. They eat much more than native animals did even when bison roamed the West more 130 years ago.

Possibly even more destructive to vegetation than the feeding itself is the trampling that comes with the search for food. Most Western native plants are ill-equipped to survive intensive pounding from the hooves that bust the sod with a pressure of 24 pounds per square inch. Combined with overgrazing, trampling has transformed much of the landscape from relatively lush vegetation to scraggy stands of less desirable "increaser", "invader", and "exotic" plants -or to bare dirt.

With altered and depleted plant cover, most native animals—from insects to birds to large mammals—have less to eat, less cover in which to hide from predators, less vegetation in which to take shelter during extreme weather conditions, and fewer places to mate and nest. It is no exaggeration to say that many rangeland areas are now zoological wastelands.

Extensive damage has also been caused to the soil. No longer sheltered or held together by organic matter, loose soil particles can be carried away by water and blown by the wind, leading to eroded and desertified landscapes. According to the USDA, livestock grazing is outranked only by farming (which *intentionally* manipulates the soil) as a cause of soil loss and damage. Some experts estimate that half of the original top-soil has been eroded in large areas. As a result of soil loss and vegetation destruction, it is further estimated that Western rangelands today produce less than half the biomass they did before being damaged by the grazing industry.

Likewise heavy grazing has also adversely affected what some call the West's most precious process -the water cycle. By killing off most of the vegetative groundcover and damaging the soil, grazing livestock have destroyed the "sponge" which used to soak up and store most of the West's precipitation. Thus, since the late 1800s, when livestock numbers skyrocketed, many thousands of creeks and springs throughout the West have gone dry -especially in drier areas, where, ironically, they are most needed. Rivers and streams have experienced reduced flows, or flow only intermittently. The amount of water on the surface and in water tables has dropped in many areas, drastically in some. Western riparian areas are now only beaten, pathetic remants of what they were only 120 years ago. In Arizona, livestock grazing has been the major factor in the loss of more than 85 per cent of the state's original riparian area. Though many ranchers claim there has been a drying trend in climate, overwhelming evidence suggests cattle are the cause.

All of this has resulted in suffering and death for countless aquatic and riparian-dependent life forms. Many have been pushed out of existence as riparian areas have been destroyed and water sources dried up. Others have been suffocated from pollution — the combination of loosened sediments and fecal matter — that concentrates at water sources. Populations of many species have seriously declined in numbers as a result of these influences—most notably native trout.

Simply put, most of our public lands are either too dry, rugged, thinly soiled, or sparsely vegetated for practical livestock grazing. Dave Foreman of Earth First! sums up the effects of livestock grazing: "Suffice it to say that the livestock industry has probably done more basic ecological damage to the western United States than any other single agent".

"Managing" our public lands

While the problems caused directly by the livestock themselves are more than enough reason to call for an end to livestock grazing on public lands, that's only half the story. In their attempt to create favourable conditions for cattle and sheep, ranchers and government agents have declared war on the environment. This war is being fought with a tactical system called "range management" and weapons called "range improvements".

One of these "improvements", barbed-wire fencing, which stretches for hundreds of thousands of miles across the West, exists solely to serve the grazing industry. These barbed-wire boundaries prevent migration and restrict the free movement of many wild animals—especially pronghorn and bighorn sheep. This shrinks their range and limits their access to necessary food and water sources, mating grounds, and hibernating areas. Barbed-wire also entangles and mutilates many animals each year. The dangling corpses of pronghorns, coyotes, foxes, and many other large mammals are a testament to ranchers' success in "taming" the West.

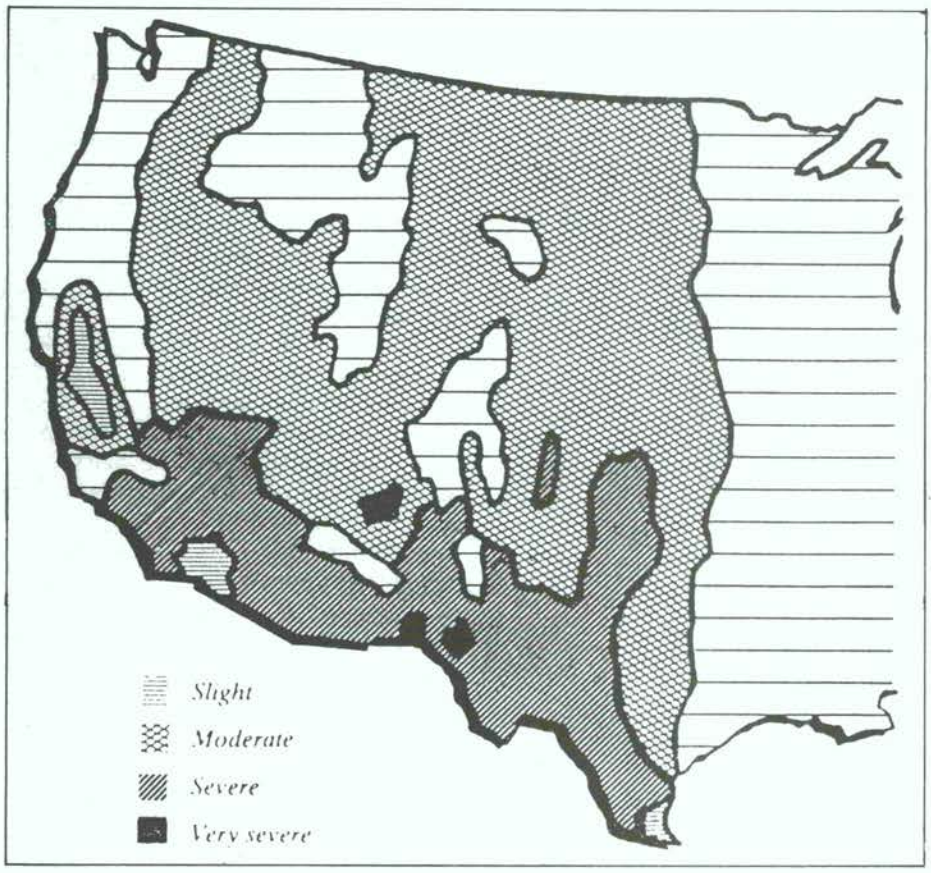


Fig. 3. The Status of Desertification in the Unitied States: Overgrazing has helped put about 10 percent of the land in the United States, all in the West, in a state of severe or very severe desertification, according to Harold Dregne, head of the International Center for Arid and Semi-Arid Land Studies at Texas Tech University. While the most severely desertified areas are in the Southwest, millions of acres of land to the north are also losing their productivity. Of all the activities that cause desertification, overgrazing is the most potent in this country, according to a 1981 report by the US Council on Environmental Quality. Source: Harold Dregne, "Desertification of Arid Lands." Economic Geography 53(4):325 (1977) (© Clark University).

Along with artificial boundaries have come artificial water sources. "Tanks", livestock watering developments of various kinds, allow cattle to survive in areas that are otherwise too arid to support them. Hundreds of thousands of tanks have been scraped into the land with bulldozers, spreading the impact of intensive grazing to areas that would otherwise be lightly grazed or not grazed at all. The "sacrifice area" surrounding a livestock tank (or a salt block) for a radius of several acres gets its name because all life in the area is sacrificed under the pounding hooves of numerous cattle. Not only are they sores on the land, open metal and concrete stock tanks often become death traps for birds and small animals who try to drink from them, fall in, and drown. Few ranchers bother to provide escape ramps for wildlife.

More dirt roads have been blazed and blasted through the West for the benefit of the grazing industry than for any reason. They meander along almost every valley and canyon floor, hilltop and mountainside, plain and plateau. In this way, the grazing industry has contributed to the infiltration of the West by others interested in exploiting its resources. These roads have opened up huge areas to destructive and/or illegal hunting, off-road vehicle use, mining, woodcutting, arson, and a wide range of other activities harmful to native animals and the environment.

One form of range management—manipulation of vegetation cover—has changed the very nature of the land. Stockmen and their government lackeys destroy inedible vegetation by spraying dangerous herbicides, burning, chaining (dragging a heavy chain between two tractors), bulldozing, plowing, and any number of other methods. The whole idea is to create as much livestock forage as possible, by any means necessary.

Often, after a vegetation removal or fire, an area is seeded by government agents with an imported grass, usually crested wheatgrass from Asia. Seedings create grass monocultures—sterile biological deserts—which significantly diminish the diversity of plant and animal life that would normally exist.

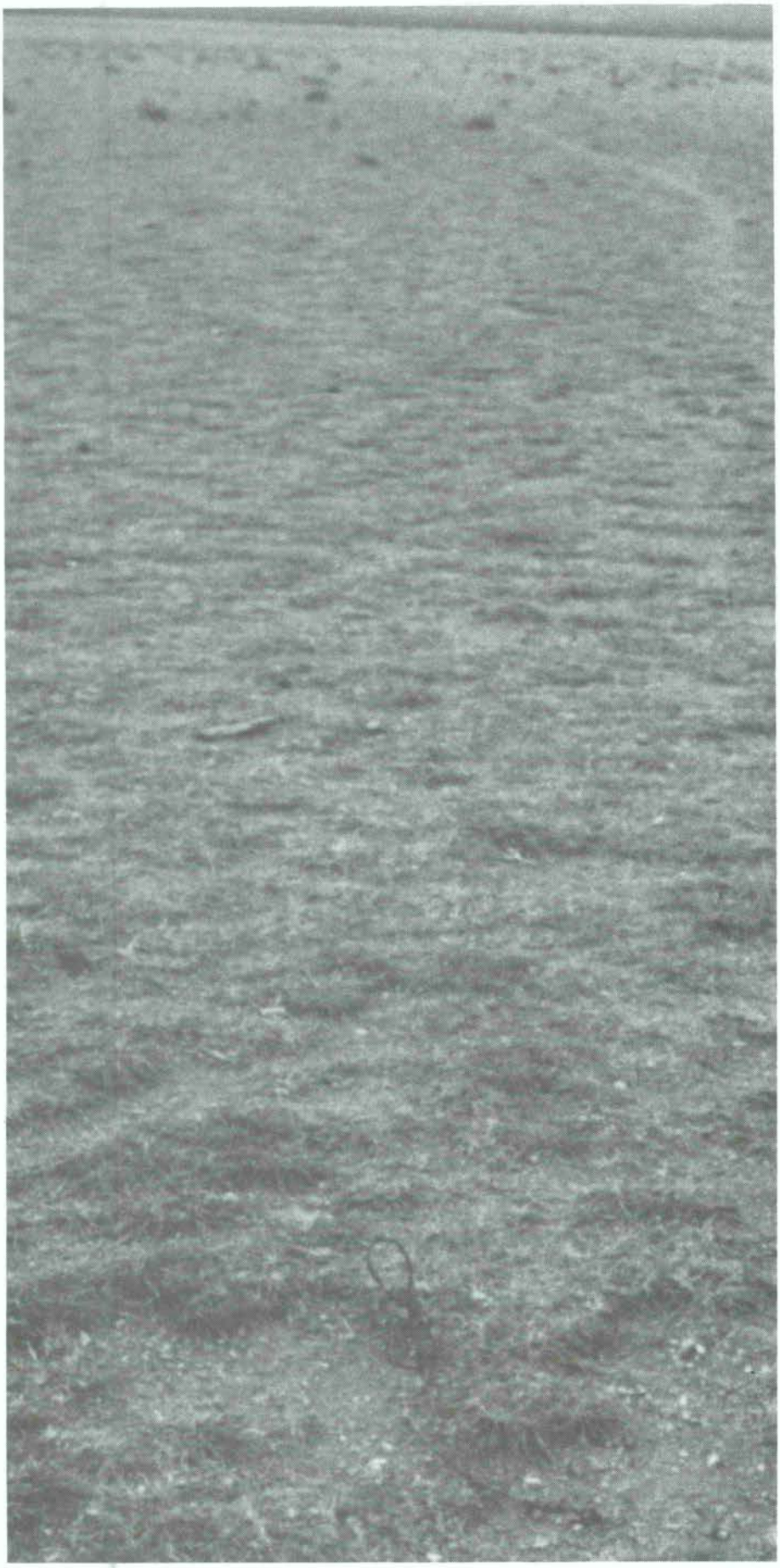
Blaming the victims

The livestock grazing industry fights a never-ending battle against three main groups of animals enemies—predators, competitors, and "pests". The predator control program is probably the most obvious of the grazing industry's harmful activities against animals. Historically, Federal agents and ranchers have targeted wolves, bears, mountain lions, bobcats, lynx, coyotes, and eagles as their nemeses. But non-target species have suffered an even worse toll as a result of the indiscriminate tools of the trade: traps and poisons. It is estimated that two-thirds of animals trapped are non-target or "trash" species, and that poisons take an even higher toll. Much of the sport and commercial trapping that occurs throughout the West, while usually not done by stockmen themselves, is nonetheless encouraged and/or subsidized by them. In addition, killing predators is an obsession with many ranchers, and they shoot at every one they see.

"Competitor" animals are those who might eat the same kind of vegetation as cattle or sheep. This includes a huge number of animals, large and small. Often the killing of animals such as pronghorn, bighorn, deer, and elk is done under the pretence of "big game" hunting in order to disguise the true purpose.

Two of the many "competitor" species are wild horses and burros. Ranchers and the BLM generally consider them pests, even though they usually eat less than five percent as much of the forage in their range as do livestock. Millions of wild horses and thousands of wild burros have been killed over the years by public lands ranchers and their government helpers. The BLM spent $16 million last year to domesticate and slaughter feral horses and burros, yet made no serious attempt to reduce the number of livestock.

The livestock industry itself is largely to blame for its problems with "pests" because they have killed off the predators that once kept their numbers in check. Ranchers and government agents have poisoned rabbits, kangaroo rats, squirrels, pocket gophers, and other



Crested wheatgrass from Asia creates a sterile biological desert, as here in Nevada, after reseeding of devegetated land by government agents. (Photo: Lynn Jacobs)

rodents *en masse,* often with air drops of poisoned grain. Plagues of grasshoppers and locusts are symptoms of overgrazing, as are excessive numbers of aphids, harvester ants, and certain kinds of beetles who are fought with massive doses of dangerous insecticides.

In sum, when all is said and done, there are actually very few animals who aren't considered enemies of the grazing industry. In fact, very few animal species haven't been adversely affected by either overgrazing or range management—from soil microbes to salamanders, from geese to grizzly bears, and even dogs and their human companions. Steve Gallizioli, who as the Research Chief of the Arizona State Game and Fish Department could not be accused of being over-sympathetic to animals and the environment, echoes a point we heard earlier: "The grazing of domestic livestock on Western rangelands has probably had a greater adverse impact on wildlife populations than any other single factor."

Domestic range animals are also victims

While not intensively confined for their entire lives as are factory-farmed animals, range livestock experience harsh and abbreviated lives. Cattle are usually turned out onto the range in the spring or summer (depending on the location) and must then fend for themselves. Because most Western rangelands are overgrazed, range livestock have to cope with many of the same problems as wild animals. As I write this in Tucson, hundreds of cattle on nearby overgrazing rangelands are dying of starvation. Bred to be slow, eat a lot, and gain excessive weight, the cow is, in a sense, an experimental animal—the ongoing subject of modification and manipulation to increase productivity and resiliency with the lowest possible expense. On top of all this, most public lands cattle operations are geared toward producing yearling heifers and steers ("feeder cattle") to send to the feedlots for fattening prior to slaughter.

It is clearly the grazing industry, not the grazing animals themselves, who are to blame for degrading the Western landscape.

Lynn Jacobs has put together a 48 page publication entitled "Free Our Public Lands!" which is entirely devoted to the issue of livestock grazing in the West. "Free Our Public Lands!" can be obtained free of charge by writing to Lynn Jacobs, P.O. Box 5784, Tucson, Arizona, 85703.

Arid Land Plants for Economic Development and Desertification Control

by
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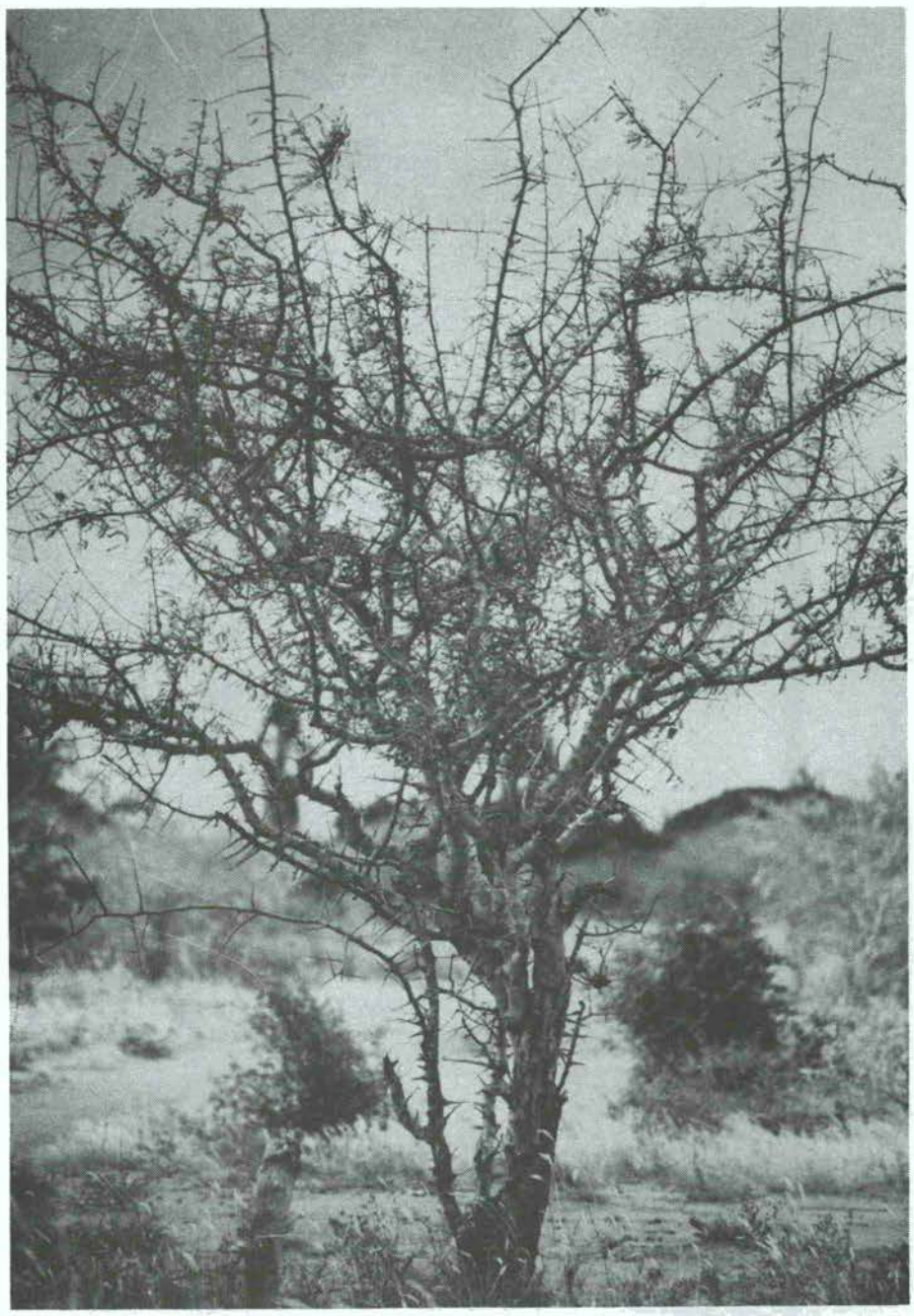
Introduction

One third of Africa is desert. Another third is semi-arid and arid. One of the most intractible problems facing African governments and donor aid agencies has been how to make this land productive, able to support people and contribute to national economies. The current trend is for this land to decrease in productivity and eventually be abandoned through a process called desertification. With rising population growth and shrinking land resources, the prognosis for Africa is not good.

Vast areas that used to be vegetated by dryland *Acacia-Commiphora* bush in the Sudano-Sahelian region — and longer ago in the past in what is today the Sahara — have been and are being degraded by the actions of man, aided by drought. The weak soils are blown and washed away due to poor land management and population pressures, leaving desert. This trend must stop and be reversed.

It is possible that thornbush country previously thought almost worthless could in fact be natural resource gold mines. The *Acacia, Commiphora, Boswellia, Sterculia* and many other trees and shrubs in these drylands produce gums, resins, oils and other extracts that are currently in demand in many of today's industries. There is great potential to develop more products that would make use of these renewable resources. The benefits to Africa could be enormous: the creation of employment and new industries, foreign exchange earnings and land conservation and rehabilitation.



Boswellia, *a prickly dryland tree, produces the valuable frankincense (olibanum). (UNEP/Daniel Stiles)*

Ten thousand years ago in Africa a massive area stretching from approximately 20 N. down to about 12 N. in the west and running through the Horn and down into southern Africa in the east was made up of *Acacia-Commiphora* bushland. Early explorers and African oral traditions refer to these forests as recently as 100 years ago in areas of the Sahel that today are desert. Parts of eastern Africa show today what much of this *Acacia-Commiphora* zone stretching more than 5000 km. across Africa must have looked like in the past. In Kenya it is called *nyika* and is considered by most as almost useless bushland, used today by nomadic pastoralists and, as population pressures mount, by marginal farmers. This type of bush, and less dense versions of it in the north of the country, occupy some 70% of Kenya's land surface. Although much

reduced in extent, this bushland and remnants of it still cover some 15 million sq. km. of Africa, about 50% of the continent.

Many of the indigenous tree and shrub species of this vegetation type hold known or potential promise as producers of economically valuable products, principally resins, gums, oils and extracts. Gum arabic, frankincense, myrrh, henna and aloe are some of the better known of these, but an even greater potential lies in developments to be made through research in the pharmaceutical, fragrance and flavour, food technology, epoxy resin/plastics and industrial coatings industries. These are each multi-billion dollar industries which make use of, and are constantly searching for, natural products from trees and shrubs.

The *nyika* of eastern Africa is going in the same way that it did in the Sudano-Sahelian region in previous centuries. Senegal, Mali, Burkina Faso, Niger, Chad, etc. only have sparse remnants of this vegetation left, most of it having been destroyed for use as firewood, charcoal, livestock enclosures, building materials and intentionally cleared off to make way for grazingland or cultivation. This type of vegetation usually develops under an average annual rainfall regime of between 100 to 600 mm (4 to 24 in.) and under high temperatures, thus the soils associated with it are generally not well developed. When the trees are destroyed and the ground cover removed by overgrazing or cultivation, the fragile soils are very susceptible to erosion by wind and water. This has happened over vast areas of the Sudano-Sahelian zone, leaving sand and more resistant surfaces (B/C horizons or bedrock) in their wake. This process, called "desertification", results in lowering productivity of the land and decreases in food production. During drought periods the process speeds up dramatically and results in famine and the environmental refugee. Land becomes desert and deserts do not produce food without high inputs.

Since populations continue to increase and people must have land to survive, what is the solution?

Kenya can serve as a test case for the possible solution which is proposed here to investigate in the study outlined here.

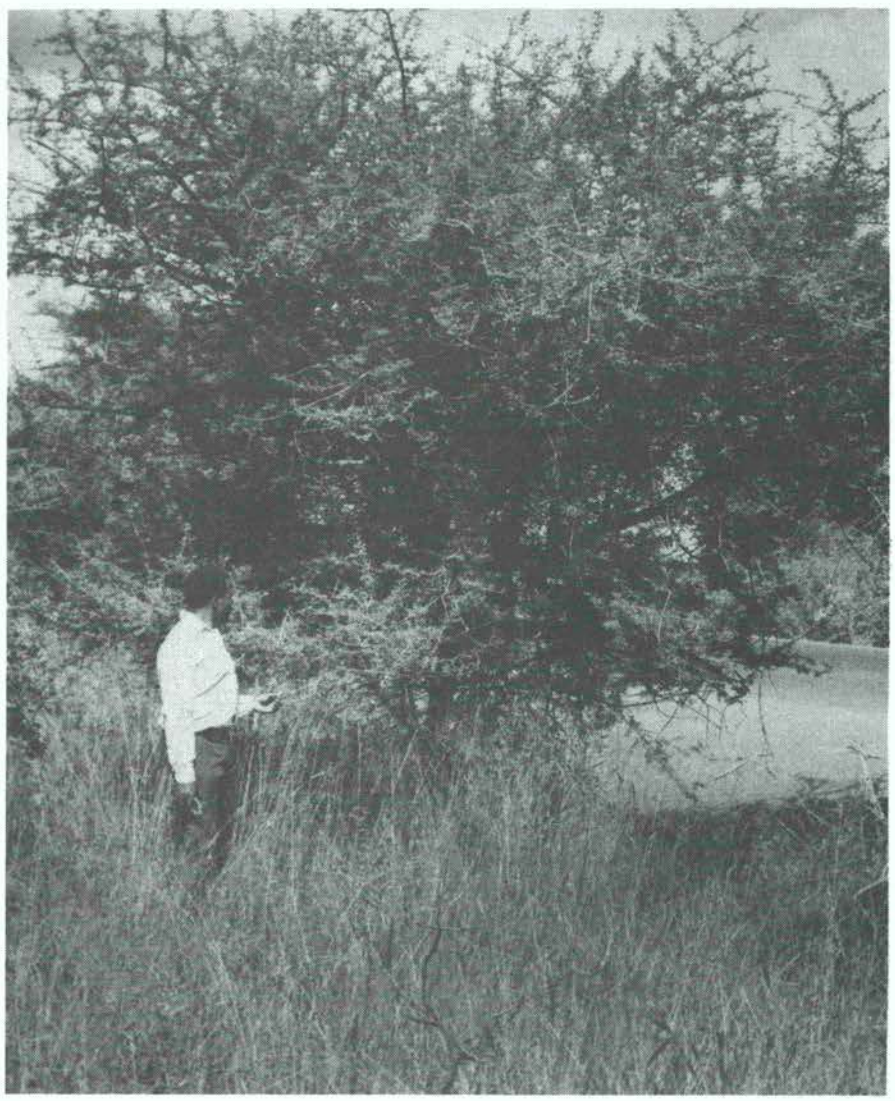
Strategy

The problem is twofold: (1) How to make *Acacia-Commiphora* bushland sustainably productive and capable of supporting increasing population and (2) How to halt destruction of this land and the resource base it represents?

The two problems are interrelated and require a common solution. The solution proposed here is to find out whether the trees and shrubs which grow in this ecosystem produce products which have economic value and for which a viable market exists or can be created. Except for the annual shrubs, the techniques used to extract these products are non-destructive and thus will render the bushland a renewable resource. Because of the economic value of the trees and shrubs people will cease destroying them, thus conserving the land. Plantations of the more economically valuable species can be established, preferably in agro-forestry configurations (possibly with food crops), which can rehabilitate degraded land.

The foregoing strategy can be used in conjunction with the development approach being taken today. Today, research and development for the drylands is concentrating on breeding fast growing, drought resistant food crops for rainfed agriculture, small and large scale irrigation projects for food and cash crops, the introduction of more productive livestock, subsidiary cash-earning schemes (bee-keeping, handicrafts, tanneries, poultry, etc.) and alternative sources of energy. Afforestation and agro-forestry projects are also widespread, using mainly exotics which grow faster than most indigenous species. Up to the present, a great deal of money has been spent and success has been limited, to say the least. Per capita income and food production have been decreasing in almost all African countries since 1970, particularly those with large areas of semi-arid and arid lands. Land continues to be destroyed by overexploitation. A new approach is needed.

Using Kenya as a test case, six research areas need to be addressed:



Acacia senegal, *which produces the much sought after gum arabic, could be grown in agro-forestry configurations with other trees and shrubs to create economically viable dryland agro-industries. (UNEP/Daniel Stiles)*

1. Taxonomic identification of the trees and shrubs of interest down to the subspecies/variety level and a survey of the distribution and densities of these plants, noting the environmental parameters under which they occur, i.e. soil, porosity, slope, altitude, rainfall and associated vegetation community.
2. Tapping/collecting trials of the gums and resins produced by the trees to gain estimates of yield and potential *supply* to industry. For some of the shrubs (see below), growing trials will have to be carried out and tests conducted.
3. Chemical analysis of the gums, resins and oils to assess quality and to research possible new products that can be derived from them.
4. A detailed study of potential markets for the products. This would include contacting the buyers and end-users to ascertain market volume, quality requirements, product variability to assess potential for developing agro-processing industries in-country, sources and availability of the products from elsewhere, and basically all of the *demand* information necessary to know before emarking on any economic development project.
5. Socio-economic study. There are many different ways development of these resources could be done, and probably several would occur. To ensure that this agro-industry would be properly managed studies need to be carried out to recommend how best to plan development under the different contexts. The contexts are: (i) wild bush on communal land under pastoral land-use; (ii) communal land under primarily cultivation land-use; (iii) small-holder private land; (iv) large privately owned group or individual ranches. The land tenure and land rights systems must be ascertained, along with decision-making mechanisms at the local level. These must be integrated with government policy and plans at the higher level. A study of local uses of the plants should also be carried out.
6. Growing trials eventually will need to be carried out to test how best to propogate and produce the products desired. Different spacing and species combinations will have to be tried under various conditions in different areas to develop the best agro-systems.

Sterculia, *another tree adapted to arid lands, produces a gum with great economic potential already being exploited in India. (UNEP/Daniel Stiles)*

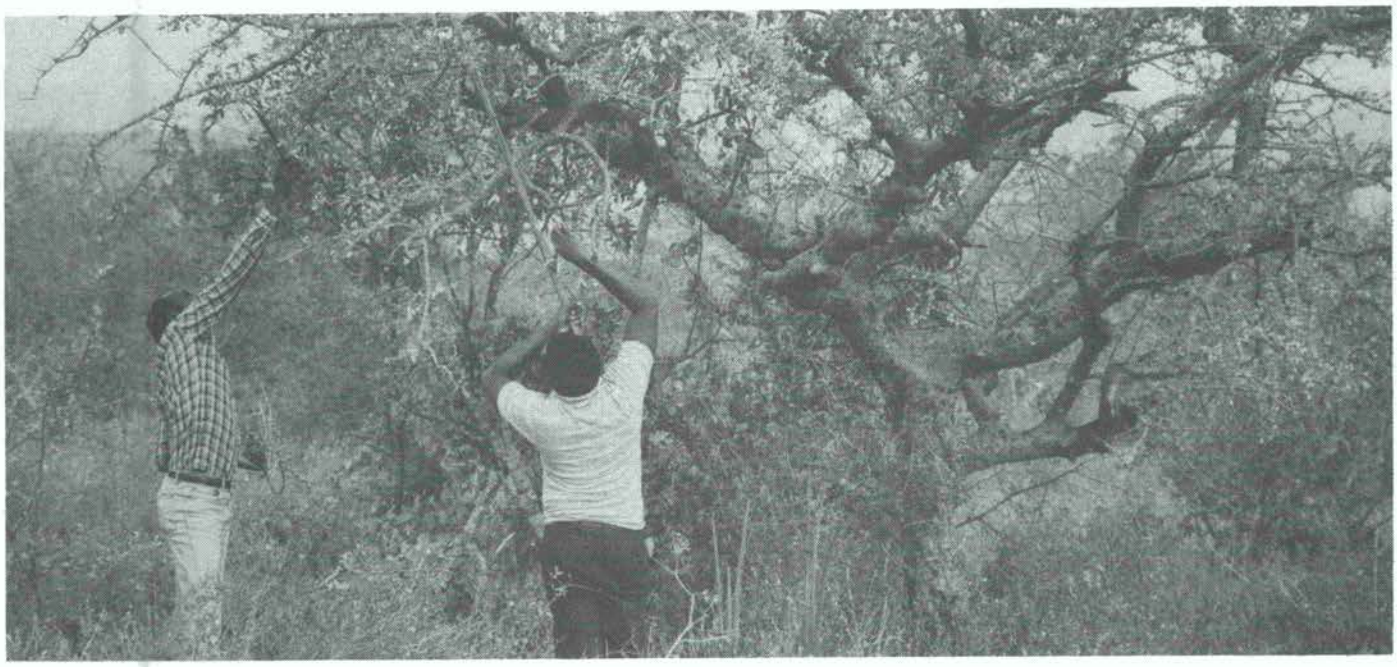
The countries in Africa for which this study has relevance are:

Burkina Faso	Gambia	Mozambique	Somalia
Cape Verde	Kenya	Namibia	Sudan
Chad	Mali	Niger	Tanzania
Ethiopia	Mauritania	Senegal	Uganda

Trees, Shrubs and Products

Listed below are the trees and shrubs of interest at present along with their products and current or potential uses in industry.

Name	*Product*	*Use*
Acacia senegal	Gum arabic	Emulsifier/stabiliser in processed foods and beverages, ink, paper, textiles, pharmaceuticals, glues, etc.
A. mellifera	Gum	Possibly same as above
Astragalus sp.	Gum	Possibly same as gum tragacanth, processed foods (very valuable)
Boswellia sp.	Frankincense, olibanum	Incense, perfumes, food and beverage flavouring
Commiphora myrrha	Myrrh	Incense, pharmaceuticals, perfumes and flavouring
Commiphora sp.	Opopanax, opopanom	Perfumes and flavouring
Lawsonia sp.	Henna	Shampoos, soaps and cosmetics
Sterculia sp.	Gum karaya	Pharmaceuticals, paper and processed foods
Vernonia galamensis	Oil	Epoxies for adhesives, plasticizers, industrial coatings, varnishes and paints. Meets EPA regulations to replace solvents as a reactive diluent in resin systems.



There are several species of ***Commiphora*** *which produce resins which can be used in the flavouring and fragrance industries and which have great potential in the pharmaceuticals field. (UNEP/Daniel Stiles)*

In more detail, these plants are:

Acacia senegal — produces gum arabic, used as an emulsifier in foods, diet drinks, ink and used in textiles, paper, adhesives and paints. 80% of the world's production comes from the Sudan. Production has dropped because of desertification and demand is high. Large scale restocking programmes are underway in Sudan, Mali, Senegal and Burkina Faso, but success rates are low because of weak infrastructure and adverse governmental control. Many parts of Kenya have *A. senegal* trees. The different varieties need to be identified and tested for gum quantity and quality production. Trees in various parts of the country should be tested, and seeds planted in test plots and monitored over time. Tapping can begin at five years of age. The global market is virtually unlimited if the price is not too high, as it currently is because of shortage of supply. *A.mellifera* produces a similar gum.

Commiphora myrrha — produces the resin myrrh, used as an incense, in perfumes, a flavouring additive in soft drinks and sweets and has potential in pharmaceuticals. It is currently exported from Kenya, mainly by Somalis. The main research needed is in the field of marketing and in myrrh quality. There is also the possibility of distilling myrrh into an essential oil or a resinoid, but the potential market for these products needs to be researched.

Commiphora hortziana — produces opopanax, a "bisabol" myrrh, similar to but of lower value than true myrrh. Similar uses as myrrh. The same research needs to be conducted as with myrrh.

Commiphora sp. — There are several other species which have potential in pharmaceuticals, flavourings, etc., but research is needed.

Boswellia neglecta — produces frankincense, also known as olibanum. Used as a scenting agent in perfumes, lotions, etc. Same research needed as with myrrh.

Astragalus sp. — produces gum tragacanth, used in processed foods, of high value in today's market. The commercial tragacanth today comes from Turkey, Iran and Syria. Little is in the literature about its propagation. There are several *Astragalus* species in Kenya which should be tested for gum production. If one does contain gum, propagation trials should be made.

Sesbania sesban — produces a gum similar to guar, used in the food industry. Tests need to be conducted to see if commerciable quantities are produced from this species, and what the quality is: It has even better nitrogen-fixing properties than *A. senegal.*

Sterculia sp. — produces a gum which currently is exported in small quantities from Kenya to go into a laxative. *S. urens* gum karaya from India is used as a substitute for *A. senegal* gum arabic and gum tragacanth. It has considerable economic potential in pharmaceuticals as well.

Vernonia galamensis — produces an oil which can be used in the manufacture of polyvinyl chloride (PVC), adhesives, plasticizers, industrial coatings, varnishes and paints. The Agricultural Research Service of the U.S. Department of Agriculture has conducted tests on it and judges it to have a very high potential for Commercial exploitation. Growing trials need to be carried out on the various sub-species, followed by oil extraction and use tests.

All of the plants listed above are indigenous to Kenya. There are hundreds of thousands or millions of individuals of each species listed in the country. There are also many exotic species which would probably do well in the country, but why introduce them if the indigenous plants, already well adapted to local conditions and important for ecosystem functioning, are available and of economic value?

Conclusions

An approach to economic development briefly discussed here could have significant consequences for land use policy and planning in future in Africa. Of critical importance in the initial stages is determining what market potential exists and what the quality and quantity of product supply would be.

Village tree planting in Zambia: problems and prospects

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Introduction

The area lost to deforestation annually in Zambia is estimated at 0.5% of the 75.26 million ha. territory (Government of Zambia and International Union for Conservation of Nature and Natural Resources, 1985). In 1985 the Forest Service estimated that natural woodland covered 58.23 million ha. Copperbelt and Lusaka Provinces, of the nine Provinces in the country, have the least woodland areas due to high charcoal production (Chidumayo and Chidumayo, 1984), Deforestation is estimated at 2% per annum, four times the national average. In the other seven provinces, the main cause of deforestation is agricultural expansion. Given the 58.23 million ha. of woodland and a population of about 5.6 million in 1980, it would at first appear that there is no shortage of wood resources in Zambia.

FAO's world map depicting the fuelwood situation in developing countries in 1981 tells a different story. The map shows that the eastern half of Zambia, consisting of Copperbelt, Central, Luapula, Lusaka, Northern and Eastern Provinces are fuelwood deficient areas in which demand is met by overcutting wood resources. While this may be an exaggeration of the fuelwood situation in the country, there are nevertheless localized areas with fuelwood shortage. Generally shortage of local wood is common in regions with high rural population density per unused woodland, as in regions with fishing and semi-permanent hoe cultivation and semi-commercial ox and tractor cultivation. (Table 1). The distribution of farming regions is shown in Fig. 1. The fishing and semi-permanent hoe cultivation system is associated with wetlands (i.e. lakes,

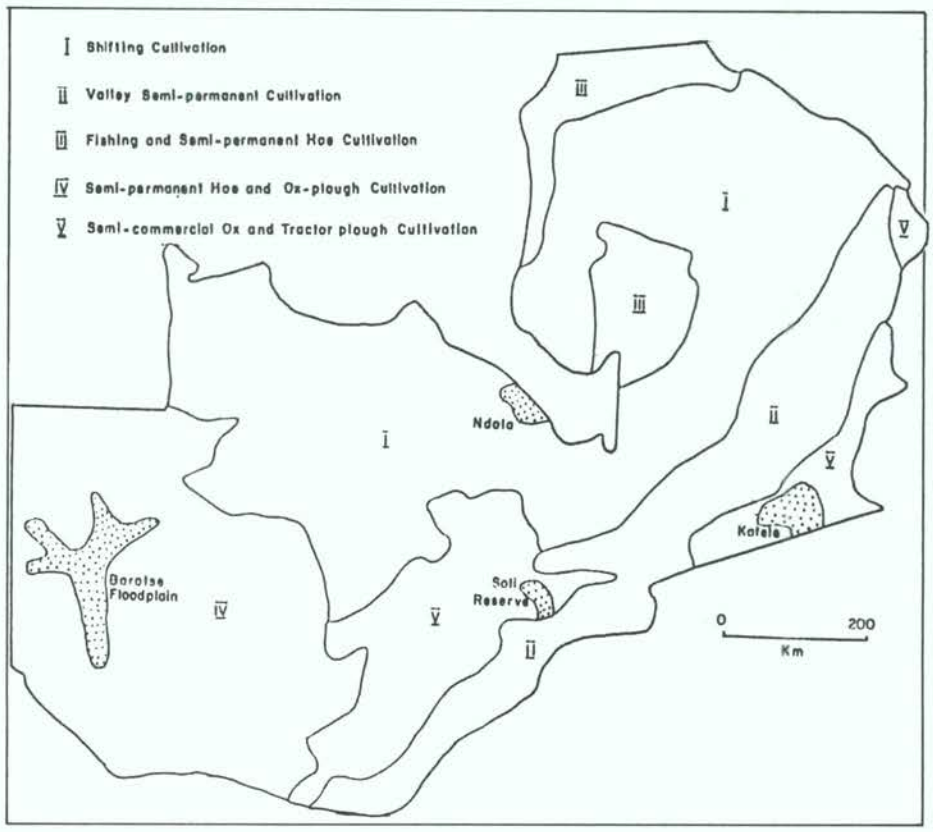


Fig. 1: Farming Regions in Zambia (modified after Schultz, 1974) and Location of Study Areas

Farming region	Unused woodland (km^2)	Rural population (in 1969)	Population density per km^2 of unused woodland
Shifting cultivation	113,091	792,500	7.0
Valley semi-permanent hoe cultivation	17,811	99,000	5.6
Fishing and semi-permanent hoe cultivation	11,120	325,000	29.2
Semi-permanent hoe and ox cultivation	96,706	682,500	7.1
Semi-commercial ox and tractor cultivation	25,682	749,000	29.2

Source of data Schultz (1974).

Table 1: Rural population density per unused woodland by farming regions in Zambia. The distribution of farming regions is shown in Fig. 1.

swamps and floodplains) which have a natural wood resources deficit. In the semi-commercial ox and tractor cultivation farming system, practised in the plateau regions of Central, Lusaka, Eastern and Southern Provinces, expansive crop agriculture is the primary cause of deforestation. The population and wood resources relationship given in Table 1 is indicative of a gradually worsening situation; while rural population growth was 1.1% per annum during 1969-1980, the rate of deforestation was estimated at 0.5% per annum.

To date, Zambia has established about 60,000 ha. of industrial plantations located mainly in the Copperbelt Province. These plantations produce enough trees to meet industrial timber needs through the year 2000 (World Resources Institute, 1986). But in spite of the ambitious rural or village afforestation programmes in the neighbouring eastern African countries (Aworry, 1984), Zambia has fallen behind. The observance of the international year of the forests in 1985, however, did increase awareness about the need for village afforestation in Zambia. The Forest Service has recently upgraded its extension and advisory division to help promote rural afforestation. But over eager implementation of village afforestation programmes without adequate planning and experience can lead to failure. Hence there is a need for a critical review and evaluation of past rural tree planting activities from which mistakes can be learned and future failure minimised.

From July 1985 to August 1986, the author carried out a series of surveys to evaluate rural tree planting activities in Zambia to assess people's perceptions and attitudes toward tree planting. The surveys were conducted in three areas: Barotse Floodplain in Mongu district of Western Province, Katete district in Eastern Province and Soli Reserve of Lusaka Rural district in Lusaka Province (Fig. 1). Since 1975 the Forest Service has promoted tree planting under the "Operation Kwacha" programme. In order to evaluate this programme, I investigated the production and distribution of seedlings for "Operation Kwacha" at Mushishi nursery in Ndola Urban district as a case study. In Katete district, the Swedish International Development Agency (SIDA) has supported, albeit on a small scale, village tree planting since 1981 (Bohlin and Larsson, 1983). In Soli Reserve, the Natural Resources Department initiated a village tree planting project in 1985 with financial support from Africare. There has been no similar tree planting programme in the Barotse floodplain.

Study methods involved the use of questionnaires to determine people's perceptions about natural wood resources and attitudes toward tree planting and past tree planting activities. Sample woodlots were visited in Katete and Soli Reserve to assess the condition of trees, mortality and growth rate.

"Operation Kwacha"

There was hardly any organised rural tree planting in Zambia before the launching of "Operation Kwacha" in 1975. Operation Kwacha was a country-wide campaign mounted by the Forest Service to promote tree planting by and for the people. Since the launching of "Operation Kwacha," thousands of seedlings have been raised and either sold cheaply to individuals or distributed freely to institutions, such as schools and colleges, by the Forest Service. The quantities and species of seedlings raised for "Operation Kwacha" are not known, although the majority were *Eucalyptus,* especially *E. grandis.* There is no record about what happened to "Operation Kwacha" seedlings after distribution.

The story of seedlings raised at Mushishi forestry nursery in Ndola, Copperbelt Province, between 1975 and 1985 (Table 2) perhaps typifies the "Operation Kwacha" situation throughout the country. Only 27 per cent of the seedlings raised were sold, and of the remaining 73 per cent, an unknown quantity was distributed free of charge. During December 1985, 1,075 seedlings were given to schools and individuals in Ndola Urban district. By April 1986, 18 per cent of the seedlings had been stolen from growers, 54 per cent had died and 14 per cent could not be traced. This respresents a seedling survival rate of only 14 per cent. Most accounts of rural afforestation programmes give the number of seedlings raised and distributed; here the number of surviving seedlings is rarely discussed. And yet it is the surviving seedlings that ultimately determine the success of any tree planting programme.

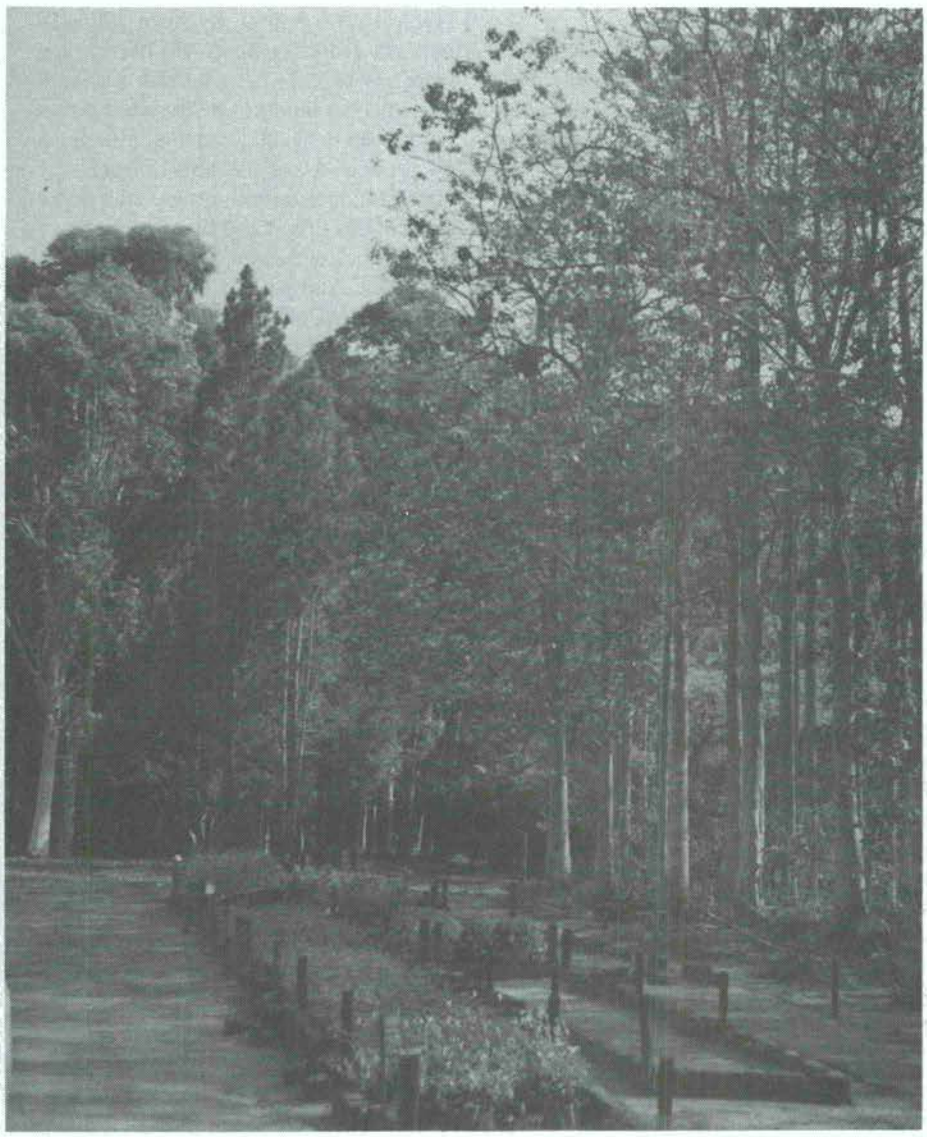
Perceptions and realities about rural tree planting

The explicit purpose of rural afforestation in developing countries is to produce adequate firewood in the shortest possible time. This is the most commonly-heard objective of national governments. In Zambia, however, wood scarcity is rarely perceived by rural inhabitants, so that the fuelwood problem can only be investigated by use of indices (Table 3).

In spite of the level of awareness about wood conservation, less than 30% of rural households in the study areas cut live trees for firewood, and there is little trade in fuelwood, except in the naturally wood deficient Borotse Floodplain, where cow dung and crop residues are also used for cooking fuel. Firewood collection in Zambia is traditionally a woman's responsibility. However, it was observed that when firewood resources become scarce, men also get involved in firewood collection using ox-drawn carts. In both Katete and Soli Reserve men were actively involved in firewood collection with ox-carts. Given these perceptions and

Year	Total seedlings raised	Seedlings sold	Unsold seedlings
1975	1,500	—	1,500
1976	2,500	—	2,500
1977	5,000	2,277	2,723
1978	5,000	92	4,908
1979	6,000	410	5,590
1980	10,000	1,895	8,105
1981	6,500	4,987	1,513
1982	10,000	2,956	7,044
1983	7,500	236	7,264
1984	8,000	150	7,850
1985	10,000	6,610	3,390
Total	72,000	19,613	52,387

Table 2: Eucalyptus grandis, Pinus kesiya *and* Cypress lusitanica *seedlings raised at Mushishi forest nursery in Ndola for "Operation Kwacha".*



It is the surviving seedlings that ultimately decide the success rate of any tree planting programme. (UNEP/Timo Maukonen)

realities about the fuelwood situation in rural Zambia, it is interesting to explore inhabitants' willingness to plant trees for firewood. Table 4 summarizes some answers about why rural people want to plant or have planted trees in Katete and Soli Reserve.

Although the majority of rural households in wood deficient areas wish to plant trees for firewood, only a minority of actual tree-growers acknowledge firewood as a need. Most of the growers want to use trees for timber and as building poles (Table 4). This discrepancy may be explained by the fact that households wishing to plant trees may have been influenced by government propaganda. But live trees are rarely considered a source of firewood. Living trees are the major source of building poles and timber and, because these are selectively extracted from natural woodlands, the shortage of building poles often precedes that of firewood. Rural households, therefore, value planting trees first for poles and timber and only secondarily, after felling, for firewood. This contradicts the official view of promoting tree planting primarily for firewood.

Most rural afforestation projects in Africa have concentrated on establishing communal woodlots. In both Katete and Soli Reserve, however, the majority of households prefer individual or private household woodlots. In spite of considerable efforts to organise village communities to establish communal woodlots in Soli Reserve, none was established by the villages. In both Katete and Soli Reserve the only communally owned woodlots were those belonging to schools.

Private woodlots were planted either by husbands or by husbands and their sons: 88 per cent and 77 per cent of woodlots in Katete and Soli Reserve, respectively. Women did not participate in tree planting as much as men. This may be caused by several factors. First, men are responsible for construction work and since the shortage of building poles precedes that of firewood, men are keen to plant trees for poles. Second, in this area men control the household budget, and since trees are also planted for sale, men may deliberately discourage women from planting trees in order to maintain total control over any income. Third, the role of men in firewood collection increases as the wood resources diminish. It is therefore advantageous to men to plant trees to reduce their firewood collection burden.

Woodlots in Soli Reserve were established from December 1985 to February 1986 and in Katete from 1982 to February 1986. Only *E.grandis* has been planted in Katete, while in Soli Reserve, 20,815 *E.grandis* and 4,000 *Gmelina arborea* seedlings were planted. Woodlots have been established around homesteads and on cultivated land, although in most cases trees have not been interplanted with traditional crops. The care given to woodlots is summarized in Table 5. School woodlots were generally better managed than private woodlots.

Survival of seedlings

The success of a tree planting programme is ultimately determined by the survival and growth rate of trees. In Soli Reserve, *G.arborea* enjoyed a survival rate of 92 per cent 6-7 months after planting, while that of *E.grandis* was 65 per cent. In Katete, *E.grandis* in woodlots of different ages (6 months — 3½ years) had a survival rate of 46 per cent. It is apparent that *E.grandis* has a lower survival rate than *G.arborea.* However, the survival rate of *E. grandis* in school woodlots was slightly better, at 59 per cent, than that of 52 per cent in private woodlots, perhaps due to slightly better management at school woodlots (Table 5). In Katete, seedlings planted on the nationally-sponsored World Forest Day, 21st March, had a survival rate of 2% compared to that of 44% among seedlings planted in December. March marks the end of Zambia's rainy season.

The single major cause of *E.grandis* seedling mortality was termite damage to the root system. Seventy-one per cent of seedlings dying at the time of inspection in Soli Reserve had root damage from termites. In Katete, 63 per cent woodlot owners who had

Table 3: Indexes of wood resources scarcity in three study areas with a presumed wood resources deficit. N is number of sample households.

Parameter	*Frequency of acknowledgement by rural households*		
	Borotse Floodplain (N=112)	Soli Reserve (N=307)	Katete (N=276)
Wood resources scarce or very far	98%	73%	56%
Cut live trees for firewood	33%	28%	9%
Menfolk involved in firewood collection	28%	57%	40%
Commercial acquisition of firewood	57%	2%	0%
Use of cow-dung and crop residues for cooking	96%	0%	0%

Table 4: Anticipated uses of planted trees in Katete and Soli Reserve study areas.

Anticipated use of planted trees	Soli Reserve		Katete	
	Households wishing to plant trees (N=124)	Households that have planted trees (N=30)	Households wishing to plant trees (N=276)	Households that have planted trees (N=14)
Firewood	78%	47%	77%	14%
Timber poles and furniture	99%	93%	79%	100%
Soil fertility	44%	0%	66%	0%
Sale	79%	33%	53%	14%
Fodder	17%	17%	67%	0%
Shade	94%	13%	84%	7%
Erosion control and conservation	47%	20%	0%	0%

Table 5: Woodlot management practices in Katete and Soli Reserve study areas.

Management practice	Percent of woodlots that received management practice	
	School woodlots (N=10)	Private woodlots (N=34)
Applied fertiliser	90%	94%
Applied pesticide	80%	79%
Applied irrigation	60%	27%
Weeding: (i) Around plants	0%	15%
(ii) Whole woodlot	100%	65%
Fencing	90%	32%

experienced high seedling mortality attributed this to termite attack; only 37 per cent attributed the destruction to livestock. Because of these experiences, most schools and households wishing to plant trees requested government assistance in the form of pesticides and fencing wire for seedling protection from both termites and livestock, respectively.

In spite of its susceptibility to termite attack, *E.grandis* grows relatively faster than *G.arborea.* In Katete the mean height of *E.grandis* was 0.56 meters after 6 months, 1.78 meters after 18 months and 3.86 meters and 9.08 meters after 30 months and 42 months, respectively. After 42 months, one school in Katete was already selling poles with a mean girth of 23.0 cm from its woodlot trees. In the neighbouring district of Chipata, *G.arborea* trees in a 54 months old woodlot had a mean girth of 22.0 cm which *E.grandis* attained at only 42 months. The mean heights of *G.arborea* trees was 0.43 meters and 3.9 meters in woodlots aged 6 months and 54 months, respectively.

Future rural tree planting in Zambia

This study is the first attempt to evaluate the success of the rural tree planting programme in Zambia. In the past, rural tree planting has ended with the distribution of seedlings; no attention has been given to what happens after distribution. As a result, promoters of rural tree planting have had little chance to acquaint themselves with practical problems of rural afforestation. Many contend that the rural afforestation programme in Zambia is failing because seedlings are given to growers free of charge. What is not realised is that for a species such as *E.grandis,* termites cannot distinguish between free and purchased seedlings. often growers are given little or no information about tree growing but are nevertheless expected to raise trees successfully.

Competition for labour spent between food crops and tree crops may favour food crops. But education may help overcome this bias for food crops, particularly as growers realise that tree crops can and do contribute to the improvement of household welfare. Generally, tree crops require less time and labour to manage than food crops and growers do not need to sacrifice effective food production.

Since the launching of "Operation Kwacha" thousands of seedlings have been raised. (UNEP/Timo Maukonen)

Weeding during the early life of a tree is essential in order to reduce competition for water and nutrients from weeds as well as to minimise the risk of fire. Livestock present a hazard to young trees, particularly thornless seedlings, by browsing or trampling upon them. This danger is greatest when woodlots are not weeded. Both fencing and weeding, therefore, are essential to proper management of woodlots and should be emphasized by afforestation extension workers.

The farming system in most wood deficient areas in Zambia consists of mixed crop and livestock production. Tree planting, therefore, should aim at the production of trees for building poles, fuels, fodder, soil fertility and erosion control. Currently tree planting aims at the production of timber and fuelwood only. Trees with multiple uses are more valuable and need promotion. With this in mind, a large quantity of *Leucaena* seedlings has been distributed in the Soli Reserve during the 1986/87 planting season.

Later planting reduces the survival of seedlings and can be avoided by the timely production and distribution of seedlings. These should be distributed before the middle of the rainy season. Prior to 1985, most trees for rural afforestation were planted on the World Forest Day, 21st March. But seedlings planted in March rarely survive. This inappropriate tree planting day contributed to the poor success of the rural afforestation programme in Zambia. On 21st March 1985, President Kaunda designated December 15 and December 15-January 15 as the national tree planting day and month, respectively. This long overdue change will ensure that seedlings are adequately rain-fed and established before the end of the rainy season.

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Land for Food Security in Africa

Paper presented at the AFAA Sixth General Conference on Food Security in Africa

Togo, 9—14 November, 1987

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Land Potential

The precarious food situation in a number of African countries necessitates drastic measures to fill the gap between food demand and supply. The potential of the land to produce resources is determined by soil and climatic conditions and by the level of inputs and management. Assessments are needed in three areas of production: crops, both rainfed and irrigated, livestock, and timber and fuelwood.

Africa's great diversity of soils and climates reflects considerable potential for production. Africa as a whole contains immense reserves of land, 603 million hectares, which fall into several different ecosystemic zones. Seventy-five per cent of Africa's reserved land lies in two general regions: humid Central Africa and semi-arid Southern Africa, and 10 per cent of this is in the Sudano-Sahelian Africa. The Mediterranean and arid North Africa region contains no remaining reserve of land.

There are practically no extensive areas of African soils without limitations of one sort or another, but most soils are nevertheless capable of production. Constraints must simply be removed or overcome in order to obtain high yields. Some contraints can be dealt with by individual farmers, others require community or government intervention. Large parts of the continent in the semi-arid and sub-humid regions are covered by sandy soils. In humid areas the soils are frequently acidic, while in the arid regions soils are shallow, saline and beset with shifting dunes. The most fertile soils are confined to areas of volcanic or basic rocks in the highlands and are often susceptible to water erosion. The dark, clay soils covering extensive plains have tillage problems.

Population Pressure

Many traditional agricultural systems that were ecologically stable only 40 years ago are now breaking down under pressure from increasing populations. For about the last two decades, food production in Africa has failed to keep pace with the growth of its population. Africa's population is growing at the rate of 3.2 per cent a year, faster than that of any other region. Food production per person fell by about 12 per cent between 1965 and 1982. In all other developing regions, production rose by between 6 and 49 per cent. Malnutrition is the most acute physical expression of absolute poverty. It is estimated that 69 per cent of the African

Food production per person fell by 12 per cent in Africa between 1965 and 1982. Part of the cause was the loss of valuable top soil through erosion, as here in Ethiopia. (UNEP/Charles Stewart)

population lack the basic needs for a minimal diet, shelter or clothing. These are overwhelming phenomena in rural areas, where small farmers are unable to meet family needs for food or cash.

The roots of the food and poverty crisis reach back to colonial days when Africa was exploited as a source of cheap raw materials. Since that time, the world economy has not favoured Africa. The real price of most of her commodity exports has fallen while the price of Africa's imports have risen. Financial crisis has contributed to the deepening of Africa's environmental crisis.

Some 3.7 million hectares of forests and woodlands in Africa are disappearing every year. Across the Sahel the leafy branches of a few remaining trees are cut to provide fodder for camels, goats and donkeys. In Zaire and elsewhere, chainsaws cut through the massive trunks of forest trees for timber and to clear land for planting. In East Africa, savannah trees are cut down and used for firewood or charcoal.

Around the continent, the story is repeated. Landscapes are denuded to meet needs for fodder, timber, fuel and land to cultivate. Rates of vegetation removal are escalating as populations increase. When exposed to human practices and natural elements, soils quickly lose fertility or are lost through erosion.

Soil is a finite resource. A thin, fragile layer over the surface of the land, it is extremely vulnerable to over-use and mismanagement. All terrestrial ecosystems have their origins in soil, and soil is essential for the growth of plants which provide food, fibre, fuel, timber and oxygen.

Most people who contribute to soil loss do so out of ignorance. Peasant farmers denude hillsides of their protective vegetation. When governments allow commercial exploiters to cut down forests, soil loss soon follows vegetation loss.

Bare soil, without plant cover and the tangle of roots to anchor and bind it, can erode rapidly. Wind lifts particles of soil and carries them away, particularly in dry areas. Rain water, especially torrential tropical downpours, washes away soil and deposits the precious load into streams and rivers. The soil is carried far from its place of origin and much is finally deposited in the sea where it causes problems for marine ecosystems.

Soil Loss

Losses of 20 to 50 tonnes of topsoil per hectare per year are a common syndrome in the cultivated areas of Africa. A total of 742 million hectares, more than a quarter of the whole continent, is in the process of becoming useless for cultivation. Crop yields are falling, and fuelwood is growing scarce. The process is self-perpetuating, threatening not just the hope of progress, but even the hope of survival.

An erosion gulley in a sorghum field, Lesotho. In Lesotho, the average soil depth has been reduced from 38 cm to 28 cm during this century. (Photo: J. Wilkinson)

There are no comprehensive surveys on the extent and scale of soil loss in Africa, but scattered reports construct an alarming image. Ethiopia, for example, loses between one and three billion tonnes of fertile soil every year. This soil loss translates to a loss of about 1.5 million tonnes of grain a year, equal to all food relief shipped to Ethiopia in 1985. In Zimbabwe, it was calculated that 1.5 million tonnes of nitrogen, 15.6 million tonnes of organic matter and 0.24 million tonnes of phosphorus are lost annually due to erosion. Financially, these losses (most prevalent in communal arable and grazing lands), are estimated at costing US$1.5 billion a year. In Lesotho, the average soil depth has been reduced from 38 cm to 28 cm during this century. In Madagascar, every section of cropland is losing between 25 and 250 tonnes of topsoil a year.

Virtually no inhabited area is unaffected by soil loss, and many areas face potential loss of more than 50 tonnes per hectare per year. Water erosion poses such a risk in humid and sub-humid Africa, while similar threats exist from wind erosion in the Sudano-Sahelian zone.

What to do?

Soil erosion control became the subject of serious concern in the 1930s, but since independence only a few African governments have given soil conservation the priority it demands. Successes in soil conservation are rare.

Soil degradation can be halted. Needed are simple, cheap and effective techniques that farmers can learn easily and afford to use. Soil conservation measures should minimize the loss of land to crop production, as well as minimize costs in both money and labour input, and they should compensate for costs through increased production of food, fuelwood, fodder or other useful goods.

The techniques for saving soil are well-established. They include terracing steep slopes, a labour intensive but often necessary measure, contour ploughing, alley-cropping, and mulching.

Effective soil conservation requires awareness and commitment on the part of governments and the public. At the grassroots level, strategies to integrate agriculture, forestry, energy and rural development are vital. There is also a need for governments to re-evaluate policies to provide greater economic stimulus to agricultural production and to give more attention to the implications of population growth. Most of Africa's farmers are women, but they are often ignored by

Some UNEP assisted projects relate to soil management, such as contour terracing as here in Ethiopia. (UNEP/Charles Stewart)

programmes aimed at agricultural productivity and soil conservation. Women must be fully involved in conservation schemes from initial planning to final implementation.

How UNEP is helping

The United Nations Environment Programme is a catalysing, not an implementing agency. Its role in conserving soil, as in other areas, is to identify the problem, create awareness of it, and help co-ordinate strategy. In 1982, UNEP's Governing Council adopted a World Soils Policy, drawn up with the help of FAO and UNESCO. Member Governments agreed to pursue sound policies of soil management to curb degradation and enhance productivity.

The plan is divided into five major programmes. The first assists countries to formulate their national soil policies. The second helps in the implementation of the policies through missions, field projects, seminars, technical publications and training programmes to produce technical cadres to take responsibility for soil management. The third programme enhances international awareness at all levels about the problems of land degradation, and stresses the importance of conservation issues. The fourth develops the technical and scientific knowledge necessary to promote the rational use of soil. The fifth programme involves collecting and disseminating data on the world's soil resources, their use and management requirements.

UNEP is now working to implement the 12 major projects that comprise the World Soils Policy. One project concentrates on protecting the watersheds of rivers threatened by poor land management. The watershed project aims to provide productive, sustainable systems of agriculture, to carry out soil surveys, land evaluation and related studies, and to train local personnel in the techniques of environmentally sound watershed management.

Other projects relate to initiating strategies for soil management. One aims to improve farming methods in fragile mountain ecosystems in the developing world. In the Himalayas, Ethiopia and other mountain areas, pressure on land is intense with populations of subsistance farmers moving higher and higher up the mountainsides. Removal of vegetation and poor farming methods on steep slopes rapidly cause erosion, particularly in areas of heavy rainfall.

The aim of the biological nitrogen fixation project is to increase soil productivity by increasing soil fertility. The level of soil nitrogen can be increased using nitrogen-fixing bacteria in leguminous plants, an environmentally safe method that avoids adding synthetic chemicals to the soil. Other projects include the planning of environmentally sound development programmes and evaluative studies of land resources for future populations. Global projects involve the assessment and testing of methodologies on the worldwide extent and degree of soil degradation. UNEP is also developing and testing guidelines for selection of management practices in arid, semi-arid and humid tropics and mountain ecosystems.

In December 1985, in the wake of the African famine, Africa's Environment Ministers met in Cairo under UNEP's auspices and in co-operation with the UN Economic Commission for Africa (ECA) and the Organization of African Unity (OAU). Their aim was "to seek an African solution to the African problem". The Conference (AMCEN) agreed to set up networks of co-operating African institutions to deal with such issues as soils, climate and water resources. It also agreed to set up a series of pilot projects in villages and stock-raising zones where experts will help each community to work towards self-sufficiency in food and energy on sustainable basis.

(This conference, AMCEN, is reported on in the News from UNEP section Ed.).

Developing rangeland resources in African drylands

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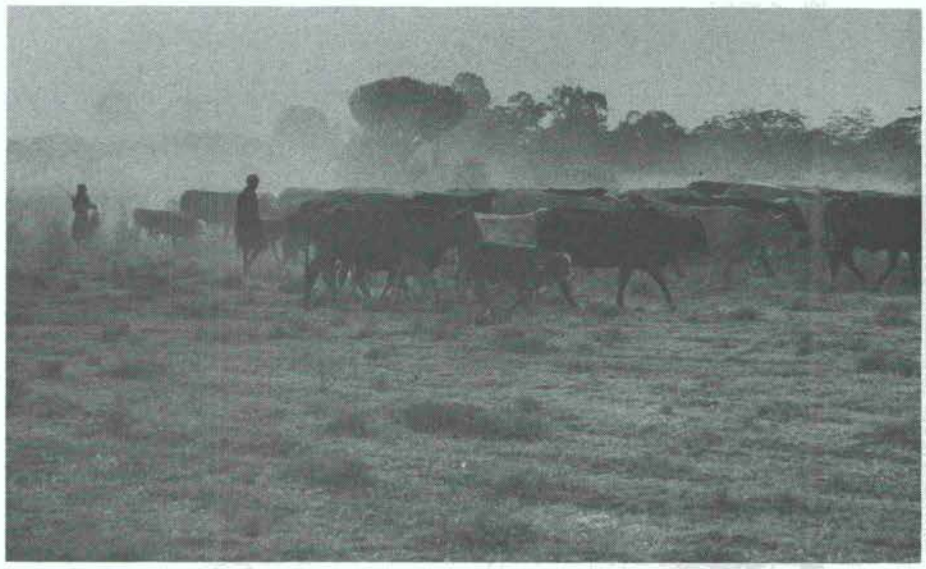


Cattle, unless well managed, are a major cause of desertification in rangelands. (UNEP/Daniel Stiles)

Introduction

Arid and semi-arid regions constitute more than 50 per cent of tropical Africa and support more than 35 per cent (116 million) of its population. The drylands of tropical Africa extend over an area of 24 countries[1] divided into the following:

(a) largely desert countries with more than 66 per cent arid areas: Botswana, Cape Verde, Chad, Djibouti, Kenya, Mali, Mauritania, Niger, Somalia;
(b) countries with over 30 per cent arid and semi-arid areas: Burkina Faso, Ethiopia, Gambia, Mozambique, Senegal, Sudan, Tanzania, Zambia, Zimbabwe; and
(c) countries with below 30 per cent arid and semi-arid areas: Angola, Benin, Cameroon, Madagascar, Nigeria, Uganda.

In arid lands, the dryland vegetation is a fundamental resource which transforms solar energy into food and which protects and stabilizes the surface of the ground. This vegetation survives by adapting to water deficit in ways which are important because they determine seasonal differences in the usefulness of dryland pastures.

Under natural conditions and through appropriate strategies the dryland ecosystems maintain a balanced exchange of water and energy. The equilibrium is readily disturbed when meagre vegetation is reduced by man's actions that expose the ground surface; humus will be mineralized and soil structure lost. Rain will fall directly on the soil and break it down. As the water budget deteriorates in the soil beneath, the level of groundwater in nearby wells may fall. The water lost to storage in the soil now contributes to increased runoff. Where the surface has been loosened or disturbed, the top soil layer, with the best structure and the bulk of plant food, may be washed away, or blown away in dust storms. All these changes mean a more hostile environment for plants. Vegetation will respond less well to rain, produce less biomass and many plants will die at an increasingly

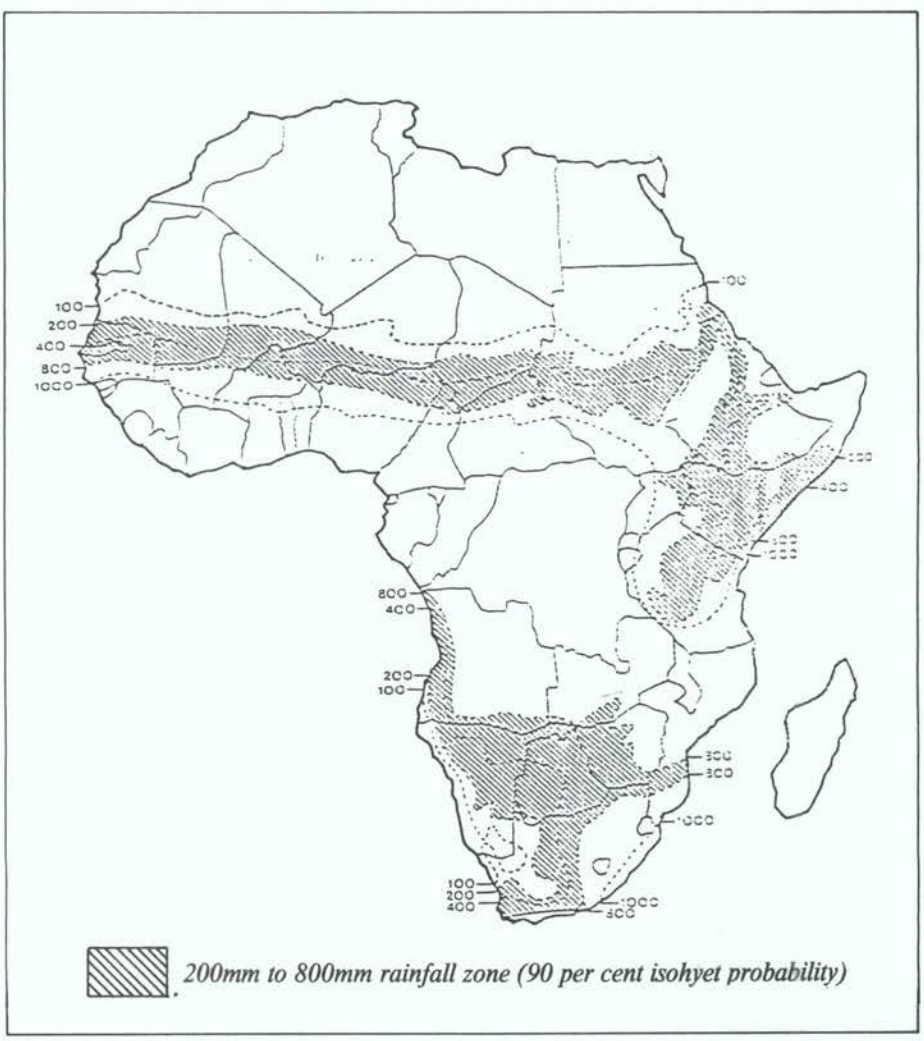


Fig. 1. Africa rainfall. Source: Adapted from Atlas for Africa. Editions Jeune Afrique, 1973.

early stage of drought. Such changes are typical of desertification.[2]

While traditional systems of livestock management were generally well adjusted to local ecological conditions in the past, today rangelands in Africa have severely deteriorated. We know far less than we need to about relevant human ecology as applied to rangeland management. A long history of failed resources is part of a large process by which local mechanisms to manage resources in good or bad years have been eroded by events beyond their control. The development of rangeland resources in African drylands must be carried out hand in hand in an integrated fashion with antidesertification measures.

Table 1: Growing stock and deforestation rates by country

Country	Volume of forests and savannas 10^6 m^3	Annual deforestation rate 1981-85		
		Total deforestation (1000 ha(1)	Savannas % of Savanna area	Forests % of forests area
A.	*Largely desert countries (over 66% of area arid)*			
Botswana	229	30	0.1	n.a
Cape Verde	n.a	n.a	n.a	n.a
Chad	213-(2)	80-(2)	0.6	0.0
Djibouti	n.a	n.a	n.a	n.a
Kenya	116	39	1.6	1.7
Mali	102	40	0.5	n.a
Mauritania	n.a	n.a	n.a	n.a
Namibia	214	50	0.2	n.a
Niger	34	60	2.1	n.a
Somalia	156	13	0.1	0.2
B.	*Countries with over 30% of area in arid and semi-arid zones*			
Burkina Faso	85	60	0.8	n.a
Ethiopia	752	88-(2)	0.4	0.2
Gambia	7	5	2.0	3.4
Mozambique	133	120	0.8	1.1
Senegal	145	49	0.5	n.a
Sudan	997	504	1.1	0.6
Tanzania	693	130	0.3	0.7
Zambia	629	70	0.1	1.3
Zimbabwe	222	70	0.4	n.a
B.	*Countries with below 30% of area in arid and semi-arid zones*			
Angola	1091	94	0.1	1.5
Benin	60	66	1.7	2.6
Cameroon	4861	100	0.3	0.4
Madagascar	1104	156	0.2	1.5
Nigeria	958	400	1.1	5.0
Uganda	165	50	0.8	1.3

Sources: FAO/UNEP (1982), FAO (1984), J. Kotschi et al. (1986)
(1) Mean gross volume over bark
(2) J. Kotschi et al. calculation
n.a not available
Remark: The given wood volumes exclude shrubs and woody fallows.

Natural conditions

Tropical Africa, as delineated by FAO[4], lies between the northern and southern isolines of 18°C as mean temperature in the coldest month. Figure 1 shows rainfall zones in Africa.

Soil fertility in arid and semi-arid regions is determined primarily by water availability. Low nitrogen content is the next limiting factor for production, followed by phosphorus availability. Nutrient levels of potassium, calcium and magnesium are normally sufficient; pH is commonly neutral to slightly alkaline. Wind and water erosion are the most common mechanical problems.

Water conservation measures are of primary importance. Apart from large alluvial valleys, such as along the Niger River, water is generally scarce. In most cases, surface water is available only during and shortly after the rainy season, which lasts from zero to six months. Reduced annual rainfall during the last two decades, combined with increased surface run-off on degraded lands and greater demands for water, have led to a situation in which water use exceeds water replenishment. The ground water levels have dropped. In some areas natural vegetation is dying because root systems no longer reach ground water tables. Consequently, boreholes supplying drinking water for humans and animals must be continually deepened.

Much of Africa's natural vegetation is characterised by savannas, woodlands and sparse forests. The savannas range from grassland plains with a few scattered trees, through shrub and open woodlands, to dense and complex systems of trees, bushes and grasses. In many areas, the savanna merges into a true forest in which there are several levels of trees, often described as broad-leaved woodland or wooded grassland. With increasing aridity, the density of trees decreases and thorny, xerophilic and drought-resistant species gain in importance. Most of these are slow-growing, and many are difficult to regenerate.

Large areas of savanna woodland and dry tropical forest are being cleared every day to make way for cash crops. Domestic grazing animals can also destroy woodland. It is even more difficult to keep track of the destruction of trees outside the forests. Yet the loss of such trees, rarely recorded in forestry statistics, may be more important to rangeland ecology than loss of forests. Growing stock and deforestation rates by country are given in Table 1.

Bush fires, another cause of deforestation, are most common in areas with a homogeneous biomass greater than 1 tonne ha^{-1}. South of the 700mm isohyet, the vegetation burns every year[8]. Bush fires influence the dynamics of the rangelands in two ways: directly, via the seed balance and indirectly, via the burning of the biomass.

Drought exacerbates the situation in African drylands. The 1968 — 73 Sahel drought killed between 50,000 people and some 3.5 million head of cattle[3]. However, prolonged droughts are a "normal phenemenon" in the Sahel. Drought is a relative concept implying rainfall insufficient to support human and animal population. Drought has revealed, not caused, ecological imbalance, environmental degradation and mismanagement.

Production of rangelands

The production of rangelands is often expressed in the number of cattle, sheep, and goats per hectare, or in kilogrammes of meat and milk per animal. Although this production (secondary production) is the ultimate goal, we must accept that plant production (primary production) is the basis for this secondary production[8].

Primary production can refer to natural vegetation, cultivated forage or agricultural by-products. The quantity and quality of primary production determines secondary production. Likewise, secondary production influences primary production. Here we will merely mention overgrazing, deforestation, bush fires and drought as factors which influence this primary production.

Primary production depends on the environment, although humans can intervene by irrigating, fertilizing, reseeding, tree planting, etc. Climatic factors (rainfall, temperature, humidity, radiation, evaporation, photoperiod) and edaphic ones (topography, physical and chemical characteristic of the soil, depth of the soil) determine the quantity and quality of forage.

People have modified the primary production of African rangeland through agricultural and pastoral expansion, deforestation, fire and new settlements. In many instances these activities have reduced biological diversity and productivity and caused serious breakdowns in essential ecological processes. We have to find a way out of the present situation before we can develop rangeland resources on a sustainable basis.

Investments and achievements in the rangelands of Africa

In the last 15 years the equivalent of 600 million US dollars in international development funds has been invested in the rangelands of Africa in an attempt to develop a strategy of resource exploitation that would be as efficient as traditional pastoralism but that would have a chance of coping adequately with the greatly changed conditions of late twentieth century African life[9]. There is, however, very little to show for that investment. Several reasons have been suggested for the failure of livestock and rangeland projects:

(a) Domestic livestock systems have undoubtedly been introduced into some areas which are ecologically unsuited to that form of land use;

(b) it has been difficult to design projects to the required geographic scope; pastoralists are highly mobile and their cultures and economics often transcend more than one political boundary;

(c) pastoralist systems and rangeland ecologies are insufficiently respected as a basis for planning;

(d) projects intended to improve pastoralist conditions have frequently been poorly designed and executed; there are numerous examples where development and charitable institutions have attempted to assist rangeland without adequately assessing or understanding the total system these people live and work within;

(e) projects have been imposed without an understanding of pastoralist societies, and imposed to achieve objectives which have little to do with the objectives of those societies[10].

Ways and means of developing rangeland resources

While there is no single fix or package for livestock and rangeland management, and little prospect for dramatic improvement, there are nevertheless a number of promising improvements and techniques which could provide benefits, particularly if used in combination. These include controlled extension of water points and any other forms of water development, livestock population control adjustment and carrying capacity improvement, pastoral grazing strategy development, planting of multipurpose fodder trees and shrubs, natural forest management, sand dune fixation, reseeding of range and education, training and research.

Controlled extension of water points

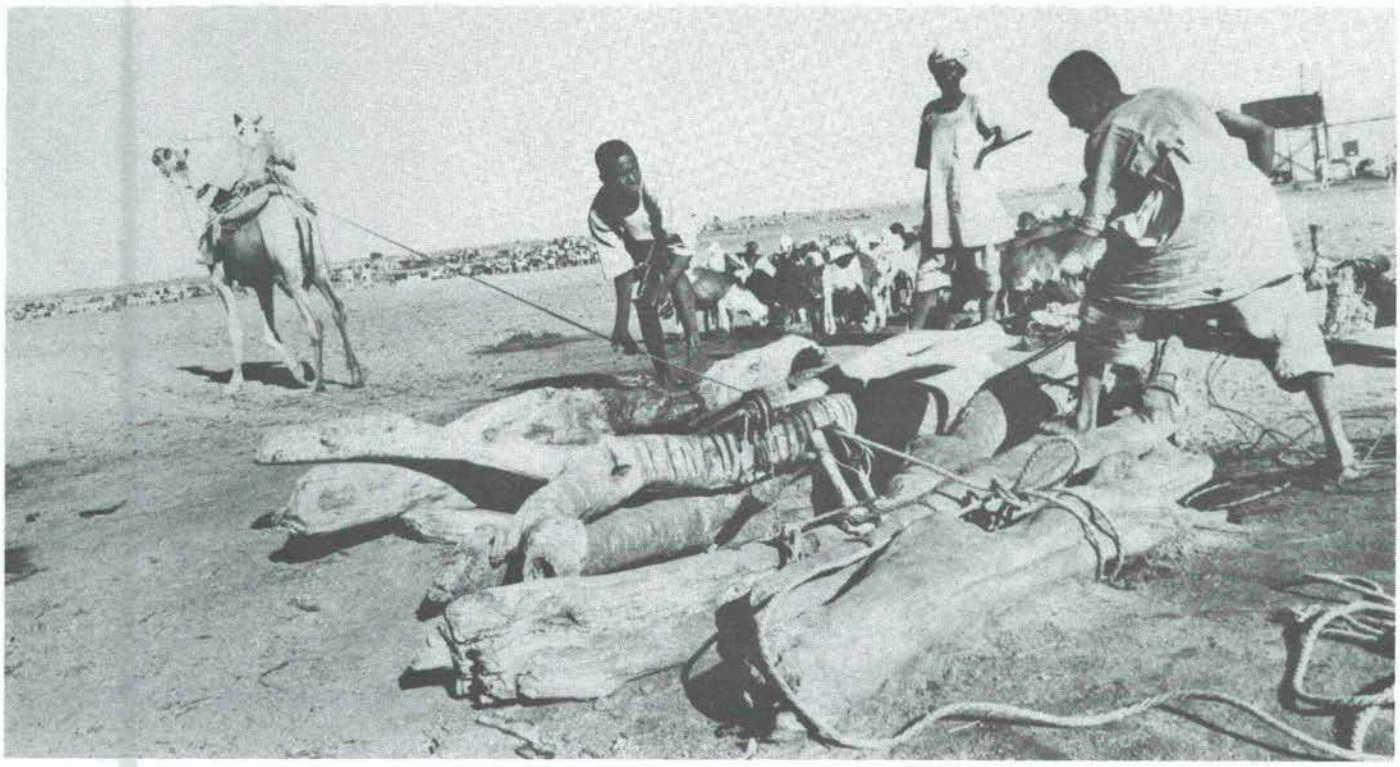
Much effort has been put into trying to improve the infrastructure of pastoralism by sinking of new wells, mainly in the Sahelian region of Senegal, Mauritania and Mali. The phenomenal growth in the number of watering points has concentrated herds in limited areas and caused desertification through grazing. browsing and trampling. Watering points tend to be over-used and often contribute more to degradation than to the opening of new ranges. Boreholes also tend to break down. In northeast Kenya only fourteen of 54 boreholes drilled since 1969 were working in 1979. In Botswana 40 per cent of boreholes never function. In Tanzania most of the former permanent water supplies are either broken down, clogged up or in need of spare parts[10].

However, in Botswana, water development increased available grazing area by 2.5 times, and in Somalia it appears to have been technically successful and without negative ecological impacts, although limitations of access have increased inequalities between pastoralists[11].

Evidence suggests that water development without careful planning, donor co-ordination and control over water use has considerably aggravated the severity of droughts. Today it is generally agreed that water development can play an important role in development of livestock production, but that it must be seen in the context of resource management as a whole if negative effects are to be avoided. In the future, water development will continue to be an important means of opening up grazing areas which are presently under-utilized or not used at all. For example, Mauritania has 55 million hectares of usable rangelands, but only 39 million are used, largely because of water shortage[10]. However, the capacity of wells or dams should be limited so that the number of animals which can be watered is not so great as to cause widespread overgrazing. The ideal situation with regard to water development in the Rendille area in northern Kenya would be to place a watering point every 25 sq. km[12]. Manual or animal-driven pumps rather than motor pumps should be used to draw water.

Livestock population and carrying capacity

Relative to area and human population, a



Much effort has been put into trying to improve the infrastructure of pastoralism by sinking new wells, mainly in the Sahelian region. (Earthscan/Mark Edwards)

Table 2: Human and livestock population in African drylands

Zone	Arid	Semi-arid	Drylands
Surface area (million km²)	8.3	4.1	12.4
Agricultural population (million people)	24.8	65.7	90.5
Livestock population (million head)			
Cattle	31.5	45.5	77.0
Sheep	37.0	23.0	60.0
Goats	48.3	33.2	81.5
Camels	11.1	—	11.1
Total TLU*)[1]	41.7	37.4	79.1
People /km²	3.0	16.0	7.3
TLU/km²	5.0	9.1	6.4
TLU/Person	1.7	0.6	0.9

Source: Jahnke (1982), adapted.
[1] TLU . . . Tropical livestock Unit: 1 camel = 1 TLU, 1 cow = 0.7 TLU, 1 sheep/goat = 0.1 TLU.

higher percentage of total livestock population is found in the arid and semi-arid drylands of Africa than in other dry tropical areas, such as those in South Africa and Australia. Table 2 shows that the drylands of Africa have a high stock density (6. 4 TLU/Km²)*. The semi-arid zone has the highest density of livestock and agriculturally active people than any other ecological zone in Africa apart from the highlands[5].

Carrying capacity may be defined as the upper rate of stocking that can be supported on a sustainable basis without damage to the habitat. With increased numbers of people and livestock, large parts of arid and semi-arid lands have been severely overgrazed, leading to gross modification of the natural vegetation and serious soil erosion. The productivity and therefore the carrying capacity of the African dryland range resources have declined. This is true of trees and bushes, both browse resources. It is also true of grazing resources, which are affected by a probable change in species composition of annual grasses. Moreover, carrying capacity depends not only on the plants but also on the water available to livestock. The carrying capacity also changes with local variations in average annual rainfall, seasonal distribution of rainfall, soils and inputs of energy and nutrients.

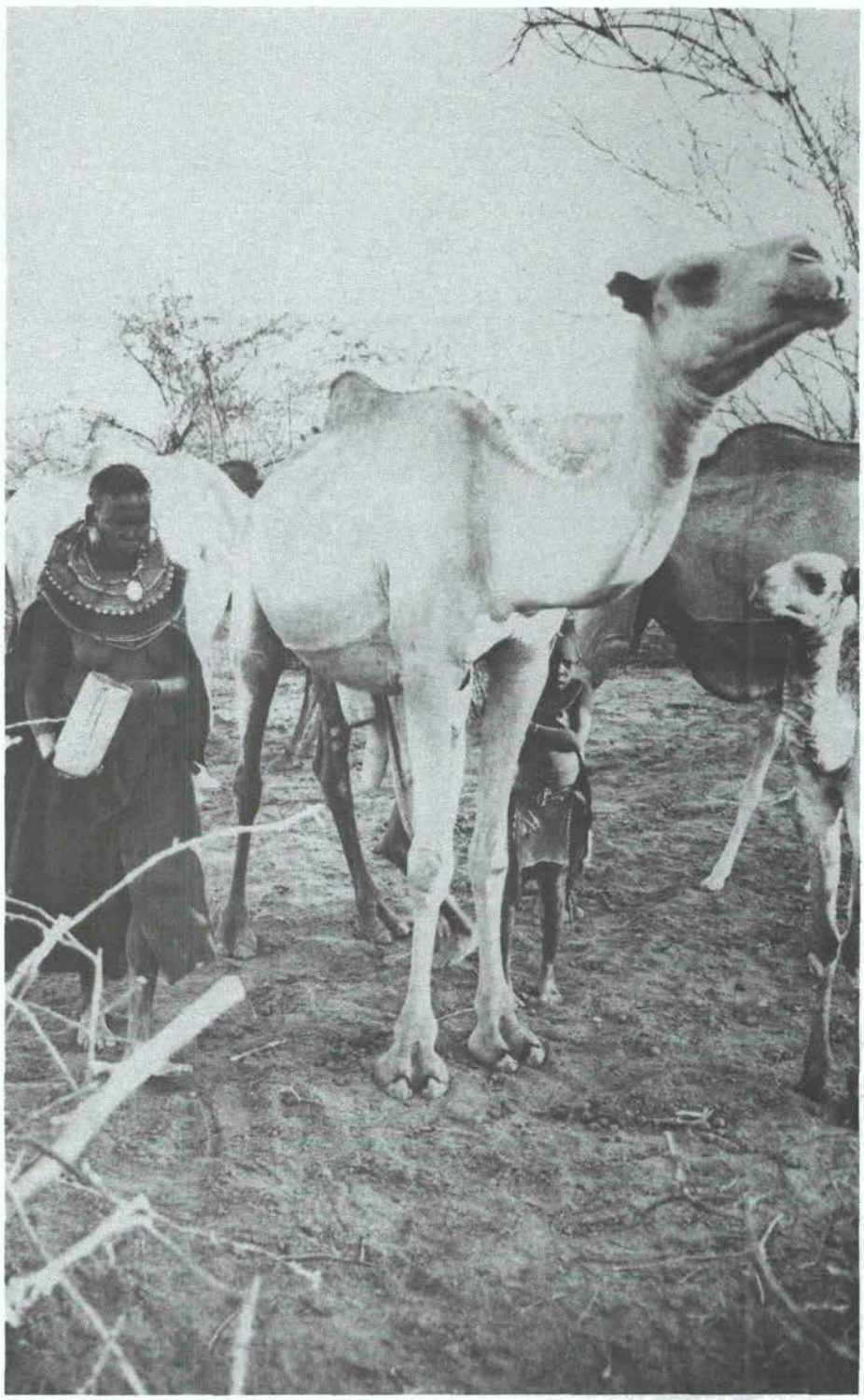
*) TLU . . . Tropical Livestock Unit.

How many people and domestic animals can be sustained in dryland rangelands without destroying it? Estimating the sustainable carrying capacity of rangeland is fundamental to any long term effort to help the environment to recover. Moreover, it is difficult and often a completely academic exercise. FAO finds an excess of current population in terms of food production for many African countries[7]. A World Bank study finds enough land to support a much larger population until the end of the century, with regional variations[14]. Both studies assume a continued low input for this case; both predict much higher carrying capacities with increased inputs, by which is meant more capital-intensive methods.

Many pastoralists are good stockmen but poor pasture managers. Few will notice or be able to take heed of the deterioration of food plants or the time lag between disappearance of food plants and their effects on stock numbers. Often stock losses are heaviest in dry years, when they are blamed on poor rainfall rather than on range deterioration. Recovery in such areas may appear rapid with good rains but this is often misleading. Where there has been a loss of species or a change in the structure of plant communities, recovery of vegetation will depend on plant succession and may take decades. Where top soil has been lost, the recovery will take substantially longer.

Demographic regulation would be effective in the medium and long term. Control of pasture use is particularly important in determining the sustainability of land use. In the Sahel, access to pasture and browse along with rights to water, salt licks, and access to trees and wild food plants are regulated by traditional mechanisms in the pastoral economies. Seasonal and annual variations in plant growth make collective use of pastures inevitable.

Calculations of carrying capacity should be treated with caution, particularly if the methodology is not stated. Instead of an overall figure, a production system approach indicating specific forage limitations would be more appropriate for estimates of carrying capacity[1].



One of the herding strategies in arid areas is to keep the milking herd at home and disperse the dry herds to far away pastures in order to improve grazing around the homestead. (UNEP/Daniel Stiles)

Pastoral grazing strategies

A common strategy in mobile pastoral systems is herd splitting, e.g. milking animals are kept close to the homestead and the dry herd is taken to outlying areas, thus conserving pasture for the milch animals. In arid areas, dividing by species is also practised: the milking camel herd is kept close to the camp, the small ruminants some distance away, and the dry camel herd still further away, so that different grazing areas are used for different production purposes.

The patchy and unreliable rainfall in arid areas demands high mobility of herds, and the more arid the area the more opportunistic the land use must be to achieve any livestock production[11]. Moving from area to area, mobile livestock have an advantage over sedentary animals in being able to graze for a longer period relatively young grass with higher nutritional value. The effects of long distance movements on animal production are often regarded as negative. However, if driving is done carefully, animals can even gain weight en route[15].

Sedentarization

The essential adaptive strategy of pastoral societies is movement. The policy of most countries is to settle the pastoralists in order to provide them with services such as education, health and veterinary services, and to better integrate the pastoralists into the marketing system.

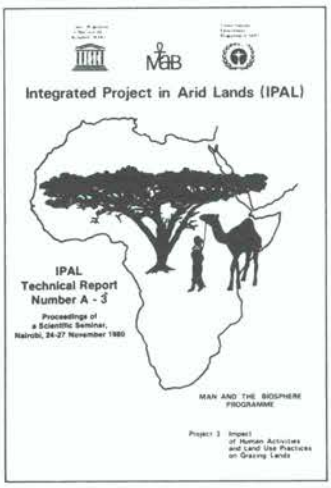
Development services for pastoral societies should, as much as possible, be based on training local members of a community in the fields needed, such as those mentioned above and providing them with all the infrastructures of services. Undoubtedly, this trend heightens the need for range monitoring and control in zones surrounding settlements, trading centres and water points.

In 1976, UNESCO and UNEP started a programme in a 22,500 km² area of northern Kenya traditionally grazed by four groups of nomadic pastoralists. This Integrated Project in Arid Lands (IPAL) was an interdisciplinary research project designed to determine the process leading to desertification and to find solutions.

The project appeared to combine both modern and traditional techniques. It included permanent settlements, as well as food aid and veterinary and well-digging services. The project found that desertification accompanied settlements around wells, shops, schools and famine relief centres, and has been exacerbated by a reduction in available grazing areas.

IPAL — KALRES (Kenya Arid Lands Research Station) has over the years produced an impressive quantity of published documentation, containing much valuable scientific information, including ecological studies, the composition and density of woodlands and shrublands, and monitoring trends in tree populations, human consumption of wood and browse production and consumption. The long term objectives were to develop a system of land use which would reverse the present trend towards rangeland degradation and to establish production at a level sufficient to provide for the needs of the growing and increasingly sedentarized population. However, the mobility and dispersion of livestock can be increased considerably, and overall numbers of livestock can be better controlled through a greatly improved marketing system[16].

Resettlement and training in non-pastoral occupations can reduce pressure on pastoral land. Success in resettlement of pastoralists has been reported from Somalia, where some were trained as fishermen[17]. Hogg[18] suggests that rather than resettling destitute pastoralists after drought or similar disaster, it may be economically more rational to help them to restock, at least in areas where widespread overgrazing is not an immediate problem.



The Unesco implemented Integrated Project in Arid Lands, begun in 1976 with UNEP funding, has published a large number of technical reports on the results of their research in northern Kenya.

Planting trees and shrubs

Few afforestation efforts have been made to improve arid/semi-arid rangelands in Africa. Most of the present forestry programmes were launched in response to the 1969 — 1973 drought. Since 1975, commitments have been growing rapidly especially by CILSS (Comité permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel). The main efforts are concentrated in West Africa, followed by East Africa.

In the early years, forestry activities were aimed primarily at meeting domestic energy demand, e.g. fuelwood and charcoal. A slight change in approach can be observed within the last three to four years. FAO, USAID and some other organizations have tried to encourage greater use of trees and shrubs for livestock fodder. Trees of the *Prosopis* genus and *Acacia* genus are highly resistant to drought. *Prosopis* bears pods which are up to 14 per cent protein and 45 — 55 per cent carbohydrate[3]. The foliage of *Prosopis juliflora* and *P. cineraria* are lopped for fodder every winter in the arid and semi-arid zones of India.

Acacia albida is also valuable fodder and often is the only remaining bit of greenery in the dry seasons of the Sahel. This leguminous, nitrogen-fixing tree has a deep root system that enables it to tap lower sources of water and nutrients inaccessible to agricultural plants. The leaf litter of the tree contributes nitrogen, other nutrients and much-needed organic matter to the soil. The wood is used for local construction and as fuel. The thorny branches serve as fencing material.

Acacia albida is leafless during the agricultural season and therefore does not compete with crops for light. Crop yields under and around *Acacia albida* have been found to be equivalent to those in fertilized fields. Therefore, *Acacia albida* has been given high priority in agroforestry projects in suitable parts of the Sahel[19]. The idea of agroforestry is to plant shrubs and trees intermixed with crops and grasses in spatial and periodical combinations such that there is little competition between them; instead, their various requirements should be complementary. In this way, optimum productivity per unit area can be achieved.

Many tree and shrub species have already proved useful for forestry activities within African drylands. Exotic tree species have been favoured, including *Eucalyptus camaldulensis, Azadirachta indica, Prosopis juliflora, Albizia lebbeck, Casuarina equisetifolia, Parkinsonia aculeata, Cassia siamea* and others. The indigenous African species have been largely ignored, even though it is well known that they are fully adapted to the local conditions, are highly resistant to drought and serve a great variety of functions. Among those successfully planted are *Acacia senegal, A. albida* and *Khaya senegalensis.*

In many cases, it would probably be preferable to plant shrubs rather than trees. Shrubs appear to have been largely neglected, yet they could represent a valuable contribution of forestry to improved land use.

Sand dune fixation is designed to prevent the movement of sand for a long enough period to enable either natural or planted vegetation to become established. The technique of dune fixation is, therefore, based on the principle of reducing the threshold velocity of wind at the dune surface by establishing a pre-planting mechanical system. Good results with sand dune fixation have been obtained in Senegal, Morocco, Mauritania, Mali, Somalia and Tunisia. Of all the tree species, the hardiest and the most adaptable in the arid regions is *Tamarix aphylla.*

Given the tremendous fuelwood needs within the rangeland regions and the fact that national forestry departments are not able to match present afforestation

needs, the only long term answer seems to be social forestry. This involves mobilizing the support and active participation of local people to plant and protect trees. Social forestry in African drylands is still at a very modest level compared with Asia, notably India and China. The most popular afforestation measure is the "green belt", a shelterbelt of hard, drought resistant trees that protects settlements from sandstorms and encroaching sand dunes, and can be harvested for fuelwood, fodder and poles. A green belt of 500 hectares was established around Ouagadougou, capital of Upper Volta and one of 300 hectares around Niamey, capital of Niger with UNEP support.

Fuel-saving cook stoves aim at reducing fuelwood consumption by replacing the traditional three-stone fire. Energy savings in the range of 30-40 per cent can be achieved[1]. Many stove programmes have been quite successful.

Reseeding of range

Determining whether a range can be restored by natural means or will require artificial seeding is a matter of judgment. The decision, however, should be based on the kinds and quantities of plants remaining, the expected rate of natural recovery and the cost of alternative approaches. The climate, the soil conditions, the availability of supplementary treatments that may be used to accelerate natural restoration, and whether the site is adapted to artificial seeding techniques also play a role in the decision.

Reseeding ranges with indigenous grass species has been attempted in many parts of Africa. However, in view of the high cost and low animal production yields per unit area reseeding is not likely to be economically viable[1]. Furthermore. reseeded areas must be protected.

Education, training and research

People's knowledge should be the starting point of rigorous scientific enquiries. There is need for a two-way channel of communication between scientists and local people in which both sides gain a better knowledge of animal husbandry practices and farming.

It is important that scientific and technological advances be communicated in such a way that their adoption is facilitated by a perception that they are seen as both socially and economically beneficial and ecologically sound.

Some of the recommendations to be proposed for acceptance will be quite new to local nomadic populations. To convince them that the recommendations made are workable and desirable, demonstrations are necessary. Two types of demonstrations should be emphasized: active participatory demonstration and non-active participatory demonstration.

Suitable topics for training include: afforestation programmes, construction of water points, soil rehabilitation, energy savings, the use of veterinary drugs, livestock breeding, antidesertification measures and health care.

Conclusions

Rangeland rehabilitation is a highly specific process and must be based on a large number of community ecodevelopment projects of manageable size. Many different actions are necessary to solve the problem of environmental degradation in drought-affected regions of Africa. These are needed at all levels, from local to international, and from an enormous spectrum of individuals and organizations.

Environmental rehabilitation cannot be a purely technical process. African societies cannot resurrect the past, nor can they be expected to adopt an environmental philosophy shaped largely by the concerns of Western society. To achieve the balance between productivity, ecological sustainability and equity, African societies need to develop an ethic with corresponding attitudes and behaviour that reflects an appreciation of the harmony expected from ecodevelopment. Local people must be fully involved in the necessary and slow search for a new ethical and behavioural attitude.

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NEWS FROM UNEP

UNEP has assisted Jordan to formulate a National Plan of Action to Combat Desertification. Planning agricultural development is a major focus of the Plan. (WFP/U. Pizzi)

UNEP Assists National PACDs

Jordan, Syria and the Yemen Arab Republic have completed their national Plans of Action to Combat Desertification (PACD). UNEP, anxious to see the plans implemented, has provided support and expertise to the countries, acting in close collaboration with governments to ensure the formulation of concrete projects that address the rehabilitation of salinized agricultural lands, the stabilization of shifting agriculture and the restoration of degraded rangelands.

UNEP has provided help with the expectation that each national PACD becomes an integral part of the countries' overall development plans. In order to carry out projects proposed in the PACDs, the countries will have to seek their own funding through the traditional bilateral donor network.

Jordan

Jordan's PACD has been drawn up jointly by UNEP, FAO and the Economic and Social Commission for Western Asia (ESCWA). It includes data taken from a survey of agricultural resources, an assessment of the status of existing projects and identification of the causes of desertification.

Jordan is suffering from a combination of rising population and limited agricultural potential. Ninety-one percent of the country is classified as arid land, and it is estimated that 99 percent of the total land is subject to varying degrees of desertification. Despite this recognition of the problem, up until now there has been a lack of a coherent plan for desertification control.

The new PACD suggests the causes behind the failure of past national plans, as well as making new recommendations. It is a comprehensive document of 135 pages, containing a considerable body of important statistics of use to planners, developers and anyone involved in agricultural development of desertification control. Useful statistics include information on many socio-economic aspects of the country, from population statistics to rural development. The first two Five Year Plans up to 1985 are discussed in detail, while the current (1986-1990) plan shows that environmental protection and pollution prevention are gaining importance in Jordan's overall development.

If the PACD is implemented successfully, Jordan should see dramatically improved protection of agricultural lands from desertification, as well as greater control over the sources of water pollution.

Syria

Syria's national PACD was formulated in 1987 with assistance from the UNEP Regional Office for West Asia (ROWA). The plan is the result of a fruitful co-operation between ROWA, the Arab Center for the Study of Arid Zones and Dry Lands (ACSAD) and Syria's State Ministry for the Environment.

The PACD highlights the gravity of the desertification problems encountered in the various Syrian ecological regions, notably soil erosion in the coastal ranges, overgrazing in the rangeland areas, salinization of irrigated lands in the Euphrates Valley, sand dune movement in the dry zones and the pollution problems of soil, air and water.

The plan proposes a number of priority demonstration projects. Several ministries will be involved in implementing the plan in seven ecological zones: (1) mountainous regions, (2) agricultural plains, (3) deserts, (4) marginal lands, (5) river valleys, (6) oases and (7) national parks. Although Syria currently has no national parks, three sites have been selected by the government for designation. UNEP will assist the Syrian government in identifying donors for the projects.

The PACD is designed to function in synch with Syria's ongoing five year development plan, and would make an excellent reference for other Arab countries drawing up desertification control plans.

Yemen Arab Republic

Yemen Arab Republic's national PACD was completed in January, 1988 after formulation by the UNEP Regional Office for West Asia. The plan has been submitted to the government, and discussions to identify priority projects will be forthcoming.

Cairo Programme

The Cairo Programme for African Co-operation is now underway in its mission to halt environmental degradation. The programme is a multifaceted plan of action that grew out of the first African Ministerial Conference on the Environment (AMCEN) in December, 1985. Since that time, the conference has convened a second time and the conference's Bureau members have recently met to discuss the Programme's implementation. Some donors have been secured.

AMCEN was originally convened under the auspices of UNEP, the U.N. Economic Commission for Africa (ECA) and the Organization of African Unity (OAU) to instil co-operation between African countries in protecting natural resources and achieving self-sufficiency in food and energy (see *Desertification Control Bulletin,* No. 14, 1987). Representatives from 41 African nations attended the conference. They elected a president, set up four committees of experts on the major ecosystems of Africa, and institutionalized AMCEN to meet every two years. The four ecosystems represented are deserts and arid lands, river and lake basins, forests and woodlands, and seas.

AMCEN is committed to addressing the root causes of environmental degradation. The conference espouses the use of indigenous technology, local participation and small-scale, grass-roots development. To ensure that these goals are met, the conference will be working closely with the African NGO's Environment Network (ANEN), whose members sit on conference committees and will help implement projects.

AMCEN has identified four priorities for its agenda: halting environmental degradation; enhancing the food producing capacity of the continent; achieving self-sufficiency in energy; and correcting the imbalance between population and resources.

To encourage co-operation across national boundaries, AMCEN has created eight regional networks, each focussed on a specific area in need of research and management. These are: water resources, soils and fertilizers, conservation of genetic resources, climatology, renewable sources of energy, science and technology, environmental monitoring and environmental education and training.

One of the four ecosystem committees set up under the Cairo programme is the African Deserts and Arid Lands Committee (ADALCO). The committee, with support from UNEP, first convened in Dakar, Senegal in March, 1987. ADALCO's immediate plan of action consists of two basic components, as formulated by UNEP's Desertification Control Programme Activity Centre (DC/PAC) and the Regional Office for Africa. The first is to set up three model villages in each of 50 African countries. These projects would emphasize self-sufficiency and environmental revitalization. The second component is to create 30 pilot livestock zones in which small-scale irrigation can provide fodder for relief in the dry season. The main emphasis in these projects lies in their replicability for future projects, and in their demonstration of the AMCEN approach.

Other priorities of ADALCO include strengthening the North Sahara Green Belt Project and consolidating water resource development in North Africa; combating the spread of deserts and promoting food production in Southern Africa; rehabilitating ecological zones in the south Sahara in West Africa; and establishing co-operative efforts to combat savannization in the Central African region.

In order to help realize these and other goals of the Cairo Programme, UNEP co-ordinated the first meeting of donors and governments to discuss projects on March 24, 1988 at UNEP headquarters. The AMCEN Bureau requested the meeting. Attending were 16 African countries, 11 donor countries, eight U.N. organizations and seven NGO's. Fifty-four project proposals at the national, sub-regional and regional level were presented to donors. Twenty-three African countries have nominated 75 villages and 22 stock-raising zones to receive funding so far. Pilot projects are ready to begin in Egypt, Lesotho, Senegal, Sudan, Uganda, Zaire, Zambia and Zimbabwe.

UNEP has committed funds to seven projects so far, including an agro-sylvo-pastoral integrated development of four pilot villages and one livestock zone in Senegal, the development of natural resources and skills for rehabilitation and improved productivity of degraded resources around watering points in Darfur region of Sudan, rehabilitation of mechanized rainfed crop production in eastern Sudan, and planning for sustainable development in three pilot villages of Gombe, Butaleja and Ruhaama in Uganda.

All projects are expected to receive needed funding eventually. UNEP's Regional Office for Africa and DC/PAC are following up on expressions of interest received from donors at the meeting, although it remains the responsibility of each country to secure funds. In addition to external funding, AMCEN also expects each African country to contribute voluntarily to implementation of the programme through specially earmarked UNDP funds.

UNEP's Regional Office for Africa has been instituted as the secretariat for AMCEN. As such, it will help co-ordinate the many components of the Cairo Programme and mediate between the African nations and the international donor community, as well as between the African nations themselves. UNEP is ideal for this co-ordination because of its environmental priorities and its long-standing co-operation with other organizations.

Thus far all the structural elements envisaged in the AMCEN programme have been instituted. The conference has met twice, the committees have been established and their plans of work approved. Five of the eight regional networks identified for priority attention are in the process of formulating their programmes. Two networks, environmental monitoring and soils and fertilizers, have progressed to the point of estimating operating budgets. Sub-regional projects covering the Mediterranean, West Africa, Central Africa, East Africa, the Red Sea and Gulf of Aden, and the Zambezi River basin are all underway.

AMCEN Pilot Villages in Uganda

The government of Uganda is committed to the implementation of the decisions of the First African Ministerial Conference on the Environment (AMCEN) held in Cairo in December, 1985. One of AMCEN's recommendations is the creation of three pilot villages in each participating African country. The villages are meant to demonstrate environmentally sound development that aims to help control desertification.

In 1986-1987 UNEP provided assistance to the Ugandan government for project formulation studies in Gombe, Butelaja and Ruhaama sub-counties. Working through UNEP, Norconsult consultants performed comprehensive resource inventory studies and prepared survey reports containing profiles of the proposed village action plans. These were formulated through extensive discussions with village residents.

The Ugandan Ministry of Environment Protection also held consultations with the residents of the villages. These interviews culminated in a community seminar held from 3-7 August 1987. Participating in the seminar were village representatives, the Chairman of the Resistance Committees of the sub-counties and staff from the ministries of Environment Protection, Animal Industry and Fisheries and UNEP.

Consultants identified project priorities with input from the communities. The government of Uganda and the villagers decided to start immediately on the first phase of the pilot project in order to rehabilitate the human environment for a sustainable basis of development activities.

Phase one (December 1987 — June 1988) activities focus on improving water and shelters, establishing tree nurseries for agro-forestry and watershed management, introducing simple technological packages for management on demonstration plots and farms and introducing cheap building materials utilising lime-reinforced bricks and tiles.

Phase two activities, currently underway with UNEP support, are intended to

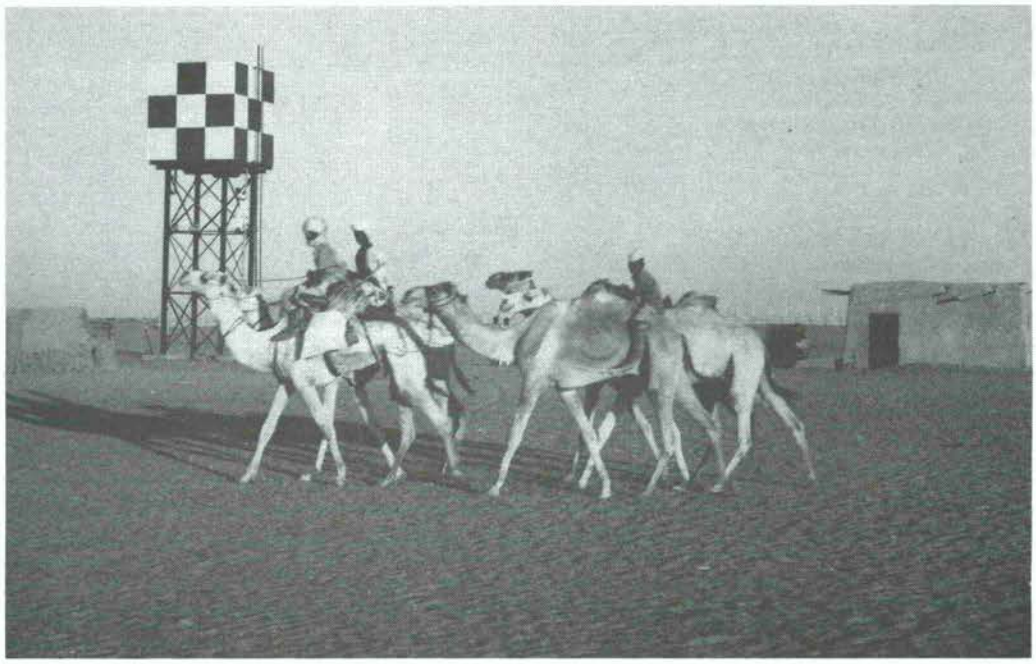
consolidate the pilot activities undertaken in phase one and to extend the scope of the project to Ibuje sub-county at the request of the Ugandan government. The project will draw on the practical field experience gained under the first phase and include additional parishes and subsistence farmers in the sub-counties. The aim of the project is to provide a local capability for self-sufficiency in food and energy based on the field-tested methodology established under phase one.

Once the commitment of the local people and administrations have been established, the project will rely on the active participation of community members during all stages of project implementation. A major component of the project is the satisfaction of basic human needs in water, shelter, energy, nutrition and health through low cost, environmentally sound methods that raise basic living standards. This will help prevent the possibility of poverty induced activities that are environmentally destructive, such as farming marginal lands or depleting the natural resource base.

Project activities will include appropriate soil and water conservation methods, a programme of institutional support to local co-operatives and community groups and a programme of on-the-job training and education for the local population to ensure the sustainability of the project beyond the end of the implementation phase.

Preparation of AMCEN Villages in Egypt

Last December UNEP and government officials began discussions on the preparation of pilot village projects in Egypt. A UNEP programme officer travelled to Egypt to meet with the Cabinet of the Egyptian Environment Affairs Agency, scientists from the Desert Institute in Cairo and officials from the Ministry of Foreign Affairs, Department of Technical Co-operation. Also assisting in the discussions were representatives from UN/FAO World Food Programme and UNDP.



The development of strategically placed water points is one of the areas in the UNSO work plan. (UNEP/Daniel Stiles)

The officials met over nine days in Cairo to develop a strategy for the development and implementation of the pilot villages. The projects are designed to demonstrate village self-sufficiency in food and energy through successful stock-raising programmes and increased general welfare of village inhabitants.

As part of his visit, the UNEP programme officer visited the site of one of the proposed villages, El Foukah, in northwestern Egypt. There he met with local villagers to begin assessing the needs and problems of the area. Accompanying him was Dr. Ahmed Moursy, Professor of Plant Ecophysiology, Desert Institute, Cairo.

El Foukah is a predominantly pastoral community on the Mediterranean coast. Rangelands are its most important renewable resource. Arable land area, now totalling 28,000 feddans, is expected to increase under the project's proposed ground water harvesting structures. In addition to such irrigation schemes, the project will help develop local industries from agricultural and animal products, integrate livestock and co-operative food production, improve rural roads and provide basic social and health services.

Other proposed village sites are Abu Suweira near Sinai and Abu Ghossum on the Red Sea in southeastern Egypt. UNEP is currently working with the Desert Institute, Cairo on further development of the village projects.

UNSO to Combat Desertification in 22 Countries

In 1973 the UN General Assembly created the United Nations Sudano-Sahelian Office (UNSO) as a response to the severe five-year drought that began in 1968. One of the office's mandates is to assist UNEP with the implementation of Plans of Action to Combat Desertification (PACD) in those countries lying south of the Sahara and north of the equator. UNSO began in 1978 the first phase of a project to implement the PACD, and is now embarking on phase two.

UNSO handles 22 countries: Benin, Burkina-Faso, Cameroon, Cape Verde, Chad, Djibouti, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Ghana, Kenya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan, Tanzania, Togo and Uganda.

Phase two is funded as a joint venture by UNEP and UNDP, and will demand close co-operation between UNEP and UNSO. UNEP and UNDP are each contributing one million dollars a year to the project. Funds are intended to expand UNSO's operational and institutional capacities, and to serve as seed money to attract other donors interested in desertification control.

The two-year work programme for phase two consists of four general components: project preparation; project and programme monitoring and reviews; consciousness-raising and public participation; and training and consultant services.

UNSO's first priority is project identification and formulation. Needed for successful and comprehensive desertification control are carefully planned projects that fit into a large framework of development in the region. Sectoral projects will be designed to mitigate deforestation, manage water resources and manage rangeland use.

Deforestation is one of the gravest forms of desertification in the Sudano-Sahelian zone. Projects for afforestation and reforestation are desperately needed. Fuelwood plantations, village and family woodlots, and integrated agroforestry and sylvo-pastoral schemes can all help contribute to replacing lost sources of wood. In addition, UNSO will implement projects that reduce the demand for ligneous materials through developing alternative sources of energy and introducing fuel-

efficient stoves. In order to control bush fires, a cause of severe forest destruction, projects will be aimed at modifying cultural and sociological factors that lead to unsound land practices.

The careful management of water resources is fundamental to improved conditions in the region. Before any integrated management schemes can be formulated, however, in-depth studies are needed on the region's hydrometeorology and groundwater and surface water conditions. Projects will then be designed using small dams, small-scale irrigation, strategically placed water points and drilling.

Rangeland management is one of the most difficult methods of desertification control due to its deep entrenchment in cultural practices and values. The limited carrying capacity of the zone's ranges also makes experimental management difficult. The area receives highly variable rainfall, and both human and animal populations are steadily increasing. Needed in the area are ecological monitoring systems, incentives to reduce cattle and goat populations, an increase of irrigated fodder to provide food in drought and additional applied research.

UNSO is determined to monitor and review its projects thoroughly, a step not always taken by international developers. The reviews should prove invaluable to future development activities.

Hand in hand with the above projects will be a comprehensive education and training campaign. Using audiovisual equipment, workshops and seminars, UNSO hopes to engender a conservation ethic in the region. Short study tours and fellowships will also be available to train students on specific desertification control techniques.

UNSO is now preparing 40 projects, 32 of which are specific to one country while eight are regional. The regional projects include seminars, a tree seed network, a plan to rehabilitate Lake Chad and a greenbelt for the Mali-Mauritania Common Zone. Concurrently, individual country PACDs are being formulated in Chad, Mauritania, Somalia and Sudan in accordance with UNEP's worldwide mandate.

DC/PAC's DESIS is involved in databasing and desertification assessment and mapping. (UNEP/Jairo Granados)

Information and Database Unit

In 1984, following Governing Council 12, DC/PAC set out to upgrade its information collecting, analyzing and disseminating capabilities in accordance with G.C. decision 12/10. Since then GC decisions 13/30 and 14/15 have reiterated the importance of information and database activities as a priority in the DC/PAC programme. In addition, DC/PAC is expected to assist governments establish their own national desertification databases and to help them collect and analyze data through monitoring and assessment programmes and the creation of Geographic Information Systems (GIS). The actions undertaken since 1985 are outlined below.

1. Desertification Information System (DESIS)

The necessary hardware and software were purchased and installed in 1985-86. Several databases were designed and data were collected and entry begun in 1986 through 1987. Seven databases have been completed (see attached table) and two are in advanced stages. Two databases, one on Water Erosion Control and one on Salination Control, are currently being designed. Databases indicated as completed in the table are subject to revision and updating as new data become available. DC/PAC is already receiving requests for information from the databases and DESIS is increasing its effectiveness and efficiency through the use of the computerized system. A new micro-computer system will be installed shortly which will allow increased databasing capacity, GIS operations and desk-top publishing.

The Desertification Library has been completely reorganized to facilitate cataloguing, storage, search and retrieval of documents/publications linked to the DELI database. Distribution documents (20,000+) have been inventoried and organized.

DC/PAC prepares and disseminates information materials through its own special publications, the *Desertification Control Bulletin,* contributions to other publications, films and slide shows. Since 1985 the following have been produced:

Special Publications:

1. Assessment of Water Resources in Arid and Semi-arid Regions.
2. Arid Land Development and Combating Desertification: Integrated Approach.
3. Principles and Methods of Fixing Shifting Sands.
4. Desertification Control in Africa. Vol. 1 Directory and Vol. II Actions.
5. Proceedings of the Training Course 'Rainfed Agriculture and Soil Conservation in Dry Zones'
6. Annotated Directory of Organizations Dealing with Desertification and Dryland Development.
7. Rolling Back the Desert
8. Research and Training for Desertification Control.
9. Les Plantations sylvo-pastorales dans la zone aride de Tunisie. (With UNESCO).
10. Aspects météorolgiques de la croissance et du developpement végétal dans les déserts et les zones menacées de désertification. (With WMO).
11. Financial and editing contribution to Special Issue on Desertification of *Land Use Policy.*
12. Voices From the Desert.
13. United Nations Compendium on

Desertification Control Activities.

14. Introducing the Camel.

15. Upgraded Regional Assessment of Desertification for Southern Africa (sent to UNEPCOM for printing)

In preparation:

1. UNEP's Desertification Control Programme Achievements: the First Ten Years.
2. Wind Erosion Control Manual.

Desertification Control Bulletin Nos. 13-17.

The Bulletin has been upgraded in quality since 1984 and the print run has increased from 3000 to 5000 due to increased demand. No. 15 was a special issue on the 10th anniversary of UNCOD.

Television Documentary Films:

1. "Seeds of Despair" (with TVE and Central ITV)
2. "Seeds of Hope" (with TVE and Central ITV)
3. "The Crowded Desert" (with TVE)
4. "Trees for Tomorrow"
5. "Tomorrow's Famine"
6. "China — Shifting Sands" (with TVE)
7. "Salt of the Earth" (with TVE)
8. "After the Harvest"
9. "The Camel"
10. "Environmental Song Contest" (with TVE)
11. "Dam on the River Kwai" (with TVE)
12. "Depending on Heaven-the Grasslands" (with TVE)

In preparation:

1. Films in Colombia and Vietnam (with TVE)

Slide shows:

1. "Harvest of Dust" slide show.
2. "Combating Desertification in Pre-Saharan Zones" in English and French (with UNESCO)

DC/PAC has entered into discussions with desertification research institutions in the U.S.A. (Arizona), USSR (Ashkhabad), China (Lanzhou) and India (Jodhpur) to offer assistance in the establishment of Desertification Database Systems and GISs which would be compatible with those utilized by DC/PAC and GEMS. The Office of Arid Lands Studies is now using the same databasing software as DC/PAC and is fully compatible with us. DC/PAC has entered into information and data exchange relations with them. It is hoped that all of these institutions will establish compatible systems to facilitate data exchange on desertification matters and form the basis for regional and global information networks. A proposal for a similar type of network to be set up in the ESCWA region has been made and DC/PAC would, within its available resources, be willing to assist.

II. Desertification Assessment and Monitoring and GISs

Assistance to countries in desertification assessment:

Following recommendations made at an Expert Group Meeting in 1985, the FAO/UNEP methodology for assessment and mapping of desertification is being tested and refined in a pilot project in Kenya. The project started implementation in 1987 in co-operation with GEMS and the Kenya Department of Resource Surveys and Remote Sensing (formerly KREMU). (see report below).

A similar assessment and mapping project has started up in Mali with UNEPCOM support. This project will test and refine a variation on the FAO/UNEP methodology appropriate to the Sudano-Sahelian context.

DC/PAC began implementation of a project with the Institut Géographique National of France to conduct a remotely sensed north-south transect through the West African Sudano-Sahelian zone in 1987 to test a variation of the FAO/UNEP methodology.

Current Status of Desis Databases

Database	Number of Entries	Description
Main Databases		
BIWIND	6300	Worldwide documentation on wind erosion control (completed)
ACWIND	183	Activities on techniques of erosion and wind effect; (completed)
DELI	680	DC/PAC-Desertification library bibliographic references (ongoing)
DIOR	528	Directory of Oganizations dealing with desertification control and dryland development (completed)
REWIND	355	Network of researchers and institutions dealing with wind erosion (completed)
KEYS	308	DESIS thesaurus (completed)
DEPRO	73	UNEP desertification control projects (completed)
PROCOM	326	UN-compendium on dryland development and desertification control projects (completed)
Utility Databases		
MAIL	2600	DC/PAC mailing list (ongoing)
LICO	—	DC/PAC library control (borrowing and distribution of documents)
Total	11,353	

Desertification GIS

DC/PAC staff and consultants have visited Sudan and Mali to discuss and study the feasibility of GIS establishment. Detailed reports exist and project formulation and discussions with potential donors have started. Project documents should be ready for both countries in 1988.

Thematic Atlas of Desertification.

Preparations for the Thematic Atlas have started with the three assessment projects mentioned above. Following recommendations of the Expert Group Meeting in 1985 further work on the Thematic Atlas will await finalization of the methodology.

Kenya Desertification Assessment and Mapping

As reported in *Desertification Control Bulletin,* no. 16, UNEP's Desertification Control/Programme Activity Centre (DC/PAC) and Global Environment Monitoring System (GEMS) are working in collaboration with the Kenya Department of Resource Survey and Remote Sensing (DRSRS) to improve desertification assessment and mapping techniques. The team is undertaking a project that will refine the set of indicators and modelling rules contained in the FAO/UNEP Provisional Methodology for mapping and assessing desert study areas.

The assessment and mapping project was initiated in April, 1987 and is slated to end in July, 1989. The project is now in its third of six phases. The phases are:
(i) study design, (ii) data acquisition, (iii) assembly of digital data base, (iv) model development, (v) production of analysed results, (vi) evaluation.

Field trips for collecting data have been conducted in the Marsabit and Baringo sample areas during both the dry and rainy seasons. Specialists are also ground checking existing soil and vegetation data against SPOT satellite imagery. A revised set of maps was produced and is currently being digitized.

So far, twenty maps have been digitized by DC/PAC for Marsabit at GEMS facilities from data collected from various sources and overlays have been designed using ERDAS and ARC/INFO software showing rangeland carrying capacity, livestock density and agroecological zones. Even more elaborate maps can delineate the potential for overgrazing and the inherent risk of desertification from using climate, soil and slope variables.

DRSRS has digitized a set of base maps for Baringo and similar maps for Marsabit will be carried out.

A more extensive and detailed report on the results of the project will be presented in the next issue of this bulletin.

Assessment Transects Across West Africa

A project is well underway to assess the impact of desertification on the West African landscape through satellite pictures and field data. The project, "Development of a Methodology for Assessment of Desertification in the South Sahara Arid, Semi-arid and Sub-humid Ecozones," will compare certain variables over time in four large transect zones. UNEP's Desertification Control Programme Activity Centre, having found previous geographic analyses of the region inaccurate or incomplete, recognized the need for a new, consistent methodology of desertification assessment. A recent UNEP mission went to Paris to review progress of the project, now in its first phase.

Funded by UNEP, the project began in November, 1987 under direction of the Institut Géographique National (IGN) in Paris in association with ORSTOM and the Laboratoire de Géographie Physique of the University of Reims. Using state of the art aerial photography and SPOT statellite imagery, researchers will compare the present ecology of the region with earlier aerial photographs taken between 1955 and 1961. This technique will help observers ascertain the extent of sahelization and deforestation. Four meridien transects have been chosen that follow the former flight routes from the latitude of 100 mm rainfall to isohyet 1500 mm. The first transect currently under study extends north-south through Mauritania, Mali and the Ivory Coast.

Under the project, scientists will introduce new parameters to the traditional study of desertification photos, such as ways to connect soil and erosion types with vegetation and the impacts of land use and human settlements. Maps will be made on the extent of water erosion, human migration patterns and detailed soil and vegetation types. Using the new photographs, IGN experts will calculate the index of normalised vegetation, enabling them to estimate the stability of conditions in the future.

UNEP's mission to Paris reviewed work on the first set of aerial photographs, taken on transect one in November, 1987. The assessment of the region shows dramatic changes in vegetation types over the last three decades, especially with regard to land area under cultivation. The mission report stresses the need to co-ordinate this assessment project with similar cartographic studies in Kenya and Mali. The West African transect project is slated to end in December, 1990.

New DC/PAC Publication

DC/PAC has produced an updated Compendium of Projects and Programmes of the United Nations system in the field of desertification issued by UNEP in May 1984 within the framework of the Inter-Agency Working Group on Desertification. It contains information on projects up to 1 December 1987. The following agencies and bodies of the United Nations system were requested to provide up-dates to their previous entries for inclusion in the Compendium by the end of June 1987: ECA, ECLAC, ESCWA, ESCAP, FAO, ILO, UN/DTCD, UNESCO, UNIDO, UNDRO, UNSO, the World Bank, WFP, WHO and WMO. With respect to the time frame, the present Compendium includes recently completed, ongoing and planned programmes and projects for which provision has been made or, in the case of field projects (UNDP-financed and others), those which had been adopted for implementation, within the period 1971 to 1995.

The United Nations system has a major role to play in three areas of activity. This relates, first of all, to the area of "Assessment of Issues relating to Desertification," particularly because the actual situation in the majority of areas affected by desertification has not been fully assessed. Most of the work within the United Nations system in this area is done by FAO, UN/DTCD, UNESCO, UNIDO, UNSO, WHO and the Regional Economic Commissions as well as UNEP, either individually or in collaboration with sister agencies and international scientific organizations. For example, FAO and UNESCO are quite active in conducting studies for the improvement and development of pastures, forestry, soil conservation and erosion control. Assessment of water resources and investigations on hydrological potential are being carried out by FAO, UN/DTCD, UNESCO, UNSO. and WMO. World Health Organization projects are related to health aspects and also to science and technology transfer. At the regional level, ECA, ECLAC, ESCAP and ESCWA are all taking an active interest in the socio-economic impact of desertification.

The main emphasis in the area of "Management of Arid and Semi-arid Ecosystems" is placed on programmes aimed at improving or introducing effective land management in areas subject to desertification, or to degradation processes leading to it. Furthermore, the management of natural resources is a critical component of any strategy for physical, social and economic development and is essential to all ecosystems if their productivity is to be developed and maintained. To meet the needs for management of those resources is a function which the agencies and organs of the United Nations system have been actively carrying out within their respective sectoral fields, activities which lead to the prevention of desertification and rehabilitation of desertified lands. This assistance covers a wide range of activities in such sectors as integrated rural development including development of irrigated lands (World Bank and FAO), soil conservation and

afforestation (FAO and UNESCO), rangeland and livestock development, water resources planning, development and management (UNESCO, UN/DTCD, WMO) and research linked to improved management of land and water resources (UNESCO and WMO).

The area "Supporting Measures" is of high importance for the implementation of programmes and activities in monitoring, studying and combating desertification and in a rational management of natural resources in lands subject to desertification. Assistance to countries in this area covers a wide range of activities, particularly the construction of physical and institutional infrastructures and provision of education and training for developing the needed manpower. Such UN agencies and organs as FAO, ILO, UNESCO, UNSO, WHO, WMO and the World Bank are active in providing the above prerequisite in the fields of agriculture, water management, arid land ecology, health, and transfer of techniques for attaining socio-economic development objectives including employment. It should be emphasized that many of the projects and programmes presented in the Compendium and executed by UN agencies under all the three above-mentioned areas of activity are funded by UNDP.

Each project has been evaluated for its relevance to the recommendations that were drawn up for the Plan of Action to Combat Desertification (PACD) which resulted from the United Nations Conference on Desertification (UNCOD) in 1977. The 28 recommendations were divided into seven major sub-sections. Two of the sub-sections, on the socio-economic aspects of desertification and on the effects of industrialization, urbanization and agriculture on the ecology of arid areas, are not represented by any of the projects in this Compendium. This is in part owing to the fact that certain organizations in the UN system did not submit updated information on current projects.

Copies can be obtained on request from DC/PAC.

Ad Hoc Group Improves DESCON

An Ad Hoc Working Group met over three days in Rome, Italy, in October, 1987 to discuss methods for improving the effectiveness of the Consultative Group on Desertification Control (DESCON). The meeting took place seven months after the sixth session of DESCON in Geneva, at which time members discussed the committee's poor record and the need for structural improvements *(Desertification Control Bulletin,* No. 16, 1988).

The Ad Hoc Group examined in detail the key problems of the DESCON mechanism, specifically, its inability to raise needed funds, lack of institutional co-ordination and poor communication between members. As a basis for discussion, representatives from UNEP and the Federal Republic of Germany each presented a working paper containing thorough and critical assessments of DESCON. Also present at the meeting were representatives from UNDP, UNSO, FAO and the World Bank.

As their recommendation for better funding procedures, the *ad hoc* group suggested that DESCON no longer consider projects for funding individually, but rather create conditions under which bilateral and multilateral assistance programmes can provide support at the national level as part of an integrated plan. The group recommended more support for international efforts in controlling desertification, such as monitoring systems, research networks and training programmes.

Addressing the problems of co-ordination and communication, the Group suggested that the DESCON secretariat prepare a report on progress and development every two years. The report should include information on the status of national action plans, newly formulated projects, donor priorities and other emerging issues. In addition, DESCON should support UNEP efforts in the compilation and analysis of desertification data. DESCON should advise UNEP on the priorities of information needed, and assist in the formulation of biennial compendia on training activities, periodical technical manuals, annual activity status reports and comprehensive assessments on progress to be published every six years.

The working group expressed concern over the limited human and financial resources of UNEP as the DESCON secretariat. In order to strengthen its capabilities, the group recommended that UNEP explore with FAO, UNDP and the World Bank possibilities for its re-organization. Options for this are acquiring more secretariat staff or establishing a joint UNEP/FAO technical unit that could utilize outside expertise.

A draft report on the *ad hoc* meeting was distributed in March, 1988 to all DESCON member governments and organizations.

IAWGD Ad Hoc Meeting

Members of the Inter-Agency Working Group on Desertification (IAWGD) gathered for their third ad hoc meeting on 25-28 April, 1988, hosted by UNEPCOM in co-operation with the UNEP Secretariat. The meeting, attended by ESCWA, ECA, ESCAP, FAO, UNEP, UNDP/UNSO, UNESCO, World Bank, WMO, IIED and SADCC, was held at the Academy of Sciences of the Turkmen Socialist Soviet Republic in Ashkhabad.

In addition to being the first Working Group meeting outside of UN Headquarters, the setting was highly conducive for discussing the implementation of the Plan of Action to Combat Desertification (PACD). The Institute of Desert Research in Ashkhabad sponsors high-powered research on desertification problems and field projects that the Working Group could view on film and visit personally.

The meeting received and deliberated on technical papers presented by FAO, UNSO, UNESCO and IIED on networking in desertification control. Paper topics included technical co-operation among developing countries, principles of research networking and the concept and function of networking. Members agreed that networking among NGOs is a useful tool, but should applied with flexibility.

The World Bank contributed a paper and led discussions on the Bank's approach to desertification control. About 29 projects proposed for funding by the Bank are to be appraised over the next two to three years. Representatives from FAO, UNESCO and ESCAP reported on the current status of anti-desertification networks they are co-ordinating.

The FAO report covered the Caribbean and Latin America Technical Co-operation Networks on watershed management, sand dune mapping, stabilisation and afforestation networks in the Middle East and North Africa, and the arid lands forestry network in the Sahelian and North Sudanian zones in Africa.

The UNESCO representative reported on the MAB research and training networks in arid and semi-arid zones in four regional clusters in Latin America, Sub-Saharan Africa, North Africa and Asia. Lesotho will become a logistical base for network activities in the region as part of the Integrated Project on Arid Lands (IPAL). Networking is also taking shape in the International Hydrological Programme (IHP).

ESCAP and UNESCO referred in their respective reports to the Network of Research and Training Centres for Desertification Control in Asia and the Pacific (DESCONAP). ESCAP is working on training activities, surveys and assessment of research and institutions in the region, and tree planting and afforestation.

Discussions on the Consultative Group for Desertification Control (DESCON) reflected the

continuing frustration arising from its failure as an effective fund raising institution for desertification control projects. The Working Group expressed strong sentiments for DESCON's discontinuation or radical transformation.

Recommendations emerging from the meeting include convening representatives from the World Bank, FAO, UNEP and UNDP/UNSO to explore reorganising the DESCON secretariat, and collating information on networks operated by members of IAWGD and other organisations.

African NGOs Unite

As a response to the many dryland development schemes that are environmentally unsound or culturally unacceptable, the International Institute for Environment and Development (IIED) is co-ordinating a project to strengthen the development role of independent people's organizations. UNEP is helping IIED fund the project, which is titled, "Survival in the Drylands."

IIED and UNEP believe that successful, self-reliant development must move from the bottom up, supported by local people and be appropriate to their needs. Non-governmental organizations (NGOs) representing various public interests can fill a valuable niche at the interface between development assistance and the local population. Many of these organizations in dryland regions are in need of support to help ensure their independence of action, improve their operational skills and build up solidarity among like-minded groups in their own and other countries.

Solutions to dryland development problems must involve participation by indigenous populations, and they must be interdisciplinary and holistic in approach. The Survival in the Drylands project therefore consists of two basic components: a network of community organizations and NGOs, and the creation of a multidisciplinary network of professionals from the social and natural sciences involved in dryland development work.

On the community level, IIED is working in close co-operation with the African NGOs Environment Network (ANEN) to establish better communication and co-ordination between dryland NGOs. This phase of the project is a two-year effort, slated to end in late 1989, that will launch a dryland NGO newsletter and arrange meetings and visits between NGOs from several Sudano-Sahelian region countries. This alliance of NGOs is called the Drylands Sustainable Livelihood network.

The network of professional researchers will be called the Alliance for Research. The researchers will produce annotated bibliographies, publish development case studies, guidelines, manuals and fact sheets of common interest to the NGOs and developers, and establish a database.

IIED hopes that in Africa, the published materials will enrich NGO knowledge and effectiveness by disseminating relevant information. Where the publications reach the developed countries, they will help inform the public of the realities of dryland survival and thus influence government development assistance policy. UNEP's Desertification Control Programme Activity Centre will assist in the preparation of published materials.

New African NGO Publications

The African NGOs Environment Network (ANEN) has published two invaluable resource guides for individuals and organizations interested in desertification control. The first is a directory of indigenous African NGOs involved in desertification control activities. The second is a booklet, entitled *How to Stop the Desert, an NGO Action Guide on Desertification Control.*

NGO DIRECTORY

DIRECTORY OF INDIGENOUS AFRICAN NGOs INVOLVED IN DESERTIFICATION CONTROL ACTIVITIES

ANEN UNEP

Both publications are part of a new effort on the part of non-governmental organisations (NGOs) to join forces and share ideas in the struggle against environmental degradation. NGOs have a vital role to play in rallying grassroots participation in reforestation and other environmental development activities. ANEN, a non-profit organisation, was founded during a UNEP conference in 1982 by 21 representatives from African NGOs in nine countries. In 1986, ANEN began a DC/PAC financed programme of networking African NGOs to combat desertification. These publications are on output of that project.

The *NGO Directory* describes only indigenous African organisations working in afforestation, soil and water conservation or fodder production. The 37 groups are listed by country. Information includes each group's mailing address and contact, types and locations of ongoing projects, future and planned projects, a profile of the target community and principal sources of funding. In addition, space is allotted for an assessment of each group's technical and administrative capabilities and professional and technical training, including major constraints and priorities for improvement.

In September, 1987, ANEN conducted a desertification control training workshop for 35 African NGO staff members in Nairobi, Kenya. The "How to Stop the Desert" manual is shaped by the experiences and techniques the NGOs shared during the workshop. The workshop and the manual were both made possible by funds from the UN's Desertification Control/Programme Activity Centre (DC/PAC) and International Tree Project Clearing House of the UN Non-Governmental Liaison Service.

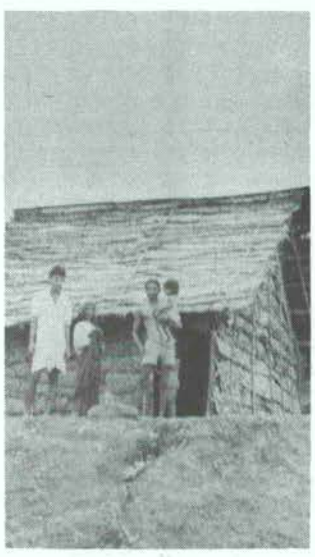
Instructions in the manual are geared toward reforestation and afforestation techniques for stabilising soil and increasing fertility. Chapters include such topics as "how to select trees/shrubs for arid and semi-arid zones," "how to collect, handle and store seeds" and "planting techniques."

ANEN's Executive Chairman Jimoh Omo-Fadaka states in his introduction that the purpose of the manual is for "training and englightening indigenous African NGOs on how to control desertification through the cheapest, most effective and appropriate methods."

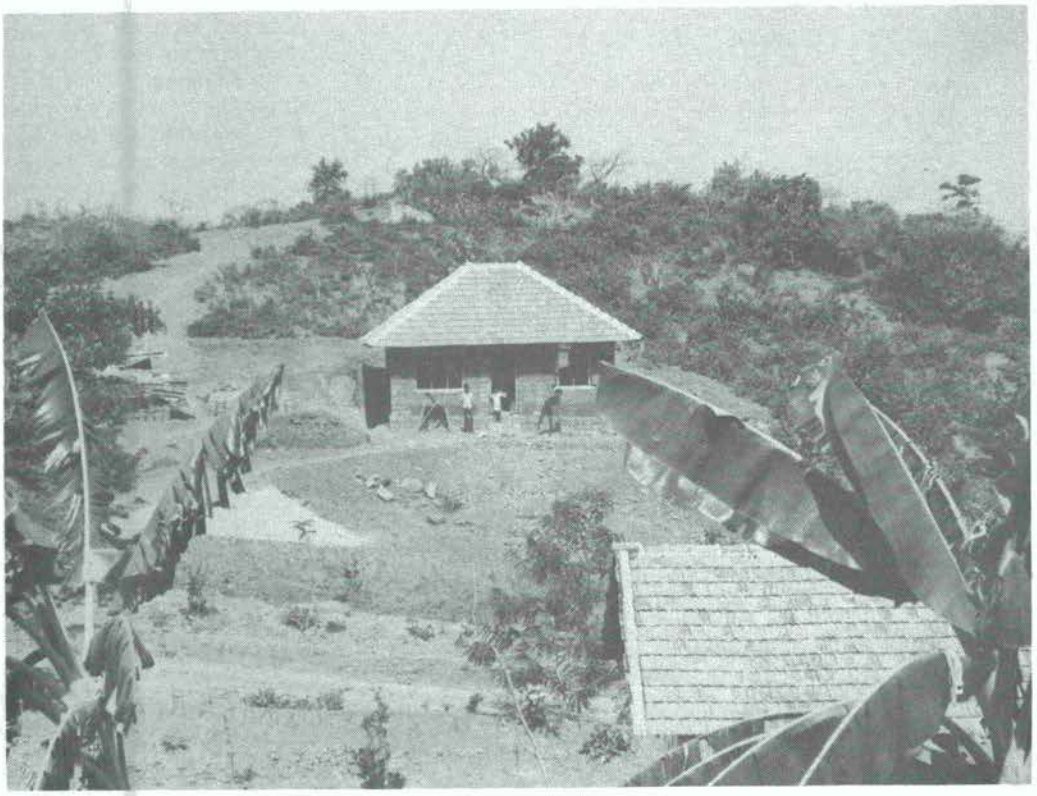
For copies of either the directory or the how-to manual, contact ANEN, P.O. Box 53844, Nairobi, Kenya.

NGO Success Story

DC/PAC has just finished its involvement with the G.G. Soans Memorial Farmers' Training and Afforestation Centre, a community action group in Karnataka and Tamil Nadu states of southern India. Between 1985 and 1987 DC/PAC funded the setting up of Peoples' Nurseries, the establishment of five Van Vigyan Kendras (afforestation training centres), the training of hundreds of farmers and school children in tree planting techniques and the actual planting of millions of trees. After successful catalytic action, this project is now being funded by the Government of India, NORAD and OXFAM under the leadership of Global 500 award winner (and the winner of two prestigious Indian awards) Ben Soans.



In 1984 the landless peasants of Herekala lived in grass huts. (Photo: Ben Soans)



After the start of the DC/PAC supported project involving the creation of Peoples' Nurseries and training centres, the people of Herekala began to build brick homes with funds gained from the sale of plants and other development activities. (UNEP/Daniel Stiles)

Mr. Soans has sent us a photograph of the typical grass hut that the landless peasants of Herekala, one of the project sites, lived in in 1984 at the time when Mr. Soans' peoples' afforestation movement was getting underway. After the successful establishment of Peoples' Nurseries and through the sale of seedlings, nurserymen are now building permanent houses (see photo). It is likely that the Government will grant the people ownership of the land, demonstrating that even the landless poor have a chance.

Asia-Pacific NGO Song Contests and Music Festival

In December 1987 DC/PAC began a project to organize an Asia-Pacific NGO environmental song contest and music festival through its NGO network in the region. In co-operation with UNEP's Information Service and assisted by the Regional Office for Asia and the Pacific, based in Bangkok, the song contests and festival turned out to be a great success.

Several countries in the region organized their own national environmental song contests, attracting thousands of entrants. Some fifteen countries from the region (Australia, Bangladesh, Peoples' Republic of China, Hong Kong, India, Indonesia, Japan, Republic of Korea, Malaysia, Nepal, Philippines, Singapore, Sri Lanka, Thailand and Viet Nam) sent song contest representatives to the World Environment Day ceremonies held in Bangkok on 5 June 1988, where for the first time the principal ceremonies were staged in the Asia-Pacific region.

The Asia-Pacific NGO Music Festival on World Environment Day 1988 in Bangkok was a great success. (UNEP/Elizabeth Walch)

The highlights included presentations by Her Majesty the Queen of Thailand of "Global 500" awards to fifteen environmental activists from thirteen countries and the environmental music festival, in which singers and musicians from fifteen countries staged a beautiful and entertaining display of the supurb musical talent which exists in the region. The awards ceremony and festival were broadcast live by Thai television in a two-hour prime-time programme. Among the speakers at the day's ceremonies and seminars were the Deputy Prime Minister of Thailand, Mr. Pong Sarasin, the Indonesian Minister for Population and Environment, Dr. Emil Salim, and the Executive Director of UNEP, Dr. Mostafa Tolba.

The feelings of solidarity generated by a common interest in conserving the environment at the World Environment Day ceremonies in Bangkok will stimulate good will and co-operation between governments and NGOs in the region in the work that lies ahead.

Seminar on Desertification in Rajasthan

DC/PAC supported a seminar and field visit by academics, scientists, government officials, journalists and NGOs on desertification in Rajasthan, India, in February 1988. The seminar, organized by the Centre for Science and Environment based in New Delhi, aimed to create awareness about the interaction of drought and desertification and man's impact on fragile dryland ecosystems.

A three day seminar was held in Bikaner followed by a field visit to the Indira Gandhi Canal Command areas north of Bikaner and to *goachars* (traditional community grazing lands) and *orans* (traditional community forests) near the city. Participants exchanged information about their respective knowledge, experiences, ideas and strategies concerning the interrelationships of man, drought and desertification. This information will be pooled, compiled and published in the form of a book for dissemination to field workers, voluntary agencies, academic institutions, government officials and the press.

For further information contact Mr. Anil Agarwal, Centre for Science and Environment, 807 Vishal Bhawan, 95 Nehru Place, New Delhi 110019, India.

UNEP assistance in desertification control through integrated socio-economic development

DCPAC/UNEPCOM provided research and technical assistance to Peru and Mali from 1984 to

1987 to establish a Regional Integrated Development Scheme (RIDS), so as to establish sound ecologically productive land and water use.

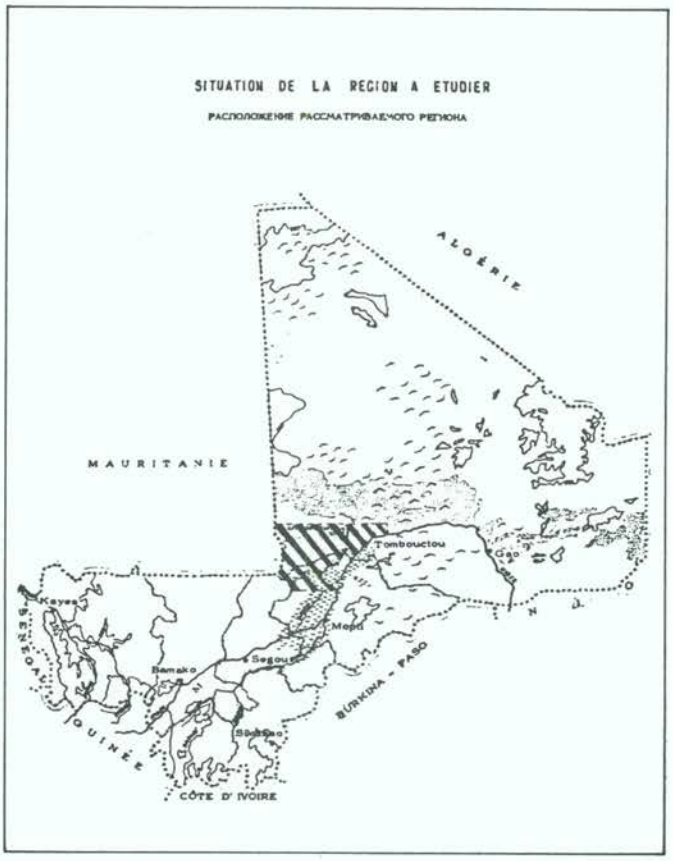
Activities sponsored under the project aimed at formulation of RIDS for one selected region in each country. It included identification of priority desertification problems of the regions under study and formulation of pilot projects according to the identified problems.

This approach has been used successfully in both Peru and Mali and highly praised by the Governments. Elaborated RIDS and the pilot projects were officially presented to the Government of Peru and Mali respectively in August 1986 and in February 1987. The Peruvian scheme, in Spanish, totaled 500 pages plus an atlas consisting of 26 maps with tables. The Malian RIDS manuscript, in French, totaled 236 pages with the pilot project document and on atlas of 10 maps.

RIDS elaborated for Peru gives a comprehensive analysis of natural, socio-economic and ecological characteristics of the Ica Department selected by the Government and provides a detailed assessment of the availability of natural and labour resources, the state of and trends in land and water resource utilization, possibilities for agricultural, urban, industrial and recreational development and identifies the priority desertification problems of the region under study. It also contains concrete proposals for the development of the service sectors in the department of Ica, with special emphasis on protection of environment through combating desertification.

The Malian RIDS was prepared for an area of 45,000 km^2 including the districts of Niafunke, Dire, Gundam and Timbuktu. The task was carried out by the All-Union Association "Soyuzvodproyect" of the USSR Ministry for Land Reclamation and Water Management, Moscow, and the Institute of Desert Research, Ashkhabad. The National Direction of Water Resources and Forestry of the Ministry of Natural Resources and Animal Husbandry, Mali, was the counterpart organization.

The Malian RIDS is

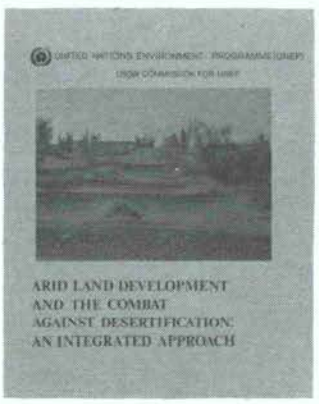


comprised of five integral parts: assessment of natural physiographic characteristics and desertification procession analysis of the present level of socio-economic development (agriculture, animal husbandry, forestry, population and infrastructure); prospects for socio-economic development to the year 2005; the complex of activities needed for desertification control; and the capital investment required to achieve the goals of the scheme.

The project elaborated within the Malian scheme aims at desertification control through a complex of agricultural activities such as agro-forestry, water and soil conservation, village development and range development as well as the establishment of a research and training centre to carry out the research and extension services envisaged in the field of desertification control.

The activities to elaborate the RIDS were combined with training, publication and information programmes to enhance exchange of experience for a better understanding of the causes of desertification and methods for combating it.

Fifty-five specialists were trained in the three training



courses organized by UNEPCOM in Moscow, USSR, during the project period. A workshop "Desertification and an Integrated Approach for its solutions" with a practical in-field training (October 1984) and two training courses "Afforestation and sand dune fixation in dry zones" (September 1985) and "Rainfed Agriculture and Soil Conservation in Dry Zones" (June 1986) were held during the project period for professionals from developing countries of Africa, Asia and Latin America.

The proceedings of the training courses were translated into three languages for distribution. In addition, a monograph "Arid Land Development and the Combat Against Desertification: an Integrated Approach" was prepared by an international group of prominent scientists in an attempt to sum up the existing world and Soviet experience in integrated development of arid-lands. The monograph exceeding 500 typed pages was translated and published in English, French, Spanish and Russian and is available upon request from DC/PAC.

Regional Networks for Desertification Control

The governing council of UNEP designated 1988 as the Year of the Trees in order to help reverse large-scale deforestation in Asia and the Pacific. In response, the Economic and Social Commission for Asia and the Pacific (ESCAP) has established and is now operating a Regional Network of Research and Training Centres on Desertification Control in Asia and the Pacific, whose acronym is DESCONAP.

UNDP is helping fund the programme in order to strengthen national and regional institutions by promoting training, research, information exchange and technical co-operation. In addition, UNDP will provide advisory services to ESCAP and facilitate the development and application of desertification control techniques in countries affected by desertification. Collaboration in the project will also by sought from other international organizations, especially UNEP, FAO and UNESCO.

DESCONAP's primary function is to provide incentive, information and support for national tree planting and afforestation activities. The programme is aimed at assisting the rural poor, direct victims of desertification, through encouraging land terracing, tree planting, alternative fuel sources, shelterbelts and general public awareness and participation. DESCONAP brings together governments, non-governmental organizations, the private sector and the people living in affected areas.

Approximately half of the 300 million people living in rural poverty and affected by desertification are in the Asia and Pacific region. Desertification

processes affect 860 million hectares of the region's land. ESCAP is the first Regional Commission to take intitiative in combating desertification through a network approach.

USSR Trains Soil Scientists

A training course funded by UNEP on "Reclamation of Saline Irrigated Soils," organized by the USSR commission for UNEP (UNEPCOM) and the Arab Center for the Study of Arid Zones and Dry Lands (ACSAD), was held on 11-29 May 1988 in the USSR. Twenty professionals already working in reclamation as researchers and technicians in Egypt, Syria, Iraq, Jordan, Libya, Morocco, Algeria and Tunisia attended the workshop.

The course focussed on teaching technical skills specific to the needs of North Africa. Through two weeks of practical training and workshops, the participants learned different methods of calculating nutrient demand and finding solutions to drainage and leaching problems using mathematical simulation methods.

The first week of the programme consisted of lectures on the ecological aspects of irrigated farming, principles of saline and alkaline soils classification, methods of mapping saline levels and chemical composition, use of different drainage systems and principles of chemical reclamation of soils.

Following the lectures conducted by scientists and specialists from USSR and ACSAD, the participants visited two transcaucasian republics, Armenia and Azerbaijan, to observe the efficiency of reclamation efforts there. The field component of the workshop enabled trainees to familiarize themselves with research underway in the USSR, as well as to view practical applications of lecture topics.

The report of the training course, "Reclamation of Saline Irrigated Soils and Their Laboratory Technology," will be printed and distributed by UNEPCOM and ACSAD.

Fourth China Training Course

A International Training Course on Desertification Control in China was held on 1-16 April 1988 in Lanzhou, China. The training course, funded by UNEP and the Government of China, was co-ordinated by the Institute of Desert Research, Academia Sinica (IDRAS), renowned for progressive achievements in the application of modern methods of desertification control.

Trainees were shown techniques of sand dune fixation during the field visits of the China-UNEP training programme. (UNEP/ L. Kroumkatchev)

Twenty professionals from more than ten developing countries in the Asia-Pacific region attended the training programme. The principal objective of the course was to facilitate the extensive use and application of remote sensing for assessment and control of desertification. More widespread use of the technique will produce greater effectiveness in the countries of the trainees. Participants viewed China's successes in order to strengthen the capabilities of national agencies in the ESCAP region to assess and plan control activities.

During the first part of the programme, the trainees received lectures on revegetation and dune stabilization, soil erosion and its control and monitoring desertification by remote sensing, which highlighted the measures of control being undertaken in China. The participants then spent ten days in the field observing pilot projects and case studies in the humid and subhumid regions of the tropical and subtropical zones of China.

The trainees' first destination was the Shapotou Desert Experiment Station in Zhongwei, Ningxia Hui Autonomous Region, where a lecture was given on the selection and introduction of dune stabilization species. Coordinators also led discussions on revegetation, desert development, irrigation, cropping on sand dunes and the establishment of shelter belts and fuelwood plantations.

The next field study visit was the Xingian Sandy Land Experiment Station, ideal for observing the utilization of sand that has encroached river banks for agricultural development. Participants also examined investigative measures for combating water erosion in the red soil region of South China, where the Yintan Research Station of Soil Reclamation and Control of Water Erosion has been set up by the Institute of Soil Science, Academia Sinica.

The final field destination was in Guangdong Province, where trainees observed water erosion and visited pilot experiments on soil erosion control in Haifeng and Lufeng counties.

Ending the course were lectures on deforestation and coastal dune utilization. The proceedings of the lectures will be prepared under the tentative title *Application of Remote Sensing Data in Desertification Assessment and Control.*

New Animal Driven Pump

UNEP has devised a prototype of an animal driven pump which is suitable for small-scale irrigation and watering points in semi-arid lands. The model pump takes into consideration the important surface and underground water resources of parts of the Sudano-Sahelian zone and the general availability of draught animals in Africa. The principal objective of the pump is to increase the resistance of stock to drought by supplying water for production of irrigated fodder.

After promising test results in a workshop in France, a pilot project has been devised to test the pump under actual field conditions, involving the people and animals of the Sudano-Sahelian zone. Mali was selected for the trial as representative of typical Sahel conditions. In addition, Mali is committed to developing small-scale irrigation, and has agreed to provide some financial support for the experiment.

The prototype of the animal-drawn pump will be used to develop small irrigated plots to test the productivity of different types of fodder plants and their adaptation to different modes of irrigation, the cost-benefits of irrigated animal feed and the insertion of the technological package into traditional stock-raising systems. Two pumps of four to five inches in diameter and drawn by four camels are expected to yield more than 25 cubic meters of water an hour from an acquifer ten meters deep.

In contrast to diesel engine pumps which bring up relatively large amounts of water from a single deep water point, the animal driven pump will provide smaller quantities of water from a number of shallow locations. The advantages of the animal driven system are: (1) the relatively small amount of water produced will not attract large numbers of people and livestock to settle around a single permanent watering point, which, in the case of bore holes, results in patches of overgrazing and desertification; (2) the production of irrigated fodder will reduce grazing stress on rangelands and increase resistance of stock to drought; (3) diesel pumps are expensive and require high maintenance costs, mostly in

foreign exchange. Frequently when a motor pump breaks down it can remain out of order for months awaiting specialists and spare parts. The animal driven pump, using a non-friction design, is almost maintenance free for up to 6000 hours; then, the only parts needing replacement are the ropes and pulley axles; and (4) the animal driven pump is based on technology that seems appropriate to African rural conditions and thus stands a good chance of successful integration into the traditional socio-economic systems of the people.

Within the context of integrated resource management of rangelands, UNEP is planning to test the pump in other Sudano-Sahelian countries under different conditions in the future.

The new animal driven water pump was first tested in France before being taken to Mali for field trials.

Seed Bank Nearing Completion in Tunisia

Together with UNEP's Desertification Control Programme Activity Centre (DC/PAC) and the Institute for Arid Regions near Medenine, the Tunisian government began in 1986 implementation of a pilot project for the creation of a seed bank and the promotion of revegetation activities in southern Tunisia. The project has grown out of Tunisia's National Plan of Action to Combat Desertification (NPACD), as formulated by the government with assistance from UNEP in 1985. The NPACD identified as its priority objective the revegetation and increased productivity of Tunisia's degraded lands.

Rural development and desertification control activities in the drylands of Tunisia are based largely on the improvement of natural rangelands. Success of these activities depends on the availability of pastoral and arboreal seeds for revegetation. In the past, however, access to seeds has been limited due to a lack of co-ordination and poor distribution networks. The Tunisian Government has since recognized that the best way to ensure seed availability is through the creation of a centre for seed treatment and storage, located in the area most severely threatened by desertification.

The seed bank project will improve the organization of seed harvesting and subsequent distribution to rangeland rehabilitation schemes. The centre will also disseminate knowledge about the species, quantities and planting techniques most appropriate to the area's arid lands. The seed bank will utilize the research of pastoral and arboreal species that has been ongoing at the Institute of Arid Regions.

The project, funded by UNEP, UNDP and the Tunisian Government, also relates closely to the objectives and work being carried out by UNEP's Genetic Resources programme. The centre will prepare a comprehensive register of various revegetation species, organize seed collection drives in different bioclimatic zones, develop an irrigated nursery for year-round seed production, train two engineers and six technicians and produce a technical report. The report will be used by DC/PAC as a basis for formulating follow-up activities and for disseminating helpful information to other arid-land countries. In addition to assistance from the Institute of Arid Regions, the project is receiving co-operation and technical support from Tunisia's forestry department.

The two-year project began in September, 1986, and is slated to be completed at the end of 1988. According to the first tripartate progress report issued 11 February 1988, most of the seed bank's activities are underway. Co-ordinators have installed three in situ experiments for comparing 14 different pastoral species. The sites are in Gabes, El Fje and Ben Gardane. Species are being specially selected for productivity, nutritional value and adaptability to water stress, drought and temperature variance. Seed collection activities have also begun, with a total collection of 562.6 kilograms from 24 different species in 18 areas. The irrigated nursery contains two relatively rare species, *Cenchrus ciliaris* and *Lotus creticus,* growing on .5 hectares. The personnel necessary for the operation of the bank have been trained for seed collection, extraction and treatment. An expert consultant, Dr. K. Boyce from Australia, visited the project in May, 1987, to advise co-ordinators on the acquisition, multiplication, stockage and conservation of arid-land seeds, as well as laboratory control and analyses.

Creation of the seed bank in southern Tunisia involves research on the best species of plants for seed distribution. (UNEP/Daniel Stiles)

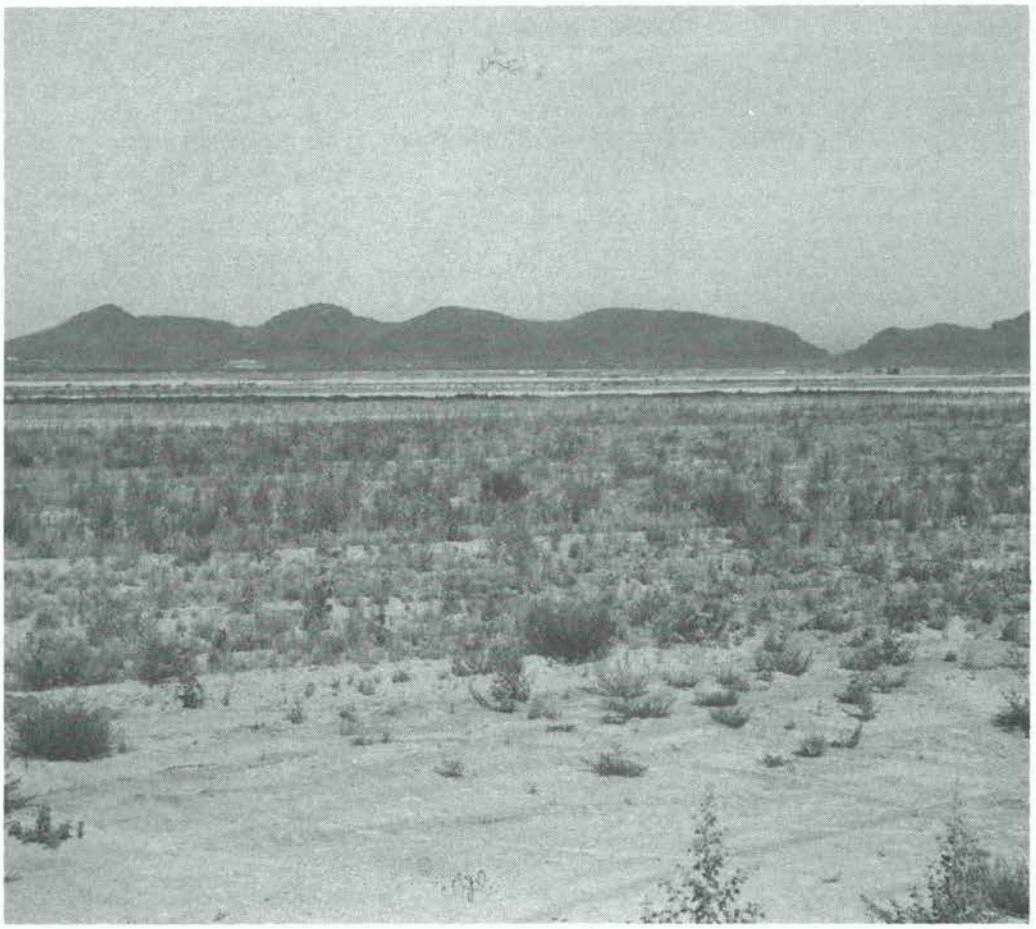
The plan of work remaining for 1988 includes a heightened campaign for seed collection, the elaboration of the seed registry, and the mechanization of laboratory techniques for the conditioning and treatment of seeds. In addition, bank managers will visit similar operations in India and Australia.

Through more complete information on and collection of various arid-land species, the seed bank will pave the way for successful revegetation of Tunisia's southern regions.

NEWS OF INTEREST

Savanna Revegetation for Agro-forestry Renewal

By Ray Anderson
Grassland Management
Consultant



View of the floodplain seeding from the construction level. The vegetation represents about two thirds planted native species, and one third annual native weeds which also benefited from the imprinting but are unable to compete with native species after the first year. (Photo: Ray Anderson)

Some good news for agro-forestry comes not from agriculture but inadvertently from a housing construction company here in Tucson, Arizona, U.S.A. In the course of "developing" a 1,800 ha tract of land with a seasonally flowing river passing through, it became necessary to shape a large floodplain three metres above the river bed and three metres below the construction area. All of the original vegetation had to be removed, giving rise to the need for complete revegetation of the floodplain to be in harmony with the natural flora of the region.

The native flora is a savanna grassland characterized by scattered shrubs and trees. Annual rainfall is 40cm in two seasons, with 60% falling in mid summer and the remainder in mid winter. Since this revegetation project would be a one-time activity, the installation of an irrigation system was rejected. The project was therefore likely to fail in a season of less than normal rainfall.

The company needed help. They were soon referred to the "land imprinting" concept, developed by the U.S. Department of Agriculture here in Tucson.* They were told that the job could be done on a minimal amount of rainfall, and that the seedbed preparation and the seeding could be done in one operation, for both growing seasons, in November 1987. A source of a wide variety of seed of native species (hand harvested) was located from a new company named "Wild Seed" in a different Arizona city. A total of fourteen annual or perennial species ranging from grasses to shrubs to trees and adapted to either the cool or warm growing seasons were planted. (Over 3,000 ha in the Tucson area have been revegetated to warm season grasses during the past several years). Winter rainfall was quite normal.

The several cool season grass, shrub and other species responded well, including sunflower (*Helianthus annus*) standing tall and colourful, and two excellent *Atriplex* fodder shrubs. The remaining species, including two of trees, are warm season plants and should germinate in July. Given an imprint, large shrub and tree seed need only more soil coverage, a simple modification on an imprinter. The imprints are only about half filled by side sloughing and thus should remain effective for the warm season concentration of rainfall. (One growing season, a much more common climatic condition, would be less difficult to work with). Final details will be available in September 1988.

The significance of this 240 ha project at this moment, only half completed from the standpoint of vegetative response, is that the seedbed prepared by the land imprinter is quite suitable to widely varied vegetative types. Furthermore, it has been clearly demonstrated that a seed mix of as many as fourteen species of equally variable size and shape seed can be applied by diluting the seed mix with a medium such as bran in a single seeder (the actual case), or, by using up to three different seeders mounted on both the imprinter and the tractor. Both are believed to be a "first" and something of a milestone where agro-forestry is concerned.

Given this seedbed and seeder capacity to deal with a wide diversity of species and vegetative types, we can reasonably conclude that something approaching a complete savanna "flora" can be re-established in one operation. In effect we have here a mechanically and biologically integrated low cost/low "tech"/high performance savanna revegetation system.

*See my article on grassland revegetation by land imprinting in Bulletin #14. Imprinting is a mechanical means of making impressions in the soil to trap and concentrate rainfall where it falls and force it to become soil moisture instead of erosive runoff.

The one obvious constraint in international savanna revegetation is the absence of seed availability. However, hand harvesting is no problem in the third world where labour is plentiful and employment always welcome. The United Nations should encourage and fund this activity. This incomplete but already fruitful project is reported at this time to motivate the beginning of activities necessary to support early future follow-up activities. Unfortunately, as in all of agriculture, just a one month delay in revegetation activities can quickly become a full year of delay.

When we see soil, the brown blood of nature flowing by it is time to apply the protective bandage of revegetation. Nature is forgiving up to a point, but desertification feeds upon itself, leading to the other alternative of actual death of the land. If it is of any comfort to anyone, death will eventually be followed by natural regeneration of the land-- in a geologic time framework of thousands of years. Can we afford to lose savanna with its wonderful biological diversity so vital to food and economic stability, while equally reducing vulnerability to drought and famine? There is also high value marketable protein production potential on these lands, and we have enough information at hand to be making great strides in the control of desertification.

A copy of Mr. Anderson's article in Bulletin #14 can be obtained by writing to him at Grassland Management, P.O. Box 12594, Tucson, Arizona, 85732, USA.

Greening the Desert

Over half a billion people live in arid and semi-arid lands, which comprise one third of the Earth's land area. Most of these arid and semi-arid lands are in the less developed and poorest countries, whose rate of population increase is among the highest in the world. The combination of poverty and a rapid increase in population has created a crisis in arid regions, a major factor of which is the process of "desertification", which is slowly but steady turning productive land to desert at a rate of some 60,000 square kilometres per year. Development schemes, technology transfers, and modernization projects have not been able to halt the decline of productivity and the worsening of human conditions in arid regions. Creative new approaches are needed if the situation is not to deterioriate further. One such approach is the Greening the Desert Programme of the International Federation of Institutes for Advanced Studies (IFIAS).

The population explosion occuring in countries in arid regions, especially those in Africa, will have a tremendous impact on these vulnerable environments. Annual population growth rates of above 3 per cent are common, and estimates show that a number of countries will double their population between 1982 and 2000. As populations in these countries increase, so does the risk of famine and economic collapse that will occur when drought conditions prevail.

It is evident that despite the great number of government and private efforts by scientists and researchers to improve productivity and human conditions in the arid regions of the world, the situation has not improved. The fundamental reason seems to be that information and capital are transferred in isolated bits and pieces. Consequently, the technology that is transferred does not fit into the existing local system. Simply transferring technology, information, and capital cannot be fruitful unless the interactions between the ecosystem, the society, and the economic system are considered, and the community is allowed to participate in a process that leads to the evolution of the development schemes and technologies have a very low chance of improving the long-term productivity of arid lands systems, unless they are designed and implemented within the ecological, social, and economic constraints of these systems.

Realizing the importance of coming up with innovative solutions for problems that many researchers have been grappling with for years, IFIAS initiated the development of a new arid lands research programme, called Greening the Desert, with a workshop in Maastricht, November 16—17, 1986. The impetus to develop such a programme was brought to the IFIAS organization by Amos Richmond in his paper entitled "Greening of the Desert: A Case for the Development of Arid Lands," presented at the Global Infrastructure Projects Conference in Anchorage, Alaska, in July 1986.

The approach of Greening the Desert to arid lands development is based on the need to develop and test a methodology that can be used by local communities to increase sustainable productivity of arid lands systems, and is guided by the following basic principles:

1. An integrated systems approach is needed which brings together technological, economic, socio-cultural, ecological, and institutional aspects of arid lands systems.

2. Emphasis should be placed on a field-level, action-oriented, "bottom up" approach for transferring information to local communities in an acceptable manner.

3. A genuine attempt must be made to synthesize local knowledge and experience with scientific resources from outside the community.

4. The approach should begin with case studies in specific arid land communities in order to develop solutions that offer improvement in the quality of life.

5. Special emphasis should be placed on a collaborative approach: IFIAS member institutes and local community-based institutions will together identify priorities.

During the past year IFIAS has been exploring possible support for Greening the Desert with a large number of institutes around the world, including many IFIAS member institutes. Proposals have been invited from a number of Western and African scientists with experience in this field and, in several cases, ongoing research that could be modified or expanded to fit the IFIAS programme.

So far two proposals have been received, and a third is in the final stages of preparation. These proposals concern Greening the Desert projects in Kenya, Senegal, Mexico and Argentina.

Desertification: A Story of Cholistan (Pakistan)

By Mohammed Arshad, Cholistan Institute of Desert Studies, Pakistan

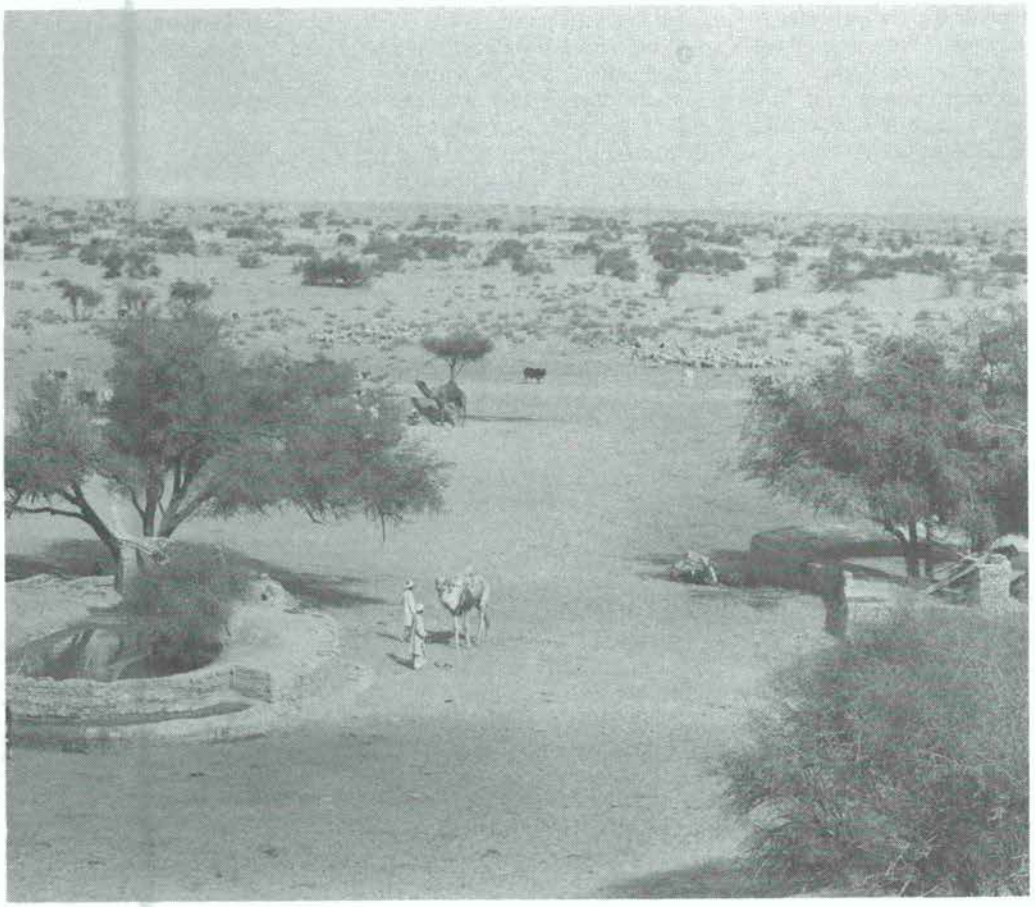
There is a growing awareness that sweet water for human consumption is becoming scarce in the world, while deserts are expanding day by day. Some scientists estimate that humanity will lose one-third of its arable land through desertification in the next fifteen to twenty years. Today the phenomenon of desertification is occuring in full force in Pakistan, seriously affecting all life patterns in the drought-stricken areas of the Cholistan, Thar and Thall deserts. The increasing incidences of drought, desertification, deforestation and soil erosion in the Cholistan Desert presents a grave situation for inhabitants there. Malnutrition, hunger and famine will continue affecting the population of this area if land degradation proceeds.

The Cholistan Desert occupies 25,800 square kilometers in south Punjab. The climate is harsh and punishing, with the temperature during the summer reaching 50 degrees celsius with low relative humidity, high wind velocities and high evaporation rates. Winters are mild, with temperatures varying between 15 and 25 degrees celsius. Rainfall levels are low and erratic, ranging from 125 to 250 mm per annum.

Cholistan soils are poor, and useful only as rangeland. The land sustains an animal population of 2.0 million, out of which 1.1 million are sheep, 0.6 million are goats and 0.3 million are cows or camels.

The vegetation of Cholistan is xeric, composed of bushes and herbs interspersed with some small trees. Overexploitation and overgrazing of the endemic vegetation has resulted in deteriorated living conditions. The vegetation in its present state is unable to support any increase in the animal population.

Rainfall, the desert's only source of sweet water, is very erratic and unpredictable. Sometimes it does not rain for three or more consecutive years, subjecting human, animal and



Rain water, when it does fall, is collected in the Cholistan desert in depressions called "tobas". (Photo: M. Arshad)

plant life to severe drought conditions. The rain water, when it does fall, is collected in depressions, locally called "tobas," and is used for drinking purposes by inhabitants and their livestock. With the exception of a few locations, the desert's ground water is unfit for human or animal consumption. Subsequently, Cholistan dwellers follow a nomadic way of life, moving with their herds in the perpetual search for pasture and sweet water.

Recognising the grave situation of the Cholistan Desert, Islamia University in Bahawalpur established the Cholistan Institute of Desert Studies (CHIDS) with the following objectives: increasing the productivity of Cholistan without deteriorating the quality of natural resources; developing techniques for diverse land use; and preventing desertification.

The Institute has planned and executed plant collecting trips to preserve genetic resources under to guidance of Dr. Altaf-ur-Rehman Rao of the University of Agriculture, Faisalabad. The Institute plans to reintroduce the multiple stress resistant species of desert grasses for increased productivity. With the help of the new Institute, Cholistan's future looks a little greener.

Greener Pastures in Colombia

The International Centre for Tropical Agriculture (CIAT), together with various Colombian agricultural research institutions, formed a network about ten years ago to investigate pasture grasses throughout tropical South America. The network, called REPT, consists of 78 institutes from 20 countries. Out of this affiliation has grown the Tropical Pastures Programme, now at work in the Cauca Valley of Colombia.

Agricultural researchers in South America are determined to rescue the ravaged lands that were once rainforests. These areas were converted to crop lands by farmers, but were soon abandoned after the soil's nutrients ran out. The researchers hope to turn such abandoned lands in the Cauca Valley into productive pastures by introducing special grasses to revitalize the soil.

Colombians, like many other South Americans, have experienced mass urban migration and the loss of fertile land to cash crops. Consequently, cattle have been driven out to more marginal lands, and beef and milk are less available. The plan to rehabilitate the Cauca Valley attempts to solve both the cattle problem and the wasteful destruction of forests.

The valley contains soils classified by agronomists as very poor. Most of the soils are low in nitrogen, with no phosphorous and high levels of aluminium and iron oxide, both toxic to plants. The land is hilly and seriously eroded in parts. Even production of cassava, a crop usually able to grow well in poor soils, has failed. The CIAT scientists feel that with proper erosion control and specially selected grasses, the valley can become productive rangeland.

One of the main techniques of the Tropical Pastures Programme is to combine legumes with grasses. Given enough time, the legumes can provide the nitrates required by the grasses. The nitrates together with organic matter stimulate microbial activity in and slowly revitalize the soil. Experiments conducted by CIAT in Las Lajas have already shown that grass-legume associations support more cattle per hectare than grasses alone.

Selecting grass species for quick growth, nutritional content and palatability, the researchers have planted three species from the genus *Bracharia,* collected in Africa. Legumes are being sought that require few fertilisers and do not compete with grasses. When the best combinations are found, the duo should provide high-quality pasture and good ground cover.

NGOs in Forestry

The World Resources Institute and the Environment Liaison Centre have published a report of three regional workshops on NGO involvement in Africa, Asia and Latin America. The booklet, entitled *Expanding the Role of Non-Governmental Organizations (NGOs) in National Forestry Programs,* summarises the views and recommendations emerging from the workshops. The purpose of the workshops was twofold: first, to provide a forum for NGOs to comment on the Tropical Forestry Action Plan, released by FAO in November, 1985; and second, to discuss improving collaboration between NGOs, national governments and aid agencies.

A diverse collection of representatives from national and international NGOs, as well as from government ministries and international aid agencies, attended the workshops held in 1986 and 1987. Participants arrived with a common interest: the commitment to sustainable forest management, achieved through an integration of local, governmental and non-governmental insight.

The Tropical Forest Action Plan (TFAP) is a five-year, eight billion dollar technical assistance programme aimed at promoting sustainable development while ensuring basic

needs of the rural poor. It has been adopted as a common framework for action by the bilateral and multilateral development assistance agencies and has been endorsed by FAO's Committee of Forest Development in the Tropics. The consensus of workshop participants was that TFAP has contributed significantly to awareness of tropical deforestation issues, but does not stress sufficiently the role of NGOs in forestry project development.

In order to integrate NGOs better into the project development process, the booklet enumerates a number of general goals as defined by workshop participants. First, mutual understanding of the complementary roles of NGOs, governments and aid agencies is needed to establish a basis for contructive collaboration. This requires better flows of information and a co-operative attitude on all sides. Second, governments and aid agencies need to adjust policies and procedures to facilitate and enhance NGO involvement in policy-making and the project cycle. Third, greater attention must be given to NGOs' institutional development if these organizations are to establish credibility and play an expanded role in forest management. Finally, new mechanisms must be found to channel funds to NGOs for strengthening their capabilities.

To meet these objectives, specific recommendations are listed. Among these are the proposals to establish an NGO Liaison Office in national governments, to open better communication lines among various NGOs and to improve NGO technical expertise. Governments should be more responsive to policy reforms that promote local-level initiatives in farm and community forestry. Both governments and aid agencies should release information on planned projects early enough to allow for public review and comment.

The spirit of the workshops is perhaps best reflected in a quote from Ajay Mehta, General Secretary of Seva Mandir, India: "The objective of our work is to build the collective strength of the poor and nurture the processes that encourage community participation and awareness." For copies of the booklet, contact World Resources Institute, 1735 New York Avenue, NW, Washington, D.C. 20006, USA.

Japan: Greening through Plastics

In April, 1988, the Ministry of International Trade and Industry (MITI) of the Japanese government began research on the development of a chemical resin that can be mixed with soil to improve water retention. The ministry is conducting the research as part of national efforts to assist African countries, according to the Japanese newspaper, *Asahi Shimbun.*

The article reports that MITI believes soils in arid and semi-arid lands can increase agricultural productivity given a better water-holding capacity. The technology MITI is working on is based on a water-absorbant resin, the same used in plastic diapers. Researchers have already tested the resin in Japanese golf courses, where plants are reportedly utilizing the extra retained water.

Some obstacles remain before the chemical can be tested in Africa, such as the resin's poor resistance to salts and the possibility of excess water rotting plant roots. The technologists hope to begin testing desert-adapted resins near Alexandria, Egypt, in 1989.

MITI is working in co-operation with the National Desertification Research Institute of Egypt and the newly-established Green Earth Foundation based in Japan.

New Species of Mahogony

By Peter S. Ashton, Director, Arnold Arboretum, Harvard University. Extracted from newsletter of Board on Science and Technology in Development (BOSTID), Vol. 7, No. 3.

Scientists have discovered a new species of mahogony, *Shorea trapezifolia,* that is fast-growing and easy to cultivate. The new species of dipterocarp, discovered by a team of researchers from the Sri Lankan University of Peradeniya and Harvard's Arnold Arboretum, differs from other dipterocarps in its growth and flowering cycle. The research was funded by the U.S. AID Office of Forestry and Natural Resources for the purpose of developing locally useful species with potential importance to villages in Sri Lanka.

Dipterocarps comprise approximately 60 percent of the world market of hardwoods. The Philipine mahoganies, *Shorea* species of the Indonesian and Philippine region, are evergreen, and have a flush of leaves once or twice a year, but only flower once every four to five years. In flowering years the trees put on little wood growth. This is because the tree's inflorescences, from which the flowers are formed, replace leafy shoots and do not retain as much photosynthetic ability. The fruits, moreover, contain seeds that have very little dormancy and must be caught at the right moment after fruiting to be grown in the nursery. Reforestation with these dipterocarps is thus quite difficult.

The Sri Lanka *Shorea* under study occurs nowhere else. Unlike other rainforest dipterocarps, it flowers every year, sometimes even more than once, generating large quantities of seeds. In addition, the species, remarkably, grows very fast.

The researchers discovered that the reason for this rapid growth is that unlike others examined, this species puts on new flushes of leaves at the same time that it flowers, and thereby remains perpetually in full leaf. The tree may well carry more photosynthetic surface than any of its cousins.

The species is found in pure stands on sloping land and various soils at medium altitude in Sri Lanka. The unique characteristics of the species, with its fast growth and hard structure, render it excellent for plywood. The tree's frequent flowering also makes it an exceptional candidate for reforestation efforts.

A broader issue is the value of traditional knowledge about useful species. As development takes place, both habitat and traditions dwindle, and valuable information about genetic resources may be lost. The success of this project demonstrates the value of supporting research that captures this local knowledge before it, and the resources on which it is based, are lost.

Green Fuel

The Chitralada Palace in Bangkok, Thailand, is not just the home of the King of Thailand. In addition to the palaces there are a number of development and research projects taking place on the spacious grounds in the middle of the huge, bustling city. One of the projects involves the manufacture of fuel cylinders from swamp vegetation. Vegetation, which grows abundantly in Thailand's water systems, can be harvested, dried and then fired in metal tubes in kiln-like ovens. The resulting brickettes make an excellent, slow-burning fuel which can be used for cooking or heating, thus taking pressure off of trees.

This technology would be applicable to many parts of the world where vegetation, often useless weeds, grows in lakes, swamps and river systems. The brickettes can be used as fuel to make even more brickettes, and the ovens can be made from local clay and straw.

For further information, write to Mr. Ekasit Wattanapreechanon, Royal Development Project's Officer, Chitralada Palace, Dusit Bangkok 10300, Thailand.

Organic Farms: Better Long-term Productivity

Organic farming is more effective in reducing erosion and maintaining soil productivity than conventional farming, according to a recent study conducted by three U.S. agronomists. The researchers found that organically farmed soil tends to have thicker topsoil depth, a higher polysaccharide content and a better ability to hold moisture.

Researchers John P. Reganold, Lloyd F. Elliott and Yvonne L. Unger compared the long-term effects (since 1948) of organic and conventional farming on two adjacent winter wheat farms near Spokane, Washington. The 320 ha organic farm has been managed without the use of inorganic fertilizers and with only

The oven in which the green fuel is produced.

An example of swamp weed which can be transformed into fuel.

The baked fuel emerges from the oven in handy cylinders ready for burning. (UNEP/Daniel Stiles)

minimal spot-spraying of pesticides. The farm relies on green manure crops, crop rotations and native soil fertility for plant nutrients. The crops used in rotation are winter wheat, spring pea and Austrian winter pea replaced by summer fallow in dry years (about every sixth year).

The adjoining 525 ha conventional farm began receiving recommended rates of fertilizers and pesticides in the late 1940s. Winter wheat receives nitrogen, phosphorous and sulphur applications.

While the crop yields of the organic farms were on average eight per cent lower than yields of the studied conventional farm, they were 13 per cent higher than those of another neighboring conventional farm. Furthermore, the researchers found that the long-term productivity of the conventional farm is declining while the organic farm is remaining constant.

The researchers attribute the better productivity to higher levels of organic matter, such as carbon. Organic matter has profound impact on soil quality, encouraging granulation, increasing water storage, nutrient supply and organism activity, and improves soil fertility and productivity.

The surface horizon of the organically farmed soil was significantly thicker (by 3 cm) than that of the neighbouring farm. Topsoil thickness, measured by the depth of the A1 and A2 horizons, was almost 16 cm greater on the organic farm. Loss of topsoil by erosion from water and frequent tillage can lead to reduced organic matter, water-holding capacity and soil productivity.

The researchers concluded that at current rates of water and tillage erosion under similar conventional farming systems, all topsoil will be lost in 50 years, leaving the denser, less fertile subsoil argillic horizons. At some point, the yield reduction from erosion may exceed any gain in yield from technical progress. These findings were reported in *Nature,* Vol. 330, 26 November 1987.

Famine Early Warning System Assumes Greater Role

The U.S. Agency for International Development (USAID) has decided to incorporate into its African operations a computer programme designed to predict drought in sub-Saharan countries. The Famine Early Warning System (FEWS) successfully predicted crop failures in Ethiopia in 1987. Although the programme was created during the 1985 emergency, until now it has been used only on a temporary basis.

FEWS combines updated research from the field with remote-sensing meteorological data. The satellite images are taken by the National Oceanic and Atmosphere Administration (NOAA), which uses an advanced, high resolution radiometer. The National Aeronautics and Space Administration (NASA) then processes the images and produces a normalized vegetation index. From this, FEWS analysts are able to exptrapolate crop status from the general condition of vegetation.

Beyond this, FEWS users would like the system to be able to provide specific information on where food shortages are developing, the numbers of people at risk, the amounts of food needed, and where and when it should be delivered.

The programme's accuracy, however, remains limited due to often unreliable ground information, according to system administrator William Trayfors in *Science* magazine (15 January 1988). FEWS covers seven of the poorest countries in Africa, where such basic information as census statistics, rainfall data and food production estimates can be incomplete or inconsistent. The countries monitored by FEWS are Mauritania, Mali, Niger, Chad, Sudan, Ethiopia, Somalia and Mozambique.

Other criticisms of the programme are that it does not lend itself to co-ordination between different aid agencies, and that it cannot be used easily by the African countries themselves. FEWS was originally designed to provide timely information for development decision-makers in Washington, D.C. Taking these complaints into account, USAID has begun a five year project to improve FEWS. The revised FEWS is expected to produce more accurate warnings on drought, and incorporate user-friendly software that will give it broader influence on the development of the region.

BOOK REVIEWS

Only One Earth

By Lloyd Timberlake
BBC Books/Earthscan
London, 1987.

"This book, despite the bleakness of the first two chapters, is about hope." With that cautionary preamble, Lloyd Timberlake, an environmental author whose previous books (see *Africa in Crisis*) have done much to secure his reputation for vivid journalistic insight and granite prose, sets off to document, diagnose and deliver judgment on the pace and quality of various development initiatives throughout the world. The stories told in this book are based on a BBC/IIED television series produced to coincide with the publication of *Our Common Future,* the report of the World Commission on Environment and Development.

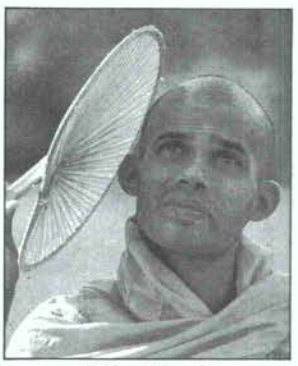
Along the way, he introduces us to a group of people who, while sharing a common humanity, have only one common point of reference between them — a deeply ingrained concern for the environment and the impact that development, taken in all of its manifestations, has on it.

In Kenya, for example, we meet D'igir Turoga, a

D'igir Turoga

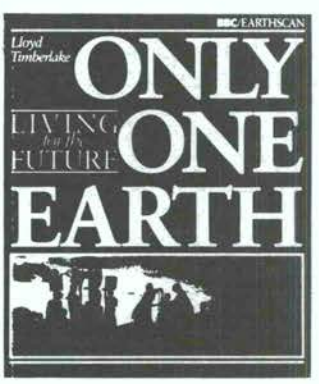
Rendille herder typical of the nomads who make their home in the drylands of East Africa. But he is typical in appearance only. For D'igir, a name that means 'man of upright stance', is a pioneer in the struggle to reclaim the man-made desert that now despoils his native region surrounding the town of Korr, some 200 kilometers South-East of Lake Turkana.

There is Kiranthidiye Pannasekara Thera, a self-effacing Buddhist monk whose



'The Monk'

monumental name amazingly fails to convey a proper sense of his unassuming ways. Working alongside the inhabitants of Galahitiya, a remote village in South-West Sri Lanka, he has for many years been a tireless foot-soldier in an ambitious, yet realistic, campaign to secure agricultural self-sufficiency for his



humble parish, improve the health of the land and the fortunes of the community, and educate the roughly 1,000 or so poor villagers, whom he also represents as spiritual mentor, in the ways of sound environmental management.

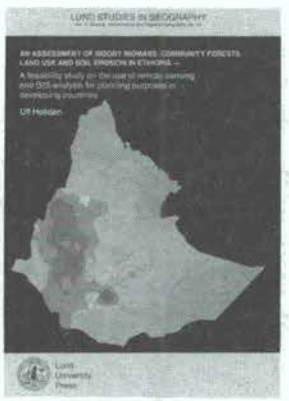
These are the sort of people, Timberlake forcefully suggests, whose efforts should be recognized and encouraged if our natural inheritance is to be rescued from the maw of environmental degradation. Only by harnessing the tremendous human potential found at the local level will a genuine, and hopefully irreversible, pattern of development take hold.

Judging by the sheer volume and singularity of the statistics with which Timberlake peppers his monographs, it is difficult to bring an overly critical eye to bear on his conclusions.

Take India as an example. In 1984, we are told, a government survey in the northern hills of Uttar Pradesh, intended to assess the status of some 2,700 village water pump projects, discovered that a staggering 2,300 had to be classified as dismal failures. Throughout the world, Timberlake maintains, misallocation of financial resources, the introduction of inappropriate technologies, the unimaginative or self-serving distribution of development aid and a continued lack of appreciation for the environmental dimensions of industrial activity, have inexorably contributed to an alarming erosion of the environment's capacity to cope.

Nor, in his view, can we expect a reversal of these trends in the immediate future. The case he outlines, and the warning that we are advised to heed, makes for a compelling and thought-provoking read. And complementing what is, by the standards of ordinary environmental reporting, a very accessible text is an eclectic compilation of photographs, from tuna fishing in the Solomon Islands, to the shantytowns that surround Lima, Peru, like so many scabs, to the organic farm of one Eddie Fewings, a stubborn, rough-hewn man who is staking out his future on a farm free of poisonous agro-chemical additives.

If for no other reason, then, *Only One Earth* deserves kudos for (lacking a better word) its populist approach. By concentrating on real people in the very real business of survival in an often hostile world, Timberlake manages to forge a bond, a commonality of concerns, between his readers and the participants in the succession of dramas, triumphs and hardships that he so ably describes. A notable achievement.



An Assessment of Woody Biomass, Community Forests, Land Use and Soil Erosion in Ethiopia

A feasibility study of the use of remote sensing and GIS-analysis for planning purposes in developing countries

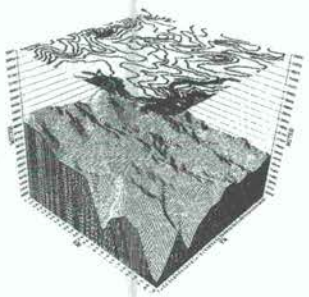
by Ulf Helldén

Lund University Press, 1987.
75 pp.

Two books on the application of remote sensing in Africa have recently been released from Lund University Press. Both publications are the result of research in remote sensing and desertification monitoring undertaken at the Department of Physical Geography, University of Lund, Sweden. Helldén's book is the final report of a feasibility study on the use of remote sensing and geographic information system analysis for land use planning in Ethiopia. The study was authorized and funded by the Swedish International Development Agency (SIDA) for Swedforest Consulting AB.

As a professor and manager for the Lund University Remote Sensing Laboratory, Helldén stands on the cutting edge of land assessment technology. The purpose of this authoritative study is to demonstrate and evaluate the potential of environmental monitoring and information analysis using two Ethiopian test areas. Helldén presents a clear and readable report that is targeted, he says, for politicians and planners in developing countries and decision-makers and planners at donor agencies and aid organisations.

The sites chosen are appropriate for planning purposes as they have fallen prey to severe deforestation and increasing population. Through such technology as the geographic information system (GIS) and satellite imagery combined with field data, Helldén attempts to answer questions that are critical for appropriate land management. For example, accurate assessments of population growth and the region's changing woody biomass can help determine the number of hectares that should be afforested in future time periods for a steady balance of supply and demand. Integration of additional data can enable the system to estimate the number of seedlings that should be planted, what soil conservation measures will increase crop yields, how many cultivated hectares should be converted to planting trees and what annual investments are needed.



In spite of its tremendous potential to monitor everything from climate to human ecology, GIS is far from an omniscient *deus ex machina,* Helldén warns. It is nearly an impossible task to gather the quantity of accurate information required for wholly successful planning. He describes his own study as being "impaired by errors," explaining that the system's faults increase exponentially as more factors are added to the land use equation. If the standing woody biomass in a 124,000 ha plot is overestimated by as little as 40 kg/ha, the total miscalculation would correspond to the fuelwood consumption of one million people for 2-4 years.

Thus, while remaining optimistic about GIS and remote sensing applications, Helldén stresses the importance of careful field observation and reminds the reader that satellite monitoring can serve as a rough guide only to help establish national strategic plans and priorities.

The Impact of Climate and Man on Land Transformation in Central Sudan

Applications of Remote Sensing

by Eva Ahlcrona

Lund University Press, 1988. 140 pp.

Eva Ahlcrona's doctoral dissertation is a fine complement to the work of her supervisor Ulf Helldén at the University of Lund. Like his book, reviewed above, her work examines the application of remote sensing techniques in monitoring land stress. Expanding on the work of Helldén, she takes the investigation further, using remote sensing to explore her thesis about the nature of land degradation in the Sudan.

Not as concerned as Helldén with policy applications, Ahlcrona sets out to examine the root causes of degradation in the White Nile Province, recognizing that recommendations are meaningless without an accurate picture. At the crux of her investigation is the decade or so old debate on the role of natural climate versus people in the process of ecological breakdown. She tackles the issue from both sides, analyzing rainfall data, crop yields, land practices and human attitudes and observations obtained through interviews. Her own field work (though somewhat scanty) also includes vegetation surveys to determine the accuracy of Landsat remote sensing data in semi-arid conditions.

In a style that is simple and easy to follow for the non-scientist, Ahlcrona unfolds her research, winding up to her

somewhat unfashionable conclusion that the major influence on declining productivity in the area is climate and not human practices, as is commonly espoused by proponents of desertification control. But the study does not leave development agencies totally out in the cold. Ahlcrona finds one component of the ecosystem that is degraded by people: grasses. Due to overgrazing by domestic animals, the vegetative trend has moved from palatable perennial grasses to unpalatable annuals.

Also of interest to those in the combat against desertification is her conclusion that there is a strong and accurate relationship between the images produced by Landsat and ground data for grass resource monitoring in the future. Although Ahlcrona admits her scientific data are in many places too weak to make conclusive statements about the nature of land degradation in the Sudan, she does succeed in proving just how hard it is to draw conclusions, and how necessary it is that monitoring continue.

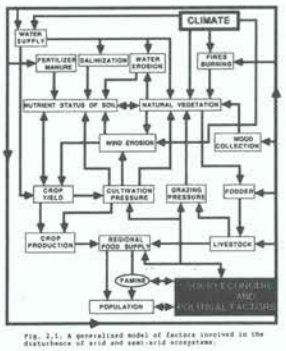


Fig. 2.1. A generalized model of factors involved in the disturbance of arid and semi-arid ecosystems.

Wamex Related Research and Tropical Meteorology in Africa

World Meteorological Organisation 1988

Tropical Meteorology Research Programme Report Series, No. 28 271 pp.

The Tropical Meteorology Research Programme has just issued a comprehensive report on WAMEX (West African Meteorological Experiment) related research and tropical meteorology of Africa. The report, published by the U.N.'s World Meteorological Organization (WMO), contains the revised and updated papers of the 1984 conference on tropical meteorology held in Dakar, Senegal.

At the concluding session of the conference, members formulated a number of recommendations, one of which stipulated the preparation and publication of a technical report on tropical meteorology in Africa based on papers that were presented.

The report contains both invited and contributed papers, which fall under one of two headings. There are 25 articles under "WAMEX Related Research," and 32 under "Topics on Tropical Meteorology of Africa," WAMEX was a West African meteorological experiment that took place from 19 May to 31 August 1979. The purpose of the experiment was to observe, describe and forecast the monsoon circulation in West and Central Africa.

Titles in the report include "Scientific Results of WAMEX," "The Monsoon and Precipitation in West Africa," and "Relationships of Drought in Africa to Anomalies in the Global Circulation."

The Tropical Meteorology Research Programme hopes the publication will prove useful for scientists and help encourage co-operation in meteorology research and its applications between African scientists and the international community.

Arid and Semi-Arid Rangelands:

Guidelines for Development

Winrock International
Morrilton, AR 72110
1987

In what can best be described as a field management tool, authors R. Dennis Child, Harold F. Heady, Roald A. Peterson, Rex D. Pieper and Charles E. Poulton have produced a work whose stated theme is the judicious co-ordination of development activities on arid and semi-arid rangelands. Basing the survey on the recognition that all components of rangeland systems are interdependent, they have delivered a comprehensive overview of the problems most typically associated with rangeland management in the developing world as well as a clearly delineated series of steps designed to counteract its most destructive tendencies.

According to the authors, the failure of many development initiatives on arid and semi-arid rangelands can be attributed to incomplete assessments of rangeland systems as a whole — systems which, in addition to soils, microclimates, decomposers, microconsumers, vegetation and animals, include indigenous peoples as a central component.

The survey has been divided into four general sections entitled *The Ecosystem, Guidelines for Natural Resource Development, Guidelines for Development of National/Regional Services* and *Guidelines for Program Planning and Documentation.* These, in turn, have been subdivided into 21 'Modules' which address such key concerns as vegetation management through grazing, game cropping, infrastructure development and the role that documentation centres can play in rangeland development drives.

The text is clear and to the point, avoiding the excessive use of statistical fillers that might otherwise have been expected in a technical survey of this sort. Rather, the emphasis has been placed on a detailed description of those mechanisms which animate rangeland ecosystems, while prescriptions are offered, in equally unambiguous terms, dealing with rangeland management techniques that conform to local conditions and needs.

As a guide to development planners in arid and semi-arid regions, the study could well prove to be of immense benefit, not only for the insights it offers into the dynamics of a sensitive environment but for the clarity and precision of the recommendations that it makes.

A Guide to Wasteland Afforestation

Well-illustrated pamphlets are a particularly useful way of introducing conservation skills to people who might otherwise remain unaware of fundamental conservation strategies.

A Guide to Wasteland Afforestation performs that task admirably.

A pocket-sized booklet numbering no more than 50 pages, the Guide prescribes ways in which rural communities might realistically pursue afforestation programmes.

With diagrams and illustrations outnumbering pages of text, the result is a guideline both easy to follow and easy to apply.

According to the Chairman of the National Wastelands Development Board in New Delhi, Dr. Kamla Chowdhry, the guide has tried to stress the role that local people can play in the planning of afforestation programmes on community lands.

In addition, special emphasis is given to the improvement of soil and moisture conservation as integral components of related efforts.

Two basic conditions are listed as essential prerequisites to the success of any afforestation programme. First, the causes of land degradation have to be understood, and second, appropriate technologies have to be introduced in an attempt to restore degraded lands to their original productive capacities.

Of particular concern, according to the guide, is degradation by water erosion. As lands are stripped of vegetation, rainwater degrades the soil and an ever increasing rate. Coupled with habitual overgrazing, the results often prove disastrous.

The Guide tries to take account of how these practices might be minimized or eliminated.

In short, this publication is a practical and detailed account of steps that can be taken in order to circumvent the most destructive aspects of soil degradation. Anyone concerned with the problems that soil degradation represents would be well advised to obtain a copy.

This can be done by contacting: ICARUS ADVERTISING PRIVATE LIMITED. 1 — 19 JANGPURA EXTN. NEW DELHI 110014 INDIA. PHONE, 625294.

Desertification Control Bulletin

United Nations Environment Programme