The Integrated Project on Arid Lands (IPAL)

Hugh Lamprey

The Integrated Project on Arid Lands (IPAL) is aimed at finding direct solutions to the most urgent environmental problems associated with desert encroachment and ecological degradation of arid lands. It forms part of the operations under MAB Project 3, the Secretariat of which is jointly held by Unesco and FAO. It is an example of the type of pilot activity that UNEP and Unesco, together with other organizations and a number of governments are trying to promote to help provide the scientific basis for the rehabilitation and rational development of arid- and semi-arid-zone ecosystems, through integrated programmes of research (including survey, observation and experimentation), training and demonstration.

During the early operational activities of IPAL, a co-ordinating unit was established in Nairobi and initial field-work started in the arid zone of northern Kenya, where a field station has been constructed on the lower slopes of Mount Kulal, the working area demarcated east of the Lake Turkana region (see Fig. 1). Work was started on several aspects of the ecology and experimental management of this area.

During the next two to three years, ongoing investigations will be extended and intensified. Initially new activities within the IPAL project will be started in Tunisia to be followed by other areas in the arid zones of Africa and the Near and Middle East.

The work within IPAL in the Mount Kulal region forms part of the Kenyan contribution to MAB Project 3. It also forms part of the response of UNEP and Unesco to the Plan of Action adopted by the United Nations Conference on Desertification.

INTRODUCTION

The Integrated Project on Arid Lands (IPAL) has completed two and a half years of field-work in the arid zone of northern Kenya. The project in Kenya, which is being carried out within the framework of the Kenyan contribution to the MAB Programme and with support from UNEP, Unesco and various governments, was established as a pilot operation to initiate investigations into the causes and effects of desert encroachment in a sub-desert region inhabited by pastoral nomads. The work of IPAL in Kenya has been planned as a programme of applied multidisciplinary research and experimental management. In addition to its main function as a scientific inquiry into the changes taking place in an arid-zone ecosystem in which human and livestock populations are dominant elements, it is also intended to seek and, if possible demonstrate, practical modifications and alternatives to the traditional livestock-based economy which could permit rehabilitation of the

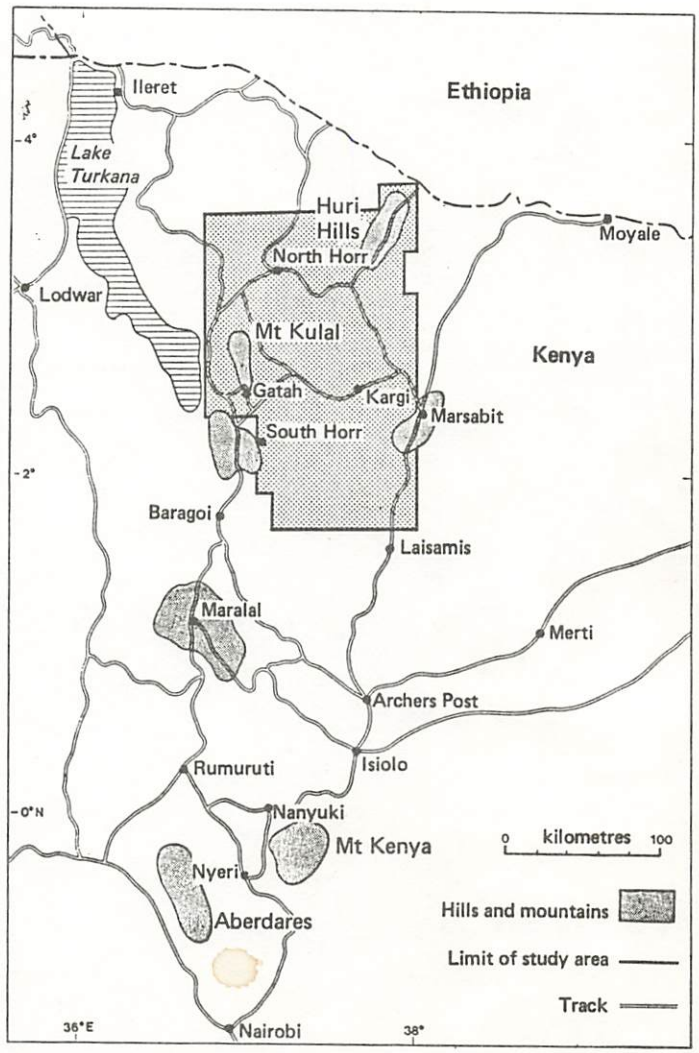


FIG. 1. Location of study area.

HUGH LAMPREY *is a terrestrial ecologist who has worked for many years in East Africa. Formerly the Director of the Serengeti Research Station in the United Republic of Tanzania, he is presently the Project Scientific Co-ordinator of the Integrated Project on Arid Lands (IPAL) and is based in the Unesco Regional Office for Science and Technology for Africa in Nairobi.*

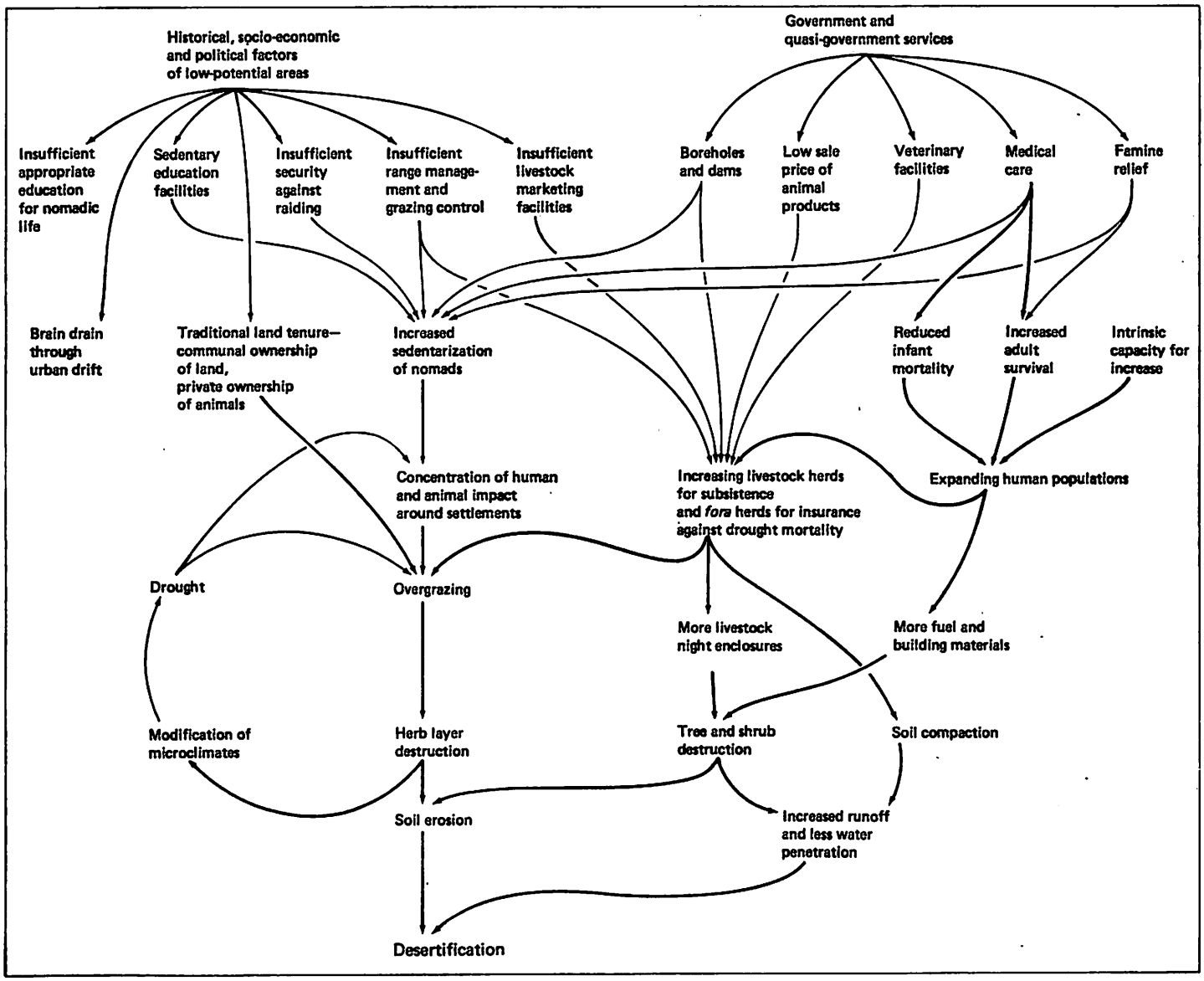


FIG. 2. Some causal factors in desert encroachment in northern Kenya.

degraded grazing lands. In the course of the ecological assessment of the region, baseline data are being gathered which will serve as the starting-point for a programme of continuous monitoring capable of measuring ecological changes and evaluating the results of improved management in the future. A further important aim is to set up a programme of training and orientation at several levels in the rational management of resources in the arid zone.

The complexities of the problems to be tackled, if desertification in this region is to be arrested and reversed, have become increasingly apparent to scientists involved in the project as the field-work has progressed. They go far beyond the well-known processes of over-

grazing and excessive tree felling, which are the most immediate causes of desert encroachment in that region of Africa. They can also be attributed to a combination of underlying administrative and socio-economic factors associated with regions having low economic potential. Figure 2 summarizes diagrammatically some of the causal factors behind desertification in northern Kenya which have been noted by IPAL in the last two years.

Progressive degradation of the arid and semi-arid regions of the world was formally recognized as a major environmental crisis at the United Nations Conference on Desertification in 1977. In unmistakable terms the process of desert encroachment was ascribed primarily to the impact of human activity upon soils and vegetation. Within the United Nations system, the Man and Biosphere (MAB) Programme has established a framework for the investigation of such interactions between man and his environment, and it is logical that UNEP and Unesco should co-operate on management-oriented research projects to look into the causes and effects of desertification and to seek possible remedies for it.

Designed as a regional project, IPAL is intended to obtain results which are applicable throughout the arid zone in Africa and possibly also in other regions. It is anticipated that its field activities will extend to several parts of the region in due course. At present the greater part of the field-work is being carried out in the subdesert and desert country of northern Kenya, while preparatory reconnaissances have been made in Sudan and Tunisia. In the latter country a programme of research and management within the framework of IPAL will begin in early 1979.

BACKGROUND TO IPAL IN KENYA

The arid zones and pastoral populations of northern Kenya

More than half of the land surface of Kenya is arid or semi-arid rangeland occupied by pastoralists who are nomadic to varying degrees. These people, belonging to several distinct tribal groups, are similar in many respects to several other tribes living elsewhere in north-eastern Africa and the Sahel who depend for their subsistence almost entirely upon their herds. However, unlike many areas in the Sahel, there is virtually no arid-zone agriculture in Kenya and thus little of the interaction and interdependence between agriculturalists and pastoralists which are a feature of the Sahel.

Common to these regions is the overwhelming problem of the apparent inability of the land to support or withstand the numbers of domestic animals possessed and, in many cases, needed by the pastoralists. Over-exploitation, first of the grasses and other herbaceous vegetation, followed by the trees and shrubs, with accompanying soil erosion, compaction and desiccation, is causing degradation over large areas, with a resulting decline in the capacity of the land to support the numbers of people living there. The spiral process of increasing populations depending upon decreasing resources is nowhere more evident than in this type of arid zone.

Expanding human populations have inevitably been accompanied by increasing livestock numbers. Two separate processes seem to be occurring simultaneously. First there is the gradual increase in the overall density of people and livestock. The human population is lower than 1 person per km^2 in the semi-arid and arid regions and there is evidence to indicate that, with the fairly even distribution of this population density over the region, which is achieved through traditional nomadic regimes, serious over-exploitation of the rangelands could be avoided, This possibility is discussed later. Unfortunately, a second process which is particularly destructive in its impact on the environment is also taking place and is compounding the effects of the growing populations.

Centres of human and livestock concentration have arisen, and recently have tended to expand rapidly, around the few springs and wells and especially around the boreholes which have been installed. While the presence of fresh water is the most important factor in such concentrations, several other incentives contribute to their expansion. Many of them become the sites for shops, schools, medical centres and famine-relief centres. However, of the greatest significance is the fact that these centres offer security from intertribal raiding. The lack of security over large tracts of land is a major reason why such areas are avoided, and the more secure areas are grossly over-exploited. Each of the concentration areas becomes a nucleus of denuded land which spreads in widening circles as the people are obliged to go farther for grazing and for the wood they need for fuel and for the fences for their livestock night enclosures. The process of localized desertification appears to be accelerating as an increasing proportion of the pastoral population becomes sedenterized.

During the dry seasons and also during the more prolonged droughts, such as that experienced between 1968 and 1976, there is almost total dependence upon the few perennial water supplies and the destructive effects of the concentration are most marked. During and imme-

diately following rain, there is a traditional dispersal of nomadic family groups into areas where rain has fallen, to take advantage of the new growth and the rain pools.

To a great extent this dispersal still takes place, but an increasing proportion of the population, especially the women and children and the older men, tends to remain close to the villages and to the amenities which they provide, keeping with them the livestock they need for milking. The young men continue to take away into the surrounding country the unproductive animals (known as the *fora* herds), males, castrates and barren females, following largely traditional nomadic practices.

The *fora* herds serve to some extent as insurance against future drought years but often appear to be a large surplus stock of unproductive animals which contribute to the depletion of the vegetation. However, it is extremely desirable to achieve the maximum possible dispersal of existing livestock populations to relieve the pressure upon the concentration areas and, seen from this point of view, the *fora* herd system has advantages. It is equally important to find means to get the family herds dispersed despite the social influences which are tending to concentrate them around the settlements.

As yet, although the problem of desertification in northern Kenya is recognized by the government and is expected to receive considerable attention in the course of development programmes in the coming years, a number of administrative and economic constraints have until recently militated against appropriate corrective measures. Among the most important have been the lack of funds available for the development of 'low potential' areas, the insufficiency of suitable educational facilities, the migration of educated people out of the more remote and inhospitable regions to the towns, the lack of attraction of such regions for civil servants and, above all, the lack of information on human and other resources that is essential for the rational development of the region.

Certain inescapable problems have to be taken into account in planning the management of the region with a view to conserving and rehabilitating its resources and improving the quality of life of the people. Under the prevailing climate (less than 150 mm mean annual rainfall) sustained agriculture is not possible over the greater part of the region and animal husbandry will inevitably remain the basis for the economy. The requirement for full support of pastoral people is approximately 1,000 kg live weight per person; and although this necessitates a minimal level of stocking for the subsistence of the population, it is evident that under existing pastoral regimes, and more particularly with recent trends towards sedenterization, the long-term carrying capacity of the large areas of rangeland is being exceeded. During favourable years (as in 1977 and 1978) there may be a temporary abundance of animal fodder resulting in a build-up of livestock herds and the subsequent overstocking of the grazing lands during the drier periods which follow.

Management of grazing

No mechanism exists in the region at present for the management of grazing (although prior to 1962 a system of grazing control had been introduced to ensure the complete protection of vegetation within the vicinity of wells and springs during the rains). Traditional land tenure provides for communal ownership of the grazing resources within each tribal area but for individual ownership of livestock, with an apparent absence of responsibility for the maintenance and management of the rangeland. Although some perceptive individuals among the pastoralists are aware of the prevailing over-exploitation, they are unable to influence the remainder of the community and uncontrolled competition for the limited grazing continues to be a dominant factor in the decline of the productivity of the region.

The same perceptive individuals realize the need to dispose of surplus animals in order to reduce the pressure on the grazing but they point out the difficulty of culling their herds in areas where livestock marketing facilities are few or totally lacking. Even where opportunities occur for the sale of livestock, the prices offered to the pastoralists are commonly insufficient to persuade them to sell a significant number of animals during times of abundance. Without a suitable outlet, the herds tend to grow and the pastoralists are motivated to keep their wealth in the form of livestock instead of converting it into money.

In spite of obvious disadvantages in the present livestock economy, it is clear that the traditional animal husbandry practised by the Rendille and Gabra peoples of northern Kenya (to mention those being studied by IPAL) is in most respects efficient and well adapted to the harsh and variable climatic conditions and to the subdesert vegetation. Any modification of traditional systems intended to rationalize land use in the region must take into account the skills inherent in them and attempt to replace them only where their practice is shown to contribute to environmental damage.

As has happened throughout the arid zone in Africa, drought has caused much suffering to those pastoralists,

who have lost all or most of their domestic animals. Many of these people have been saved from starvation by famine-relief food. Unfortunately, with the return of favourable conditions, many families have been left without livestock and have become destitutes dependent upon the continued supply of famine food provided through the government and the missions. Such people tend to swell the unproductive sedentary populations in the villages and appear to lose their will to resume a nomadic pastoral life even when presented with livestock which could enable them to do so. Thus they become a permanent and increasing liability to the government, as they continue to grow in number. The dilemma of such famine-relief systems becomes even more pronounced when the numbers of refugees is increased by other families that have found it easier to subsist on the food provided than to continue their nomadic way of life.

Measures for rehabilitation

It is against this background of socio-economic constraints that IPAL is attempting to find and demonstrate practical means to achieve a measure of ecological and social rehabilitation. It seems clear that such means must include modifications of the traditional economy and suitable alternatives to the present single source of livelihood.

It is also apparent that no changes have any hope of being adopted without the co-operation of the pastoralists themselves. Range-management procedures will necessitate a degree of control which must be supported by the willing involvement of the pastoralists. For this reason, IPAL's approach to the broad problem of introducing reforms in land use includes a public-relations programme intended to gain the confidence of the pastoralists as well as to provide a means of obtaining feedback to the project of their own ideas, attitudes and skills. This public-relations programme is one aspect of a process of public reorientation, education and technical training which must accompany any future development in the region.

THE WORK PROGRAMME OF IPAL IN KENYA

In designing a multidisciplinary work programme intended to provide practical solutions to problems of the arid zone of the kind outlined above, one is presented with a bewildering array of possible approaches. Even the nature and extent of the problems themselves will tend to remain obscure until a period of study has been completed. A programme of work under these circumstances is likely to evolve in the light of early discoveries during the first year or two of investigation and this has been the case with IPAL in Kenya. In practical terms the scope of the work programme will be dictated by the funds and the manpower available. IPAL began its preparatory activities in early 1976 with three full-time ecologists and a project administrator. This small team has been supported by several consultants and other field scientists working on short-term investigations, and by some twenty field and laboratory assistants. Work was begun on the task of filling the gaps in the basic ecological data on the region. The immediate requirements were for a scientific assessment of the human and natural resources.

The study area

The area selected for the investigation is 22,500 km^2 of subdesert and desert country situated between Lake Turkana in the west and Marsabit Mountain in the east. The greater part of this area lies at some 500 m above sea-level but includes within it Mount Kulal, rising to 2,500 m, with 34 km^2 of rain forest on its summit ridge. Between the ridge top and the neighbouring Chalbi and Koroli deserts is a steep gradient of ecoclimatic zones. The mountain is the main water catchment supplying the few springs in the surrounding desert country. In April 1978, Mount Kulal was formally designated as a biosphere reserve under the MAB Programme. The study area thus forms one of the sites of the international network of biosphere reserves—areas established for long-term activities of research, training and monitoring, as well as for the conservation of genetic diversity.

The project field station is situated on the slopes of Mount Kulal and provides a working laboratory for the small team of scientists whose main activities take place in the adjacent arid country. The working area is the home of the greater part of the Rendille tribe and also includes a large part of the Gabra tribe. Both these peoples are nomadic pastoralists who keep camels, sheep and goats. They occupy the south and the north of the working area respectively and do not overlap geographically because of antagonism in the past. Small numbers of cattle-keeping Boran and Samburu occupy the more mountainous fringes of the area.

Baseline information

During the past two and a half years, a major activity of the project has been the collection of an inventory

of baseline information on the climate, soils, water distribution, vegetation, wildlife and domestic livestock, and on human populations and their economic, social and cultural characteristics. Vegetation and soil maps have been made using ground and aerial reconnaissance, aerial photography and satellite imagery. A network of rain gauges has been set up across the area, together with three meteorological stations (two of them automatic). The data from these installations, coupled with those supplied by the Meteorological Department from other stations in northern Kenya, have provided the basis for a preliminary map of climatic patterns in the area. In addition to its aridity, the most important feature of the climate is its variability, which has been only too well demonstrated over the last ten years. During the drought years between 1968 and 1976, mean annual rainfall over the semidesert areas was less than 50 mm. In 1977 rainfall over the same area was approximately 400 mm and this was reflected in the greatly increased plant productivity in that year.

Plant productivity

Measurements of plant production are an essential part of the project's central study of interaction between livestock populations and the vegetation, as well as an aspect of the baseline data collection. For this purpose and for the purpose of measuring the impact of livestock upon plant communities, fenced enclosures have been set up over a range of ecological conditions. Primary productivity, sampled by clipping herb and dwarf shrub vegetation in randomly distributed frames of 0.5 m^2, has been related to the rainfall of the immediately preceding wet season and also to the characteristics of the individual sites, including topography, drainage, soil type and history of use.

Although considerable variability in the rainfall/primary productivity relationship has been found, it is expected that the results obtained from further series of observations will clarify the separate quantitative effects of the different environmental factors upon production levels. In addition to the measurements of overall biomass and productivity, those of the important individual plant species have been obtained, permitting an assessment of those species which form the bulk of the diets of the various livestock species.

Impact of livestock

Livestock food preferences have been studied on the experimental sites. Using the exclosure plots in the Balesa Kulal experimental site, situated in the low-lying subdesert scrub vegetation, feeding trials with camels, sheep and goats have been carried out to measure the effects of different stocking rates upon the herb and dwarf shrub vegetation.

These trials have been set up with the intention of simulating actual densities of livestock as observed during the systematic aerial surveys carried out by the project (described below) over the working area. Such densities vary from those seen over the greater part of the area (approximately 1 camel per km^2 and 10 sheep or goats per km^2 or less) to those in the concentration areas within 10 km of settlements (approximately 20 camels and 200 sheep or goats per km^2). Actual offtake of plant material by the animals is obtained by measuring the biomass present before and after each stocking trial. To date such impact experiments have been carried out with the camels separated from the sheep and goats.

These initial experiments in measuring consumption by livestock under controlled conditions have been exceptionally instructive, not only from the relationships observed between production and animal offtake. In order to carry out such experiments it was necessary to predict stocking intensities which would give significant offtake of the vegetation under the prevailing conditions of rainfall and plant productivity. Since such predictions had to be based upon past observations of the climate and on the level of productivity determined by it, there was some possibility that a change in the climate would render the predictions of productivity and relative stocking rates inappropriate.

In point of fact such a change of climate did take place and it was found that the stocking intensities tried out after a period of exceptional rain had negligible impact upon the large quantities of vegetation produced. This useful experience showed the necessity for preparing for a much wider range of stocking intensities than had originally been anticipated for experiments of this kind. It also demonstrated the contrast between the productivity levels during dry periods and wet periods and the superabundance of plant material to be expected after heavy rain and indicated that the phenomenon of overgrazing is likely to take place only during dry spells.

Woody vegetation

A large proportion of the vegetation in northern Kenya and elsewhere in the arid zone in Africa is composed of trees and shrubs among which the genus *Acacia* is

dominant. Woody vegetation forms an important part of the diets of livestock, particularly of camels and goats, but is also eaten by sheep and cattle when grass is not available. A very serious limitation of existing techniques for measuring plant productivity in rangeland communities is the lack of established methods for assessing the production of tree foliage and other aerial parts of trees.

The urgent need to obtain primary production values for the whole rangeland, including the woody vegetation, has necessitated a series of experiments in which IPAL scientists have dissected sample trees of the dominant species in order to weigh their component parts. From the measurements obtained it is hoped to obtain regressions relating the biomass of each component (leaves, fruit, new woody growth and branches and trunk) to linear dimensions, so that biomass estimates can be obtained from the canopy size and height of statistical samples. It is anticipated that, in woodlands composed of few species, as is the case in the IPAL working area, biomass and productivity of the tree species will be estimated from measurements of canopy area obtained from aerial photographs.

Very useful co-operation is taking place between IPAL and the Kenya Rangeland Ecological Monitoring Unit (KREMU) on the use of remote sensing techniques for assessing the biomass and primary productivity of large areas of rangeland from the air. The apparatus being used for this purpose is a photometer which measures the intensity of greenness. This apparatus is being calibrated from detailed ground observations for each major vegetation type to show the general level of primary production in the area surveyed.

If IPAL and KREMU are successful in calibrating the photometer for the woodland vegetation, an important breakthrough will have been made in the problem of productivity calculation over wide areas. Such a capability would be expected to be an important tool in rangeland monitoring and in the detection of long-term trends including desertification.

Aerial surveys

Although the 22,500 km^2 rectangle of the working area has been selected as far as possible as a self-contained unit containing a large proportion of the total ranges of two nomadic tribes, there is an almost continuous interchange of people, livestock and wildlife across the borders of the area as well as continuous nomadic movement within it. The exploitation of the region as a whole takes place by virtue of this movement, which enables the pastoralists to respond to the changing distribution of available water and grazing.

In order to follow this movement, a programme of systematic aerial survey has been established which provides, at intervals of two to four months, data on the numbers and distribution of livestock and wild ungulates in relation to seasonal variations in water availability and vegetation condition.

The project uses a Cessna 185 light aircraft for several purposes, including survey, when it is manned by members of the project staff acting as pilot/navigator, recorder and two observers. By means of a radar altimeter, a flight level of 100 m above the ground is maintained wherever possible and a transect strip of 300 m on either side of the aircraft is scanned using marker rods so mounted on the wing struts that they subtend for the observers this strip width on the ground. By flying a pattern which follows the 10 km grid squares on the map, the 600 m transect strip observed provides a 6 per cent sample of the total area. Small herds and small numbers of houses are counted and large herds (larger than twenty-five animals) and the houses of large settlements are photographed for accurate counting later under a dissection microscope in the laboratory. A total of sixteen hours' flying, over three days, is needed to complete one survey of the working area.

A series of computer programmes has been designed in co-operation with the Institute of Terrestrial Ecology in the United Kingdom for the storage, integration and analysis of survey and other data obtained by IPAL. Preliminary analysis of data collected in 1976 and 1977 suggests that promising results might be obtained in detecting sensitive relationships between human and animal densities and trends in plant community succession. It is hoped that such an analysis will contribute to an understanding of the vital question of long-term carrying capacity of arid-zone rangelands and the early detection of ecological degradation.

The baseline data being collected by the project together with the results of the systematic aerial survey and measurements of rangeland productivity have the additional purpose of providing a starting-point for a programme of continuing ecological monitoring of the working area, which is seen as one of the main features of the follow-up programme of IPAL. It is anticipated that the aerial-survey techniques together with the associated ground studies introduced by IPAL and KREMU will continue to be used for routine monitoring purposes by the government as an adjunct to its future programme of range management in the arid zone in Kenya.

Ecology and husbandry of livestock

In close association with its study of plant productivity and range-carrying capacities, IPAL is conducting investigations on several aspects of the ecology and husbandry of livestock for the purpose of understanding the quantitative relationships of the herds, both with their food resources and with the human populations that depend upon them. Work is in progress and good results have been obtained on several aspects of the productivity of camel, sheep, goat and cattle populations, including population dynamics (fecundity, mortality), growth and weight gain, milk production and potential for meat production. Diets and water intake in relation to seasonal changes and availability are being studied. The identification of plant species has been helped by the project's herbarium collection which now includes some 900 named specimens covering 80 families and 261 genera.

While many of the observations on livestock ecology have been made on the projects' own herds of camels, sheep and goats, co-operation with several of the local herdsmen, particularly certain chiefs, has made it possible to obtain data from many other herds.

An aspect of the livestock studies that has made considerable progress is that of the food habits of camels in northern Kenya. Table 1, taken from a forthcoming IPAL Technical Report on this topic by C. R. Field, gives the results of chemical analysis of six of the most important plant species in the diet of camels in the working area.

Other results of the same study include: important vegetation types occupied by camels and the proportion of the total area occupied by each; availability of preferred plant species in the different vegetation types; composition of the diet of camels according to plant types (trees, dwarf shrubs, herbs, vines and grasses), and according to plant species; assessment of greenness of plant types being selected.

Three of the project's camels have been trained for riding so that they can be used for making journeys into country inacessible to vehicles by IPAL staff and by the public-relations assistants in particular.

Looking ahead to the time when IPAL will present recommendations on livestock and range-management methods which are consistent with the rehabilitation of the vegetation, it seems probable that management guidelines will be based very largely upon rational modifications to the traditional methods of animal husbandry being practised by the nomadic pastoralists. Before any attempt can be made to plan such modifications, possibly including improved breeding, the introduction of controlled grazing, controlled use of available water, obligatory selective culling of herds and the introduction of new methods of animal-product marketing, it is essential to gain a thorough understanding of the traditional animal-husbandry regimes in the region.

For this purpose, a programme has been established jointly by Unesco and the governments of Kenya and the Federal Republic of Germany, with funds-in-trust provided by the latter government, as an integrated component of IPAL. The main objective of this programme, which started in early 1978, is to study the efficiency of traditional methods of livestock management and their relevance to the possible introduction of

TABLE 1. Chemical analysis of plant species in the diet of camels[1]

Species	Part analysed	Protein	Fibre	Fat	Ash	Nitrogen-free extract	Energy
Boscia coriacea	Leaves	12.38	35.75	11.00	19.25	21.62	4.19
	Stems	15.37	51.77	4.72	8.66	19.48	4.20
Duosperma eremophilum	Whole	7.13	35.41	6.88	21.69	28.89	3.55
Indigofera spinosa	Whole	9.48	43.94	4.99	13.73	27.86	4.69
Leptothrium senegalense	Whole	12.37	45.72	4.87	5.56	31.48	4.20
Maerua crassifolia	Leaves	16.27	10.22	8.32	27.71	37.48	3.29
	Stems	11.53	52.08	6.04	6.17	24.18	4.51
Salvadora persica	Leaves	10.90	13.32	5.46	32.79	37.53	2.82
	Stems	16.03	37.37	4.61	18.10	23.89	3.53

1. All figures are percentages of dry matter except energy which is in Kcal/g dry matter.

modern techniques designed to optimize both production and the conservation of the rangelands. An important aspect of this study is the assessment of food requirements of the pastoralists and the efficiency of existing management regimes in producing sufficient food for the needs of the people.

Historical perspectives and human ecology

It is evident that some of the more indirect causes of ecological and sociological decline in northern Kenya are to be found in the many aspects of traditional land tenure, in social organization, long-standing tribal customs, interactions between tribes, and many others which might impinge on the ways in which the pastoralists exploit their environment. Changes in traditional life in response to the impact of modern trends in government, trade, education, medical aid, missionary influence and the provision of famine-relief food must also be taken into account. In order to obtain the greatest possible understanding of the various societies living in the region, a study of its history has been undertaken. Evidence from archaeology, historical records, oral tradition and the recollections of living members of the pastoral tribes has been drawn together to present an account of the last 2,000 years of human occupation of the region and, as far as possible, the changes in distribution of the different ethnic groups and their causes.

In the analysis of modern trends and their influence, IPAL is adopting an approach which will combine the methods of social anthropology with those of the ecologist. A programme of studies of human ecology in its broadest sense is planned for the immediate future with the object of relating the human populations and their institutions and interactions to their use of essential resources. It is hoped that the results of this study will provide material relevant to the search for feasible alternatives in the economy of the region.

IPAL finds itself in constant close contact with the indigenous people of the region. The value of this contact to the project cannot be over-emphasized. By gaining the confidence and the friendship of Gabra and Rendille peoples it has been possible to obtain essential information on their societies, their animal husbandry, their opinions on the problems of gaining a livelihood from marginal lands and on their own impact upon the vegetation, among many other subjects. At the same time there has been co-operation in the establishment of fenced experimental plots in villages for demonstrating the protection and controlled use of vegetation and the planting of trees. A small team of public-relations assistants recruited from among the Gabra and the Rendille people, after receiving instruction from the project staff, has been working among the pastoralists, primarily to explain the purposes of IPAL and also to obtain information.

Training and demonstration

In addition to its activities in the field of research and monitoring, IPAL has the important functions of demonstration and of training and orientation in management techniques.

At the local and national levels, the project has been integrated into the Kenyan Government's development plans for the north of the country. Members of the IPAL staff attend periodic meetings of the Marsabit District Development Committee and the District Commissioner has entrusted to the project certain supervisory duties in connection with conservation of natural resources.

On the basis of experience gained by the project staff, and taking advantage of the logistic base for field-work that has been established, a series of training activities will be carried out during the remaining years of operation of the project in Kenya. Following the appointment of a full-time training officer, it is anticipated that training and orientation courses at several levels will be given at the Mount Kulal field station and in the IPAL working area. The courses will include instruction by the staff in all aspects of the project's work, especially in observation techniques, lectures and demonstrations in arid-zone ecology and range management, arid-zone forestry and nomad sociology. The facilities and experience of IPAL are also being made available to visiting scientists and extension officials from other countries in the region, especially those in which IPAL might be established in the future.

Study grants are being used to enable trainees to be attached to the project; one such trainee is undertaking a study on the ectoparasites of camels, as part of his post-graduate programme within the Department of Zoology of the University of Nairobi. Concrete co-operative links are being built up with other departments of the university; e.g. the Department of Animal Production is playing a key role in a component study on the digestibility and nutritive value of browsing plants.

Prospects

In the course of the next three years of work in Kenya, IPAL should be strengthened by the addition of several investigations relating to their main stream of applied

research on human and animal impact on the vegetation and soils and the search for solutions to the problem of ecological degradation. Among these investigations will be studies on soil types, on the dynamics of the herb layer in response to grazing, on hydrology and geomorphology. This last inquiry will be centred mainly on soil erosion and soil deposition under the influence of heavy exploitation by livestock.

As regards project personnel, the present team of scientists within IPAL will shortly be reinforced by the attachment to the project of at least four extension and research officers, seconded from various departments of the Kenyan Government and working in the fields of forestry, range management, hydrology and social sciences. It is also hoped that specialists in the fields of soil survey and plant ecology will join the project through the Unesco Associate Expert scheme.

As a result of the work undertaken within the framework of IPAL, it is hoped to provide guidelines for improved management of the resources of arid lands in northern Kenya and in other regions sharing similar ecological conditions and socio-economic problems. At first sight it is extremely difficult to foresee what alternative forms of land use might be introduced to diversify the present economy based entirely on livestock. As a first approach there appears to be the possibility of developing arid-zone forestry, using drought-adapted tree species to provide firewood and building materials. IPAL has forestry trials in progress which it is hoped will indicate techniques and suitable species. One line of investigation which will be followed is the harvesting of gum arabic from *Acacia senegal* trees which are indigenous to the region and from plantations to be introduced in the next ten-year period under trial. The success of a forestry programme will depend very greatly on adequate rainfall in the next ten years. There are some hopes that, having experienced a drought of eight years ending in 1977, a wet phase is beginning. With the assistance of favourable weather, an arid-zone forestry programme has a chance of succeeding.

In conclusion, its must be emphasized that IPAL is, by its very nature, a pilot project of ecological research, training and demonstration. It has the task of promoting activities related to rehabilitation of the arid zone, rather than undertaking those activities itself. However, it is hoped that the useful insights and indications obtained by IPAL will be implemented on a practical scale in due course, and that the experience gained within the project can be disseminated adequately through training, publication and demonstration in the many countries where similar situations occur.

